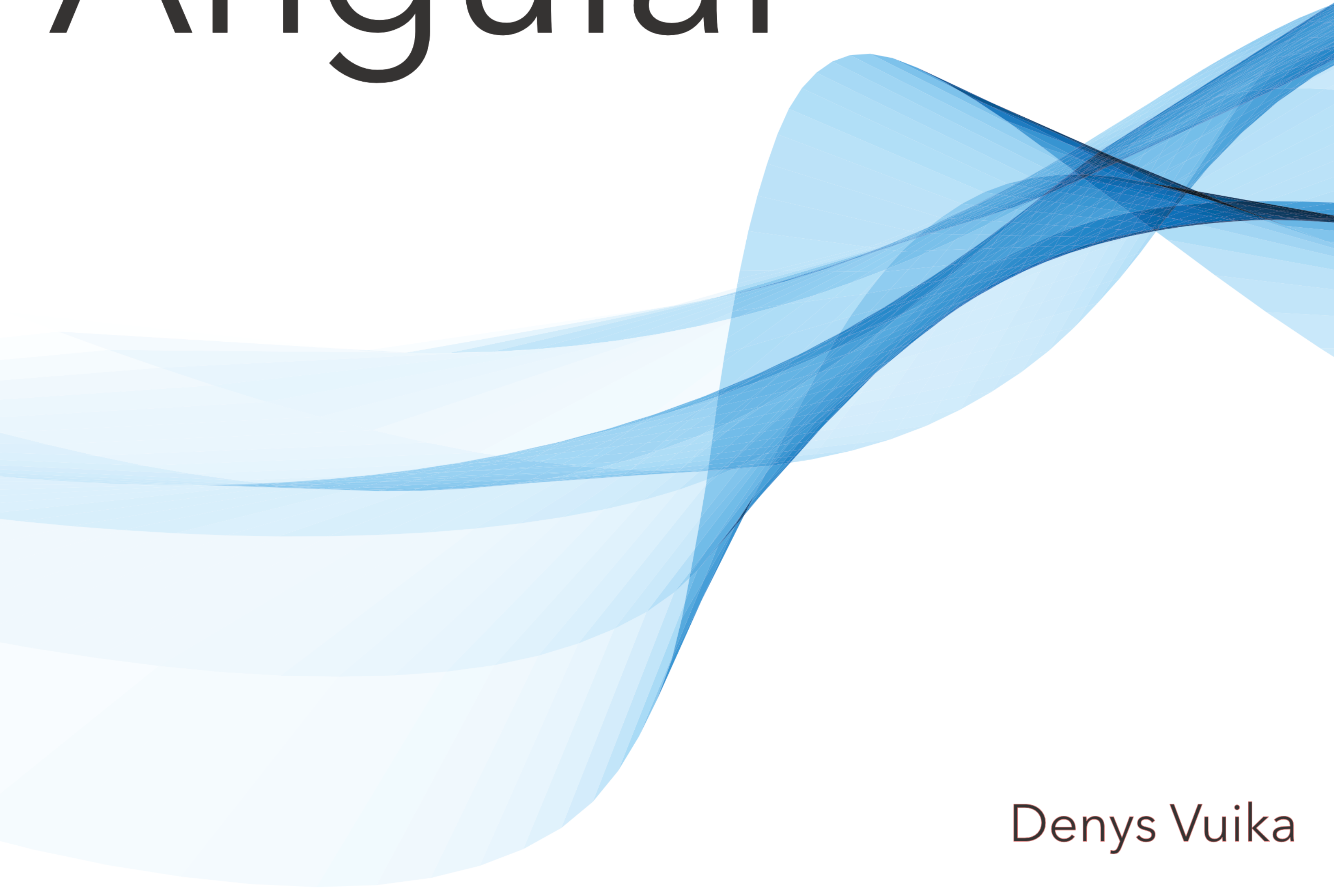
developing with

Angular



Denys Vuika

Developing with Angular

Denys Vuika

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#developing-with-angular

To my dear wife, Iuliia, who always inspires me and supports me in anything I try.

Contents

Introduction

This author of this book follows Lean Publishing[1] principles, and the book evolves with readers' feedback.

In the first few chapters, we are going to dwell on the basics you may need to understand Angular development better later on.

We are going to start with the main ES6 (ECMAScript 2015) features you should come across frequently when using TypeScript.

Next, the most remarkable TypeScript features you should get familiar before starting the Angular development.

After that, we are covering the Angular framework and supplemental toolings, like Angular CLI (Command Line Interface) and Webpack.

Finally, you should expect many practical topics that are addressing specific application requirements and scenarios, including those coming from the community requests.

Book Revision

Revision 16 (2018-10-23)

- Upgrade all examples to Angular 7 and Angular CLI 7
- Update chapters to use Angular 7 examples
- Setup Travis CI and unit testing for all example projects
- Setup Prettier and provide better code formatting for example projects
- Minor text polishing and link fixes

Revision 15 (2018-06-03)

- Updated: ngOnDestroy
- New Listening for View and Content changes

Book progress

You can see the progress of the writing on this GitHub board[2]. Be sure to check the board if you want to see what's coming next or what is in progress right now.

[1]https://leanpub.com/manifesto
[2]https://github.com/DenysVuika/developing-with-angular/projects/1

Code examples

You can find all code examples in this GitHub repository: developing-with-angular[3]. The source code gets frequently revisited and updated.

Feedback, Bug Reports and Suggestions

If you have noticed a typo in the text or a bug in the code examples, please don't hesitate and contact me using the next email address: denys.vuika@gmail.com[4]

You are also invited to raise issues for the source code and examples using corresponding issue tracker[5] at GitHub.

Feel free to raise feature requests and suggestions on what you would like to see next.

Other publications

You can find many other interesting publications at my Medium channel[6].

Testimonials

Your feedback on the book content is very appreciated. I would love to publish your photo and testimonial on the web page of the book. Email me at: denys.vuika@gmail.com[7].

[3]https://github.com/DenysVuika/developing-with-angular
[4]mailto:denys.vuika@gmail.com?subject=developing-with-angular%20feedback
[5]https://github.com/DenysVuika/developing-with-angular/issues
[6]https://medium.com/@DenysVuika/
[7]mailto:denys.vuika@gmail.com?subject=developing-with-angular%20testimonial

Prerequisites

Node

> Node.js is a JavaScript runtime built on Chrome's V8 JavaScript engine[8]. Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient. Node.js' package ecosystem, npm[9], is the largest ecosystem of open source libraries in the world.

Navigate to the main page[10], download installer for your platform and follow setup instructions.

You can use the following commands to test currnet versions of the Node and NPM on your machine:

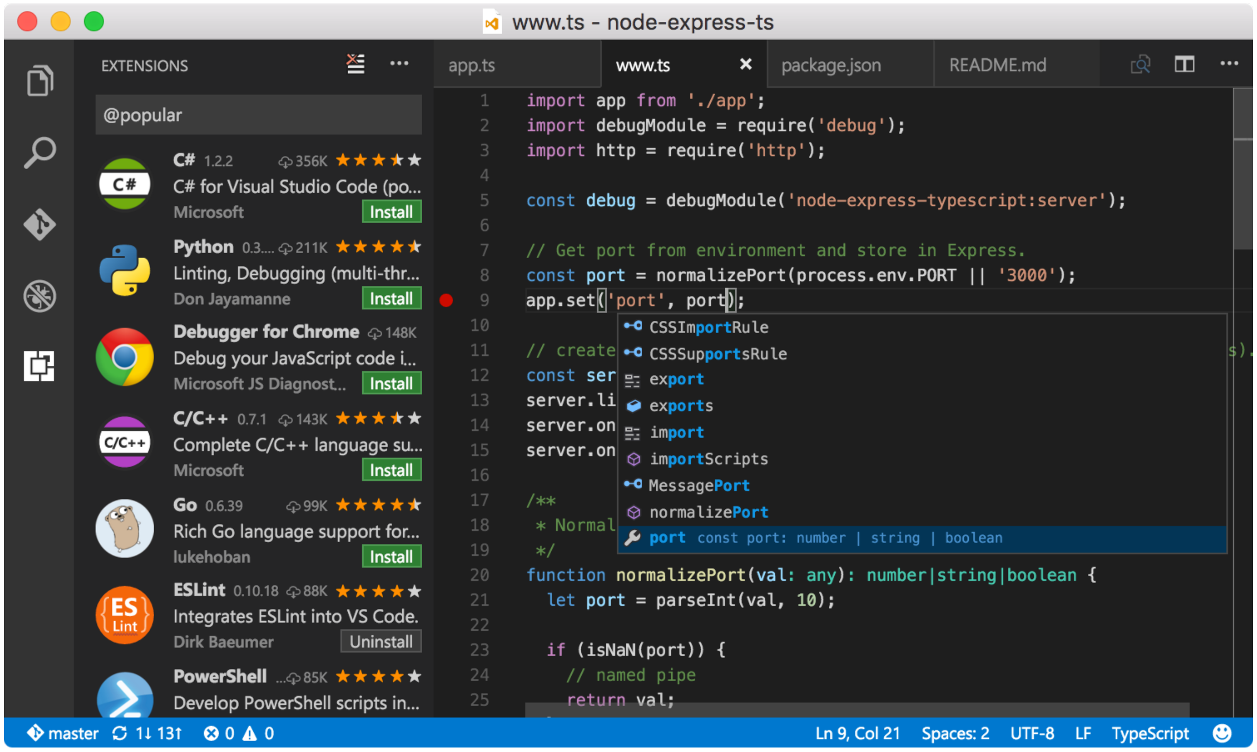
```
node -v
# v8.4.0

npm -v
# 5.0.4
```

Please note that the actual versions may differ.

Visual Studio Code

> Visual Studio Code is a source code editor developed by Microsoft for Windows, Linux and macOS. It includes support for debugging, embedded Git control, syntax highlighting, intelligent code completion, snippets, and code refactoring.

[8]https://developers.google.com/v8/
[9]https://www.npmjs.com/
[10]https://nodejs.org/en/



C# 1.2.2 356K
C# for Visual Studio Code (po...
Microsoft Install

Python 0.3.... 211K
Linting, Debugging (multi-thr...
Don Jayamanne Install

Debugger for Chrome 148K
Debug your JavaScript code i...
Microsoft JS Diagnost... Install

C/C++ 0.7.1 143K
Complete C/C++ language su...
Microsoft Install

Go 0.6.39 99K
Rich Go language support for...
lukehoban Install

ESLint 0.10.18 88K
Integrates ESLint into VS Code.
Dirk Baeumer Uninstall

PowerShell ... 85K
Develop PowerShell scripts in...

```
import app from './app';
import debugModule = require('debug');
import http = require('http');

const debug = debugModule('node-express-typescript:server');

// Get port from environment and store in Express.
const port = normalizePort(process.env.PORT || '3000');
app.set('port', port);

// create
const ser
server.li
server.on
server.on

/**
 * Normal
 */
function normalizePort(val: any): number|string|boolean {
  let port = parseInt(val, 10);

  if (isNaN(port)) {
    // named pipe
    return val;
```

vs code

Recommended extensions

TSLint[11]

Integrates the tslint linter for the TypeScript language into VS Code.

Launch VS Code Quick Open (âŒ˜+P), paste the following command, and press enter.

```
ext install tslint
```

ESLint[12]

Integrates ESLint into VS Code. See project page[13] for more details.

```
ext install vscode-eslint
```

EditorConfig[14]

EditorConfig Support for Visual Studio Code

[11]https://marketplace.visualstudio.com/items?itemName=eg2.tslint
[12]https://marketplace.visualstudio.com/items?itemName=dbaeumer.vscode-eslint
[13]https://marketplace.visualstudio.com/items?itemName=dbaeumer.vscode-eslint
[14]https://marketplace.visualstudio.com/items?itemName=EditorConfig.EditorConfig

```
ext install EditorConfig
```

Hiding files

This step is optional. In the code go to the `Preferences -> Workspace Settings` and paste the following settings into the opened file:

```
{
    "files.exclude": {
        "**/.git": true,
        "**/.DS_Store": true
    }
}
```

You can extend the list with the files, extensions or directories based on your preferences.

ES6

ECMAScript 2015 (also known as ES6 and often referred to as `Harmony`) is the 6th major release of the ECMAScript language specification. I am going to cover the most important features here to get you started with ES6 and then be able moving to TypeScript and Angular faster.

Classes

The `class` syntax in JavaScript is not a new object-oriented inheritance model but simply a syntactical sugar on top of the existing prototype-based inheritance. Traditionally we have been using standard Objects and Prototypes like shown below:

```
var Widget = function(id, x, y) {
    this.id = id;
    this.setPosition(x, y);
}
Widget.prototype.setPosition = function(x, y) {
    this.x = x;
    this.y = y;
}
```

With class syntax developers get more natural and boilerplate-free result:

```
class Widget {
    constructor(id, x, y) {
        this.id = id;
        this.setPosition(x, y);
    }

    setPosition(x, y) {
        this.x = x;
        this.y = y;
    }
}
```

The `constructor` function is automatically called when you create a new instance of `Widget`:

```
let myWidget = new Widget(1, 10, 20);
```

Inheritance

The `extends` keyword is used to define a class as a child of another class. The following example demonstrates inheritance in practice:

```
class TextBox extends Widget {
    constructor (id, x, y, text) {
        super(id, x, y);
        this.text = text;
    }
}
```

We created a new `TextBox` class that is based on the `Widget` and adds additional `text` property. Note that a base Widget constructor must also be called when a child class instantiated. It must be the very first line of the child constructor implementation.

Here's another example:

```
class ImageBox extends Widget {
    constructor (id, x, y, width, height) {
        super(id, x, y);
        this.setSize(width, height);
    }

    setSize(width, height) {
        this.width = width;
        this.height = height;
    }

    reset() {
        this.setPosition(0, 0);
        this.setSize(0, 0);
    }
}
```

`ImageBox` also inherits `Widget` class and adds size-related information alongside position. Access to both classes is demonstrated with the `reset` function that calls `Widget.setPosition` and `ImageBox.setSize` functions.

Arrow Functions

ES6 offers a shorter syntax for a **function expression** called **arrow function**, also known as **fat arrow function**. Arrow functions provide more expressive closure syntax, simplify function scoping and change the way `this` is handled.

Expression Bodies

When used as expressions bodies arrow functions work much like anonymous one-line **lambdas** that you can meet in many programming languages. Let's filter a book collection to find something to read using both ES5 and ES6 to see the difference:

```
var books = [
    { name: 'Book 1', read: true },
    { name: 'Book 2' , read: false },
    { name: 'Book 3', read: true }
];

// ES5
var booksToRead = books.filter(function (b) { return !b.read });

// ES6
var booksToRead = books.filter(b => !b.read);
```

Curly brackets and `return` statement are not required if only one expression is present. You could write the same example like following:

```
// ES6
let booksToRead = books.filter(b => { return !b.read; });
```

Statement Bodies

Arrow functions provide more expressive closure syntax.

```
// ES6
// list the books I've read
books.forEach(b => {
    if (book.read) {
        console.log(b.name);
    }
});
```

And another example using DOM:

```
// ES6
let button = document.getElementById('submit-button');
button.addEventListener('click' () => {
    this.onButtonClicked();
});
```

Parameterless arrow functions are much easier to read

```
// ES6
setTimeout(_ => {
    console.log('First callback');
    setTimeout(_ => {
        console.log('Second callback');
    }, 1);
}, 1);
```

Lexical *this*

One of the best features of arrow functions in ES6 is the more intuitive handling of current object context. These function expressions do not bind their variables:

- arguments
- super
- this
- new.target

```
// ES6
this.books.forEach(b => {
    if (!b.read) {
        this.booksToRead.push(b);
    }
});
```

There are multiple ways of doing the same with ECMAScript 5, and all of them involve manual context management

```
// ES5: using 'bind()'
this.books.forEach(function(b) {
    if (!b.read) {
        this.booksToRead.push(b);
    }
}).bind(this);

// ES5: referencing 'this' via variables
var self = this;
this.books.forEach(function(b) {
    if (!b.read) {
        self.booksToRead.push(b);
    }
});

// ES5: passing context if supported
this.books.forEach(function(b) {
    if (!b.read) {
        this.booksToRead.push(b);
    }
}, this);
```

As arrow functions do not create and bind their own `this` context the following code is concise and works as expected:

```
// ES6
function ProgressBar() {
    this.progress = 0;

    setInterval(() => {
        this.progress++;
    }, 1000);
}

let p = new ProgressBar();
```

In the example above `this` properly refers to the `ProgressBar` object. Before ES6 you would most probably additional variables like `self`, `that`, and other.

```
// ES5
function ProgressBar() {
    var self = this;
    self.progress = 0;

    setInterval(function () {
        self.progress++;
    }, 1000);
}
```

Template Literals

Template Literals (formerly called "template strings" in prior drafts of the ECMAScript 6 language specification) are string literals providing intuitive expression interpolation for single-line and multiline strings.

You use backticks to enclose a string literal and ${} to interpolate JavaScript variables or arbitrary expressions

```
// ES6
let point = { x: 10, y: 20 };
console.log(`Position is ${point.x}:${point.y}`);
// output: Position is 10:10
```

With ES5 you have to concatenate strings when dealing with multiple lines:

```
// ES5
var title = 'Title'
var component = {
    template: '' +
        '<h1>' + title + '<h1>\n' +
        '<div class="grid">\n' +
        '    <div class="col-6"></div>\n' +
        '    <div class="col-6"></div>\n' +
        '</div>'
}
```

Multi-line string creation with template literals becomes very clean and readable:

```
// ES6
let title = 'Title';
let component = {
    template: `
        <h1>${title}</h1>
        <div class="grid">
            <div class="col-6"></div>
            <div class="col-6></div>
        </div>
    `
}
```

Extended Parameter Handling

ES6 brings improvements to parameter handling by introducing `default values`, `rest parameter` and `spread operator`.

Default Parameter Values

Simple and intuitive default values for function parameters.

```
// ES6
function playSound(file, volume = 50) {
    console.log(`Playing '${file}' with volume ${volume}.`);
}
playSound('test.mp3');
// Playing 'test.mp3' with volume 50.

playSound('test.mp3', 70);
// Playing 'test.mp3' with volume 70.
```

With ES5 you have to check every parameter to be `undefined` and setting defaults manually if needed.

```
// ES5
function playSound(file, volume) {
    if (volume === undefined) {
        volume = 50;
    }
    console.log("Playing '" + file + "' with volume " + volume);
}
playSound('test.mp3');
// Playing 'test.mp3' with volume 50.

playSound('test.mp3', 70);
// Playing 'test.mp3' with volume 70.
```

So support for `default parameter values` is a huge step forward and real time saver.

Rest Parameter

In ES5, if you want your function to handle an indefinite or an arbitrary number of arguments, you must use special `arguments` variable:

```
// ES5
function logMessages() {
    for (var i = 0; i < arguments.length; i++) {
        console.log(arguments[i]);
    }
}

logMessages('Hello,', 'world!');
```

Which produces:

```
Hello,
world!
```

In ES6, you can aggregate all remaining arguments into a single function parameter

```
// ES6
function logMessages(...messages) {
    for (const message of messages) {
        console.log(message);
    }
}

logMessages('Hello,', 'world!');
```

Also, that gives the same console output as before:

```
Hello,
world!
```

Rest parameters become even more valuable when you need collecting arguments starting from a different position. In the next example, the rest parameter is used to collect arguments from the second one to the end of the array.

```
// ES6
function greet(message, ...friends) {
    for (const friend of friends) {
        console.log(`${message}, ${friend}!`);
    }
}

greet('Hello', 'John', 'Joan', 'Bob')
```

The function above allows you to set the greeting message as the first parameter and array of friend names to generate messages. The console output, in this case, should be:

```
Hello, John!
Hello, Joan!
Hello, Bob!
```

Spread Operator

Spread operator is used to expand an iterable collection into multiple arguments.

```
// ES6
let positive = [ 1, 2, 3 ];
let negative = [ -1, -2, -3 ]

let numbers = [...negative, 0, ...positive];

console.log(numbers);
// [-1, -2, -3, 0, 1, 2, 3]
```

You can use spread operator even with strings:

```
// ES6
let message = 'Hello, world';
let chars = [...message];

console.log(chars);
// ["H", "e", "l", "l", "o", ",", " ", "w", "o", "r", "l", "d"]
```

Spread operator easily becomes an alternative to the `Array.prototype.concat()` method. With ES5 the example above will look like the following:

```
// ES5
var positive = [ 1, 2, 3 ];
var negative = [ -1, -2, -3 ];
var zero = [0];

var numbers = negative.concat(zero, positive);

console.log(numbers);
// [-1, -2, -3, 0, 1, 2, 3]
```

Destructuring assignment

ES6 provides a way to extract values out of the objects or collections into the separate variables to access them easier in the code. That is often called "value unpacking" or "destructuring".

Basic example

As an example, you can extract a subset of values from the collection using the following format:

```
let [ <var1>, <var2> ] = <array>
```

Let's create an array of words and extract the first couple of them into separate variables "first" and "second" like in the code below:

```
// ES6

let words = [ 'this', 'is', 'hello', 'world', 'example' ];
let [ first, second ] = words;

console.log(first);  // 'this'
console.log(second); // 'is'
```

As you can see from the example above, you can extract a subset of an array and split it into multiple variables. Without destructuring your code might look like the following:

```
// ES5

var words = [ 'this', 'is', 'hello', 'world', 'example' ];
var first = words[0];
var second = words[1];

console.log(first);  // 'this'
console.log(second); // 'is'
```

Array destructuring

You have already seen some of the array destructuring examples earlier in the section. We enclose variables in square brackets using the following syntax:

```
let [ <var1>, <var2> ] = <array>
```

Please note that you can also apply the same destructuring technique to the function call results:

```
// ES6

function getWords() {
    return [ 'this', 'is', 'hello', 'world', 'example' ];
}

let [ first, second ] = getWords();
console.log(`${first} ${second}`); // 'this is'
```

In addition to basic unpacking and variable assignment, several other things bring much value and reduce the code.

Value assignment

The destructuring syntax can be used to assign values to variables instead of extracting them. Take a look at the following example:

```
// ES6

let first, second;

[ first, second ] = [ 'hello', 'world' ];

console.log(first);  // 'hello'
console.log(second); // 'world'
```

Default values

Another great feature of the array destructuring is default values. There might be cases when the array has no values, and you want to provide some reasonable defaults.

The format of the syntax, in this case, is as follows:

```
let [ <variable> = <value> ] = <array>
```

Let's see this feature in action:

```
// ES6

let words = [ 'hello' ];
let [ first = 'hey', second = 'there' ] = words;

console.log(first);  // 'hello'
console.log(second); // 'there'
```

The array we got initially does not contain two words. We are trying to extract first two variables from it, and set 'hey' as the default value for the first word, and 'there' as a default for the second one. At the runtime however only second variable stays with the default value.

Default value assignment is a compelling feature that helps you reduce the code for variable initialization and safety checks. Below is how the same code could look like in ES5:

```
// ES5

var words = ['hello'];

var first = words[0];
if (!first) {
    first = 'hey';
}

var second = words[1];
if (!second) {
    second = 'there'
}

console.log(first);  // 'hello'
console.log(second); // 'there'
```

Swapping values

Traditionally to swap two variables, developers need a third temporary one to hold the value of either first or second variable.

```
// ES5

var first = 'world';
var second = 'hello';

var temp = first;
first = second;
second = temp;

console.log(first + ' ' + second); // 'hello world'
```

With ES6 you can now reduce the code by using destructuring assignment syntax to swap variables in a single line like in the next example:

```
// ES6

let first = 'world';
let second = 'hello';

[ first, second ] = [ second, first ];

console.log(`${first} ${second}`); // 'hello world'
```

This feature may be a great time saver when it comes to sorting functions.

Skipping values

We have been using examples that take the beginning of the array so far.
The ES6 does not restrict you to that only scenario; it is also possible skipping values when unpacking or destructuring arrays.

```
let [ <variable-1>, , , , <variable-X> ] = <array>
```

You can just put the commas instead of variables like in the example below:

```
let words = [ 'this', 'is', 'hello', 'world', 'example' ];
let [ first, second, , , last ] = words;

console.log(`${first} ${second} ${last}`); // 'this is example'
```

Grouping tail values into a single variable

As you see, the ES6 allows you to unpack the head of the array into separate variables. Sometimes you may want to access the tail of the array as a single variable as well.

For this particular case, there's a special syntax that utilises ES6 "rest" parameters.

```
let [ <variable1>, <variable2>, ...<restVariable> ] = <array>
```

We use "rest parameter" to define a variable to hold the tail of the array and below is an example of how to achieve this behaviour:

```
let command = [ 'greet', 'user1', 'user2', 'user3' ];
let [ action, ...users ] = command;

console.log(action); // 'greet'
console.log(users);  // [ 'user1', 'user2', 'user3' ]
```

Object destructuring

Besides arrays and collections, you can use destructuring assignment syntax with the object instances as well.

We enclose variables in curly brackets using the following syntax:

```
let { <var1>, <var2> } = <object>
```

Unpacking properties

ES6 allows you to extract properties by their names similar to how to unpack arrays.

Let's try to unpack a couple of properties from a user object:

```
let obj = {
    id: 1,
    username: 'jdoe',
    firstName: 'John',
    lastName: 'Doe'
};

let { id, username } = obj;

console.log(id);        // '1'
console.log(username);  // 'jdoe'
```

Renaming properties

You can also give destructured property an alias if you want to use it as a variable with a different name.

The syntax, in this case, is going to be as follows:

```
let { <property> : <alias> } = <object>;
```

Let’s now rewrite our previous example to use custom property names.

```
let obj = {
    id: 1,
    username: 'jdoe',
    firstName: 'John',
    lastName: 'Doe'
};

let { id: uid, username: login } = obj;

console.log(uid);    // '1'
console.log(login);  // 'jdoe'
```

We are using “uid” and “login” instead of “id” and “username” properties this time.

Default values

When applying property destructuring to the object properties, you can provide default values for missing properties. That saves time for property checks and reduces coding efforts.

```
let { <variable> : <value> } = <object>
```

For example, let’s provide a default value for the “id” property and also unpack the property “role” that that does not exist for the given object, and set it to be “guest” by default.

```
let obj = {
    id: 1,
    username: 'jdoe',
    firstName: 'John',
    lastName: 'Doe'
};

let { id = 0, role = 'guest' } = obj;

console.log(id);    // '1'
console.log(role);  // 'guest'
```

Unpacking methods

You can extract object methods into separate variables and use them as shortcuts:

```
let { log } = console;
log('hello world');
```

The example above demonstrates a “console.log” method being extracted into the “log” variable and used separately.

We utilise the following syntax:

```
let { <method> } = <object>
```

Next, let’s create a custom class and export multiple methods:

```
// ES6

class MyClass {

    sayHello(message) {
        console.log(`Hello, ${message}`);
    }

    sayBye(message) {
        console.log(`Bye, ${message}`);
    }

}

let myClass = new MyClass();
let { sayHello, sayBye } = myClass;

sayHello('how are you?');  // 'Hello, how are you?'
sayBye('see you soon.');   // 'Bye, see you soon'
```

Renaming methods

You can also rename destructured methods if needed. The following syntax should be used to give the unpacked method a custom name:

```
let { <method> : <alias> } = <object>
```

Let’s update the “MyClass” we used earlier and rename “sayHello” and “sayBye” methods to just “hello” and “bye”:

```
let myClass = new MyClass();
let { sayHello: hello, sayBye: bye } = myClass;

hello('how are you?');  // Hello, how are you?
bye('see you soon');    // Bye, see you soon
```

Using with function parameters

The best scenario for using destructuring with objects and functions is default parameter values and options.

First, let’s reproduce the most common use case for the “options” parameter passed to a function or object member:

```
// ES5

function showDialog(options) {
    options = options || {};
    var message = options.message || 'Unknown message';
    var size = options.size || { width: 400, height: 400 };
    var position = options.position || { x: 200, y: 300 };

    console.log('message: ' + message);
    console.log('size: ' + size.width + ':' + size.height);
    console.log('position: ' + position.x + ':' + position.y);
}
```

Above is the simplified version of the custom options management that has been very popular for years. We provide a JavaScript object as an “options” parameter, and function does parsing and detecting missing properties to initialize default values if needed.

Depending on the size of the options object there might be many checks just to set the default values for them. Especially if there are nested objects with own properties, like “size” and “position” in our case.

Now, if you call the “showDialog” function with no parameters except the “message” value, the output should be similar to the following one:

```
showDialog({
    message: 'hello world'
});

// message: hello world
// size: 400:400
// position: 200:300
```

Next, try to call the same function with a partial set of options, for instance, the “size” settings:

```
showDialog({
    message: 'hey there',
    size: { width: 200, height: 100 }
});

// message: hey there
// size: 200:100
// position: 200:300
```

Now you can rewrite the “showDialog” implementation to use destructuring with default values like in the next example:

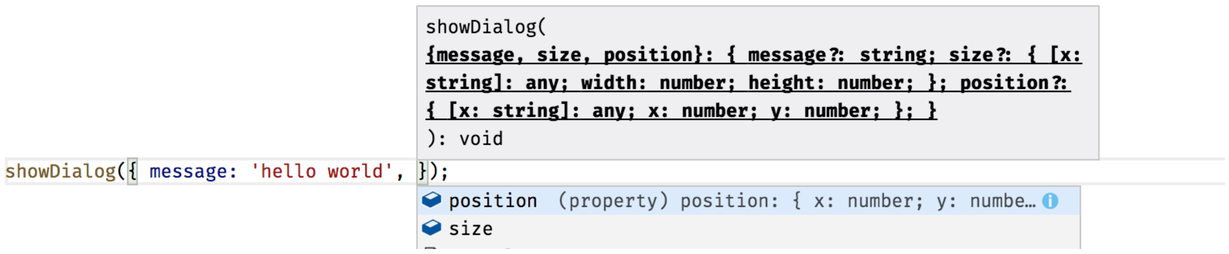
```
// ES6

function showDialog({
    message = 'Message',
    size = { width: 400, height: 400 },
    position = { x: 200, y: 300 } }) {

    console.log(`message: ${message}`);
    console.log(`size: ${size.width}:${size.height}`);
    console.log(`position: ${position.x}:${position.y}`);
}
```

Notice how we use the destructuring assignment syntax to declare a function parameter.

```
showDialog({
    message: 'hey there',
    size: { width: 200, height: 100 }
});

// message: hey there
// size: 200:100
// position: 200:300
```

IDE support

Many modern IDEs already provide support for destructuring syntax within function or method parameters. VS Code[15], for instance, provides auto-completion both for function calls and for nested properties.



```
showDialog(
{message, size, position}: { message?: string; size?: { [x: string]: any; width: number; height: number; }; position?: { [x: string]: any; x: number; y: number; }; }
): void
showDialog({ message: 'hello world', });
position  (property) position: { x: number; y: numbe…
size
```

Modules

Before ES6 developers traditionally were using `Revealing Module` pattern to emulate modules in JavaScript. The basic concept of a Revealing Module is that you use `closures` (self-invoking functions) with an `Object` which encapsulates its data and behaviour.

```
// ES5
var Module = (function() {
    var privateMethod = function() {
        // do something
        console.log('private method called');
    };

    return {
        x: 10,
        name: 'some name',
        publicMethod: function() {
```

[15]https://code.visualstudio.com/

```
            // do something
            console.log('public method called');
            privateMethod();
        }
    };
})();

Module.publicMethod()
```

You should get the following output to browser console:

```
public method called
private method called
```

I recommend also reading an excellent article "Mastering the Module Pattern[16]" by Todd Motto to get deep coverage of **Revealing Module** pattern in JavaScript.

The rise of module systems based on either AMD or CommonJS syntax has mostly replaced revealing modules and other hand-written solutions in ES5.

Exporting and Importing Values

ECMAScript 6 provides a long-needed support for exporting and importing values from/to modules without global namespace pollution.

```
// ES6

// module lib/logger.js
export function log (message) { console.log(message); };
export var defaultErrorMessage = 'Aw, Snap!';

//  myApp.js
import * as logger from "lib/logger";
logger.log(logger.defaultErrorMessage);

//  anotherApp.js
import { log, defaultErrorMessage } from "lib/logger";
log(defaultErrorMessage);
```

Here's how the same approach would look like if written with ECMAScript 5:

[16]https://toddmotto.com/mastering-the-module-pattern/

```
// ES5

// lib/logger.js
LoggerLib = {};
LoggerLib.log = function(message) { console.log(message); };
LoggerLib.defaultErrorMessage = 'Aw, Snap!';

// myApp.js
var logger = LoggerLib;
logger.log(logger.defaultErrorMessage);

// anotherApp.js
var log = LoggerLib.log;
var defaultErrorMessage = LoggerLib.defaultErrorMessage;
log(defaultErrorMessage);
```

Default Values

You can make your ES6 module exporting some value as `default` one.

```
// ES6

// lib/logger.js
export default (message) => console.log(message);

// app.js
import output from 'lib/logger';
output('hello world');
```

Wildcard Export

Another great feature of ES6 modules is support for wildcard-based export of values. That becomes handy if you are creating a composite module that re-exports values from other modules.

```
// ES6

// lib/complex-module.js
export * from 'lib/logger';
export * from 'lib/http';
export * from 'lib/utils';

// app.js
import { logger, httpClient, stringUtils } from 'lib/complex-module';
logger.log('hello from logger');
```

See also

- ECMAScript 6 â€” New Features: Overview & Comparison[17]

[17] http://es6-features.org/

TypeScript

TypeScript is a typed superset of JavaScript that compiles to plain JavaScript.

```
npm install -g typescript
```

Getting Started with TypeScript

Installing TypeScript

```
npm install -g typescript
```

Using tsc

In your code editor create a file `logger.ts` with the following content:

```
function log(message) {
    console.log(message);
}

log('Hello, world!');
```

Now you can use a command line to compile your source code to ES5 with `tsc` tool and run it with `node.js`:

```
tsc logger.ts
node logger.js
```

TypeScript compiler takes `logger.ts` file, processes it and produces a JavaScript output to `logger.js`. At this point, the `.js` file is ready to be used with an HTML page or executed by node.js.

You should see the following output in the command line:

```
Hello, world!
```

Now let's see how type validation works. Add `string` type annotation for the `log` function and call it with a `number`.

```
function log(message: string) {
    console.log(message);
}

log(0);
```

If you compile `logger.ts` once again `tsc` should produce an error:

```
tsc logger.ts
> logger.ts(5,5): error TS2345: Argument of type '0' is not assignable to parameter
of type 'string'.
```

Typings

TBD

Linting

TBD

tslint

> TSLint checks your TypeScript code for readability, maintainability, and functionality errors.

```
npm install -g tslint
```

TBD

TypeScript Features

TBD

Types

TypeScript supports all the types used in JavaScript:

- **boolean**
- **number**
- **string**
- **arrays**

TypeScript also adds the following types:

- **enum**
- **any**
- **void**

Basic Types

Boolean

> The most basic datatype is the simple true/false value, which JavaScript and TypeScript call a boolean value.

```
let isEnabled: boolean = true;
```

Assigning non-Boolean value to the variable will produce an error.

```
isEnabled = 'YES';
// logger.ts(2,1): error TS2322: Type '"YES"' is not assignable to type 'boolean'.
```

It is also possible annotating function or method return types.

```
function isEmpty(str: string): boolean {
    return !str;
}
```

Number

TypeScript maps all JavaScript numbers to the `number` type:

- floating point numbers (default JavaScript type for all numbers)
- decimal numbers
- hexadecimal numbers
- binary literals (ES6)
- octal literals (ES6)

Here's an example:

```
let decimal: number = 6;
let hex: number = 0xf00d;
let binary: number = 0b1010;
let octal: number = 0o744;
```

String

Typescript supports ES6 **template literals** (formerly known as **template strings**). As in ECMAScript 6, you use backticks (`) to enclose a string literal and **${}** to interpolate JavaScript variables or arbitrary expressions. Either double quotes (“) or single quotes (‘) can be used to surround string data.

```
let firstName: string = "Joan";
let lastName: string = 'Doe';
let fullName: string = `${firstName} ${lastName}`;
let template: string = `
    <h1>Title<h1>
    <p>Hello, ${fullName}</p>
`;
```

Arrays

There are two main ways you can provide type definition for arrays of values in TypeScript:

```
let arr1: string[] = [];
let arr2: Array<string> = new Array();
```

You can also initialize arrays upon declaring them:

```
let arr1: string[] = ['hello', 'world'];
let arr2: Array<string> = ['hello', 'world'];

let flags1: boolean[] = [true, false, true, false];
let flags2: boolean[] = new Array(false, true);
```

As in JavaScript arrays, you can **push** elements and access them by **index**

```
let users: string[] = [];
users.push('user1');
console.log(`First user: ${users[0]}`);
```

The sample above demonstrates array element access together with string interpolation. When executed it should produce:

```
First user: user1
```

Enum

TypeScript provides support for an **enumerated type** known in many languages (Swift, C#, Java, C, and others). This data type consists of a set of named values mapped to numbers.

```
enum Suit { Club, Diamond, Heart, Spade };
let s: Suit = Suit.Spade;
```

By default numbering of enum members starts with 0 and increments by one. You have full control of the values if needed.

```
enum Suit { Club = 1, Diamond, Heart, Spade };
enum Suit { Club = 1, Diamond = 2, Heart = 4, Spade = 8 }
```

Another valuable feature is accessing by a numeric value.

```
enum Suit { Club, Diamond, Heart, Spade };
console.log(Suit[0]); // Club
```

It must be noted however that you access names by the numeric values, not by an array index as it may seem.

```
enum Suit { Club = 1, Diamond, Heart, Spade };
console.log(Suit[0]); // undefined
console.log(Suit[1]); // Club
```

Any

A special **any** type is used to opt-out of the TypeScript type-checking process and addresses the following cases:

- dynamic content (objects created on the fly)
- 3rd party libraries (having no TypeScript support via definition files)

```
let obj: any = {
    log(message) {
        console.log(message);
    }
};
obj.log('hello world');
```

Please note that by opting-out of the type-checking process you take full responsibility for safety checks, as now TypeScript compiler is not able to verify the code at compile time. The following example shows valid TypeScript code:

```
obj.log('hello world');
obj.helloWorld('log');
```

However, at runtime the second line causes a TypeError exception:

```
hello world
TypeError: obj.helloWorld is not a function
```

So it is recommended using **any** type only where necessary.

Void

The **void** type is used to declare a function does not return any value explicitly.

```
class Logger {

    log(message: string): void {
        console.log(message);
        return true;
    }

}
```

If you try compiling the code above you should get an error:

```
error TS2322: Type 'true' is not assignable to type 'void'.
```

You can fix the type-check error by removing **return** statement from the **log** method:

```
class Logger {

    log(message: string): void {
        console.log(message);
    }

}
```

You might also be using **void** types as function parameters or with **Interfaces**:

```
function fn(x: () => void) {
    x();
}

interface Logger {

    log(message: string): void;
    warn(message: string): void;
    error(message: string): void;

}
```

*You will get more information on **Interfaces** later in this book.*

Classes

TypeScript provides support for classes introduced with ES6 (ECMAScript 2015) and adds a set of features to improve object-oriented development.

```
class Widget {

    id: string;

    constructor(id: string) {
        this.id = id;
    }

    render() {
        console.log(`Rendering widget "${this.id}"`);
    }

}
```

```

let widget = new Widget('text1');
widget.render();
```

You should get the following output when executed:

```
Rendering widget "text1"
```

Properties

With ES6 you define class properties from with the class constructor:

```
// ES6
class Widget {

    constructor(id) {
        this.id = id;
        this.x = 0;
        this.y = 0;
    }

}
```

If you try compiling example above with `tsc` utility (TypeScript compiler) you should get the following errors:

```
error TS2339: Property 'id' does not exist on type 'Widget'.
error TS2339: Property 'x' does not exist on type 'Widget'.
error TS2339: Property 'y' does not exist on type 'Widget'.
```

The errors are raised because TypeScript requires you to define properties separately. It is needed to enable many other features TypeScript provides.

```
class Widget {

    id: string;
    x: number;
    x: number;

    constructor(id: string) {
        this.id = id;
        this.x = 0;
        this.y = 0;
    }
}
```

Properties in TypeScript can have default values:

```
class Widget {

    id: string;
    x: number = 0;
    x: number = 0;

    constructor(id: string) {
        this.id = id;
    }
}
```

Setters and Getters

TypeScript supports *computed properties*, which do not store a value. Instead, they provide *getters* and *setters* to retrieve and assign values in a controlled way.

TBD: describe get/set format

One of the common cases for a *getter* is computing a return value based on other property values:

```
class User {

    firstName: string;
    lastName: string;

    get fullName(): string {
        return `${this.firstName} ${this.lastName}`.trim();
    }

    constructor(firstName: string, lastName: string) {
        this.firstName = firstName;
        this.lastName = lastName;
    }

}

let user = new User('Joan', 'Doe');
console.log(`User full name is: ${user.fullName}`);
```

If you save this example to file `script.ts`, compile it and run like shown below

```
tsc --target ES6 script.ts
node script.js
```

You should see the output with the full username as expected:

```
User full name is: Joan Doe
```

Now let's introduce a simple *setter* for the `firstName` property. Every time a new property value is set we are going to remove leading and trailing white space. Such values as " Joan" and "Joan " are automatically converted to "Joan".

```
class User {

    private _firstName: string;

    get firstName(): string {
        return this._firstName;
    }

    set firstName(value: string) {
        if (value) {
            this._firstName = value.trim();
        }
    }
}

let user = new User();
user.firstName = '  Joan   ';
console.log(`The first name is "${user.firstName}".`);
```

The console output, in this case, should be:

```
The first name is "Joan".
```

Methods

Methods are functions that operate on a class object and are bound to an instance of that object. You can use `this` keyword to access properties and call other methods like in the example below:

```
class Sprite {

    x: number;
    y: number;

    render() {
        console.log(`rendering widget at ${this.x}:${this.y}`);
    }

    moveTo(x: number, y: number) {
        this.x = x;
        this.y = y;
        this.render();
    }

}

let sprite = new Sprite();
sprite.moveTo(5, 10);
// rendering widget at 5:10
```

Return values

```
class NumberWidget {

    getId(): string {
        return 'number1';
    }

    getValue(): number {
        return 10;
    }

}
```

You can use a `void` type if the method does not return any value.

```
class TextWidget {

    text: string;

    reset(): void {
        this.text = '';
    }

}
```

Method parameters

You can add types to each parameter of the method.

```
class Logger {

    log(message: string, level: number) {
        console.log(`(${level}): ${message}`);
    }

}
```

TypeScript will automatically perform type checking at compile time. Let's try providing a string value for the `level` parameter:

```
let logger = new Logger();
logger.log('test', 'not a number');
```

You should get a compile error with the following message:

```
error TS2345: Argument of type '"string"' is not assignable to parameter of type 'nu\
mber'.
```

Now let's change `level` parameter to a number to fix compilation

```
let logger = new Logger();
logger.log('test', 2);
```

Now we should get the expected output:

```
(2): test
```

Optional parameters

By default, all method/function parameters in TypeScript are `required`. However, it is possible making parameters optional by appending **?** (question mark) symbol to the parameter name. Let's update our `Logger` class and make `level` parameter optional.

```
class Logger {

    log(message: string, level?: number) {
        if (level === undefined) {
            level = 1;
        }
        console.log(`(${level}): ${message}`);
    }

}

let logger = new Logger();
logger.log('Application error');
```

The `log` method provides default value automatically if `level` is omitted.

```
(1): Application error
```

Please note that optional parameters must always follow required ones.

Default parameters

TypeScript also supports default values for parameters. Instead of checking every parameter for `undefined` value you can provide defaults directly within the method declaration:

```
class Logger {

    log(message: string = 'Unknown error', level: number = 1) {
        console.log(`(${level}): ${message}`);
    }

}
```

Let's try calling `log` without any parameters:

```
let logger = new Logger();
logger.log('Application error');
```

The output, in this case, should be:

```
(1): Application error
```

Rest Parameters and Spread Operator

In TypeScript, you can gather multiple arguments into a single variable known as *rest parameter*. Rest parameters were introduced as part of ES6, and TypesScripts extends them with type checking support.

```
class Logger {

    showErrors(...errors: string[]) {
        for (let err of errors) {
            console.error(err);
        }
    }

}
```

Now you can provide an arbitrary number of arguments for `showErrors` method:

```
let logger = new Logger();
logger.showErrors('Something', 'went', 'wrong');
```

That should produce three errors as an output:

```
Something
went
wrong
```

Rest parameters in TypeScript work great with *Spread Operator* allowing you to expand a collection into multiple arguments. It is also possible mixing regular parameters with *spread* ones:

```
let logger = new Logger();
let messages = ['something', 'went', 'wrong'];
logger.showErrors('Error', ...messages, '!');
```

In the example above we compose a collection of arguments from arbitrary parameters and content of the `messages` array in the middle. The `showErrors` method should handle all entries correctly and produce the following output:

```
Error
something
went
wrong
!
```

Constructors

Constructors in TypeScript got same features as methods. You can have default and optional parameters, use rest parameters and spread operators with class constructor functions.

Besides, TypeScript provides support for automatic property creation based on constructor parameters. Let's create a typical `User` class implementation:

```
class User {

    firstName: string;
    lastName: string;

    get fullName(): string {
        return `${this.firstName} ${this.lastName}`.trim();
    }

    constructor(firstName: string, lastName: string) {
        this.firstName = firstName;
        this.lastName = lastName;
    }

}
```

Instead of assigning parameter values to the corresponding properties we can instruct TypeScript to perform an automatic assignment instead. You can do that by putting one of the access modifiers **public**, **private** or **protected** before the parameter name.

You are going to get more details on *access modifiers* later in this book. For now, let's see the updated `User` class using automatic property assignment:

```
class User {

    get fullName(): string {
        return `${this.firstName} ${this.lastName}`.trim();
    }

    constructor(public firstName: string, public lastName: string) {
    }

}

let user = new User('Joan', 'Doe');
console.log(`Full name is: ${user.fullName}`);
```

TypeScript creates `firstName` and `lastName` properties when generating JavaScript output. You need targeting at least ES5 to use this feature. Save example above to file `script.ts` then compile and run with `node`:

```
tsc script.ts --target ES5
node script.js
```

The output should be as following:

```
Full name is: Joan Doe
```

You have not defined properties explicitly, but `fullName` getter was still able accessing them via `this`. If you take a look at the emitted JavaScript you should see the properties are defined there as expected:

```
// ES5
var User = (function () {
    function User(firstName, lastName) {
        this.firstName = firstName;
        this.lastName = lastName;
    }
    Object.defineProperty(User.prototype, "fullName", {
        get: function () {
            return (this.firstName + " " + this.lastName).trim();
        },
        enumerable: true,
        configurable: true
    });
    return User;
}());
var user = new User('Joan', 'Doe');
console.log("Full name is: " + user.fullName);
```

Now you can also switch to ES6 target to see how TypeScript assigns properties:

```
tsc script.ts --target ES6
```

The generated JavaScript, in this case, is even smaller and cleaner:

```
// ES6
class User {
    constructor(firstName, lastName) {
        this.firstName = firstName;
        this.lastName = lastName;
    }
    get fullName() {
        return `${this.firstName} ${this.lastName}`.trim();
    }
}
let user = new User('Joan', 'Doe');
console.log(`Full name is: ${user.fullName}`);
```

Inheritance

One of the important TypeScript features is the class inheritance that enables OOP patterns for developers. Under the hood TypeScript is using the same `extends` syntactic sugar when targeting ES6 JavaScript, and prototypical inheritance wrappers when generating output in ES5.

We can refer to animals as a classic example of class-based programming and inheritance.

```
class Animal {
    name: string;
    constructor(name: string) {
        this.name = name;
    }
    makeSound() {
        console.log('Unknown sound');
    }
}
```

You have created a basic `Animal` class that contains a `name` property and `makeSound` method. That translates to ES5 as following:

```
// ES5
var Animal = (function () {
    function Animal(name) {
        this.name = name;
    }
    Animal.prototype.makeSound = function () {
        console.log('Unknown sound');
    };
    return Animal;
}());
```

Now you can create a `Dog` implementation that provides a right sound:

```
class Dog extends Animal {
    constructor(name: string) {
        super(name);
    }
    makeSound() {
        console.log('Woof-woof');
    }
}
```

Please note that if you have a constructor in the base class, then you must call it from all derived classes. Otherwise, TypeScript should raise a compile-time error:

```
error TS2377: Constructors for derived classes must contain a 'super' call.
```

Here's how a `Dog` gets converted to ES5:

```
var Dog = (function (_super) {
    __extends(Dog, _super);
    function Dog(name) {
        return _super.call(this, name) || this;
    }
    Dog.prototype.makeSound = function () {
        console.log('Woof-woof');
    };
    return Dog;
}(Animal));
```

Now let's add a `Cat` implementation with its sound and test both classes:

```
class Cat extends Animal {
    constructor(name: string) {
        super(name);
    }
    makeSound() {
        console.log('Meow');
    }
}

let dog = new Dog('Spot');
let cat = new Cat('Tom');

dog.makeSound();
cat.makeSound();
```

Once the code compiles and executes you should get the following output:

```
Woof-woof
Meow
```

Access Modifiers

TypeScript supports `public`, `private` and `protected` modifiers for defining accessibility of the class members.

Public

By default, each member of the class is `public` so that you can omit it. However, nothing stops you from declaring `public` modifier explicitly if needed:

```
class User {
    public firstName: string;
    public lastName: string;

    public speak() {
        console.log('Hello');
    }

    constructor(firstName: string, lastName: string) {
        this.firstName = firstName;
        this.lastName = lastName;
    }
}
```

Now if you compile example above to JavaScript you should see the following:

```
var User = (function () {
    function User(firstName, lastName) {
        this.firstName = firstName;
        this.lastName = lastName;
    }
    User.prototype.speak = function () {
        console.log('Hello');
    };
    return User;
}());
```

Private

You mark a member as `private` when it should never be accessed from outside of its containing class. One of the most common scenarios is creating private fields to hold values for properties. For example:

```
class User {
    private _firstName: string;
    private _lastName: string;

    get firstName() {
        return this._firstName;
    }

    get lastName() {
        return this._lastName;
    }

    constructor(firstName: string, lastName: string) {
        this._firstName = firstName;
        this._lastName = lastName;
    }
}
```

The class we have created above allows setting user's first and last name only from within the constructor.

If you try changing name properties from outside the class, TypeScript will raise an error at compile time:

```
let user = new User('John', 'Doe');
user.firstName = 'Rob';
// error TS2540: Cannot assign to 'firstName' because it is a constant or a read-onl\
y property.
```

Protected

The `protected` modifier restricts member visibility from outside of the containing class but provides access from the derived classes.

Let's start with base `Page` class implementation:

```
class Page {

    protected renderHeader()    { /* ... */ }
    protected renderContent()   { /* ... */ }
    protected renderFooter()    { /* ... */ }

    render() {
        this.renderHeader();
        this.renderContent();
        this.renderFooter();
    }
}
```

We created a `Page` class that has public method `render`. Internally `render` calls three separate methods to render header, content and footer of the page. These methods are not available from the outside the the class.

Now we are going to create a simple derived `AboutPage` class:

```
class AboutPage extends Page {

    private renderAboutContent() { /* ... */ }

    render() {
        this.renderHeader();
        this.renderAboutContent();
        this.renderFooter();
    }

}
```

As you can see the `AboutPage` defines its `render` method that calls `renderHeader` and `renderFooter` in parent class but puts custom content in the middle.

You can also use `protected` modifier with class constructors. In this case, the class can be instantiated only by the derived classes that extend it. That becomes handy when you want to have properties and methods available for multiple classes as a base implementation, but don't want a base class to be instantiated outside its containing class.

For example

```
class Page {
    protected constructor(id: string) {
        // ...
    }

    render() { /* base render */ }
}

class MainPage extends Page {
    constructor(id: string) {
        super(id);
    }

    render() { /* render main page */ }
}

class AboutPage extends Page {
    constructor(id: string) {
        super(id);
    }

    render() { /* render about page */ }
}

let main = new MainPage('main');
let about = new AboutPage('about');
```

You can create instances of `MainPage` and `AboutPage` both having access to protected members of the `Page` class. However, you are not able creating an instance of the `Page` class directly.

```
let page = new Page();
// error TS2674: Constructor of class 'Page' is protected and only accessible within\
 the class declaration.
```

Readonly modifier

One of the common ways to create a read-only property in many object-oriented programming languages is by having a private local variable with a `getter` only.

```
class Widget {

    private _id: string;

    get id(): string {
        return this._id;
    }

    constructor(id: string) {
        this._id = id;
    }
}

let widget = new Widget('textBox');
console.log(`Widget id: ${widget.id}`);
// Widget id: textBox
```

You can also make properties read-only by using the `readonly` keyword. That reduces repetitive typing when dealing with many read-only properties, and greatly improves overall code readability.

Let's update the previous example to use `readonly`:

```
class Widget {
    readonly id: string;

    constructor(id: string) {
        this.id = id;
    }
}
```

If you try changing the value of the property outside of the constructor TypeScript will raise an error:

```
let widget = new Widget('text');
widget.id = 'newId';
// error TS2540: Cannot assign to 'id' because it is a constant or a read-only prope\
rty.
```

You can provide default values for read-only properties only in two places: property declaration and constructor.

```
class Widget {
    readonly id: string;
    readonly minWidth: number = 200;
    readonly minHeight: number = 100;

    constructor(id: string) {
        this.id = id;
    }
}

let widget = new Widget('text');
widget.minWidth = 1000;
// error TS2540: Cannot assign to 'minWidth' because it is a constant or a read-only\
 property.
```

Interfaces

An *interface* is a description of the actions that an object can do.

You might already be familiar with *interfaces* in other programming languages like C# and Java, or *contracts* in Swift.

Interfaces are not part of the ECMAScript. It is a level of abstraction supported by TypeScript to improve the type-checking process, and not converted to JavaScript code.

Here's an example of an interface describing generic **Text** component:

```
interface TextComponent {

    text: string;
    render(): void;

}
```

Now you can use the interface above to describe the requirement of having the **text** property that is a string and a **render** method:

```
class PlainTextComponent implements TextComponent {

    text: string;

    render() {
        console.log('rendering plain text component');
    }

}
```

We are using `implements` keyword to wire class with a particular interface. It is not important in what order class members are defined as long as all properties and methods the interface requires are present and have required types.

Let's create another class that implements `TextComponent` interface partially:

```
class RichTextComponent implements TextComponent {
    text: string;
}
```

Upon compilation TypeScript will produce the following error:

```
error TS2420: Class 'RichTextComponent' incorrectly implements interface 'TextCompon\
ent'.
Property 'render' is missing in type 'RichTextComponent'.
```

You can use multiple interfaces delimited by a comma:

```
class RichTextComponent implements TextComponent, OnInit, OnDestroy {
    // ...
}
```

The example above shows a class that must implement three different interfaces to compile.

Abstract Classes

Interfaces describe only requirements for classes; you cannot create an instance of the interface. You need `abstract` classes un order to provide implementation details.

```
abstract class PageComponent {

    abstract renderContent(): void;

    renderHeader() {
        // ...
    }

    renderFooter() {
        // ...
    }
}
```

Same as with interfaces you cannot create instances of abstract classes directly, only other classes derived from an abstract one. Also, it is possible marking class methods as `abstract`. Abstract methods do not contain implementation, and similar to `interface` methods provide requirements for derived classes.

```
class HomePageComponent extends PageComponent {

    renderContent() {
        this.renderHeader();
        console.log('rendering home page');
        this.renderFooter();
    }

}
```

Note how `HomePageComponent` implements abstract `renderContent` that has access to `renderHeader` and `renderFooter` methods carried out in the parent class.

You can also use access modifiers with abstract methods. The most frequent scenario is when methods need to be accessible only from within the child classes, and invisible from the outside:

For example:

```
abstract class PageComponent {

    protected abstract renderContent(): void;

    renderHeader() {
        // ...
    }

    renderFooter() {
        // ...
    }
}
```

Now `HomePageComponent` can make `renderContent` protected like shown below:

```
class HomePageComponent extends PageComponent {

    constructor() {
        super();
        this.renderContent();
    }

    protected renderContent() {
        this.renderHeader();
        console.log('rendering home page');
        this.renderFooter();
    }

}
```

Any additional class that inherits (extends) `HomePageComponent` will still be able calling or redefining `renderContent` method. But if you try accessing `renderContent` from outside the TypeScript should raise the following error:

```
let homePage = new HomePageComponent();
homePage.renderContent();
// error TS2445: Property 'renderContent' is protected and only
// accessible within class 'HomePageComponent' and its subclasses.
```

Abstract classes is a great way consolidating common functionality in a single place.

Modules

TypeScript supports the concept of modules introduced in ES6. Modules allow isolating code and data and help splitting functionality into logical groups.

One of the major features of ES6 (and TypeScript) modules is their file scope. The code inside the module (classes, variables, functions, and other) does not pollute global scope and is not accessible from the outside unless `exported` explicitly.

To share the code of the module with the outside world, you use `export` keyword:

```
// module1.ts
export class TextBoxComponent {
    constructor(public text: string) {}
    render() {
        console.log(`Rendering '${this.text}' value.`);
    }
}
```

To use this code in your main application file or another module, you must import it first. You import the `TextBoxComponent` class using `import` keyword:

```
// app.ts
import { TextBoxComponent } from './module1'

let textBox = new TextBoxComponent('hello world');
textBox.render();
```

Module Loaders

ES6 and TypeScript rely on `module loaders` to locate files, resolve external dependencies and execute module files.

The most popular module loaders are:

- Server side
    - CommonJs (used by node.js)
- Client side
    - SystemJS
    - RequireJS
    - Webpack

TypeScript supports different formats of generated JavaScript output. You can instruct compiler to generate code adopted for multiple module loading systems using formats such as

- CommonJS (used in node.js)
- RequireJS
- UMD (Universal Module Definition)
- SystemJS
- ES6 (or ECMAScript 2015)

Running at server side

You can test `TextBoxComponent` we have created earlier with node.js using `commonjs` module target:

```
tsc app.ts --module commonjs
node app.js
```

When executed it produces the following output:

```
Rendering 'hello world' value.
```

TypeScript automatically compiles referenced modules. It starts with `app.ts`, resolves and compiles `module1` as `module1.ts` file, and produces two JavaScript files `app.js` and `module.js` that can be executed by node.js.

Here's an example of `app.js` file content:

```
"use strict";
// app.ts
var module1_1 = require("./module1");
var textBox = new module1_1.TextBoxComponent('hello world');
textBox.render();
```

Running in browser

In order to run module-based application in browser you can take `SystemJS` loader:

```
<script src="systemjs/dist/system.js"></script>
<script>
  SystemJS.import('/app/app.js');
</script>
```

Let's take a look at a simple TypeScript application that references an external module.

```
// logger.ts
export class Logger {

    output: any;

    constructor(outputId: string) {
        this.output = document.getElementById(outputId);
    }

    info(message: string) {
       this.output.innerText = `INFO: ${message}`;
    }

}
```

Our simple `logger` is going to put a message as a content of the document element provided from the outside.

```
// app.ts
import { Logger } from './logger';

let logger = new Logger('content');
logger.info('hello world');
```

The application needs to be compiled with SystemJS support to load correctly. You can configure TypeScript to generate compatible JavaScript code by setting module code generation setting to `system`:

```
tsc app.ts --module system
```

Source code

You can find source code for the examples above in the "typescript/systemjs-example[18]" folder.

To install dependencies, compile and run the demo use the following commands:

```
npm install
npm start
```

Your default browser should run example page automatically. Once the page gets loaded you should see an expected message:

[18]https://github.com/DenysVuika/developing-with-angular/tree/master/typescript/systemjs-example

```
INFO: hello world
```

Decorators

TypeScript introduces `decorators` feature, metadata expressions similar to Java annotation tags or C# and Swift attributes. ECMAScript does not yet have native support for annotating classes and class members (the feature is in the `proposal` state), so `decorators` is an experimental TypeScript feature.

Decorators have a traditional notation of `@expression` where `expression` is the name of the function that should be invoked at runtime. This function receives `decorated` target as a parameter and can be attached to:

- class declaration
- method
- accessor
- property
- parameter

Class Decorators

Class decorators are attached to class declarations. At runtime, the function that backs the decorator gets applied to the class constructor. That allows decorators inspecting, modifying or even replacing class instances if needed.

Here's a simple example of the `LogClass` decorator that outputs some log information every time being invoked:

```
function LogClass(constructor: Function) {
    console.log('LogClass decorator executed for the constructor:');
    console.log(constructor);
}
```

Now you can use newly created decorator with different classes:

```
@LogClass
class TextWidget {
    text: string;

    constructor(text: string = 'default text') {
        this.text = text;
    }

    render() {
        console.log(`Rendering text: ${this.text}`);
    }
}
```

When a new instance of `TextWidget` class is created, the `@LogClass` attribute will be automatically invoked:

```
let widget = new TextWidget();
widget.render();
```

The class decorator should produce the following output:

```
LogClass decorator executed for the constructor:
[Function: TextWidget]
Rendering text: default text
```

Decorators with parameters

It is also possible passing values to decorators. You can achieve this with a feature known as `decorator factories`. A *decorator factory* is a function returning an expression that is called at runtime:

Let's create another simple decorator with log output that accepts additional `prefix` and `suffix` settings:

```
function LogClassWithParams(prefix: string, suffix: string) {
    return (constructor: Function) => {
        console.log(`
            ${prefix}
            LogClassWithParams decorator called for:
            ${constructor}
            ${suffix}
        `);
    };
}
```

It can now be tested with the `TextWidget` class created earlier:

```
@LogClassWithParams('BEGIN:', ':END')
class TextWidget {
    text: string;

    constructor(text: string = 'default text') {
        this.text = text;
    }

    render() {
        console.log(`Rendering text: ${this.text}`);
    }
}

let widget = new TextWidget();
widget.render();
```

You have marked `TextWidget` class with the `LogClassWithParams` decorator having a `prefix` and `suffix` properties set to `BEGIN:` and `:END` values. The console output, in this case, should be:

```
BEGIN:
LogClassWithParams decorator called for:
function TextWidget(text) {
    if (text === void 0) { text = 'default text'; }
        this.text = text;
    }
}
:END
```

Multiple decorators

You are not limited to a single decorator per class. TypeScript allows declaring as much class and member decorators as needed:

```
@LogClass
@LogClassWithParams('BEGIN:', ':END')
@LogClassWithParams('[', ']')
class TextWidget {
    // ...
}
```

Note that decorators are called from right to left, or in this case from bottom to top. It means that first decorator that gets executed is:

```
@LogClassWithParams('[', ']')
```

and the last decorator is going to be

```
@LogClass
```

Method Decorators

Method decorators are attached to class methods and can be used to inspect, modify or completely replace method definition of the class. At runtime, these decorators receive following values as parameters: target instance, member name and member descriptor.

Let's create a decorator to inspect those parameters:

```
function LogMethod(target: any,
                   propertyKey: string,
                   descriptor: PropertyDescriptor) {
    console.log(target);
    console.log(propertyKey);
    console.log(descriptor);
}
```

Below is an example of this decorator applied to a `render` method of `TextWidget` class:

```
class TextWidget {
    text: string;

    constructor(text: string = 'default text') {
        this.text = text;
    }

    @LogMethod
    render() {
        console.log(`Rendering text: ${this.text}`);
    }
}

let widget = new TextWidget();
widget.render();
```

The console output in this case will be as following:

```
TextWidget { render: [Function] }
render
{ value: [Function],
  writable: true,
  enumerable: true,
  configurable: true }
Rendering text: default text
```

You can use `decorator factories` also with method decorators to support additional parameters.

```
function LogMethodWithParams(message: string) {
    return (target: any,
            propertyKey: string,
            descriptor: PropertyDescriptor) => {
        console.log(`${propertyKey}: ${message}`);
    };
}
```

This decorator can now be applied to methods. You can attach multiple decorators to a single method:

```
class TextWidget {
    text: string;

    constructor(text: string = 'default text') {
        this.text = text;
    }

    @LogMethodWithParams('hello')
    @LogMethodWithParams('world')
    render() {
        console.log(`Rendering text: ${this.text}`);
    }
}

let widget = new TextWidget();
widget.render();
```

Note that decorators are called from right to left, or in this case from bottom to top. If you run the code the output should be as follows:

```
render: world
render: hello
Rendering text: default text
```

Accessor Decorators

Accessor decorators are attached to property `getters` or `setters` and can be used to inspect, modify or completely replace accessor definition of the property. At runtime, these decorators receive following values as parameters: target instance, member name and member descriptor.

Note that you can attach accessor decorator to either `getter` or `setter` but not both. This restriction exists because on the low level decorators deal with Property Descriptors[19] that contain both `get` and `set` accessors.

Let's create a decorator to inspect parameters:

[19]https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Global_Objects/Object/defineProperty

```
function LogAccessor(target: any,
                     propertyKey: string,
                     descriptor: PropertyDescriptor) {
    console.log('LogAccessor decorator called');
    console.log(target);
    console.log(propertyKey);
    console.log(descriptor);
}
```

Now the decorator can be applied to the following `TextWidget` class:

```
class TextWidget {
    private _text: string;

    @LogAccessor
    get text(): string {
        return this._text;
    }

    set text(value: string) {
        this._text = value;
    }

    constructor(text: string = 'default text') {
        this._text = text;
    }
}

let widget = new TextWidget();
```

Once invoked the decorator should produce the following output:

```
LogAccessor decorator called
TextWidget { text: [Getter/Setter] }
text
{ get: [Function: get],
  set: [Function: set],
  enumerable: true,
  configurable: true }
```

Same as with class and method decorators you can use decorator factories feature to pass parameters to your accessor decorator.

```
function LogAccessorWithParams(message: string) {
    return (target: any,
            propertyKey: string,
            descriptor: PropertyDescriptor) => {
        console.log(`Message from decorator: ${message}`);
    }
}
```

TypeScript allows using more than one decorator given you attach it to the same property accessor:

```
class TextWidget {
    private _text: string;

    @LogAccessorWithParams('hello')
    @LogAccessorWithParams('world')
    get text(): string {
        return this._text;
    }

    set text(value: string) {
        this._text = value;
    }

    constructor(text: string = 'default text') {
        this._text = text;
    }
}

let widget = new TextWidget();
```

The console output should be as shown below, note the right-to-left execution order:

```
Message from decorator: world
Message from decorator: hello
```

In case you declare decorator for both accessors TypeScript generates an error at compile time:

```
class TextWidget {
    private _text: string;

    @LogAccessorWithParams('hello')
    get text(): string {
        return this._text;
    }

    @LogAccessorWithParams('world')
    set text(value: string) {
        this._text = value;
    }
}
```

```
error TS1207: Decorators cannot be applied to multiple get/set accessors of the same\
 name.
```

Property Decorators

Property decorators are attached to class properties. At runtime, property decorator receives the following arguments:

- target object
- property name

Due to technical limitations, it is not currently possible observing or modifying property initializers. That is why property decorators do not get Property Descriptor value at runtime and can be used mainly to observe a property with a particular name has been defined for a class.

Here's a simple property decorator to display parameters it gets at runtime:

```
function LogProperty(target: any, propertyKey: string) {
    console.log('LogProperty decorator called');
    console.log(target);
    console.log(propertyKey);
}
```

```
class TextWidget {

    @LogProperty
    id: string;

    constructor(id: string) {
        this.id = id;
    }

    render() {
        // ...
    }
}

let widget = new TextWidget('text1');
```

The output in this case should be as following:

```
LogProperty decorator called
TextWidget { render: [Function] }
id
```

Parameter Decorators

Parameter decorators are attached to function parameters. At runtime, every parameter decorator function is called with the following arguments:

- target
- parameter name
- parameter position index

Due to technical limitations, it is possible only detecting that a particular parameter has been declared on a function.

Let's inspect runtime arguments with this simple parameter decorator:

```
function LogParameter(target: any,
                      parameterName: string,
                      parameterIndex: number) {
    console.log('LogParameter decorator called');
    console.log(target);
    console.log(parameterName);
    console.log(parameterIndex);
}
```

You can now use this decorator with a class constructor and method parameters:

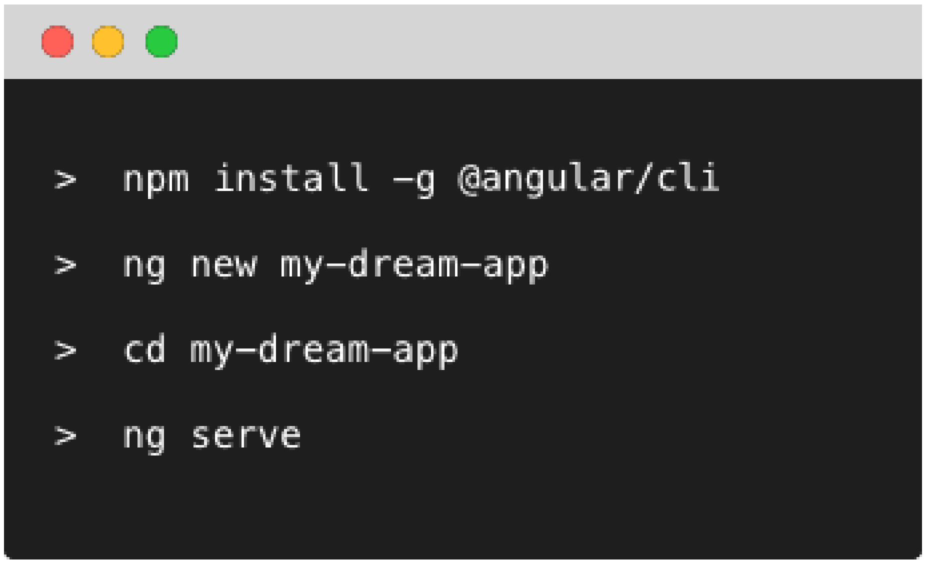
```
class TextWidget {

    render(@LogParameter positionX: number,
           @LogParameter positionY: number) {
        // ...
    }

}
```

Parameter decorators are also executed in right-to-left order. So you should see console outputs for `positionY` and then `positionX`:

```
LogParameter decorator called
TextWidget { render: [Function] }
render
1
LogParameter decorator called
TextWidget { render: [Function] }
render
0
```

Angular CLI

The Angular CLI[20] is a command line interface for Angular.



```
>  npm install -g @angular/cli
>  ng new my-dream-app
>  cd my-dream-app
>  ng serve
```

Angular CLI

As you might have noticed from the previous chapters, creating a project structure for a new web app may be a non-trivial task. Working with multiple projects or frequently creating new ones may become extremely time-consuming as you need configuring project structure again and again.

> The Angular CLI makes it easy to create an application that already works, right out of the box. It already follows our best practices!

This command line tool automates and simplifies many common scenarios, including:

- create new project structure from scratch with most optimal configuration out of the box
- scaffold common Angular building blocks using one of the various blueprints (components, directives, pipes, services and other)
- serving, watching and live reload
- code linting
- unit testing, code coverage reports, and end-to-end testing
- development and production builds

[20] https://cli.angular.io

Installing

```
npm install -g @angular/cli
```

The tool installs globally and is available via `ng` command. Angular CLI supports lots of features; you can view details on available commands with the `help` command:

```
ng help
```

Your first application

To create a new application you should use `ng new <project-name>` command:

```
ng new my-first-app
```

The `ng` tool should produce console output similar to the following one:

```
installing ng
  create .editorconfig
  create README.md
  create src/app/app.component.css
  create src/app/app.component.html
  create src/app/app.component.spec.ts
  create src/app/app.component.ts
  create src/app/app.module.ts
  create src/assets/.gitkeep
  create src/environments/environment.prod.ts
  create src/environments/environment.ts
  create src/favicon.ico
  create src/index.html
  create src/main.ts
  create src/polyfills.ts
  create src/styles.css
  create src/test.ts
  create src/tsconfig.app.json
  create src/tsconfig.spec.json
  create src/typings.d.ts
  create .angular-cli.json
  create e2e/app.e2e-spec.ts
  create e2e/app.po.ts
  create e2e/tsconfig.e2e.json
  create .gitignore
  create karma.conf.js
  create package.json
  create protractor.conf.js
  create tsconfig.json
  create tslint.json
Successfully initialized git.
Installing packages for tooling via npm.
Installed packages for tooling via npm.
You can `ng set --global packageManager=yarn`.
Project 'my-first-app' successfully created.
```

The `scripts` section of the `package.json` file should point to `ng` tool for all the actions:

package.json

```
{
    ...
    "scripts": {
        "ng": "ng",
        "start": "ng serve",
        "build": "ng build",
        "test": "ng test",
        "lint": "ng lint",
        "e2e": "ng e2e"
    },
    ...
}
```

Running application

Now switch to the newly generated `my-first-app` folder and launch the app:

```
cd my-first-app/
ng serve
```

The `ng serve` command compiles and serves entire project using `webpack` bundler with an output similar to following:

```
** NG Live Development Server is running on http://localhost:4200 **
Hash: 2c5e702e0dbbc24e055c
Time: 10564ms
chunk    {0} polyfills.bundle.js, polyfills.bundle.js.map (polyfills) 158 kB {4} [in\
itial] [rendered]
chunk    {1} main.bundle.js, main.bundle.js.map (main) 3.62 kB {3} [initial] [render\
ed]
chunk    {2} styles.bundle.js, styles.bundle.js.map (styles) 9.77 kB {4} [initial] [\
rendered]
chunk    {3} vendor.bundle.js, vendor.bundle.js.map (vendor) 2.37 MB [initial] [rend\
ered]
chunk    {4} inline.bundle.js, inline.bundle.js.map (inline) 0 bytes [entry] [render\
ed]
webpack: Compiled successfully.
```

It is important to note that with `ng serve` you are going to run your project with `live development server`. The server is going to watch for code changes, rebuild all affected bundles and reload the browser.

Now if you navigate to `http://localhost:4200` you should see the following default text:

```
app works!
```

Alternatively, you can run `serve` command with the `--open` switch to automatically open system browser with the application once compilation is complete:

```
ng serve --open
```

It is also possible configuring default `host` and `port` settings:

```
ng serve --host 0.0.0.0 --port 3000
```

The command above allows accessing your application from the local machine and local network via port 3000.

There are plenty of options and switches that can be used with `ng serve` command; you can refer to full details by calling `ng help`.

Code Linting

Checking code is one of the essential steps. Angular CLI ships with the TSLint support and predefined set of rules in the `tsconfig.json` file.

```
ng lint
```

Default auto-generated project should contain no errors. You should see the following result in the console:

```
All files pass linting.
```

Let's try to ensure TSLint works as expected by modifying the `/src/app/app.component.ts` file. Just change single quotes with double quotes like below:

src/app/app.component.ts

```
export class AppComponent {
  title = "app works!";
}
```

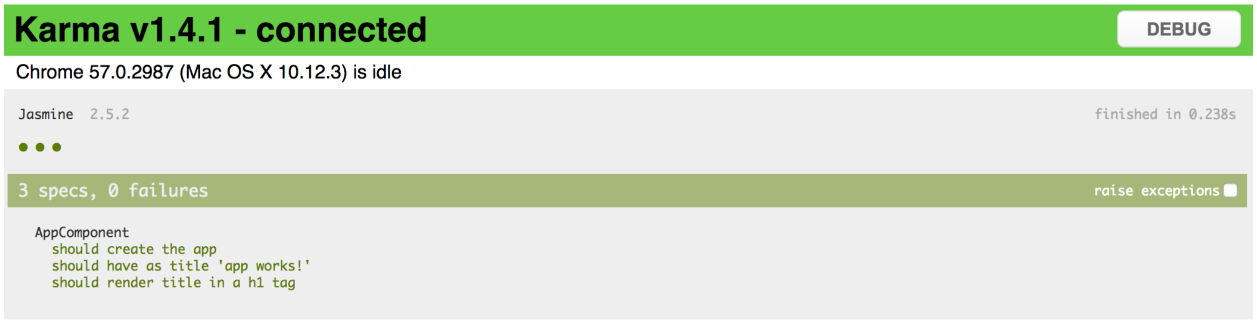
Now running `ng lint` should produce next output:

```
src/app/app.component.ts[9, 11]: " should be '
Lint errors found in the listed files.
```

Unit tests

You get a predefined unit testing configuration with every generated project. By default, you are going to use `Karma` runner with the `Jasmine` test framework.

```
ng test
```



Chrome 57.0.2987 (Mac OS X 10.12.3) is idle

Jasmine 2.5.2 finished in 0.238s

3 specs, 0 failures raise exceptions

```
AppComponent
  should create the app
  should have as title 'app works!'
  should render title in a h1 tag
```

Unit tests

Tests run in `watch` mode, meaning they automatically re-run upon code changes.

Please note that out-of-box configuration requires Google Chrome browser to run tests, via the `karma-chrome-launcher` plugin.

As per Angular code style guides, all the unit test files reside next to the components tested. The Angular CLI generates three dummy tests in the `src/app/app.component.spec.ts`:

src/app/app.component.spec.ts

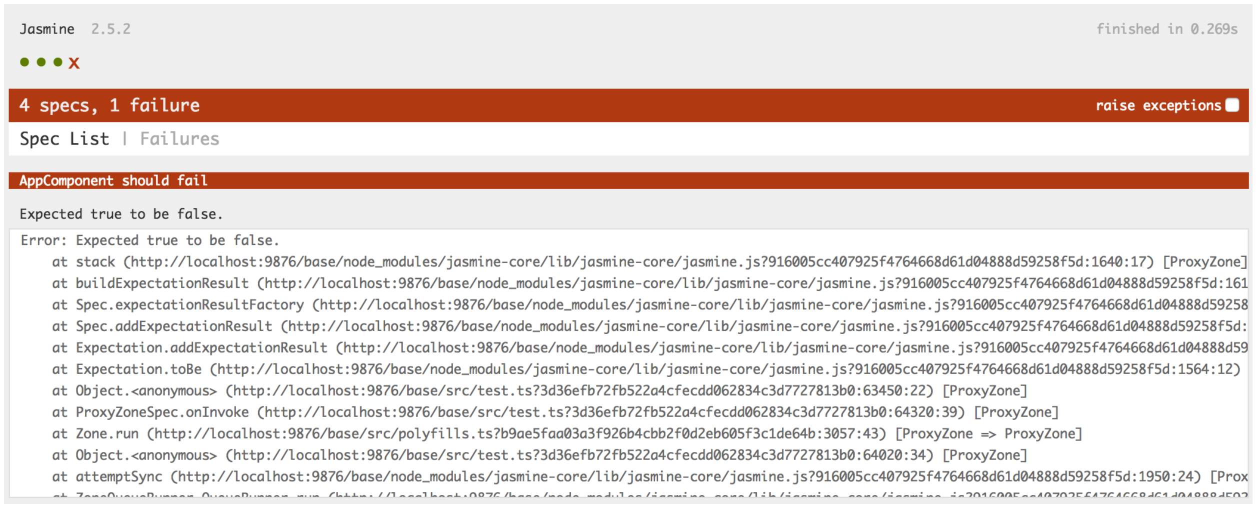
```
it('should create the app', async(() => {
    const fixture = TestBed.createComponent(AppComponent);
    const app = fixture.debugElement.componentInstance;
    expect(app).toBeTruthy();
}));

it(`should have as title 'app works!'`, async(() => {
    const fixture = TestBed.createComponent(AppComponent);
    const app = fixture.debugElement.componentInstance;
    expect(app.title).toEqual('app works!');
}));

it('should render title in a h1 tag', async(() => {
    const fixture = TestBed.createComponent(AppComponent);
    fixture.detectChanges();
    const compiled = fixture.debugElement.nativeElement;
    expect(compiled.querySelector('h1').textContent).toContain('app works!');
}));
```

Let's check what happens when a test fails. Append the following code to the end of the `app.component.spec.ts`:

src/app/app.component.spec.ts

```
it('should fail', () => {
    expect(true).toBe(false);
});
```

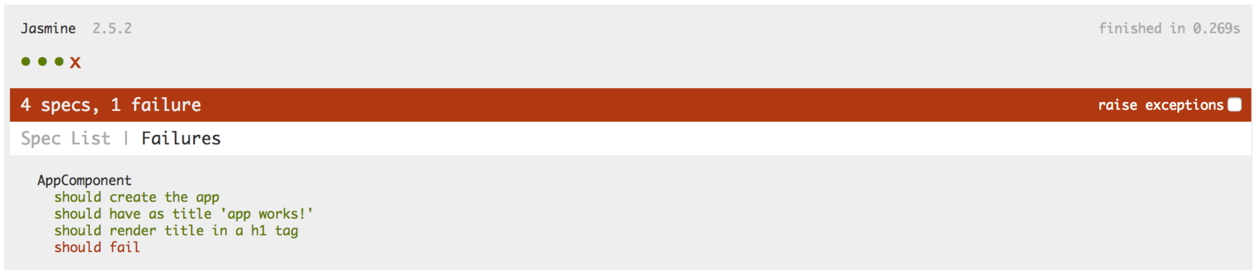
Now if you run `ng test` once again you should see the following report:



```
Jasmine 2.5.2                                                        finished in 0.269s
•••x
4 specs, 1 failure                                                   raise exceptions
Spec List | Failures
AppComponent should fail
Expected true to be false.
Error: Expected true to be false.
    at stack (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59258f5d:1640:17) [ProxyZone]
    at buildExpectationResult (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59258f5d:161
    at Spec.expectationResultFactory (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59258
    at Spec.addExpectationResult (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59258f5d:
    at Expectation.addExpectationResult (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59
    at Expectation.toBe (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59258f5d:1564:12)
    at Object.<anonymous> (http://localhost:9876/base/src/test.ts?3d36efb72fb522a4cfecdd062834c3d7727813b0:63450:22) [ProxyZone]
    at ProxyZoneSpec.onInvoke (http://localhost:9876/base/src/test.ts?3d36efb72fb522a4cfecdd062834c3d7727813b0:64320:39) [ProxyZone]
    at Zone.run (http://localhost:9876/base/src/polyfills.ts?b9ae5faa03a3f926b4cbb2f0d2eb605f3c1de64b:3057:43) [ProxyZone => ProxyZone]
    at Object.<anonymous> (http://localhost:9876/base/src/test.ts?3d36efb72fb522a4cfecdd062834c3d7727813b0:64020:34) [ProxyZone]
    at attemptSync (http://localhost:9876/base/node_modules/jasmine-core/lib/jasmine-core/jasmine.js?916005cc407925f4764668d61d04888d59258f5d:1950:24) [Prox
```

Failed test

There are two tabs on the page: **Spec List** and **Failures**. You should see **Failures** by default but if there's more than one unit test failed you can check them on the **Spec List** page:



```
Jasmine 2.5.2                                                        finished in 0.269s
•••x
4 specs, 1 failure                                                   raise exceptions
Spec List | Failures
  AppComponent
    should create the app
    should have as title 'app works!'
    should render title in a h1 tag
    should fail
```

Spec List

If you do not plan to debug tests and just want to see a quick result of the test run just add `--single-run` switch to the `test` command:

```
ng test --single-run
```

Developers typically use single run configurations for continuous integration (CI) scenarios.

Code coverage

You can generate a coverage report for your unit tests by adding `--code-coverage` switch to the `test` command:

```
ng test --single-run --code-coverage
```

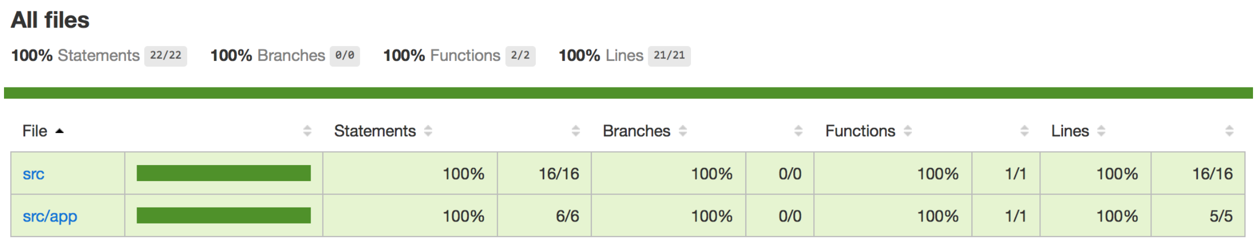
Under the hood the `ng` tool performs the following actions:

- compile the project with webpack, including TypeScript transpilation with source maps
- use Karma runner and Jasmine to execute unit tests
- remap code coverage report for JavaScript back to TypeScript
- generate HTML report within `coverage` folder

After testing finishes you can either open `coverage/index.html` with your favourite browser. For example:

```
open ./coverage/index.html
```

The command above should serve your coverage report and automatically launches default browser with the main page.

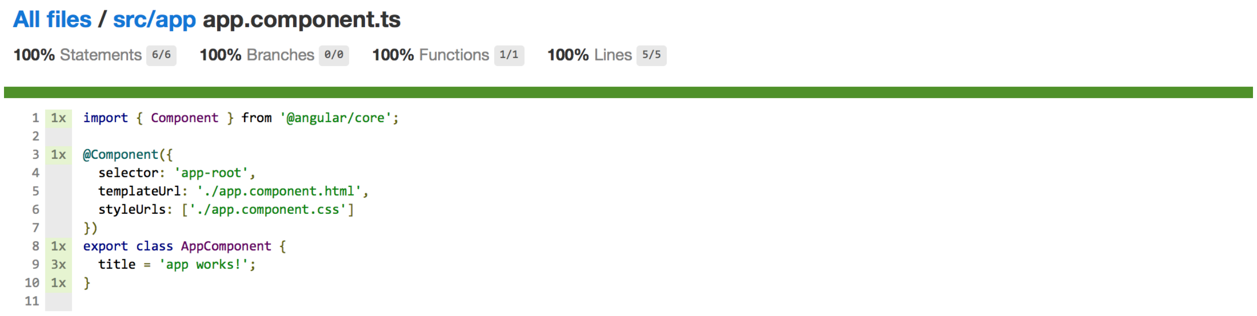

All files

100% Statements 22/22 100% Branches 0/0 100% Functions 2/2 100% Lines 21/21

File		Statements		Branches		Functions		Lines	
src		100%	16/16	100%	0/0	100%	1/1	100%	16/16
src/app		100%	6/6	100%	0/0	100%	1/1	100%	5/5

Code Coverage

Click the `src/app` and then `app.component.ts` to see TypeScript coverage:


All files / src/app app.component.ts

100% Statements 6/6 100% Branches 0/0 100% Functions 1/1 100% Lines 5/5

```
1x import { Component } from '@angular/core';

1x @Component({
     selector: 'app-root',
     templateUrl: './app.component.html',
     styleUrls: ['./app.component.css']
   })
1x export class AppComponent {
3x   title = 'app works!';
1x }
```

Code Coverage for single file

Development and Production builds

The Angular CLI supports producing both `development` and `production` using the `build` command:

```
ng build
```

The format of the command is:

```
ng build <options...>
```

By default it is running in `development` mode (an equivalent of `ng build -dev`) and produces output to the `dist/` folder. You will get bundles together with source maps for better debugging:

File	Size
favicon.ico	5430
index.html	613
inline.bundle.js	5764
inline.bundle.js.map	5824
main.bundle.js	6539
main.bundle.js.map	3817
polyfills.bundle.js	169209
polyfills.bundle.js.map	204535
styles.bundle.js	10039
styles.bundle.js.map	13372
vendor.bundle.js	2884505
vendor.bundle.js.map	3081499

For production purposes you will want using the following command:

```
ng build -prod
```

Which is an equivalent of the:

```
ng build --target=production
```

This will give you much smaller output:

File	Size
favicon.ico	5430
inline.d72284a6a83444350a39.bundle.js	1460
main.e088c8ce83e51568eb21.bundle.js	12163
polyfills.f52c146b4f7d1751829e.bundle.js	58138
styles.d41d8cd98f00b204e980.bundle.css	0
vendor.a2da17b9c49cdce7678a.bundle.js	362975

Please note that `styles` bundle will be empty because by default newly generated app has `src/styles.css` file empty.

The `ng` tool removes `dist` folder between the builds so you should not worry about files left from previous builds and modes.

The content of the `dist` folder is everything you need to deploy your application to the remote server. You can also use any web server of your choice to run the application in production.

For example:

- Nginx server
- Tomcat server
- IIS server
- and many others

In addition, you can deploy your application to any static pages host, like:

- GitHub pages[21]
- Netlify[22]
- and many others

It is still possible to use Angular CLI and embedded development server to test production builds. You can use the following command to build the app in production mode and then run and open default browser to check it:

```
ng serve --prod --open
```

Using blueprints

Besides generating new application project structure, the `ng` tool supports creating core Angular building blocks be means of `generate` (or `g`) command and several `blueprints`.

```
ng generate <blueprint> <options...>
```

For the time being Angular CLI supports the following set of blueprints out-of-box:

Blueprint name	Command line usage
Component	ng g component my-new-component
Directive	ng g directive my-new-directive
Pipe	ng g pipe my-new-pipe
Service	ng g service my-new-service
Class	ng g class my-new-class
Guard	ng g guard my-new-guard
Interface	ng g interface my-new-interface
Enum	ng g enum my-new-enum
Module	ng g module my-module

[21]https://pages.github.com/
[22]https://www.netlify.com/

Let's assume you have generated a new `my-first-app` like suggested below:

```
ng new my-first-app
cd my-first-app
```

Now to create a new component, you should be using the following command:

```
ng g component my-first-component
```

The `ng` tool takes your current directory and creates all component related files:

```
installing component
  create src/app/my-first-component/my-first-component.component.css
  create src/app/my-first-component/my-first-component.component.html
  create src/app/my-first-component/my-first-component.component.spec.ts
  create src/app/my-first-component/my-first-component.component.ts
  update src/app/app.module.ts
```

If you are running `ng generate` command (or `ng g` by alias) from the root of your project, the CLI should automatically put content to `src/app/<feature>` folder like shown above.

You can also specify additional folder structure that should become relative to `src/app` during generation. All missing directories get created automatically. Run the following command from the root project folder:

```
ng g service services/simple-service
```

The `ng` tool creates `src/app/services` path and puts `simple-service` implementation there:

```
installing service
  create src/app/services/simple-service.service.spec.ts
  create src/app/services/simple-service.service.ts
  WARNING Service is generated but not provided, it must be provided to be used
```

Finally, you can change current directory and generate Angular artefacts there:

```
mkdir src/app/directives
cd src/app/directives/
ng g directive my-first-directive
```

In this case, you should see get following output:

```
installing directive
  create src/app/directives/my-first-directive.directive.spec.ts
  create src/app/directives/my-first-directive.directive.ts
  update src/app/app.module.ts
```

All blueprints follow common Angular code style guides. You get a separate folder and all files one should expect when starting with a new Angular component:

- code file (`<component>.ts`)
- external template file (`<component>.html`)
- external css file (`<component>.css`)
- unit test file (`<component>.spec.ts`)

One of the best features of Angular CLI is that you do not get just placeholder files but a valid ready to use artefact and unit tests. Let's peek inside `MyFirstComponent` component we have created earlier, and try integrating into the application.

my-first-component.component.ts

```
import { Component, OnInit } from '@angular/core';

@Component({
  selector: 'app-my-first-component',
  templateUrl: './my-first-component.component.html',
  styleUrls: ['./my-first-component.component.css']
})
export class MyFirstComponentComponent implements OnInit {

  constructor() { }

  ngOnInit() {
  }

}
```

You get `app-my-first-component` selector, external template and style, together with a constructor and `OnInit` placeholder to save your time.

The stylesheet file (**my-first-component.component.css**) is empty by default, and template file (**my-first-component.component.html**) contains the following simple layout:

my-first-component.component.html

```html
<p>
  my-first-component works!
</p>
```

The CLI will even update `src/app/app.module.ts` to include your newly created component into the application module:

src/app/app.module.ts

```typescript
import { BrowserModule } from '@angular/platform-browser';
import { NgModule } from '@angular/core';
import { FormsModule } from '@angular/forms';
import { HttpModule } from '@angular/http';

import { AppComponent } from './app.component';
import { MyFirstComponentComponent } from './my-first-component/my-first-component.c\
omponent';

@NgModule({
  declarations: [
    AppComponent,
    MyFirstComponentComponent
  ],
  imports: [
    BrowserModule,
    FormsModule,
    HttpModule
  ],
  providers: [],
  bootstrap: [AppComponent]
})
export class AppModule { }
```

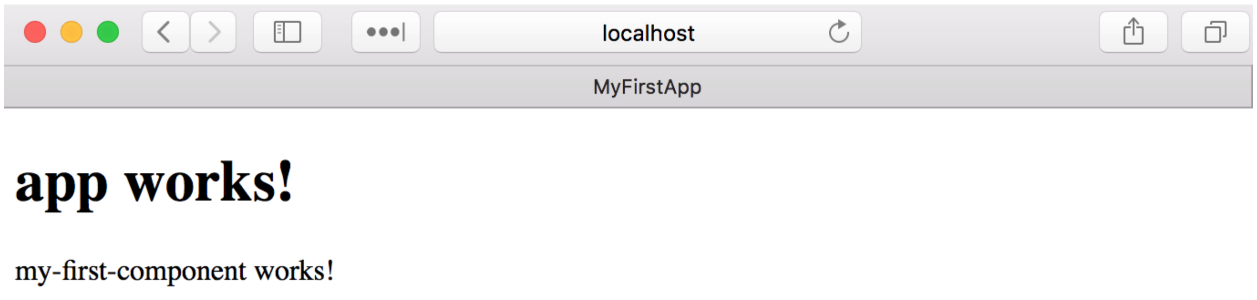
To test the generated component you can use main application template:

src/app/app.component.html

```
<h1>
  {{title}}
</h1>

<app-my-first-component>
</app-my-first-component>
```

Finally, you can run development server if it is not running already:

```
ng serve
```



app works!

my-first-component works!

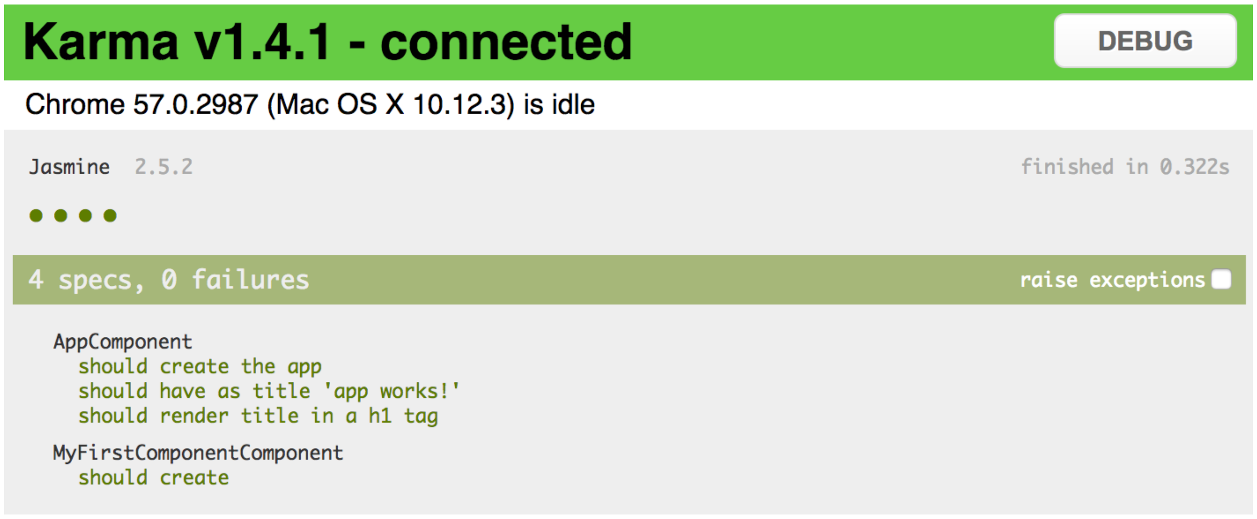
Angular CLI component

As a starting point you also get a simple ready-to-run unit test for your component:

my-first-component.component.spec.ts

```
import { async, ComponentFixture, TestBed } from '@angular/core/testing';

import { MyFirstComponentComponent } from './my-first-component.component';

describe('MyFirstComponentComponent', () => {
  let component: MyFirstComponentComponent;
  let fixture: ComponentFixture<MyFirstComponentComponent>;

  beforeEach(async(() => {
    TestBed.configureTestingModule({
      declarations: [ MyFirstComponentComponent ]
    })
    .compileComponents();
  }));

  beforeEach(() => {
    fixture = TestBed.createComponent(MyFirstComponentComponent);
    component = fixture.componentInstance;
    fixture.detectChanges();
  });

  it('should create', () => {
    expect(component).toBeTruthy();
  });
});
```

As mentioned earlier you can run unit tests in `watch` mode with the help of `ng test` command:



```
Jasmine 2.5.2                                   finished in 0.322s
••••
4 specs, 0 failures
  AppComponent
    should create the app
    should have as title 'app works!'
    should render title in a h1 tag
  MyFirstComponentComponent
    should create
```

Component Test

If you have added your component to the `app.component.html` template, some unit tests may fail. To fix them you should update test configuration in `app.component.spec.ts` and include your component into the test module:

app.component.spec.ts

```
import { TestBed, async } from '@angular/core/testing';

import { AppComponent } from './app.component';
import { MyFirstComponentComponent } from './my-first-component/my-first-component.c\
omponent';

describe('AppComponent', () => {
  beforeEach(async(() => {
    TestBed.configureTestingModule({
      declarations: [
        AppComponent,
        MyFirstComponentComponent
      ],
    }).compileComponents();
  }));

  ...
});
```

Creating modules

The Angular CLI tool also provides support for multiple modules and generating entities that belong to the particular module.

Let's start by generating a new module using the next command:

```
ng g module my-components
```

The output in the console should look similar to the following:

```
create src/app/my-components/my-components.module.ts (196 bytes)
```

And the content of the module contains a basic implementation like in the example below:

src/app/my-components/my-components.module.ts

```
import { NgModule } from '@angular/core';
import { CommonModule } from '@angular/common';

@NgModule({
  imports: [
    CommonModule
  ],
  declarations: []
})
export class MyComponentsModule { }
```

Note that by default Angular creates a folder for your module, similar to what it does for components. This is handy once you create components, services, directives and pipes that need to belongÂ to this module. But if you want to put the resulting module in a single file next to the "app.module.ts" use the "–flat" switch.

```
ng g module my-components --flat
```

In that case, the output will be:

```
create src/app/my-components.module.ts (196 bytes)
```

You can check more details on the available switches by running the "ng g module –help" command.

Assigning components to modules

By default, Angular CLI appends all generated content to the main application module inside "app.module.ts". Once you have two or more modules in the application, the CLI will require the module name for every new content.

Try running the following command to see what happens:

```
ng g component my-button-1
```

The output should be similar to the following one:

```
Error: More than one module matches.
Use skip-import option to skip importing the component into the closest module.
```

To include your new component into a particular module use the "–module" switch. If you are building a shared module, you might also use the "–export" switch, so that module exports your component besides declaration.

```
ng g component my-button-1 --module=my-components --export
```

This time, you will get the following result:

```
  create src/app/my-button-1/my-button-1.component.css (0 bytes)
  create src/app/my-button-1/my-button-1.component.html (30 bytes)
  create src/app/my-button-1/my-button-1.component.spec.ts (651 bytes)
  create src/app/my-button-1/my-button-1.component.ts (287 bytes)
  update src/app/my-components.module.ts (321 bytes)
```

And the module content now looks like in the code example below:

src/app/my-components.module.ts

```
import { NgModule } from '@angular/core';
import { CommonModule } from '@angular/common';
import { MyButton1Component } from './my-button-1/my-button-1.component';

@NgModule({
  imports: [
    CommonModule
  ],
  declarations: [MyButton1Component],
  exports: [MyButton1Component]
})
export class MyComponentsModule { }
```

Do not forget to check the "ng g component –help" to see all available options.

You can also include your new module into some other existing module from the command line.

```
ng g module my-feature --module=my-components --flat
```

As a result, the "MyComponentsModule" module will include "MyFeatureModule":

src/app/my-components.module.ts

```
@NgModule({
  imports: [
    CommonModule,
    MyFeatureModule
  ],
  declarations: [MyButton1Component],
  exports: [MyButton1Component]
})
export class MyComponentsModule { }
```

Routing support

If you plan working with Angular Router or want to experiment with routing capabilities, the Angular CLI can generate an application for you with initial Router support.

Use the "–routing" switch if you want to generate a routing module scaffold with your application.

```
ng new my-app --routing
```

The routing scaffold should look similar to the one below:

src/app/app-routing.module.ts

```
import { NgModule } from '@angular/core';
import { Routes, RouterModule } from '@angular/router';

const routes: Routes = [];

@NgModule({
  imports: [RouterModule.forRoot(routes)],
  exports: [RouterModule]
})
export class AppRoutingModule { }
```

In addition, the main application component is going to contain the router outlet component:

src/app/app.component.html

```
...
<router-outlet></router-outlet>
```

Generating standalone scripts

The Angular CLI provides a special feature that allows detaching command line tools from the project, and generating a set of scripts needed for standalone project compilation and testing:

```
ng eject
```

Which is an equivalent for `ng eject -dev` or `ng eject --target=development`, and instructs `ng` tool to use `development` configuration. Alternatively, you can use `-prod` or `--target=production` switches to enable `production` mode.

Upon running `eject` command, the CLI will:

- update `package.json` with all dependencies needed to compile project without extra tools
- generate and output the proper webpack configuration (`webpack.config.js`) and scripts for testing

The tool might provide additional notes in the console output like below:

```
==============================================================
Ejection was successful.

To run your builds, you now need to do the following commands:
   - "npm run build" to build.
   - "npm run test" to run unit tests.
   - "npm start" to serve the app using webpack-dev-server.
   - "npm run e2e" to run protractor.

Running the equivalent CLI commands results in error.

==============================================================
Some packages were added. Please run "npm install".
```

Now `scripts` section in your `package.json` file should link to local content for a `start`, `build` and various `test` scripts:

package.json

```
{
    ...
    "scripts": {
        "ng": "ng",
        "start": "webpack-dev-server --port=4200",
        "build": "webpack",
        "test": "karma start ./karma.conf.js",
        "lint": "ng lint",
        "e2e": "protractor ./protractor.conf.js",
        "prepree2e": "npm start",
        "pree2e": "webdriver-manager update --standalone false --gecko false --quiet"
    },
    ...
}
```

Components

Components are the main building blocks in Angular.

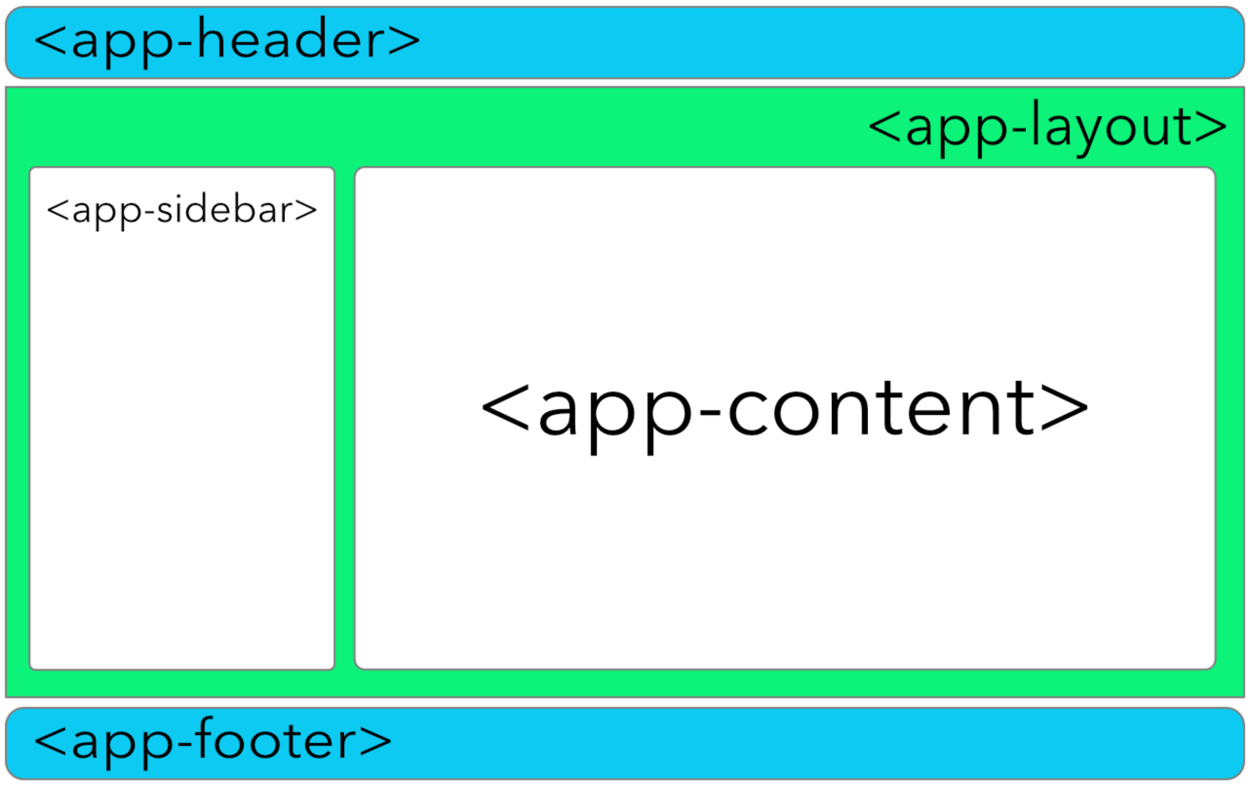
A typical Angular application is represented by a tree of elements starting with a single root one.

```
<app-root>

    <app-header title="My header">
        ...
    </app-header>

    <app-layout type="horizontal">

        <app-sidebar>
            ...
        </app-sidebar>

        <app-content>
            ...
        </app-content>

    </app-layout>

    <app-footer>
        ...
    </app-footer>

</app-root>
```

As you can see from the markup above, our main application template consists at least of the following six components:

- app-root
- app-header
- app-layout
- app-sidebar
- app-content
- app-footer

Schematically it should look similar to the following:



Creating a simple component

Let's build a simple Angular component in the new "basic-components" project.

The easiest and quickest way to prepare a project structure is using Angular CLI to setup scaffold.

Angular CLI

You can find detailed information on setting up project scaffolds in the "Angular CLI" chapter.

You start creating a component with importing the `@Component` decorator from the `@angular/core`:

```
import { Component } from '@angular/core';
```

The `@Component` decorator supports multiple properties, and we are going review them in the Component metadata section later in this chapter. For the bare minimum, you need to set the "selector" and "template" values to create a basic reusable component.

Our minimal "Header" component implementation can look in practice like in the following example.

src/app/components/header.component.ts

```
import { Component } from '@angular/core';

@Component({
  selector: 'app-header',
  template: '<div>{{ title }}</div>'
})
export class HeaderComponent {

  title: string = 'Header';

}
```

You set the selector value to ‘app-header’. That means you are registering a new HTML element called “<app-header>”.

You also set a “template” property that holds the inline HTML template string. At run time the Header element is to be rendered as a `<div>` element with its inner text bound to the “title” property of the “HeaderComponent” class.

Note that before using Header component within an application, we need to register it within the main application module.

Application module

You are going to get more detailed information on Angular modules in a separate Modules chapter.

For now, it is good for you to have just a basic understanding of how components get registered within modules.

Below you can see an example of how typically register a component. For the sake of simplicity, we are going to see only newly added content.

src/app/app.component.ts

```
...
import { HeaderComponent } from './components/header.component';

@NgModule({
  declarations: [
    ...
    HeaderComponent
  ],
  ...
})
export class AppModule { }
```

Finally, to test your component just put the following content into the main application template HTML file.

src/app/app.component.template

```
<app-header></app-header>
```

Once you compile and run your web application, you should see the following content on the main page.

```
Header
```

Congratulations, you have just created a basic Angular component that you can now reuse across all your web application.

Source code

You can find the source code as an Angular CLI project in the "angular/components/basic-components[23]" folder.

Generating components with Angular CLI

Now let's try creating another component utilising Angular CLI. This time we are going to create a Footer element. That should give a good comparison on manual versus automatically generated approaches.

Using the command line prompt execute the following command in the project root directory:

```
ng g component components/footer
```

You should instantly notice how Angular CLI saves your time. It creates you a full set of files for your Footer component and event modifies the main application module file for you.

You can check the console output below:

[23]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/basic-components

```
installing component
  create src/app/components/footer/footer.component.css
  create src/app/components/footer/footer.component.html
  create src/app/components/footer/footer.component.spec.ts
  create src/app/components/footer/footer.component.ts
  update src/app/app.module.ts
```

Angular CLI

You can find detailed information on blueprints and content generation in the "Angular CLI" chapter.

As a result, you get an initial component implementation with an external HTML and CSS templates and even a unit test scaffold.

src/app/components/footer/footer.component.ts

```
import { Component, OnInit } from '@angular/core';

@Component({
  selector: 'app-footer',
  templateUrl: './footer.component.html',
  styleUrls: ['./footer.component.css']
})
export class FooterComponent implements OnInit {

  constructor() { }

  ngOnInit() {
  }

}
```

Finally, you can update your main application template to see both header and footer elements in action:

src/app/app.component.html

```
<app-header></app-header>
<app-footer></app-footer>
```

Upon compiling the application and reloading the page, you should see the following output.

```
Header
footer works!
```

Note how Angular CLI provides a content of the automatically generated Footer element.

So as you can from the examples above, you save an enormous amount of time when using Angular CLI when it comes to scaffold generation.

Component metadata

According to the official documentation, you can use the following set of properties with a @Component decorator:

Name	Type	Description
changeDetection	ChangeDetectionStrategy	Defines the change detection strategy the component should use.
viewProviders	Provider[]	Defines the set of injectable objects that are visible to its view DOM children.
moduleId	string	ES/CommonJS module id of the file in which this component is defined.
templateUrl	string	Specifies a URL containing a relative path to an external file containing a template for the view.
template	string	An inline-defined template for the view.
styleUrls	string[]	List of URLs containing relative paths to the stylesheets to apply to this component's view at runtime.
styles	string[]	List of inline-defined styles to apply to this component's view at runtime.
animations	any[]	List of animations of this component in a special DSL-like format.
encapsulation	ViewEncapsulation	Defines style encapsulation strategy used by this component.
interpolation	[string, string]	Overrides the default encapsulation start and end delimiters (respectively `{{` and `}}`).
entryComponents	Array<Type<any> | any[]>	List of components that are dynamically inserted into the view of this component.

The `@Component` decorator extends the `@Directive` one, so it also inherits the following set of properties you can use as well:

Name	Type	Description
selector	string	CSS selector that identifies this component in a template.
inputs	string[]	List of class property names to data-bind as component inputs.
outputs	string[]	List of class property names that expose output events that others can subscribe to.
host	{ [key: string]: string; }	Map that specifies the events, actions, properties and attributes related to the host element.
providers	Provider[]	List of providers available to this component and its children.

Name	Type	Description
exportAs	string	A name under which the component instance is exported in a template.
queries	{ [key: string]: any; }	Map of queries that can be injected into the component.

Templates

There are two ways to assign a component view template: inline-defined and external file.

Inline templates

You specify inline template by setting the "template" field value of the `@Component` decorator. To get better formatting and multi-line support, you can use template literals feature introduced in ES6 and backed by TypeScript out of the box.

Template literals

Template literals are string literals allowing embedded expressions. You can use multi-line strings and string interpolation features with them.

For more detailed information on this ES6 feature, please refer to the following Template literals[24] article.

Most of the modern IDEs already have support for mixed content, including TypeScript files. If you are using Visual Studio Code[25] for development, then you already have syntax highlighting for HTML and CSS.

Let's edit the Header component template to take multiple lines like in the example below:

src/app/components/header.component.ts

```
@Component({
  selector: 'app-header',
  template: `
    <div>
        <div>{{ title }}</div>
    </div>
  `
})
export class HeaderComponent {
  title: string = 'Header';
}
```

[24]https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Template_literals
[25]https://code.visualstudio.com/

Using backtick characters also allows you to have single and double quotes in HTML without any additional escaping or string concatenation. You are using the same HTML content inlined as you would have in separate files.

Typically you may want to use inline templates only when your component view is small.

External templates

The HTML code in the templates usually grows over time and becomes less maintainable. That is why storing HTML in the separate files may be more practical and productive.

The `@Component` decorator provides support for external templates through the "templateUrl" option. Please note that you should set only "template" or "templateUrl", you cannot define both of them at the same time.

Let's now update our Header component we created earlier and move its HTML template to a separate file.

src/app/components/header.component.html

```html
<div>
    <div>{{ title }}</div>
</div>
```

The "templateUrl" property should always point to a path relative to the component class file. In our case, we put both files together in the same directory and update decorator declaration accordingly.

src/app/components/header.component.ts

```typescript
@Component({
  selector: 'app-header',
  templateUrl: './header.component.html'
})
export class HeaderComponent {
  title: string = 'Header';
}
```

Typically developers put them next to the component class implementation and give the same name for the file as the component:

- header.component.html
- header.component.ts

External files

External files are the most convenient and recommended way of storing your components' HTML templates.

Styles

Similar to the HTML templates, the `@Component` decorator also provides support for CSS styles in either inline or external form.

Inline styles

If your component is small and you decided to use inline HTML templates then high chances you may want to inline CSS styles as well.

The “styles” property of the `@Component` decorator is used to store an array of CSS styles that Angular applies to the component at runtime.

To test that in practice let’s add a couple of class names to the HTM elements inside the component’s template.

src/app/components/header.component.ts

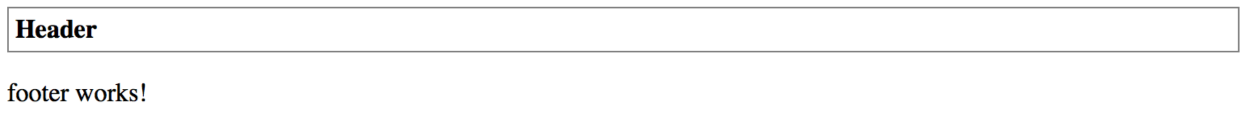
```
@Component({
    selector: 'app-header',
    template: `
        <div class="app-header">
            <div class="app-header-title">
                {{ title }}
            </div>
        </div>
    `
})
export class HeaderComponent { ... }
```

We just added “app-header” and “app-header-title” classes, and it is time to provide some CSS for those elements.

src/app/components/header.component.ts

```
@Component({
    selector: 'app-header',
    template: `
        <div class="app-header">
            <div class="app-header-title">
                {{ title }}
            </div>
        </div>
    `,
    styles: [`
        .app-header {
            border: 1px solid gray;
            padding: 4px;
        }
        .app-header-title {
            font-weight: bold;
        }
    `]
})
export class HeaderComponent { ... }
```

Now if you compile and run your web application you should see a nice grey border around your Header component. Also, the “Header” title should have the bold font style.


Header

footer works!

As with the inline templates, you may want to inline your style files only for the small components.

External styles

The CSS styles tend to grow over time even faster than HTML content. So it is recommended to move them to the separate files at early stages.

Similar to external HTML templates Angular provides support for external CSS. You can use “styleUrls” property to provide an array of the URLs with relative paths to corresponding files.

You already know how to use external HTML templates with your components. Let’s now extract the CSS into a separate file as well. Typically the main style file is called after the parent component class, in our case, it becomes “header.component.css”.

src/app/components/header.component.css

```css
.app-header {
  border: 1px solid gray;
  padding: 4px;
}

.app-header-title {
  font-weight: bold;
}
```

You should now have "Header" component split into the three separate files:

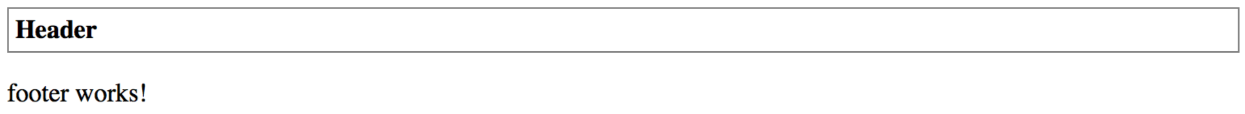
- header.component.css
- header.component.html
- header.component.ts

With the changes to @Component decorator properties, the component implementation should now look like the following:

src/app/components/header.component.ts

```typescript
@Component({
  selector: 'app-header',
  templateUrl: './header.component.html',
  styleUrls: [
    './header.component.css'
  ]
})
export class HeaderComponent { ... }
```

Visually the component should look the same as with the inline CSS styles. Once you compile and run your web application, the main page looks like on the screenshot below.



Header

footer works!

External files

External files are the most convenient and recommended way of storing your components' CSS stylesheets.

Input properties

The `@Input` decorator is used to mark a class property that binds to incoming data.

Let's take a closer look at our Header component created earlier in this chapter.

The component exposes a “title” property of the “string” type and with the default value set to “Header”.

```
@Component({...})
export class HeaderComponent {
  title: string = 'Header';
}
```

We have also provided an HTML template that binds to the underlying “title” property.

```
<div class="app-header">
  <div class="app-header-title">{{ title }}</div>
</div>
```

As you can notice from the example above the major limitation of the Header component is that we cannot change the header title text from the outside.

The only way we can use it so far is by utilising plain selector:

{{linenos=off}} `html <app-header></app-header> <app-footer></app-footer>`

Next, let's provide data-binding support for the “title” property using `@Input` decorator as following:

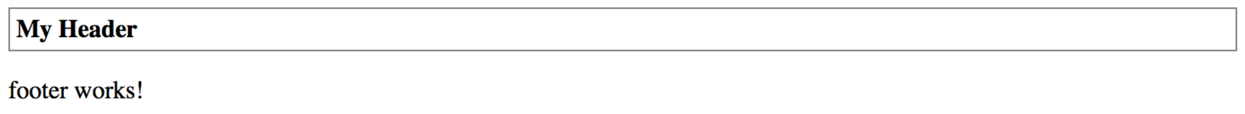
src/app/components/header.component.ts

```
import { ..., Input } from '@angular/core';

@Component({ ... })
export class HeaderComponent {

  @Input()
  title: string = 'Header';
}
```

You can now use Header component with custom title values. Set the value to “My Header” to test that in action.

```
<app-header title="My Header"></app-header>
<app-footer></app-footer>
```

This time once your web application compiles and starts the Header should look like on the picture below:



My Header

footer works!

You can also bind "title" property value to another property. For example, imagine a scenario when main application component maintains global settings and initializes Header and Footer content.

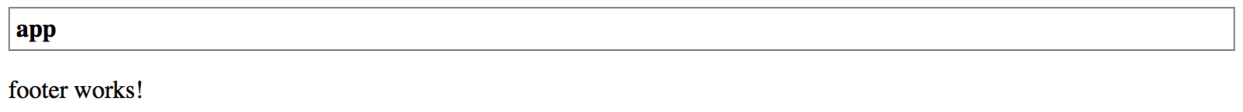
src/app/app.component.ts

```
@Component({ ... })
export class AppComponent {
  title = 'app';
}
```

In this case, you can bind the Header title like following:

```
<app-header [title]="title"></app-header>
<app-footer></app-footer>
```

Reload the page, and you are going to see the header having now the "app" title as per main application component implementation.



app

footer works!

Binding to expressions

Keep in mind that you are binding to JavaScript expressions when using square brackets with element attributes.

The example above can also be changed to bind to a string or component class method. For example `<app-header [title]="getHeaderTitle()">` or `<app-header [title]="'Hello ' + 'world'">`.

By default, the `@Input` takes the name of the decorated property when setting up the bindings. You can, however, change the name of the resulting HTML attribute.

@Input decorator accepts additional optional property alias "bindingPropertyName" to redefine the name to use in the template. Let's change the binding name of the "title" property to the "title-text" value.

```
export class HeaderComponent {

    @Input('title-text')
    title: string = 'Header';

}
```

From now on you should be settings "title-text" attribute in HTML templates when using Header component with the custom title.

```
<app-header title-text="My Title"></app-header>
<app-footer></app-footer>
```

Please note that you are going to deal with two different property names at the same time when using input aliases. The component template still references property by the original name "title" while externally this property is known as "title-text":

```
<div class="app-header">
  <div class="app-header-title">{{ title }}</div>
</div>
```

Avoid aliasing inputs and outputs

According to the Angular Style Guide (Style 05-13[26]), you should avoid using alias for @Input and @Output decorators except when is needed and serves an important purpose.

Two names for the same property is confusing and may require additional documentation and maintenance over time.

Output events

You use `@Output` decorator in combination with the `EventEmitter` type to create component events.

To better understand how events are used and work let's introduce and see a component event in action.

Raising events

We are going to extend our Header component with a "click" event. Every time the header title gets clicked the component is going to raise a "titleClick" event.

[26]https://angular.io/guide/styleguide#style-05-13

src/app/components/header.component.ts

```
import { ..., Output, EventEmitter } from '@angular/core';

@Component({...})
export class HeaderComponent {
    ...

    @Output()
    titleClick = new EventEmitter();
}
```

Now to raise the newly introduced event from the component, we call its "next" method:

```
this.titleClick.next();
```

Next, we need to wire component template with the underlying method "handleTitleClick". The latter is going to be responsible for raising the corresponding "titleClick" event.

src/app/components/header.component.html

```
<div class="app-header">
  <div class="app-header-title" (click)="handleTitleClick()">{{ title }}</div>
</div>
```

The "handleTitleClick" implementation can be as follows:

src/app/components/header.component.ts

```
@Component({...})
export class HeaderComponent {
    ...

    @Output()
    titleClick = new EventEmitter();

    handleTitleClick() {
        this.titleClick.next();
    }
}
```

Handling events

We have extended our Header component to raise an event once a user clicks the title. Now let's make our main application handle this event and display click counter on the page.

src/app/app.component.html

```html
<app-header
  [title]="title"
  (titleClick)="onTitleClicked()">
</app-header>
<div>
  Header clicks: {{ headerClicks }}
</div>
<app-footer></app-footer>
```

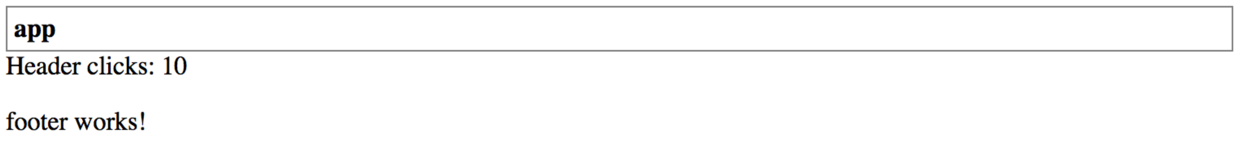
As you can see from the code above the main application component subscribes to the "titleClick" event and uses "onTitleClicked" method as an event handler.

The component also displays the "headerClicks" property value for us to see the event handler works. The final thing we need right now is incrementing the counter property like in the code below:

src/app/app.component.ts

```typescript
@Component({...})
export class AppComponent {

    headerClicks = 0;

    onTitleClicked() {
        this.headerClicks += 1;
    }

}
```

Now if you run the web application and click several times on the header text, you should see the clicks counter increase in real time.


app
Header clicks: 10

footer works!

Typed events

The EventEmitter type we used for earlier is a generic type, and by default takes the type variable of "any".

```
EventEmitter<any>
```

In many cases, you may want to provide the additional event arguments to enable better handling of your component events. For example, a “click” event may expose details on the mouse cursor position or a “textChanged” event that exposes old and new text values.

In the previous section, we have already created a Header component that raises generic “titleClick” event with no arguments. To compare both approaches let’s now update Footer component with the similar event but of a specific type.

The Footer is going to count the number of clicks itself and provide the value as part of the event. The main application is no longer required to keep track on clicks as it is going to get exact values from the corresponding event arguments.

If you remember, we created a Footer component using the following Angular CLI command:

```
ng g component components/footer
```

First, create a “FooterClickedEvent” class to hold the clicks-related information for our “titleClicked” event:

src/app/components/footer/footer-clicked.event.ts

```
export class FooterClickedEvent {

    constructor(public readonly totalClicks: number = 0) {
    }

}
```

For the sake of simplicity, we are going to create a class with a single read-only property “totalClicks” we assign in the constructor, and that defaults to zero if not provided.

Next, edit your footer component and update its code with the following pieces that add a “title” input property and “titleClicked” output event:

src/app/components/footer/footer.component.ts

```
import { ..., Output, EventEmitter } from '@angular/core';
import { FooterClickedEvent } from './footer-clicked.event';

@Component({...})
export class FooterComponent {

    @Input()
    title = 'Footer';

    @Output()
    titleClick = new EventEmitter<FooterClickedEvent>();

}
```

As you can see above, we also declare a private property “totalClicks” to hold the overall clicks count.

Note how we use EventEmitter type this time. Using “FooterClickedEvent” as an EventEmitter’s type variable allows us now to create an instance of the given type and emit as an event.

src/app/components/footer/footer.component.ts

```
@Component({...})
export class FooterComponent {
    ...

    private totalClicks = 0;

    handleTitleClick() {
        const event = new FooterClickedEvent(++this.totalClicks)
        this.titleClick.next(event);
    }

}
```

Now we can update the component template to display the title and handle mouse clicks:

src/app/components/footer/footer.component.html

```
<p>
  <span (click)="handleTitleClick()">{{ title }}</span>
</p>
```

Every time user clicks the “title” element of the Footer, the component is going to increment clicks counter and raise an event with its actual value.

Accessing event parameters

Angular provides a way to access the original event by using a special “$event” variable that you can pass to your handlers.

```
<app-footer
  title="My footer"
  (titleClick)="onHeaderClicked($event)">
</app-footer>
```

In our current case, we handle “titleClick” event and pass original “FooterClickedEvent” to the “onHeaderClicked” handler inside application controller. That provides access to “totalClicks” property we created earlier.

DOM events

Please keep in mind that “$event” usage applies to all events, either custom or standard DOM ones. For instance, you can inspect “click”, “hover”, “input” and many other DOM events from within your class methods.

Let’s now update our main application component to display the number of times the user clicked the Footer.

src/app/app.component.ts

```
...
import { FooterClickedEvent } from './components/footer/footer-clicked.event';

@Component({...})
export class AppComponent {
    ...
    footerClicks = 0;

    onHeaderClicked(event: FooterClickedEvent) {
        this.footerClicks = event.totalClicks;
    }
}
```

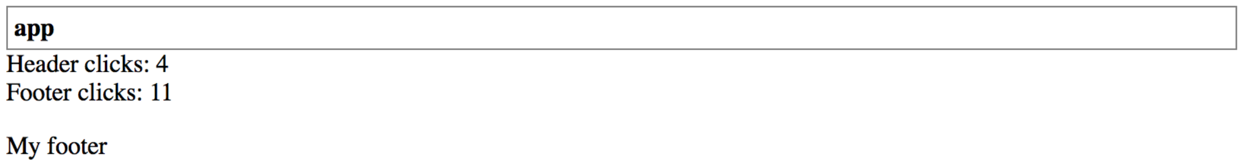
As you can see in the example above, we now can import “FooterClickedEvent” type and use with the event handler parameters to get type checking and code completion support in your IDE.

Finally, let’s update the main component template to display click counters for the Footer alongside the Header.

src/app/app.component.html

```
<app-header
  [title]="title"
  (titleClick)="onTitleClicked()">
</app-header>

<div>Header clicks: {{ headerClicks }}</div>
<div>Footer clicks: {{ footerClicks }}</div>

<app-footer
  title="My footer"
  (titleClick)="onHeaderClicked($event)">
</app-footer>
```

You can now run your web application and make several clicks on Header and Footer components to see all event handlers in action. You should see results similar to the following:



```
app
Header clicks: 4
Footer clicks: 11

My footer
```

Aliased outputs

Similar to the `@Input` decorator the `@Output` one also supports custom aliases for event names and takes the name of the decorated property as the default value.

In the previous examples, we used “titleClick” for the output property name:

src/app/components/footer/footer.component.ts

```
@Component({...})
export class FooterComponent {
    ...

    @Output()
    titleClick = new EventEmitter<FooterClickedEvent>();
}
```

You could also provide the “title-click” alias for the event like below:

src/app/components/footer/footer.component.ts

```
@Component({...})
export class FooterComponent {
    ...

    @Output('title-click')
    titleClick = new EventEmitter<FooterClickedEvent>();
}
```

In this case the "official" (or public) event name for the Footer's "titleClick" component would be "title-click", and not "titleClick":

```
<app-footer
  title="My footer"
  (title-click)="onHeaderClicked($event)">
</app-footer>
```

Avoid aliasing inputs and outputs

According to the Angular Style Guide (Style 05-13[27]), you should avoid using alias for @Input and @Output decorators except when is needed and serves an important purpose.

Two names for the same property is confusing and may require additional documentation and maintenance over time.

Providers

Every Angular component can declare its own set of providers. The use of local providers allows developers to replace global instances of services, and register and use a new copy of the service for the given component and all child components.

Let's see how local component providers work in practice. We are going to need a new service 'ClickCounterService' that you can generate with the following Angular CLI command:

```
ng g service click-counter
```

The service is going to keep track of the user clicks on the elements. Our components should notify the service upon every click, and also subscribe to the service events to get notifications on clicks from other components.

[27]https://angular.io/guide/styleguide#style-05-13

Add the "clicks" property to the service to hold total amount of clicks happened across the application. Then add the "clicked" event to allow components to subscribe and perform custom actions if needed. Finally, implement the "click" method that increments the click counter and emits the corresponding event at the same time.

```
import { Injectable, EventEmitter } from '@angular/core';

@Injectable({
  providedIn: 'root'
})
export class ClickCounterService {

  clicks = 0;

  clicked = new EventEmitter<number>();

  click() {
    this.clicks += 1;
    this.clicked.emit(this.clicks);
  }

}
```

Let's register the newly created "ClickCounterService" service as part of the global providers, in the main application module.

Registering service

Given that developers can register services in different places, the Angular CLI does not perform default registration and does not modify "app.module.ts" file like it does for other Angular entities.

Please refer to the code below for an example of service registration:

src/app/app.module.ts

```
...
import { ClickCounterService } from './click-counter.service';

@NgModule({
  ...
  providers: [
    ClickCounterService
  ],
  ...
})
export class AppModule { }
```

For the next step, we are going to need three simple components. You can quickly generate them using the following Angular CLI commands:

```
ng g component componentA
ng g component componentB
ng g component componentC
```

Now replace the content of the main application component template with the following code:

src/app/app.component.html

```
<app-component-a></app-component-a>
<app-component-b></app-component-b>
<app-component-c></app-component-c>
```

Once you build and run the application, you should see the following content on the main page:

```
component-a works! component-b works! component-c works!
```

Now, let's integrate one of the components with the "ClickCounterService" service we introduced earlier. Our component is going to have an HTML button that invokes "onClick" method upon every click. The component also subscribes to the service's "clicked" event to update the local "totalClicks" property and display it to the user.

src/app/component-a/component-a.component.ts

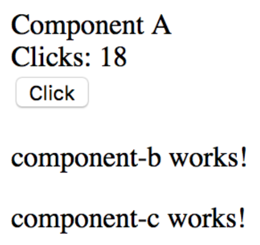
```
import { Component, OnInit } from '@angular/core';
import { ClickCounterService } from '../click-counter.service';

@Component({
  selector: 'app-component-a',
  templateUrl: './component-a.component.html',
  styleUrls: ['./component-a.component.css']
})
export class ComponentAComponent implements OnInit {

  totalClicks = 0;

  constructor(private clickService: ClickCounterService) { }

  ngOnInit() {
    this.clickService.clicked.subscribe((clicks) => {
      this.totalClicks = clicks;
    });
  }

  onClick() {
    this.clickService.click();
  }

}
```

Also, replace the component template content with the following markup:

src/app/component-a/component-a.component.html

```
Component A <br>
Clicks: {{ totalClicks }} <br>
<button (click)="onClick()">Click</button>
```

Run the application or switch to the running one. Click the component button multiple times to see the counter updates.


Component A
Clicks: 18
Click

component-b works!

component-c works!

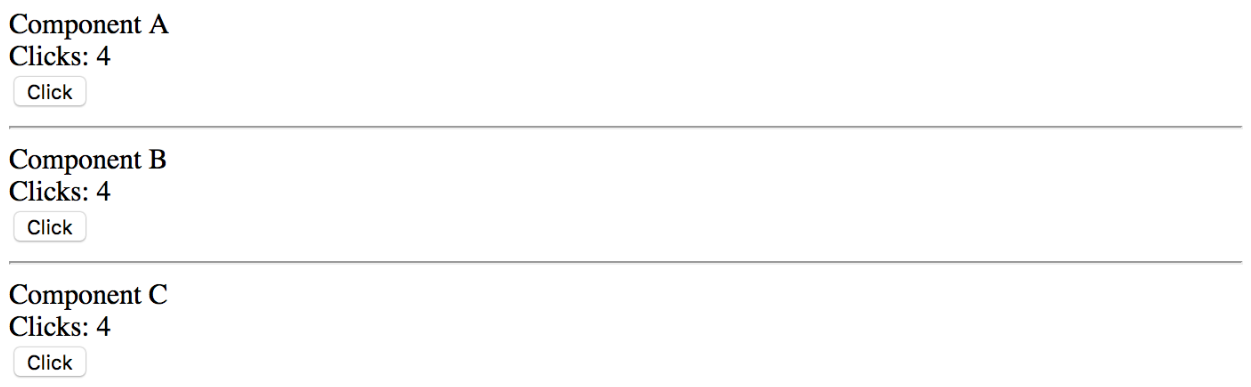
Repeat the same procedure for other two components we got. All three components should display the total number of clicks fetched from the server, and have a button for the user to click.

Also, let's slightly improve the main application template and add dividers for better visibility:

src/app/app.component.html

```html
<app-component-a></app-component-a>
<hr>
<app-component-b></app-component-b>
<hr>
<app-component-c></app-component-c>
```

Switch to your running application and try clicking one of the buttons several times. You should see that all click counters get updated automatically with the same value. That is an expected behaviour because all we got three components powered by the same instance of the "ClickCounterService" service. Every time we click a button, the service notifies other components that update local counter properties and display labels.


Component A
Clicks: 4
Click

Component B
Clicks: 4
Click

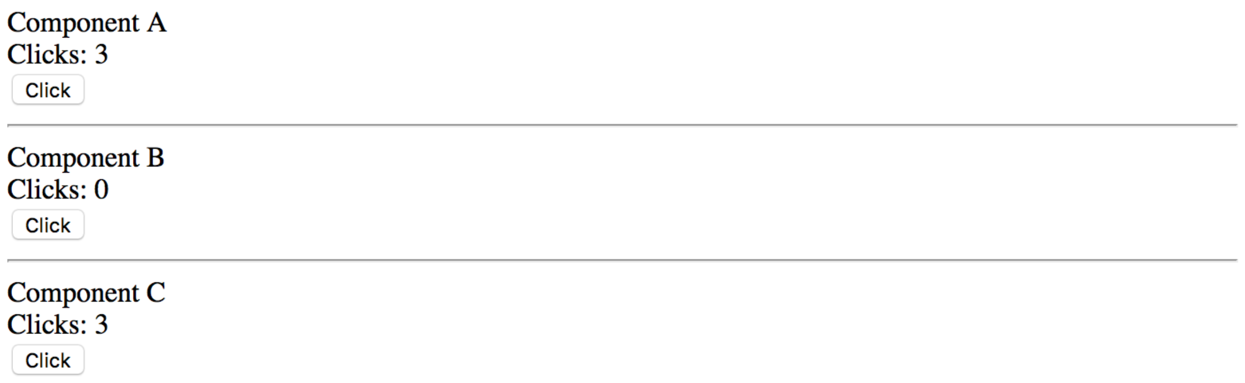
Component C
Clicks: 4
Click

Now, let's see what happens if one of the components, let it be Component B, declares its own "providers" collection. Import the "ClickCounterService" and declare it as in the example below:

src/app/component-b.component.ts

```
...
import { ClickCounterService } from '../click-counter.service';

@Component({
  selector: 'app-component-b',
  templateUrl: './component-b.component.html',
  styleUrls: ['./component-b.component.css'],
  providers: [
    ClickCounterService
  ]
})
export class ComponentBComponent implements OnInit {
  ...
}
```

If now you start clicking on the first component, only "Component A" and "Component C" are going to update the labels. The "Component B" should remain with the zero value.

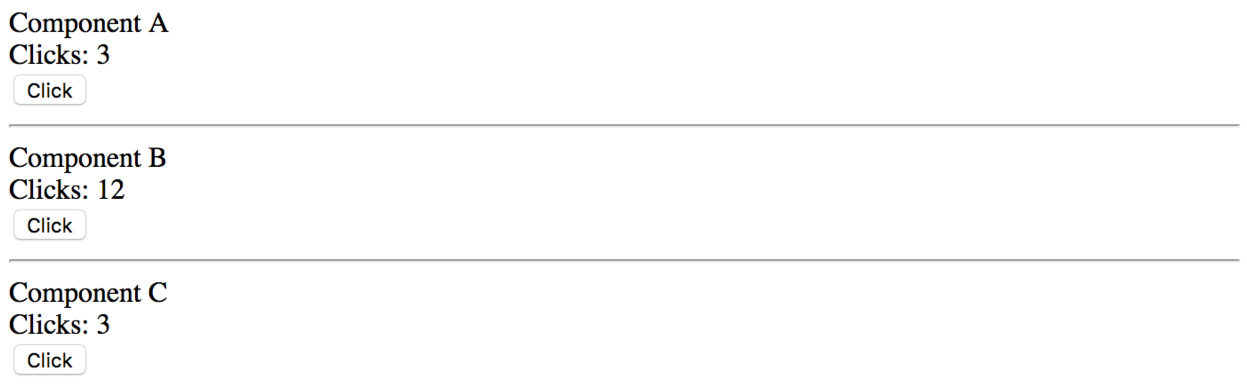


Component A
Clicks: 3

Component B
Clicks: 0

Component C
Clicks: 3

As you can see, the "Component B" declares its local instance of the service, so it does not react to the events raised by the global one. Now if you click the "Component B" button several times, its counter label should update separately from other components. Moreover, other components are not going to update on "Component B" clicks, as they are listening to the global service events.


Component A
Clicks: 3

Component B
Clicks: 12

Component C
Clicks: 3

The component-level provider is a great feature. It allows you to have more than one instance of the service or to have custom service implementation or replacement for a particular component and all child components that you use in its template.

Advanced feature

You should be very careful and use this feature only when it is necessary as it is quite easy to introduce an issue when creating multiple instances of the same service type. For example the Authentication Service. Typically you may want always to have only one instance, as the service might keep the authentication state or some other critical data, and having more than one service leads to application issues.

Source code

You can find the source code in the "angular/components/component-providers[28]" folder.

Host

The host property is an object of a Map type and specifies the events, actions, properties and attributes related to the resulting element.

Use the following Angular CLI command to generate a new "host-events" component for the tests:

```
ng g component host-events
```

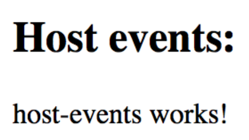
Also, replace the content of the main application component template with your component declaration:

[28]https://github.com/DenysVuika/developing-with-angular/blob/master/angular/components/component-providers

src/app/app.component.html

```html
<h2>Host events:</h2>
<app-host-events></app-host-events>
```

Run the application and ensure the main page looks similar to the following:



Host events:

host-events works!

CSS class

Your component or directive can assign a class name to the corresponding DOM element that serves the root of the component. For example setting the class name to the "host-events" value looks like the following:

src/app/host-events/host-events.component.ts

```typescript
@Component({
  selector: 'app-host-events',
  templateUrl: './host-events.component.html',
  styleUrls: ['./host-events.component.css'],
  host: {
    class: 'host-events'
  }
})
export class HostEventsComponent implements OnInit {
    ...
}
```

At runtime, if you use the "Inspect element" tool to view the compiled HTML output, it should look similar to the following:

```html
<app-host-events _ngcontent-c0="" class="host-events" _nghost-c1="">
    <p _ngcontent-c1="">
        host-events works!
    </p>
</app-host-events>
```

Note that the main "app-host-events" element has now the "host-events" class name associated with it.

You can also set multiple classes based on property values using the following format:

```
host: {
    '[class.<className1>]': '<statement1>',
    '[class.<classNameN>]': '<statementN>'
}
```

Let’s bind a couple of CSS class names to the component class properties:

src/app/host-events/host-events.component.ts

```
@Component({
  selector: 'app-host-events',
  templateUrl: './host-events.component.html',
  styleUrls: ['./host-events.component.css'],
  host: {
    '[class.is-invalid]': 'isInvalid',
    '[class.is-readonly]': 'isReadonly'
  }
})
export class HostEventsComponent implements OnInit {
    ...

    isInvalid: boolean = false;
    isReadonly: boolean = false;
}
```

The class values are toggled based on the corresponding property values.

For example, the “is-invalid” is appended to the class list of the DOM element as soon as ‘isInvalid’ property turns to “true”, also, is automatically removed from the class list if it has the value of “false”.

Host events

The component or directive you create can also use “host” metadata property to bind element events to the class methods. The usage format, in this case, is as follows:

```
host: {
    '(<event>)': '<statement>'
}
```

To test the event bindings in action let’s wire the “mouseenter” and “mouseleave” DOM events with the “onMouseEnter” and “onMouseLeave” methods that are going to change the “color” property value:

src/app/host-events/host-events.component.ts

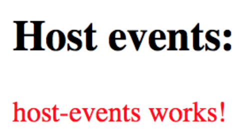
```
import { Component } from '@angular/core';

@Component({
  selector: 'app-host-events',
  templateUrl: './host-events.component.html',
  styleUrls: ['./host-events.component.css'],
  host: {
    class: 'host-events',
    '(mouseenter)': 'onMouseEnter()',
    '(mouseleave)': 'onMouseLeave()'
  }
})
export class HostEventsComponent {

  color = 'black';

  onMouseEnter() {
    this.color = 'red';
  }

  onMouseLeave() {
    this.color = 'black';
  }

}
```

Finally, update the component template to use the “color” property like in the example below:

src/app/host-events/host-events.component.html

```
<p [style.color]="color">
  host-events works!
</p>
```

Now switch to the running application and try moving the mouse cursor over the component text. You should see the colour of the text changing automatically upon mouse events.



Host events:

host-events works!

Your component can also listen to global events using the following format:

```
host: {
    '(<target>:<event>)': '<statement>'
}
```

Where 'target' can be of one the following values:

- window
- document
- body

For example, the component can listen to 'window.resize' events and adapt the layout accordingly:

src/app/host-events/host-events.component.ts

```
...

@Component({
  ...
  host: {
    class: 'host-events',
    '(mouseenter)': 'onMouseEnter()',
    '(mouseleave)': 'onMouseLeave()',
    '(window:resize)': 'onWindowResize()'
  }
})
export class HostEventsComponent {

  ...

  onWindowResize() {
    console.log('Window resized');
  }

}
```

If you run the developer tools in your browser and try resizing the browser window, you should notice the component reacts on that and writes corresponding messages to the console log.

Host attributes

The Angular framework allows you to map multiple HTML attributes to the class properties or static string values. Let's set the "role" and "aria-label" attributes from within the host metadata:

src/app/host-events/host-events.component.ts

```
...

@Component({
  ...
  host: {
    class: 'host-events',
    '(mouseenter)': 'onMouseEnter()',
    '(mouseleave)': 'onMouseLeave()',
    '(window:resize)': 'onWindowResize()',
    'role': 'button',
    'aria-label': 'Demo button'
  }
})
export class HostEventsComponent {
  ...
}
```

As soon as the page gets rendered, you can inspect the compiled HTML layout to check the element attributes. The "app-host-events" element now contains the expected attributes:

```
<app-host-events _ngcontent-c0="" aria-label="Demo button" class="host-events" role=\
"button" _nghost-c1="">
    <p _ngcontent-c1="" style="color: black;">
        host-events works!
    </p>
</app-host-events>
```

Host properties

Finally, you can bind component properties to element properties. That might be useful when developing Angular directives.

For example, a directive that automatically changes the button value based on one of its properties can look like the following:

src/app/host-properties.directive.ts

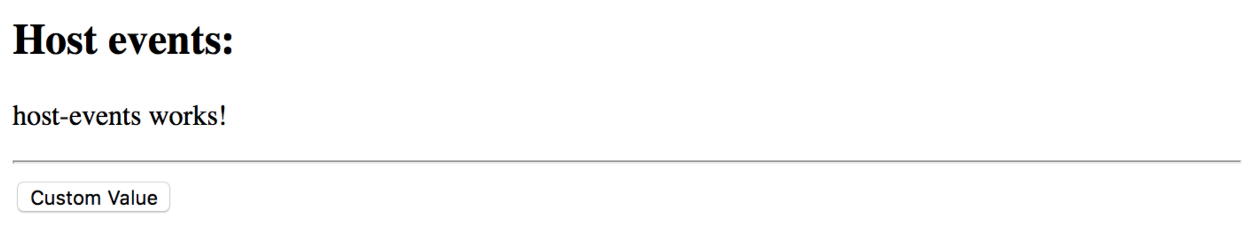
```
import { Directive } from '@angular/core';

@Directive({
  selector: '[appHostProperties]',
  host: {
    '[innerHTML]': 'value'
  }
})
export class HostPropertiesDirective {

  value = 'Custom Value';

}
```

Now, let's define a simple button and see the directive in action:

src/app/app.component.html

```
<h2>Host events:</h2>
<app-host-events></app-host-events>

<hr>
<button appHostProperties>Click me</button>
```

Note that we provided the button text in the HTML template. Switch back to the browser window and ensure the button value got changed by the directive as per the host metadata settings.



Host events:

host-events works!

Similar to the CSS classes, you can provide values for multiple attributes of the decorated DOM element using the following syntax:

```
host: {
    '[attr.<name1>]': '<statement1>',
    '[attr.<nameN>]': '<statementN>',
}
```

Let's bind a "custom1" attribute to the "attrValue" property of the class to check how that feature works.

```
import { Directive } from '@angular/core';

@Directive({
  selector: '[appHostProperties]',
  host: {
    '[innerHTML]': 'value',
    '[attr.custom1]': 'attrValue'
  }
})
export class HostPropertiesDirective {

  value = 'Custom Value';
  attrValue = 'some attribute value';
}
```

If you remember, we got a button element declared in the main application template like below:

```
<button appHostProperties>Click me</button>
```

At the runtime, the element gets a custom attribute from the directive:

```
<button _ngcontent-c0="" apphostproperties="" custom1="some attribute value">Custom \
Value</button>
```

Source code

You can find the source code as an Angular CLI project in the "angular/components/component-host[29]" folder.

[29]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/component-host

Queries

There may be scenarios when you need accessing child components from your current component that contains them. That becomes useful when you need calling public methods or change properties of the children.

Source code

You can find the source code as an Angular CLI project in the "angular/components/component-queries[30]" folder.

Preparing the project

Let's start by creating a new Angular project with the help of Angular CLI, and creating to components "List" and "ListItem" to experiment.

```
ng g component list
ng g component list-item
```

Extend the generated List component with an extra property "title" marked with the `@Input` decorator.

src/app/list/list.component.ts

```
import { ..., Input } from '@angular/core';

@Component({...})
export class ListComponent implements OnInit {

  @Input()
  title = 'List Title';

  ...
}
```

Next, update the component HTML template to display the "title" value, and also the "ng-content" component to render any other components or HTML elements the end developers provide:

[30] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/component-queries

src/app/list/list.component.html

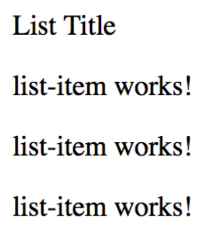
```html
<div>{{ title }} </div>
<ng-content></ng-content>
```

Now you can declare a List element in the main application component template, and also put several ListItem components inside its tags:

src/app/app.component.html

```html
<app-list>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
</app-list>
```

At runtime, the code above should give you the following output on the main page:



```
List Title

list-item works!

list-item works!

list-item works!
```

@ViewChild

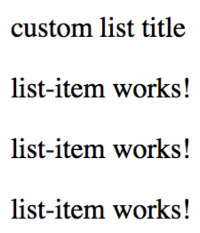
The `@ViewChild` decorator allows you to retrieve and reference the component or directive from the current component View.

For example, the main application component can gain access to the List component we have defined in its HTML template, and modify properties of the component instance from the code. To do that we need to use a @ViewChild decorator with the target type. You can access the property decorated with the @ViewChild only after component's View initialises. The "AfterViewInit" interface and corresponding method is the most appropriate place for that.

src/app/app.component.ts

```
import { ..., ViewChild, AfterViewInit } from '@angular/core';
import { ListComponent } from './list/list.component';

@Component({...})
export class AppComponent implements AfterViewInit {

  @ViewChild(ListComponent)
  list: ListComponent;

  ngAfterViewInit() {
    this.list.title = 'custom list title';
  }
}
```

In the code snippet above, we change the title of the child List component from code. Switch to the browser running your application, and you should see the following:



```
custom list title

list-item works!

list-item works!

list-item works!
```

The component query is not limited to the target type reference. You can also use local references and use string identifiers, for example, mark the List with the "myList" id:

src/app/app.component.html

```
<app-list #myList>
  ...
</app-list>
```

Now you can use this id with the "@ViewChild" decorator if needed:

src/app/app.component.ts

```
@Component({...})
export class AppComponent implements AfterViewInit {

  @ViewChild('myList')
  list: ListComponent;

  ...
}
```

@ViewChildren

If you declare more than one List component, you should notice that every time only the first instance is fetched. To get a reference to all the child instances of the particular component type you need to use a @ViewChildren decorator.

Let's have two List components separated by a horizontal line like in the example below:

src/app/app.component.html

```
<app-list>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
</app-list>

<hr>

<app-list>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
</app-list>
```

Now create a "lists" property in the underlying component class to reference all "ListComponent" instances after View gets initialised:

src/app/app.component.ts

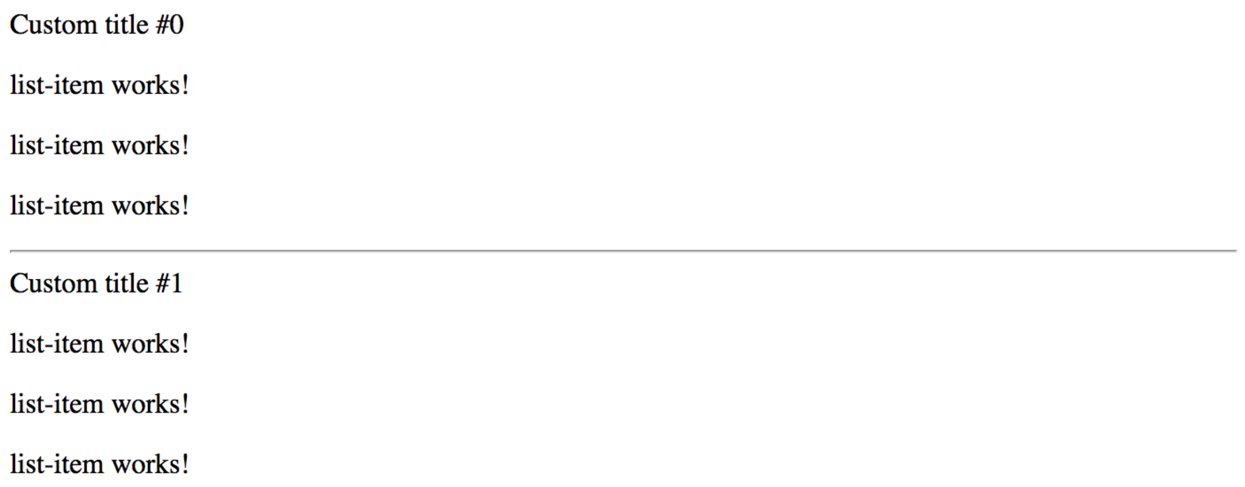
```
import { ..., QueryList, ViewChildren } from '@angular/core';
import { ListComponent } from './list/list.component';

@Component({...})
export class AppComponent implements AfterViewInit {

  @ViewChild(ListComponent)
  list: ListComponent;

  @ViewChildren(ListComponent)
  lists: QueryList<ListComponent>;

  ...
}
```

For the next step, we are going to update "title" property of every List component in the View:

src/app/app.component.ts

```
import { ..., AfterViewInit, QueryList, ViewChildren } from '@angular/core';
import { ListComponent } from './list/list.component';

@Component({...})
export class AppComponent implements AfterViewInit {
  ...

  @ViewChildren(ListComponent)
  lists: QueryList<ListComponent>;

  ngAfterViewInit() {
    let i = 0;
    this.lists.forEach(l => {
      l.title = 'Custom title #' + (i++);
    });
  }
}
```

Switch back to the browser and once the application compiles and restarts you should see the following:


Custom title #0

list-item works!

list-item works!

list-item works!

Custom title #1

list-item works!

list-item works!

list-item works!

ViewChildren Queries

@ContentChild

The @ViewChild provides access only to components and directives that are part of the view but not inside the “ng-content” tags. You need to use @ContentChild decorator to work with the elements inside “ng-content” container.

If you remember, the List component template already features the “ng-template”:

src/app/list/list.component.html

```html
<div>{{ title }} </div>
<ng-content></ng-content>
```

Update the ListItemComponent component class with the “title” property like in the following example:

src/app/list-item/list-item.component.ts

```ts
...

@Component({...})
export class ListItemComponent {

  title = 'list-item works!';

}
```

For the sake of simplicity just replace the content of the ListItem component template with the next block of HTML:

src/app/list-item/list-item.component.html

```html
<p>
  {{ title }}
</p>
```

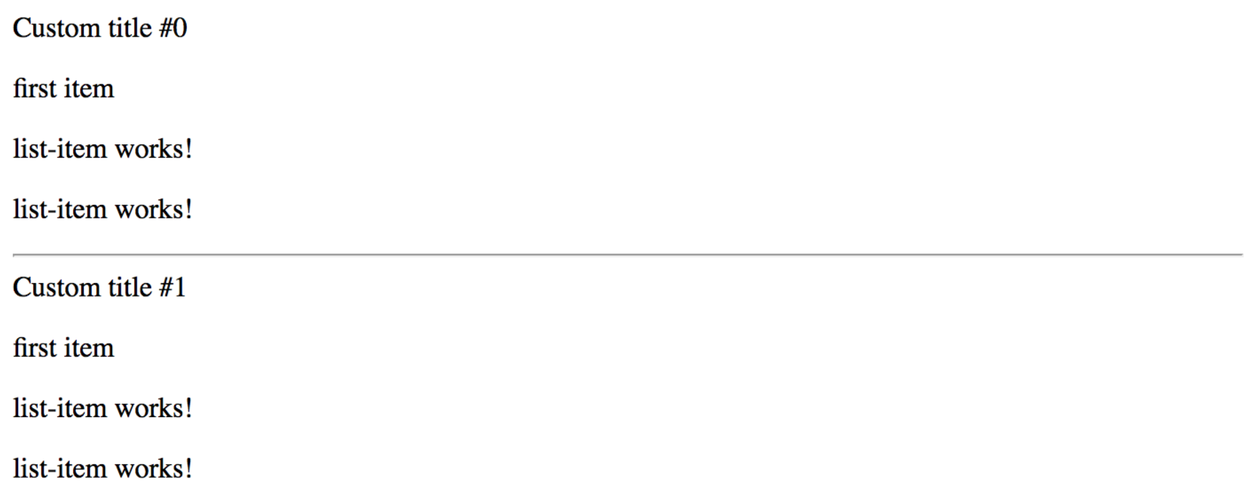
For a start, let’s access the very first entry of the List content collection by introducing a “firstListItem” property decorated with the @ContentChild. As soon as component content gets initialised, we are going to update the title of the referenced item.

src/app/list/list.component.ts

```ts
import { ..., ContentChild, AfterContentInit } from '@angular/core';
import { ListItemComponent } from '../list-item/list-item.component';

@Component({...})
export class ListComponent implements AfterContentInit {
  ...

  @ContentChild(ListItemComponent)
  firstListItem: ListItemComponent;

  ngAfterContentInit() {
    this.firstListItem.title = 'first item';
  }
}
```

Note that your component now needs to implement the “AfterContentInit” interface and have the corresponding “ngAfterContentInit” method implementation. That is the most recommended place to work with the elements provided using the @ContentChild decorator.

Switch to the browser, and you should now look the following on the main page:


Custom title #0

first item

list-item works!

list-item works!

Custom title #1

first item

list-item works!

list-item works!

ContentChild Query

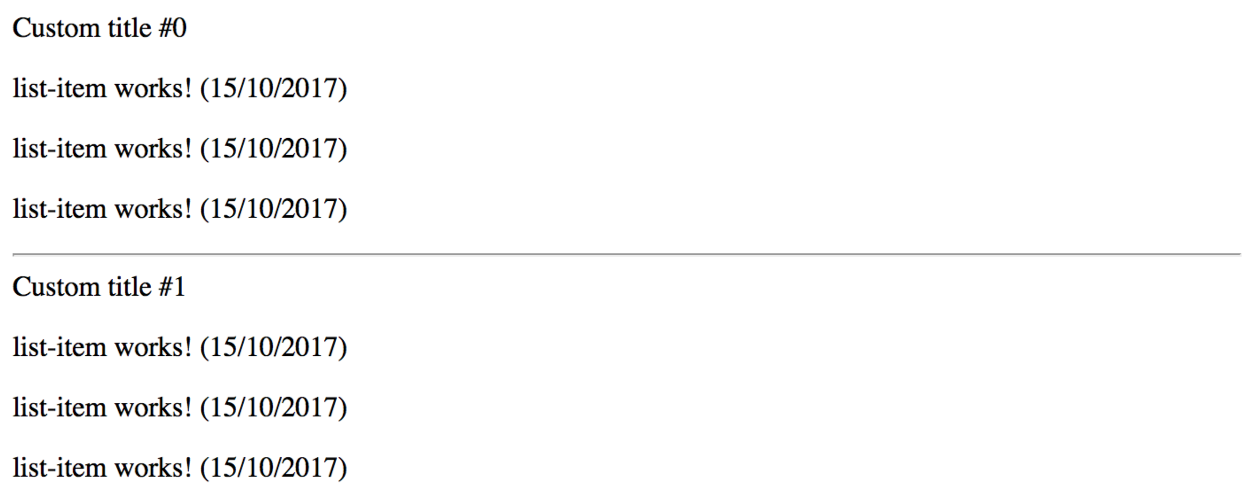
@ContentChildren

Similar to the @ViewChild, the @ContentChild decorator always returns the first found element if there are more than one declared in the Component View. You are going to need a @ContentChildren decorator if you intend working with all the instances.

src/app/list/list.component.ts

```
import { ..., ContentChildren, QueryList } from '@angular/core';
import { ListItemComponent } from '../list-item/list-item.component';

@Component({...})
export class ListComponent implements AfterContentInit {
  ...

  @ContentChildren(ListItemComponent)
  listItems: QueryList<ListItemComponent>;

  ngAfterContentInit() {
    this.listItems.forEach(item => {
      item.title = item.title + ' (' + new Date().toLocaleDateString() + ')';
    });
  }
}
```

The example above should already be familiar to you. We have just updated every item in the list by changing its title. The main page in the browser should be looking similar to the following one:



Custom title #0

list-item works! (15/10/2017)

list-item works! (15/10/2017)

list-item works! (15/10/2017)

Custom title #1

list-item works! (15/10/2017)

list-item works! (15/10/2017)

list-item works! (15/10/2017)

ContentChildren Query

Listening for View and Content changes

So with `@ContentChild`, `@ContentChildren`, `@ViewChild` and `@ViewChildren` decorators we can import and manipulate elements and components in the controller class.

But what if developer applies conditional visibility to the layout entries like in the example below?

```
<app-list>
  <app-list-item *ngIf="showFirstItem"></app-list-item>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
</app-list>
```

As we already know, based on the "ngIf state", the Angular will remove a corresponding element from the DOM, or add it back. There are many scenarios, however, when your component controller needs to know about such changes. For example, imagine a "DataTable" component that uses child components to define column structure, but then turns developer-defined view or content elements to some internal representation. The component must always know what is the "visible" part of the layout to work with.

Let's now extend our previous "ViewChildren" example with an extra flag to toggle visibility of the first list entry. We will add a "showFirstItem" property, and a button that changes the property value on each click.

src/app/app.component.ts

```
export class AppComponent implements AfterViewInit {

  showFirstItem = true;

  ...
}
```

Next, append the following block to the component template:

src/app/app.component.html

```
<hr>

<button (click)="showFirstItem = !showFirstItem">
  Toggle first item
</button>
```

We have declared two List components in the previous examples. Let's now wire the first entry of each of the components with the "showFirstItem" condition like in the example below:

src/app/app.component.html

```
<app-list>
  <app-list-item *ngIf="showFirstItem"></app-list-item>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
</app-list>

<hr>

<app-list>
  <app-list-item *ngIf="showFirstItem"></app-list-item>
  <app-list-item></app-list-item>
  <app-list-item></app-list-item>
</app-list>

<hr>

<button (click)="showFirstItem = !showFirstItem">
  Toggle first item
</button>
```

If you run the application now, you will see every first item appear and disappear from the list each time you click the "Toggle first item" buttons. We have just emulated the situation when layout changes based on the external criteria. But how does the component now react on those changes?

The "QueryList" class exposes a special "changes" property of the "Observable<any>" type that can help us watch for the layout changes and achieve the desired behaviour.

Now you can update the ListComponent implementation and add a simple change tracking code like in the following example:

src/app/list/list.component.ts

```
@Component({...})
export class ListComponent implements AfterContentInit {

  ...

  ngAfterContentInit() {
    ...

    this.listItems.changes.subscribe(() => {
      console.log(
        `List content changed and has now ${this.listItems.length} items.`
      );
    });
  }
}
```

Please run the application once again and click the "Toggle first item" button a few times. Alongside the element being added to and removed from the page, you will see the following console output:

```
List content changed and has now 2 items.
List content changed and has now 2 items.
List content changed and has now 3 items.
List content changed and has now 3 items.
List content changed and has now 2 items.
List content changed and has now 2 items.
```

We have two instances of the ListComponent declared in the application component template. And both lists have its first element wired with conditional visibility expression. That is why you will see messages from both components in the browser console output window.

As you can see, subscribing and listening to "QueryList<T>.change" events gives you an ability to react on layout changes and perform extra behaviours at the component level.

Component Lifecycle

Angular supports multiple lifecycle events for components, directives and services.

For the Components, the Angular invokes the following methods at runtime, in the order of execution:

- ngOnChanges
- ngOnInit
- ngDoCheck
- ngAfterContentInit
- ngAfterContentChecked
- ngAfterViewInit
- ngAfterViewChecked
- ngOnDestroy

As Directives do not have UI templates, they get the following set of lifecycle methods supported out of the box:

- ngOnChanges
- ngOnInit
- ngDoCheck
- ngOnDestroy

Finally, the Services get the next methods:

- ngOnDestroy

Every method represents a separate interface in the @angular/core namespace and contains a "ng" prefix appended to the interface name. For example, the "OnInit" interface declares a "ngOnInit" method, and so on. We are going to dive deeper into details on each method and interface below.

Technically, the interfaces for the lifecycle events are optional. The Angular is going to call those events in any case, and if the corresponding methods are present, they get automatically invoked. It is a good practice, however, to still expose those interfaces in your classes to enable static checks by TypeScript.

You can find additional information on the lifecycle events in the following official docs: Lifecycle Hooks[31]

Source code

You can find the source code as an Angular CLI project in the "angular/components/lifecycle[32]" folder.

[31]https://angular.io/guide/lifecycle-hooks#component-lifecycle-hooks-overview
[32]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/lifecycle

ngOnChanges

The “ngOnChanges” method is related to the “OnChanges” hook. Angular calls it every time an input property of the component or directive gets changed.

You can find the code of the interface below:

```
interface OnChanges {
    ngOnChanges(changes: SimpleChanges): void;
}
```

Let’s create a new Angular CLI project and generate an “on-changes-demo” component to see the “OnChanges” hook in action.

```
ng g component on-changes-demo
```

To visualise the property change, we need two properties to store the current and old values. The “text” property stores current string value and is decorated with the @Input to enable two-way bindings with template components, or external input. The “previous” property provides the one-way binding support to display the old string.

src/app/on-changes-demo/on-changes-demo.component.ts

```
import { Component, Input } from '@angular/core';

@Component({
  selector: 'app-on-changes-demo',
  templateUrl: './on-changes-demo.component.html',
  styleUrls: ['./on-changes-demo.component.css']
})
export class OnChangesDemoComponent {

  @Input()
  text = 'hello world';

  previous: string;

}
```

Now that we have a code defined, the minimal component implementation can look like in the following example:

src/app/on-changes-demo/on-changes-demo.component.html

```html
<p>
  Text: {{ text }}
  <br>
  Previous: {{ previous }}
</p>
```

At this point, we are ready to implement "OnChanges" interface from the "@angular/core" package. Your "ngOnChanges" method can look like the next one:

src/app/on-changes-demo/on-changes-demo.component.ts

```ts
import { ..., OnChanges, SimpleChanges } from '@angular/core';

@Component({...})
export class OnChangesDemoComponent implements OnChanges {

  @Input()
  text = 'hello world';

  previous: string;

  ngOnChanges(changes: SimpleChanges) {
    if (changes.text) {
      this.previous = changes.text.previousValue;
    }
  }

}
```

As you already know, the Angular keeps track of all property changes. In our current case, the framework collects the changes made to the "OnChangesDemoComponent" component properties and, wraps into a special "SimpleChanges" map and passes to the corresponding hook method.

```ts
interface SimpleChanges {
    [propName: string]: SimpleChange;
}
```

Every value of the "SimpleChanges" map implements a "SimpleChange" interface with at least the following properties and methods:

- previousValue: any;

- currentValue: any;
- firstChange: boolean;
- isFirstChange(): boolean;

As you can see the “SimpleChange” API allows you to inspect the current and previous values, as well as to check whether this is the first time the particular property gets changed. The “firstChange” property allows you to distinguish between setting default property value within the class initialiser as opposed to the changes caused by user interaction or runtime changes.

Now let’s use our newly created component with the main application one. The simple way to test value changes is to bind an input element to the “text” property like in the example below:

src/app/app.component.html

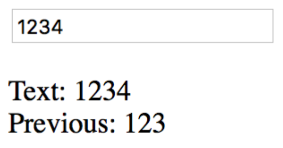
```html
<input [(ngModel)]="text">
<app-on-changes-demo [text]="text"></app-on-changes-demo>
```

Note that you are going to need an extra “text” property for the application component controller class:

src/app/app.component.ts

```typescript
import { Component, Input } from '@angular/core';

@Component({
  selector: 'app-root',
  templateUrl: './app.component.html',
  styleUrls: ['./app.component.css']
})
export class AppComponent {

  @Input()
  text: string;

}
```

Run the application with the “ng serve –open” command and try typing text in the main page. Notice that our component displays both old and new values as you type them into the input element.


```
1234

Text: 1234
Previous: 123
```

OnChanges example

ngOnInit

The “OnInit” is the most common lifecycle hook. You are probably going to use it a lot in your custom components.

It is a good practice to perform component initialisation in the “ngOnInit” method and not in the constructor. Angular invokes the “ngOnInit” after the construction and once all input properties set, so you can setup your component based on the property values from the outside.

You can find the code of the interface below:

```
interface OnInit {
    ngOnInit(): void;
}
```

In the same project, we created earlier, generate a new “on-init-demo” component with the following command:

```
ng g component on-init-demo
```

Next, define a property “currentDate” of the “Date” type, and set its value in the “ngOnInit” method like in the following example:

src/app/on-init-demo/on-init-demo.component.ts

```
import { Component, OnInit } from '@angular/core';

@Component({
  selector: 'app-on-init-demo',
  templateUrl: './on-init-demo.component.html',
  styleUrls: ['./on-init-demo.component.css']
})
export class OnInitDemoComponent implements OnInit {

  currentDate: Date;

  constructor() { }

  ngOnInit() {
    this.currentDate = new Date();
  }

}
```

Update the component template to render the value of the “currentDate”:

src/app/on-init-demo/on-init-demo.component.html

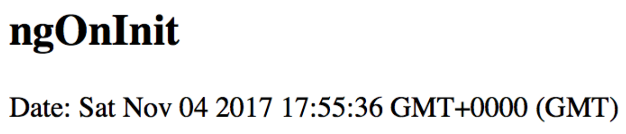
```html
<p>
  Date: {{ currentDate }}
</p>
```

Given that we do not have any input properties, the main application component template can contain just the empty tag. Append the following code to the existing template HTML:

src/app/app.component.html

```html
...

<hr>
<h2>ngOnInit</h2>

<app-on-init-demo></app-on-init-demo>
```

If you run the application right now, you should see current date and time with default string formatting:


ngOnInit

Date: Sat Nov 04 2017 17:55:36 GMT+0000 (GMT)

Let's now try creating the component multiple times on the fly to see the "ngOnInit" method calls in practice.

We can wrap our custom "OnInitDemoComponent" with the "ng-container" element decorated by the "ngIf" directive. Add a new "showNgOnInit" property of the "boolean" type to the component controller class, and bind the checkbox to toggle component at runtime:

src/app/app.component.ts

```typescript
@Component({...})
export class AppComponent {

  ...

  showNgOnInit = true;

}
```

Update the application controller template to look like the following code:

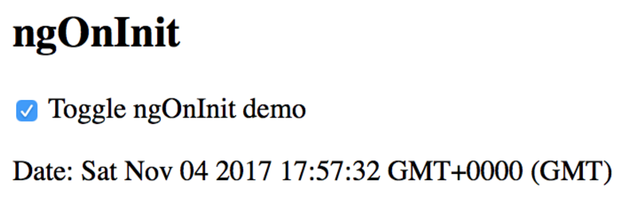
src/app/app.component.html

```html
...

<hr>
<h2>ngOnInit</h2>

<label>
  <input type="checkbox" [(ngModel)]="showNgOnInit">
  Toggle ngOnInit demo
</label>

<ng-container *ngIf="showNgOnInit">
  <app-on-init-demo></app-on-init-demo>
</ng-container>
```

ngModel

Don't forget that you need to import "FormsModule" for your root application module to be able to use "ngModel" with components.

Now, every time you tick the checkbox element a new "OnInitDemoComponent" is created and displayed, and a new date value assigned by the "ngOnInit" method.


ngOnInit

☑ Toggle ngOnInit demo

Date: Sat Nov 04 2017 17:57:32 GMT+0000 (GMT)

As you can imagine, we used a pretty basic scenario for component setup. In real life, your "ngOnInit" content might be more complicated.

ngDoCheck

The "DoCheck" hook allows you to integrate into the change detection cycle and find changes within the objects references or any areas where Angular did not detect changes automatically.

You can find the code of the interface below:

```
interface DoCheck {
    ngDoCheck(): void;
}
```

Performance Penalty

Please keep in mind that, depending on the component tree size and complexity, the "ngDoCheck" method is going to execute enormous amount of times and may become a performance bottleneck if you poorly implement the code. Avoid using "ngDoCheck" method unless necessary.

When using properties of the object type, the Angular is going to watch the changes by value reference, meaning detects the change of the entire value, but not the changes in the child properties. That is the case where we are going to use "DoCheck" lifecycle hook and detect changes in the object.

For the next exercise, we need a new component called "DoCheckDemoComponent" that you can generate using the following command:

```
ng g component do-check-demo
```

Let's integrate it into the main application template now to save the time later. Append the next HTML snippet to the content of the component template:

src/app/app.component.html

```
...
<hr>
<h2>ngDoCheck</h2>
<app-do-check-demo></app-do-check-demo>
```

Next, we need an object value and custom properties. For the sake of simplicity let's create a "User" object featuring first and last names as separate properties. The component should have "current" and "previous" values to facilitate property checks.

src/app/do-check-demo/do-check-demo.component.ts

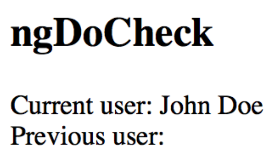
```
import { Component, Input, DoCheck } from '@angular/core';

@Component({
  selector: 'app-do-check-demo',
  templateUrl: './do-check-demo.component.html',
  styleUrls: ['./do-check-demo.component.css']
})
export class DoCheckDemoComponent implements DoCheck {

  currentUser = {
    firstName: 'John',
    lastName: 'Doe'
  };

  previousUser = {
    firstName: '',
    lastName: ''
  };

  ngDoCheck() {
  }

}
```

For the first iteration leave the “ngDoCheck” method empty and switch to the component template. Our component needs to display values for both current and previous property values.

src/app/do-check-demo/do-check-demo.component.html

```
<p>
  Current user: {{ currentUser.firstName + ' ' + currentUser.lastName }}
  <br>
  Previous user: {{ previousUser.firstName + ' ' + previousUser.lastName }}
</p>
```

You can run the application and check that component works as expected. The main page should contain the full name of the user stored in the “currentUser” property. The text for the “previousUser” property should be empty because we have not yet changed anything.


ngDoCheck

Current user: John Doe
Previous user:

As mentioned earlier, Angular calls "DoCheck" many times based on the change detection cycle. To see that in practice, let's introduce a new field "checks" that should hold a count of checks performed for our component. We are going to increment this field every time the "ngDoCheck" get called.

Next, we create a field "updates" to hold a count of "currentUser" updates detected by our custom "ngDoCheck" implementation. The method checks both "firstName" and "lastName" property values and updates the counter, in addition to setting a new instance of the "previousUser" value.

Finally, let's introduce an "Update user" button that changes the value of the current user and so triggers the change detection cycle and our custom checks. The button calls "updateUser" method upon every click.

Below is the implementation of all the mentioned class members and behaviour:

src/app/do-check-demo/do-check-demo.component.ts

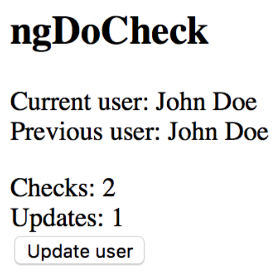
```
@Component({...})
export class DoCheckDemoComponent implements DoCheck {

  currentUser = {
    firstName: 'John',
    lastName: 'Doe'
  };

  previousUser = {
    firstName: '',
    lastName: ''
  };

  checks = 0;
  updates = 0;

  updateUser() {
    this.currentUser = {
      firstName: 'James',
      lastName: 'Bond'
    };
  }

  ngDoCheck() {
    this.checks ++;
    if (this.previousUser.firstName !== this.currentUser.firstName
      || this.previousUser.lastName !== this.currentUser.lastName) {
      this.updates ++;
      this.previousUser = Object.assign({}, this.currentUser);
    }
  }

}
```

Now, edit the component HTML template to add necessary labels and a button to update the underlying user.

src/app/do-check-demo/do-check-demo.component.html

```html
<p>
  Current user: {{ currentUser.firstName + ' ' + currentUser.lastName }}
  <br>
  Previous user: {{ previousUser.firstName + ' ' + previousUser.lastName }}
</p>

<p>
  Checks: {{ checks }} <br>
  Updates: {{ updates }} <br>
  <button (click)="updateUser()">Update user</button>
</p>
```

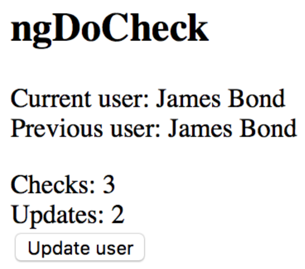
Run the application or switch to the corresponding browser tab if it is already running. You should see something like the following:


ngDoCheck

Current user: John Doe
Previous user: John Doe

Checks: 2
Updates: 1

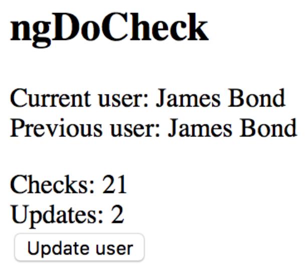
Now click the “Update user” button one time and check that both counters got incremented.


ngDoCheck

Current user: James Bond
Previous user: James Bond

Checks: 3
Updates: 2

If you continue clicking the button, you should notice that "checked" counter keeps incrementing. Note that it increments even if you click some other buttons or clickable Angular components. That demonstrates that our custom component reacts on change detection cycle managed by Angular, and increments the counter as designed.


ngDoCheck

Current user: James Bond
Previous user: James Bond

Checks: 21
Updates: 2

The "update" counter, however, should remain the same. That is obvious as we change the values of the user only once.

ngAfterContentInit

The "ngAfterContentInit" method belongs to the "AfterContentInit" hook in Angular, and is part of the "Content Projection" feature.

Angular raises "AfterContentInit" every time an injected child component gets initialised and is ready for use and access from the code if needed.

Content Projection

Content projection is the process of injection of the external HTML content and other Angular components into the body of your component template. You can get more information in the Content Projection section later in this chapter.

You can find the code of the interface below:

```
interface AfterContentInit {
    ngAfterContentInit(): void;
}
```

As all in all previous cases, let's start by generating a separate component to experiment with the hook:

```
ng g component after-content-init-demo
```

For our exercise, we do not need "constructor" and "OnInit" implementation. You can clean the component class and replace with the "AfterContentInit" interface implementation.

src/app/after-content-init-demo/after-content-init-demo.component.ts

```
import { Component, AfterContentInit } from '@angular/core';

@Component({...})
export class AfterContentInitDemoComponent implements AfterContentInit {

  ngAfterContentInit() {
  }

}
```

The "ng-content" element is going to be an injection point for external content. Update the component template to look like the following markup:

src/app/after-content-init-demo/after-content-init-demo.component.html

```
Projected content below:
<div>
  <ng-content></ng-content>
</div>
```

We now need to generate a second component to test the Angular lifecycle hook.

```
ng g component after-content-init-child
```

You can clean the component class code as we need just a default implementation.

src/app/after-content-init-child/after-content-init-child.component.ts

```
import { Component } from '@angular/core';

@Component({
  selector: 'app-after-content-init-child',
  templateUrl: './after-content-init-child.component.html',
  styleUrls: ['./after-content-init-child.component.css']
})
export class AfterContentInitChildComponent {
}
```

Also, the default component template should work fine as well. The Angular CLI usually generates a "<component> works!" label out of the box.

src/app/after-content-init-child/after-content-init-child.component.html

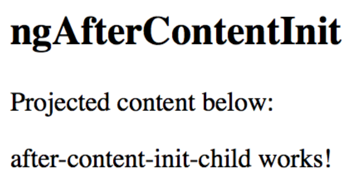
```
<p>
  after-content-init-child works!
</p>
```

Finally, let's extend the main application template with the testing parent-child hierarchy with our newly introduced components. Just append the following HTML snippet to existing template markup.

src/app/app.component.html

```
...
<hr>
<h2>ngAfterContentInit</h2>

<app-after-content-init-demo>

    <app-after-content-init-child>
    </app-after-content-init-child>

</app-after-content-init-demo>
```

Serve the application with "ng serve –open" command or switch to a running one in the browser. You should see the next layout at the bottom of your page:



ngAfterContentInit

Projected content below:

after-content-init-child works!

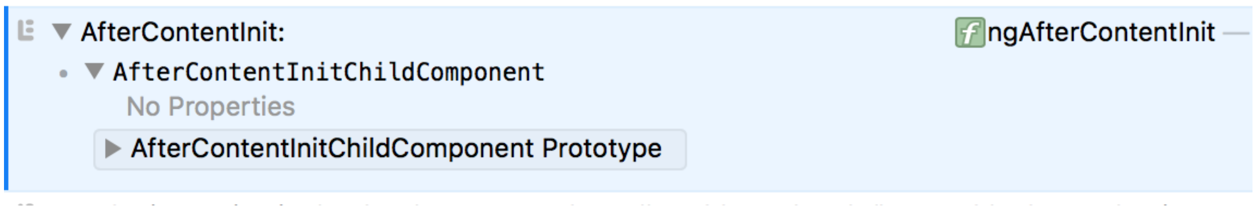
Typically you are going to use “AfterContentInit” hook with the @ContentChild decorator. While we use the “ngAfterContentInit” to detect when an injected component finished initialising, the “ContentChild” allows getting references to the component instance.

Please refer to the example below to get a better understanding of how both APIs work together.

src/app/after-content-init-demo/after-content-init-demo.component.ts

```
import {
  Component, OnInit,
  AfterContentInit, ContentChild } from '@angular/core';
import {
  AfterContentInitChildComponent
} from '../after-content-init-child/after-content-init-child.component';

@Component({...})
export class AfterContentInitDemoComponent implements AfterContentInit {

  @ContentChild(AfterContentInitChildComponent)
  child: AfterContentInitChildComponent;

  ngAfterContentInit() {
    console.log('AfterContentInit:', this.child);
  }

}
```

Once you run your application and open the developer tools, you should see the following content in the browser console output:



```
▼ AfterContentInit:                                   ngAfterContentInit
  • ▼ AfterContentInitChildComponent
        No Properties
      ▶ AfterContentInitChildComponent Prototype
```

At this point, your parent component can perform additional setup for the child one, like changing properties, subscribing to events or calling methods.

ngAfterContentChecked

The “ngAfterContentChecked” method belongs to the “AfterContentChecked” interface in Angular, and is part of the “Content Projection” feature.

The “AfterContentChecked” lifecycle hook allows you to provide a custom mechanism for checking changes in the projected components. The behaviour is similar to the “DoCheck” but applied to the components that are part of the “ng-content” container.

Content Projection

Content projection is the process of injection of the external HTML content and other Angular components into the body of your component template. You can get more information in the Content Projection section later in this chapter.

You can find the code of the interface below:

```
interface AfterContentChecked {
    ngAfterContentChecked(): void;
}
```

Let’s use the same “AfterContentInitDemoComponent” we created earlier. For the sake of simplicity, we are going to add the “checked” counter field and update it on every change detection cycle.

src/app/after-content-init-demo/after-content-init-demo.component.ts

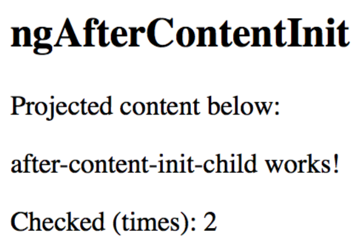
```
import { ..., AfterContentChecked } from '@angular/core';
...

@Component({...})
export class AfterContentInitDemoComponent implements AfterContentInit, AfterContent\
Checked {

  checked = 0;

  ...

  ngAfterContentChecked() {
    this.checked ++;
  }

}
```

Update the component template to also display the “checked” counter after the projected content.

src/app/after-content-init-demo/after-content-init-demo.component.html

```html
Projected content below:
<div>
  <ng-content></ng-content>
</div>
<div>
  Checked (times): {{ checked }}
</div>
```

Once your application starts or reloads, the bottom of the page should look similar to the following:



ngAfterContentInit

Projected content below:

after-content-init-child works!

Checked (times): 2

Please note that the counter is going to update multiple times even if you interact with some other components or elements on the page. You should keep the code inside "ngAfterContentChecked" method body fast and small not to introduce a performance bottleneck for the entire application.

ngAfterViewInit

Angular invokes the "ngAfterViewInit" hook once the view of the component is ready. That also includes the child components that may be part of the template. You can access child instance members and perform additional tasks in the code, for example changing properties or subscribing to events.

You can find the code of the interface below:

```
interface AfterViewInit {
    ngAfterViewInit(): void;
}
```

Let's introduce a basic scenario that requires us to access view elements and update their properties. We are going to have two buttons in the component template that have no text, and once the view gets initialised our component should update the text of each button.

We need a separate "AfterViewInitDemoComponent" component that gets generated with the next Angular CLI command:

```
ng g component after-view-init-demo
```

Import and implement the "AfterViewInit" interface from the "@angular/core" package. The "ngAfterViewInit" method can be blank for now, and we are going to implement it shortly.

src/app/after-view-init-demo/after-view-init-demo.component.ts

```
import { Component, OnInit, AfterViewInit } from '@angular/core';

@Component({
  selector: 'app-after-view-init-demo',
  templateUrl: './after-view-init-demo.component.html',
  styleUrls: ['./after-view-init-demo.component.css']
})
export class AfterViewInitDemoComponent implements AfterViewInit {

  ngAfterViewInit() {
  }

}
```

Next, add two buttons to the template. Each of the button needs to have a template reference id so that our component class can access each button using "prevPageButton" and "nextPageButton" id values.

src/app/after-view-init-demo/after-view-init-demo.component.html

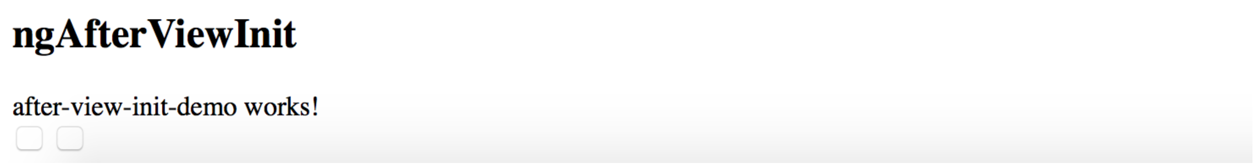
```
<div>
  after-view-init-demo works!
  <div>
      <button #prevPageButton></button>
      <button #nextPageButton></button>
  </div>
</div>
```

As a next step, declare the newly generated component within the main application template by appending the following code to the existing markup:

src/app/app.component.html

```
...
<hr>
<h2>ngAfterViewInit</h2>
<app-after-view-init-demo></app-after-view-init-demo>
```

Serve the application right now and ensure the component renders its template with a default label and two buttons with missing labels as in the picture below:


ngAfterViewInit

after-view-init-demo works!

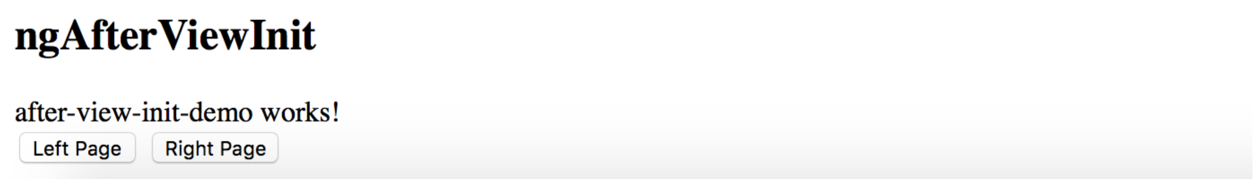
You also need importing the ViewChild decorator type. This decorator is used to get a reference to the native element of the component template.

Also, create two separate properties "prevButton" and "nextButton" or the "ElementRef" type. Every "ElementRef" instance exposes a "nativeElement" property that you can use to access the DOM element, in our case HTML button inputs. The component sets the "innerText" values for both buttons inside the "ngAfterViewInit" method body like in the next example:

src/app/after-view-init-demo/after-view-init-demo.component.ts

```
import { ..., ViewChild, ElementRef } from '@angular/core';

@Component({...})
export class AfterViewInitDemoComponent implements AfterViewInit {

  @ViewChild('prevPageButton')
  prevButton: ElementRef;

  @ViewChild('nextPageButton')
  nextButton: ElementRef;

  ngAfterViewInit() {
    this.prevButton.nativeElement.innerText = 'Left Page';
    this.nextButton.nativeElement.innerText = 'Right Page';
  }

}
```

This time, when you run the application, both buttons should have correct labels:



The "AfterViewInit" is usually used to modify the behaviour of the view elements once the corresponding component is ready.

ngAfterViewChecked

The "ngAfterViewChecked" method represents the "AfterViewChecked" lifecycle hook and interface. It allows you to provide custom change tracking that is not handled by Angular due to some reason. The behaviour is similar to the AfterContentChecked hook but applies to the view template children rather than projected content.

You can find the code of the interface below:

```
interface AfterViewChecked {
    ngAfterViewChecked(): void;
}
```

As with previous examples, let's introduce a "checked" field to hold the number of checks, and use the previous component with two buttons to demonstrate the lifecycle hook in practice.

src/app/after-view-init-demo/after-view-init-demo.component.ts

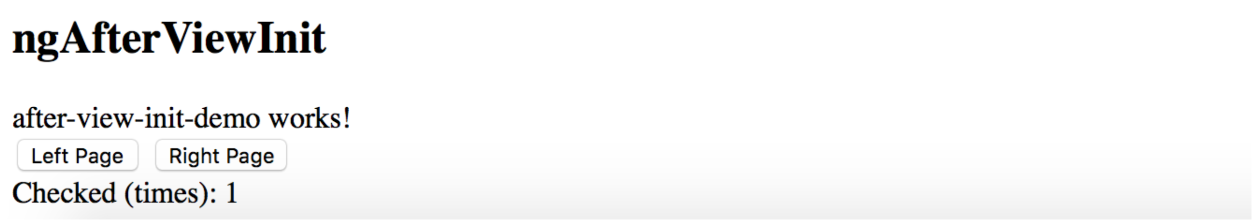
```
import { ..., AfterViewChecked } from '@angular/core';

@Component({...})
export class AfterViewInitDemoComponent implements AfterViewInit, AfterViewChecked {

  checked = 0;

  ...

  ngAfterViewChecked() {
    this.checked ++;
  }

}
```

Don't forget to update the component template by appending the label like in the next snippet:

src/app/after-view-init-demo/after-view-init-demo.component.html

```
...
<div>
  Checked (times): {{ checked }}
</div>
```

Now run the application and try clicking the buttons. You should notice that the counter updates every time you interact with the button inside the component template, or any other Angular component on the page.


ngAfterViewInit

after-view-init-demo works!

Checked (times): 1

Needless to say that your custom change tracking code should be highly optimised and run fast. Otherwise, you risk getting a performance bottleneck.

ngOnDestroy

The "OnDestroy" lifecycle hook provides you with a way to run cleanup operations for your component, directive or service to reduce resources and avoid potential memory leaks.

If your component controller subscribes to various event handlers, the "ngOnDestroy" method is the most appropriate place to tear down all event subscriptions.

You can find the code of the interface below:

```
interface OnDestroy {
    ngOnDestroy(): void;
}
```

Let's generate a new component to see how "OnDestroy" hook works in practice. We are going to produce two log entries for the browser console log, one during the "OnInit" call and one for the "OnDestroy".

```
ng g component on-destroy-demo
```

src/app/on-destroy-demo/on-destroy-demo.component.ts

```
import { Component, OnInit, OnDestroy } from '@angular/core';

@Component({
  selector: 'app-on-destroy-demo',
  templateUrl: './on-destroy-demo.component.html',
  styleUrls: ['./on-destroy-demo.component.css']
})
export class OnDestroyDemoComponent implements OnInit, OnDestroy {

  constructor() { }

  ngOnInit() {
    console.log('OnInit');
  }

  ngOnDestroy() {
    console.log('OnDestroy');
  }

}
```

Next, declare a "showNgOnDestroy" property for the main application component class to control the visibility of our generated component.

src/app/app.component.ts

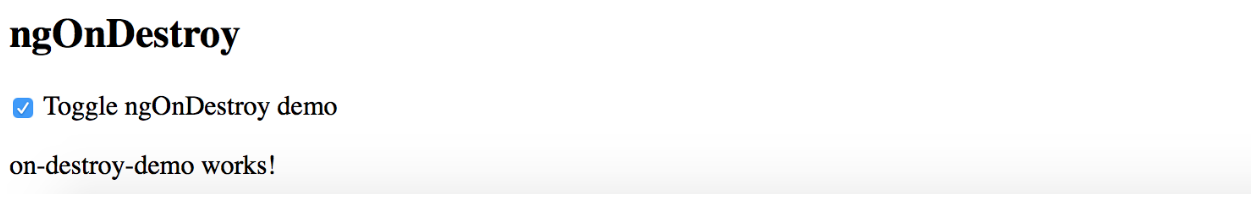
```
@Component({...})
export class AppComponent {
  ...

  showNgOnDestroy = true;

}
```

For the last step, declare a checkbox with the label to control the value of the "showNgOnDestroy" property, and a "ng-container" element that wraps the "app-on-destroy-demo".

src/app/app.component.html

```html
...
<hr>
<h2>ngOnDestroy</h2>
<label>
  <input type="checkbox" [(ngModel)]="showNgOnDestroy">
  Toggle ngOnDestroy demo
</label>

<ng-container *ngIf="showNgOnDestroy">
  <app-on-destroy-demo></app-on-destroy-demo>
</ng-container>
```

At runtime, the component should look like the following once the application starts:



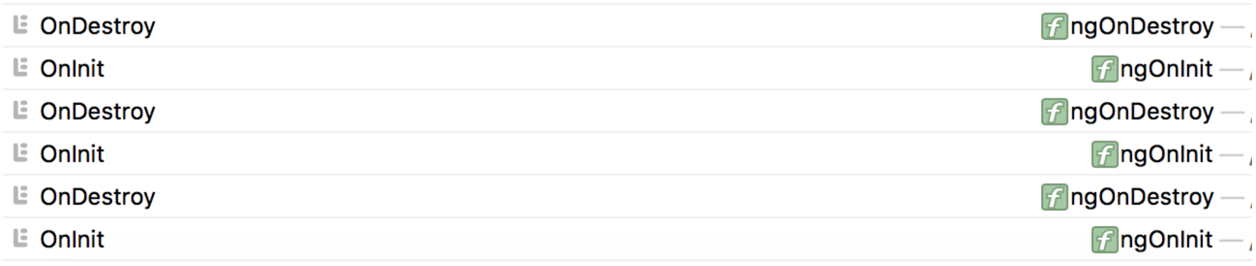
ngOnDestroy

✓ Toggle ngOnDestroy demo

on-destroy-demo works!

As soon as you untick the checkbox, the Angular is going to tear down the component that should no longer be on the page and call the "ngOnDestroy" method.

Open the development tools for your current browser and try clicking the checkbox multiple times. The console output should look like the one below:



```
OnDestroy                                    ngOnDestroy
OnInit                                       ngOnInit
OnDestroy                                    ngOnDestroy
OnInit                                       ngOnInit
OnDestroy                                    ngOnDestroy
OnInit                                       ngOnInit
```

Cleaning up subscriptions

Also, the OnDestroy event is also used to cleanup subscriptions to external service or component events. It is very important to unsubscribe from all the events to prevent memory leaks and performance degradation.

Let's take an example of a service that exposes multiple events.

src/app/on-destroy-demo/simple.service.ts

```
import { Injectable } from '@angular/core';
import { Subject } from 'rxjs/Subject';

@Injectable()
export class SimpleService {

  loaded = new Subject();
  changed = new Subject();
  somethingElse = new Subject();

}
```

We use dependency injection to get an instance of this service injected into the component constructor. And we use the “OnInit” hook to set up the event handlers.

src/app/on-destroy-demo/on-destroy-demo.component.ts

```
@Component({...})
export class OnDestroyDemoComponent implements OnInit, OnDestroy {

  constructor(private service: SimpleService) {}

  ngOnInit() {
    this.service.loaded.subscribe(() => {
      // handle event
    });
    this.service.changed.subscribe(() => {
      // handle event
    });
  }

  ngOnDestroy() {
    // ...
  }
}
```

It is sometimes difficult to spot the problem in such an approach, but we may get a memory leak with the code above. The issue is that the service we inject is a singleton one, and Angular keeps its instance somewhere. It also means that now service instance will keep a reference to our component alive due to the event handler and subscription. That is why we need to clean all subscriptions during destroy phase.

When using Observables, you get an instance of the Subscription each time you call “subscribe” method of the “Observable” or “Subject”.

Subscription

Represents a disposable resource, such as the execution of an Observable. Subscription has one important method, `unsubscribe`, that takes no argument and just disposes the resource held by the subscription.

The easiest way to process multiple subscriptions is to use them in bulk, wrapping into a private array variable. That saves a lot of time and prevents issues related to missed variables or “unsubscribe” calls.

First, let’s create a private property “subscriptions” of the array type that will hold all our subscriptions to external events.

```
@Component({...})
export class OnDestroyDemoComponent implements OnInit, OnDestroy {

  private subscriptions: Subscription[] = [];

}
```

Now you can push multiple subscriptions into the array like in the next example:

```
@Component({...})
export class OnDestroyDemoComponent implements OnInit, OnDestroy {

  private subscriptions: Subscription[] = [];

  constructor(private service: SimpleService) {}

  ngOnInit() {
    this.subscriptions.push(
      this.service.loaded.subscribe(() => {
        // handle event
      }),
      this.service.changed.subscribe(() => {
        // handle event
      }),
      this.service.somethingElse.subscribe(() => {
        // handle event
      })
    );
  }

  ngOnDestroy() {
    // ...
  }

}
```

Keeping all subscriptions in one place makes it easy to cleanup them in bulk when Angular invokes "ngOnDestroy" life-cycle hook.

```
@Component({...})
export class OnDestroyDemoComponent implements OnInit, OnDestroy {

  private subscriptions: Subscription[] = [];

  constructor(private service: SimpleService) {}

  ngOnInit() {...}

  ngOnDestroy() {
    this.subscriptions.forEach(s => s.unsubscribe());
    this.subscriptions = [];
  }

}
```

Do not forget about the technique above when dealing with subscriptions. It should prevent memory leaks and performance issues when the component is re-created or gets destroyed.

Content Projection

The process of adding custom content into the existing components without rebuilding them is often called content projection.

ng-container directive

In most cases when using structural directives or components you are dealing with an extra DOM element that serves as a root one. There are scenarios, however, when you will want to have raw content emitted at run-time, with no wrapping elements.

The "ng-container" directive allows you to group single or multiple elements and components producing no HTML output.

```
<ng-container>
    <!-- Your content comes here -->
</ng-container>
```

Let’s take a simple repeater example and render a sequence of strings wrapped with a div element and compare the same solution with ng-container use case.

First, take any existing, or generate a new Angular application using Angular CLI tools. Create an “items” property with a set of strings values so you can use that property with the “*ngFor” directive.

src/app/app.component.ts

```
import { Component } from '@angular/core';

@Component({...})
export class AppComponent  {
  items = ['One', 'Two', 'Three', 'Four'];
}
```

Next, update the component template and append the following code:

src/app/app.component.html

```
<h2>Using container element</h2>
<div *ngFor="let item of items">
  {{ item }}
</div>
```

Once you run the application, the main page should contain a header element and a list of strings like following:

```
Using container element

One
Two
Three
Four
```

If you now look at the generated HTML (right-clicking on the list and using “Inspect Element” menu item), you will see something like in the following example:

```
<h2 _ngcontent-c69="">Using container element</h2>
<!--bindings={
  "ng-reflect-ng-for-of": "One,Two,Three,Four"
}-->
<div _ngcontent-c69="">
  One
</div><div _ngcontent-c69="">
  Two
</div><div _ngcontent-c69="">
  Three
</div><div _ngcontent-c69="">
  Four
</div>
```

Note that every string is wrapped with the “div” element. That is what we will now try to avoid by using ng-container directive.

For comparison, let’s leave the exiting layout as it is now, and append a new block at the bottom with the following code.

src/app/app.component.html

```
<h2>Using ng-container</h2>
<ng-container *ngFor="let item of items">
  {{ item }}
</ng-container>
```

That is the same code, but we replaced “div” element with the “ng-container” one. At run-time, however, the result should look different.

```
Using ng-container

One Two Three Four
```

Note that repeated values are now forming a string rather than a vertical list. If you now check the source code, you will see that there are no additional elements on the page. Angular replaces them with the HTML comments instead.

```html
<h2 _ngcontent-c69="">Using ng-container</h2>
<!--bindings={
  "ng-reflect-ng-for-of": "One,Two,Three,Four"
}--><!---->
  One
<!---->
  Two
<!---->
  Three
<!---->
  Four
```

Angular does not restrict you to the “ngFor” directive only. You can use the “ng-container” in any parts of the template where you need to have a “virtual” container element, or there’s a need to group multiple elements without introducing an extra content in the DOM.

Most times using “ng-container” should also simplify layout and CSS maintenance.

Source Code and Demo

You can find the source code and the live demo[33] on Stackblitz.

Projecting single entity

A good example of the custom content projection is container components. You can have a panel-like component with some predefined content and styles. At the same time the component can host external elements in panel body implementation.

Let’s now create a panel component to see content projection in action. Use the following Angular CLI command to get started:

```
ng g component my-panel
```

Next, you should edit the main application template and replace its contents with the following HTML block:

```html
<app-my-panel></app-my-panel>
```

For demonstration and testing purposes, let’s update the generated panel component. First, replace the “p” element with the “div”.

[33]https://stackblitz.com/edit/dwa-ng-container?file=app%2Fapp.component.html

src/app/my-panel/my-panel.component.html

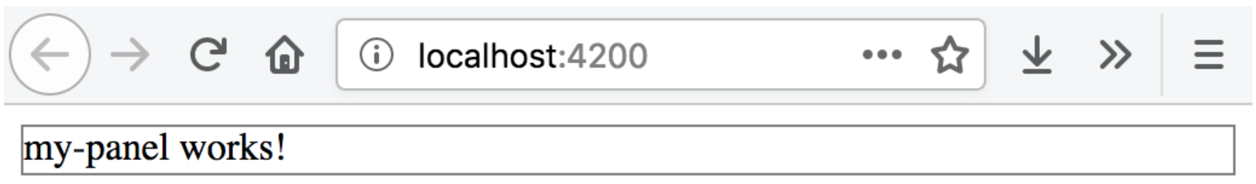
```html
<div>
  my-panel works!
</div>
```

Then you can update its stylesheet, add the border to all the "div" children of the root component layout.

src/app/my-panel/my-panel.component.css

```css
:host > div {
  border: 1px solid gray;
}
```

Run the application and should see the main page with the panel component looking like on the picture below.



my-panel works!

Default Panel

Supporting external content

To provide a basic support for external content projection, add the "ng-content" element somewhere in the panel template layout.

src/app/my-panel/my-panel.component.html

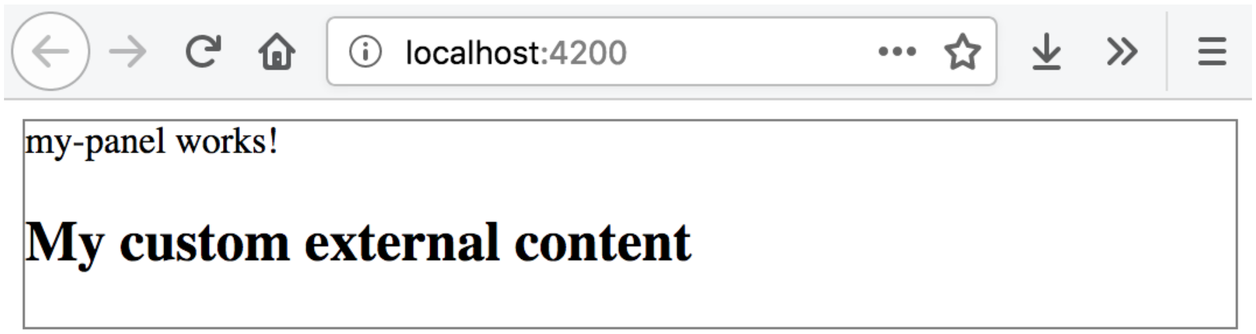
```html
<div>
  my-panel works!
  <ng-content></ng-content>
</div>
```

Now your panel component can receive custom HTML elements and Angular components inside its selector tags. Update the main application template with a header element inside the panel to see that in practice.

src/app/app.component.html

```
<app-my-panel>
  <h2>My custom external content</h2>
</app-my-panel>
```

Once your application restarts, the main page should now look similar to the next picture:



my-panel works!

My custom external content

Panel with custom content

Note you can see both the native panel content presented by the "my-panel works!" and the external "h2" element from the application level.

For your custom Angular components, treat the "ng-content" element as a placeholder for something that comes from the outside.

Projecting multiple entities

We got support for a single entity projection so far, but there are many scenarios when you will need to fill multiple placeholders in your Angular component template.

You can achieve that by using the "selector" support that "ng-content" container exposes. It allows you to match placeholders using HTML selectors, for example CSS class names, or DOM element names.

The usage format is as follows:

```
<ng-content select="<selector>"></ng-content>
```

Projecting with CSS selectors

For the first step, provide support for injecting Header, Content and Footer content for our panel component, and see CSS class name selectors in action.

You should start by adding three new content placeholders that point to unique class names.

src/app/my-panel/my-panel.component.html

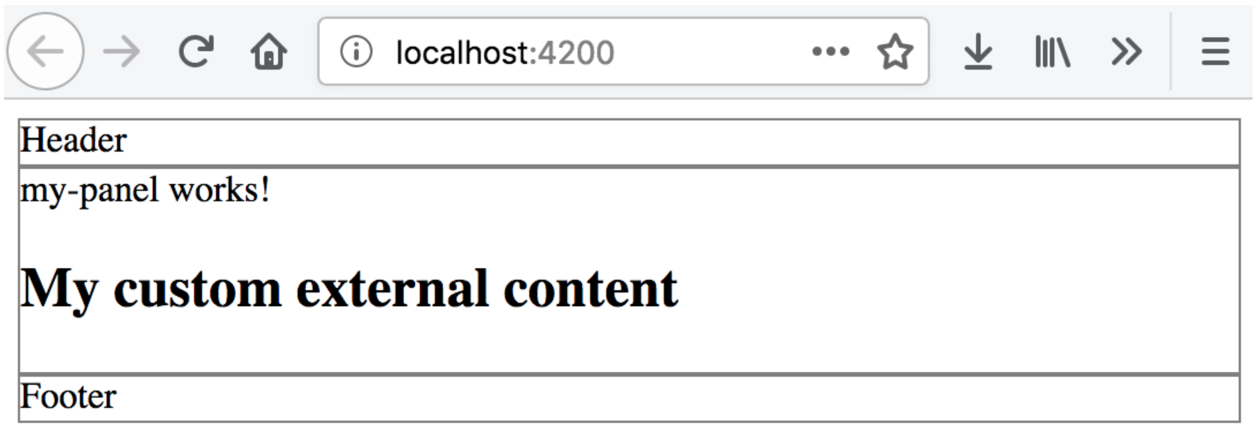
```html
<div>
  <ng-content select=".my-panel-header"></ng-content>
</div>
<div>
  my-panel works!
  <ng-content select=".my-panel-content"></ng-content>
</div>
<div>
  <ng-content select=".my-panel-footer"></ng-content>
</div>
```

To populate those placeholders, you components or DOM elements now need to declare corresponding CSS class names.

src/app/app.component.html

```html
<app-my-panel>
  <div class="my-panel-header">
      Header
  </div>
  <h2 class="my-panel-content">
    My custom external content
  </h2>
  <div class="my-panel-footer">
    Footer
  </div>
</app-my-panel>
```

At runtime, the main application page should now look like the following:



Header

my-panel works!

My custom external content

Footer

Projecting with class selectors

You have projected custom content for panel’s Header, Content and Footer areas.

Projecting with Component selectors

When dealing with CSS class name-based selectors, things may get complicated once your layout grows. Header and Footer content might need own complex layout, styling, effects or conditional rendering. The best approach for handling application growth is to introduce separate components that encapsulate the logic and presentation for panel primitives.

You can practice better separation of concerns by introducing three granular components to compose the panel.

```
ng g component my-panel/my-panel-header
ng g component my-panel/my-panel-content
ng g component my-panel/my-panel-footer
```

Note that by default, Angular CLI generates “app-“ prefixes for the component selectors. So “MyPanelHeaderComponent” will have “app-my-panel-header” selector. Same for other components we create.

Now update the panel template to reference the DOM element selectors instead of the CSS class names like in the example below:

src/app/my-panel/my-panel.component.html

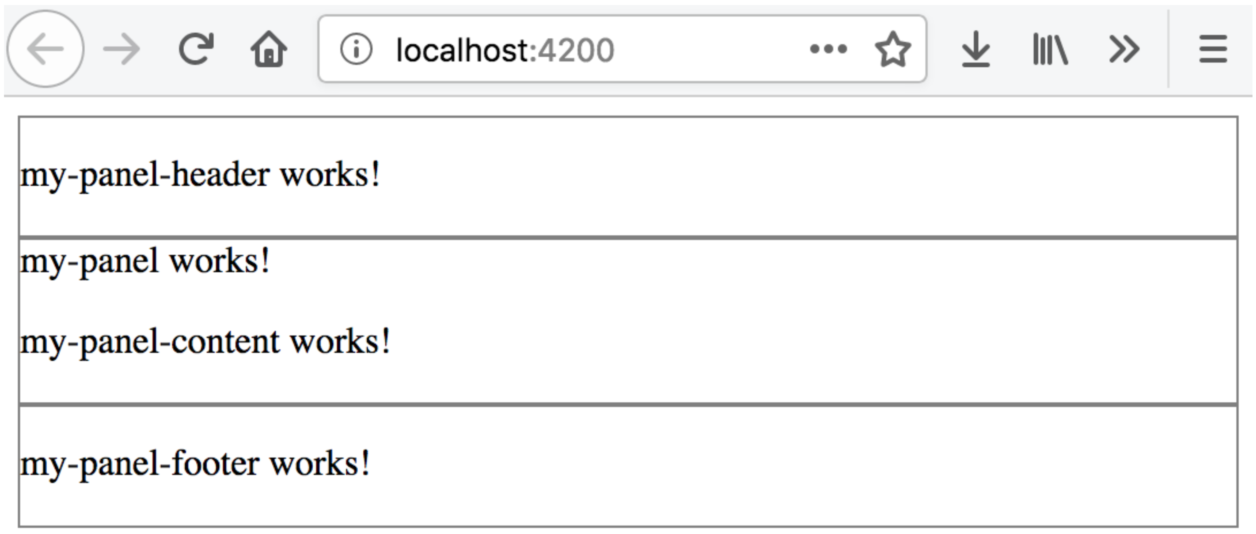
```html
<div>
  <ng-content select="app-my-panel-header"></ng-content>
</div>
<div>
  my-panel works!
  <ng-content select="app-my-panel-content"></ng-content>
</div>
<div>
  <ng-content select="app-my-panel-footer"></ng-content>
</div>
```

That allows us to refactor the main page and use Angular components instead of the DOM elements with class names:

src/app/app.component.html

```
<app-my-panel>
  <app-my-panel-header></app-my-panel-header>
  <app-my-panel-content></app-my-panel-content>
  <app-my-panel-footer></app-my-panel-footer>
</app-my-panel>
```

Run the web application again and ensure that all content is on the expected places.



my-panel-header works!

my-panel works!

my-panel-content works!

my-panel-footer works!

Projecting with component selectors

The main benefit for using Angular components over the DOM elements is that your components can have own content projection support. Besides that components can hide the complexity of the layout and expose different input properties and output events.

Fallback content

You can further improve coding experience for the developers that reuse your panel component. It is possible to provide a default fallback content to support the cases when custom projection is missing. Also, the panel may provide shortcuts for common features, like providing a simple string value for the Header via the input property, in case developer does not need complex layout.

Importing the references to content children of the component into the code can further help reuse them in the template and building conditional visibility expressions for other elements.

Let’s import the “header” component and also introduce the optional “title” shortcut property.

src/app/my-panel/my-panel.component.ts

```
import { Input, Component, ContentChild,  } from '@angular/core';
import {
  MyPanelHeaderComponent
} from './my-panel-header/my-panel-header.component';

@Component({
  selector: 'app-my-panel',
  templateUrl: './my-panel.component.html',
  styleUrls: ['./my-panel.component.css']
})
export class MyPanelComponent {

  @Input()
  title = 'Default title';

  @ContentChild(MyPanelHeaderComponent)
  header: MyPanelHeaderComponent;

}
```

Now update the panel template, if there is no “header” element provided and there is a “title” input property defined, we display the value of the “title”.

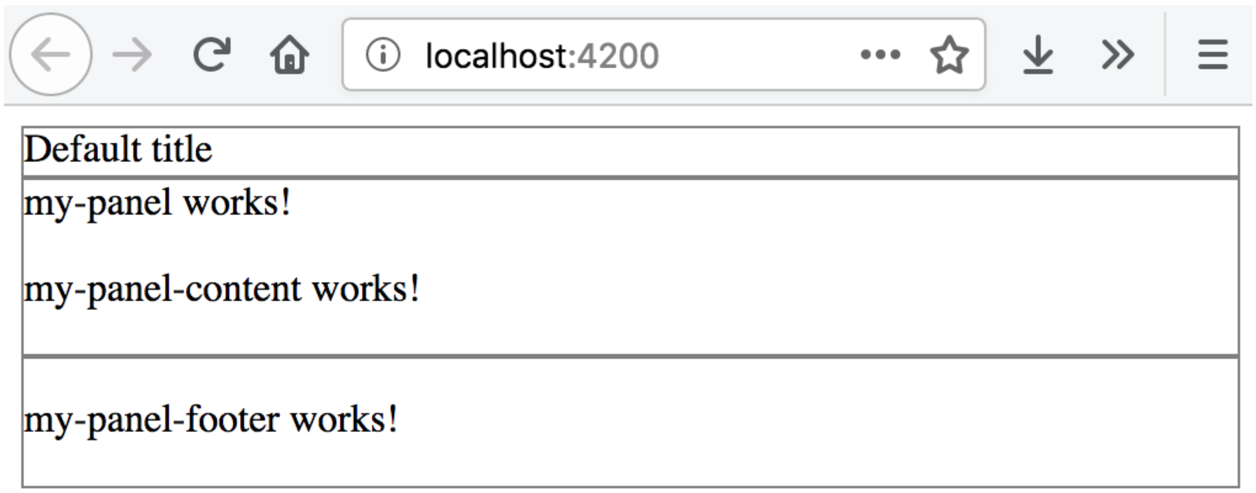
src/app/my-panel/my-panel.component.html

```
<div>
  <ng-container *ngIf="!header && title">{{ title }}</ng-container>
  <ng-content select="app-my-panel-header"></ng-content>
</div>
<div>
  my-panel works!
  <ng-content select="app-my-panel-content"></ng-content>
</div>
<div>
  <ng-content select="app-my-panel-footer"></ng-content>
</div>
```

If you want to test new functionality, comment out the header tags in the main page template and reload the application.

```
<app-my-panel>
  <!-- <app-my-panel-header></app-my-panel-header> -->
  <app-my-panel-content></app-my-panel-content>
  <app-my-panel-footer></app-my-panel-footer>
</app-my-panel>
```

We have set the default title value to “Default title”, that is the text you should now see rendered.



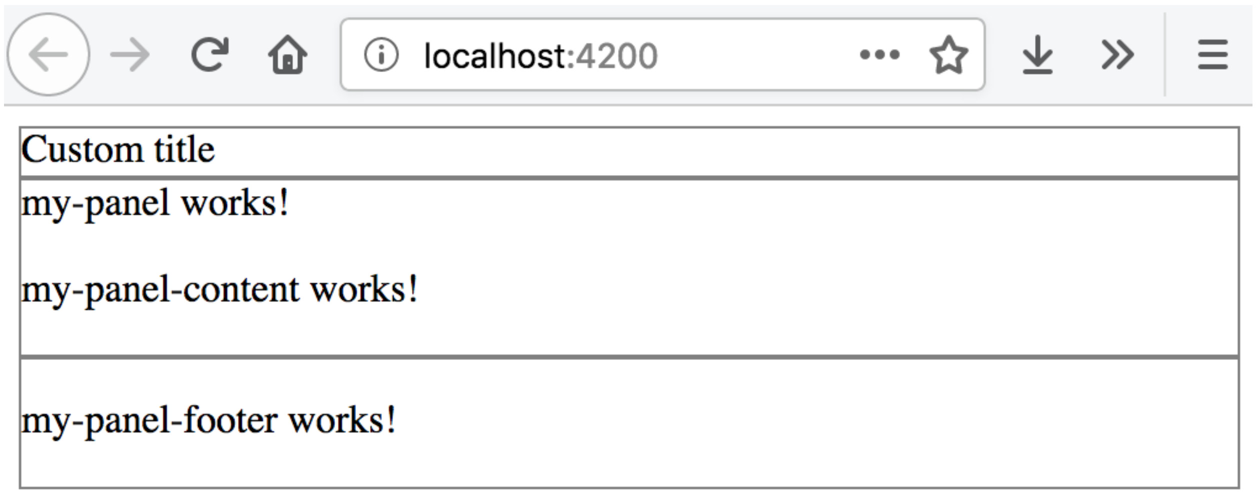
```
Default title
my-panel works!

my-panel-content works!

my-panel-footer works!
```

Projecting fallback title

Now set custom value for the “title” attribute to test that fallback content works as we expect:

```
<app-my-panel title="Custom title">
  <!-- <app-my-panel-header></app-my-panel-header> -->
  <app-my-panel-content></app-my-panel-content>
  <app-my-panel-footer></app-my-panel-footer>
</app-my-panel>
```

The panel should reflect your changes and web application should now render the “Custom title” value in the Header area.



Custom title

my-panel works!

my-panel-content works!

my-panel-footer works!

Projecting custom title

The dual rendering approach we have just tried helps a lot when you need to provide default layout portions, but still want to allow developers replacing them on demand. Imagine a dialog with the toolbar, for instance, where developers can project a new toolbar implementation, but can also have a predefined set of buttons.

Source Code and Demo

You can find the source code and the live demo[34] on Stackblitz.

[34] https://stackblitz.com/github/DenysVuika/dwa-content-projection?file=src%2Fapp%2Fapp.component.html

Dependency Injection

Dependency Injection, also known as DI, is one of the major features of the Angular framework.

With dependency injection, Angular greatly improves development and testing process by providing an infrastructure that helps to move share coded into the separate application services and blocks that can be centrally maintained, reused or replaced at run time.

In this chapter, we are going to try key features of dependency injection in practice.

Source code

You can find the source code as an Angular CLI project for this chapter in the "angular/dependency-injection[35]" folder.

Preparing a project

First, let's use Angular CLI tool and generate a new project called "dependency-injection".

```
ng new dependency-injection
cd dependency-injection
```

Next, generate two components "component1" and "component2", as in the example below:

```
ng g component component1
ng g component component2
```

Finally, update the main application component template to use both components we have just created:

src/app/app.component.html

```html
<app-component1></app-component1>
<app-component2></app-component2>
```

If you now run the application with the "ng serve –open" command you should see two default component templates that get generated automatically by Angular CLI:

[35]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/dependency-injection

```
component1 works!
component2 works!
```

You now have a working project ready for DI experiments.

Services

Creating LogService

As an example, let's build a shared Logger service now. Logging is an excellent example of how to turn a frequently used functionality into an injectable service. That is something you are not going to reimplement in each component.

You can save your time by using Angular CLI to generate a new "log" service utilising the following command:

```
ng g service services/log
```

That should give you a scaffold for a new service called "LogService":

src/app/services/log.service.ts

```
import { Injectable } from '@angular/core';

@Injectable({
  providedIn: 'root'
})
export class LogService {

  constructor() { }

}
```

We use a special "@Injectable" decorator here to mark the class and instruct Angular that the given class should participate in the dependency injection layer.

All classes marked with "@Injectable" can get imported into other entities like services, components, directives or pipes. The Angular framework creates instances of those classes, usually in the form of "singletons", and injects into other primitives on demand.

Note the warning message that Angular CLI generates for every new service scaffold:

```
installing service
  create src/app/services/log.service.spec.ts
  create src/app/services/log.service.ts
  WARNING Service is generated but not provided, it must be provided to be used
```

We are going to walk through Modules feature later in this chapter. For now, just edit the "app.module.ts" file and add the "LogService" file to the "providers" section as in the following example:

src/app/app.module.ts

```
...
import { LogService } from './services/log.service';

@NgModule({
  declarations: [
    ...
  ],
  imports: [
      ...
  ],
  providers: [
    LogService
  ],
  bootstrap: [AppComponent]
})
export class AppModule { }
```

That allows injecting "LogService" into all application components, including the "component1" and "component2" we created earlier.

Next, let's extend the service implementation with an "info" method we can reuse across the components:

src/app/services/log.service.ts

```
@Injectable({
  providedIn: 'root'
})
export class LogService {

  constructor() { }

  info(message: string) {
    console.log(`[info] ${message}`);
  }

}
```

At this point, we got a minimal logging service implementation that we can use in our components.

Injecting and using LogService

We are going to use constructor parameters to inject the LogService created earlier.

The Angular framework takes care of all the intermediate steps needed to find the expected type of the service, instantiate it and provide as a parameter when building our component.

src/app/component1/component1.component.ts

```
import { Component } from '@angular/core';
import { LogService } from './../services/log.service';

@Component({...})
export class Component1Component {

  constructor(logService: LogService) {
    logService.info('Component 1 created');
  }

}
```

You can now try to update the second component implementation yourself and add the same LogService integration as in the example above.

Once you are finished updating the code, run the application, and you should see the following output in the browser console:

```
[info] Component 1 created
[info] Component 2 created
```

Providers

In the previous examples, you should have noticed that to import and use a class decorated with “@Injectable” one needs to declare its Type in the “providers” array of the main application Module. That makes Angular “know” about the services when instantiating components for your web application.

You can have numerous services that perform various sets of functionality, all registered within the root module:

```
@NgModule({
  ...,
  providers: [
    ...
    LogService,
    AuthenticationService,
    AvatarService,
    UserService,
    ChatService
  ],
  ...
})
export class AppModule { }
```

The concept of “providers” in Angular goes beyond the collection of classes, in fact, it supports several powerful ways to control how dependency injection behaves at runtime.

Besides strings, the framework supports an object-based notation for defining providers.

Using a class

Earlier in this chapter, we have been using a string value to define a LogService dependency in the “providers” section. We can express the same value with the help of the following notation:

```
{ provide: <key>, useClass: <class> }
```

Let’s take a look at the next example:

```
@NgModule({
  ...
  providers: [
    { provide: LogService, useClass: LogService }
  ],
  ...
})
export class AppModule { }
```

We are using “LogService” both as a “key” for injection and as a “value” to build a new instance for injection. The main feature of this approach is that “key” and “value” can be different classes. That allows swapping the value of the service with a custom implementation if needed, or with a Mock object for an improved unit testing experience.

Now, let’s create a custom logger implementation “CustomLogService”:

```
ng g service services/custom-log
```

Next, implement the "info" method, but this time it should contain some different output for us to distinguish both implementations:

```
import { Injectable } from '@angular/core';

@Injectable({
  providedIn: 'root'
})
export class CustomLogService {

  constructor() { }

  info(message: string) {
    console.log(`[custom]: [info] ${message}`);
  }

}
```

Finally, you need to import this class into the main application module and declare as a new provider with the "LogService" key. Don't forget to comment out or remove the former logger declaration as in the example below:

```
import { LogService } from './services/log.service';
import { CustomLogService } from './services/custom-log.service';

@NgModule({
  ...,
  providers: [
    // LogService
    { provide: LogService, useClass: CustomLogService }
  ],
  ...
})
export class AppModule { }
```

The code above means that all the components that inject the "LogService" as part of the constructor parameters are going to receive the "CustomLogService" implementation at runtime. Essentially we are swapping the value of the logger, and no component is going to notice that. That is the behaviour developers often use for unit testing purposes.

If you now run the web application and navigate to browser console, you should see the following output:

```
[custom]: [info] Component 1 created
[custom]: [info] Component 2 created
```

Strings now contain "[custom]: " as a prefix, which proves the "Component1" and "Component2" are now dealing with the "CustomLogService" code that has been successfully injected using the "LogService" key.

Using a class factory

Previously we have been relying on the Angular framework to create instances of the injectable entities. There is also a possibility to control how the class gets instantiated if you need more than just a default constructor calls. Angular provides support for "class factories" for that very purpose.

You are going to use the following notation for class factories:

```
{ provide: <key>, useFactory: <function> }
```

Before we jump into configuration details, let's extend our newly introduced "CustomLogService" service with the custom "prefix" support. We are going to implement a special "setPrefix" method:

```
import { Injectable } from '@angular/core';

@Injectable({
  providedIn: 'root'
})
export class CustomLogService {

  private prefix = '[custom]';

  setPrefix(value: string) {
    this.prefix = value;
  }

  info(message: string) {
    console.log(`${this.prefix}: [info] ${message}`);
  }

}
```

As you can see from the code above the "info" method is going to use a custom prefix for all the messages.

Next, create an exported function "customLogServiceFactory" that is going to control how the CustomLogService instance gets created. In our case we are going to provide a custom prefix like in the example below:

```
export function customLogServiceFactory() {
  const service = new CustomLogService();
  service.setPrefix('(factory demo)');
  return service;
}
```

As you can imagine, there could be more sophisticated configuration scenarios for all application building blocks, including services, components, directives and pipes.

Finally, you can use the factory function for the "LogService". In this case, we both replace the real instance with the CustomLogService, and pre-configure the latter with a custom prefix for info messages:

```
@NgModule({
  ...
  providers: [
    { provide: LogService, useFactory: customLogServiceFactory }
  ],
  ...
})
export class AppModule { }
```

This time, when the application runs, you should see the following output:

```
(factory demo): [info] Component 1 created
(factory demo): [info] Component 2 created
```

Class factories with dependencies

When you use the default provider registration for a service, directive or component, the Angular framework automatically manages and injects dependencies if needed. In the case of factories, you can use additional "deps" property to define dependencies and allow your factory function to access corresponding instances during execution.

Let's imagine we need to manually bootstrap the "AuthenticationService" that depends on the "RoleService" and "LogService" instances.

```
@Injectable({
  providedIn: 'root'
})
export class AuthenticationService {
  constructor(private roles: RoleService,
              private log: LogService) {
  }
  ...
}
```

We should declare our factory-based provider the following way now:

```
@NgModule({
  ...,
  providers: [
      {
        provide: AuthenticationService,
        useFactory: authServiceFactory,
        deps: [ RoleService, LogService ]
      }
  ],
  ...
})
export class AppModule { }
```

With the code above we instruct Angular to resolve “RoleService” and “LogService” and use with our custom factory function when the “AuthenticationService” singleton instance gets created for the first time.

Finally, your factory implementation should look similar to the following one:

```
export function authServiceFactory(roles: RoleService, log: LogService) {
  const service = new AuthenticationService(roles, log);
  // do some additional service setup
  return service;
}
```

Using @Inject decorator

Another important scenario you might be interested in is the @Inject decorator. The @Inject decorator instructs Angular that a given parameter must get injected at runtime. You can also use it to get references to “injectables” using string-based keys.

To demonstrate @Inject decorator in practice let’s create a “date” factory function to generate current date:

src/app/app.module.ts

```
export function dateFactory() {
  return new Date();
}
```

Now we define a custom provider with the key "DATE_NOW" that is going to use our new factory.

```
@NgModule({
  ...,
  providers: [
      { provide: 'DATE_NOW', useFactory: dateFactory }
  ],
  ...
})
export class AppModule { }
```

For the next step, you can import the '@Inject' decorator from the "angular/core" namespace and use it with the "Component1" we created earlier in this chapter:

```
import { ..., Inject } from '@angular/core';

@Component({...})
export class Component1Component {

  constructor(logService: LogService, @Inject('DATE_NOW') now: Date) {
    logService.info('Component 1 created');
    logService.info(now.toString());
  }

}
```

There are two points of interest in the code above. First, we inject "LogService" instance as a "logService" parameter using its type definition: "logService: LogService". Angular is smart enough to resolve the expected value based on the "providers" section in the Module, using "LogService" as the key.

Second, we inject a date value into the "now" parameter. This time Angular may experience difficulties resolving the value based on the "Date" type, so we have to use the "@Inject" decorator to explicitly bind "now" parameter to the "DATE_NOW" value.

The browser console output, in this case, should be as the following one:

```
(factory demo): [info] Component 1 created
(factory demo): [info] Sun Aug 06 2017 08:45:36 GMT+0100 (BST)
(factory demo): [info] Component 2 created
```

Another important use case for the @Inject decorator is using custom types in TypeScript when the service has different implementation class associated with the provider key, like in our early examples with LogService and CustomLogService.

Below is an alternative way you can use to import CustomLogService into the component and use all the API exposed:

```
@Component({...})
export class Component1Component {

  constructor(@Inject(LogService) logService: CustomLogService) {
    logService.info('Component 1 created');
  }

}
```

In this case, you are getting access to real CustomLogService class that is injected by Angular for all the "LogService" keys. If your custom implementation has extra methods and properties, not provided by the LogService type, you can use them from within the component now.

This mechanism is often used in unit testing when the Mock classes expose additional features to control the execution and behaviour flow.

Using a value

Another scenario for registering providers in the Angular framework is providing instances directly, without custom or default factories.

The format, in this case, should be as following:

```
{ provide: <key>, useValue: <value> }
```

There are two main scenarios of providing the values.

The first scenario is pretty much similar to the factory functions you can create and initialise the service instance before other components and services use it.

Below is the basic example of how you can instantiate and register custom logging service by value:

```
const logService = new CustomLogService();
logService.setPrefix('(factory demo)');

@NgModule({
  ...
  providers: [
    { provide: LogService, useValue: logService }
  ],
  ...
})
export class AppModule { }
```

The second scenario is related to configuration objects you can pass to initialise or setup other components and services.

Let's now register a "logger.config" provider with a JSON object value:

```
@NgModule({
  ...,
  providers: [
    {
      LogService,
      {
        provide: 'logger.config',
        useValue: {
          logLevel: 'info',
          prefix: 'my-logger'
        }
      }
    }
  ],
  ...
})
export class AppModule { }
```

Now any component, service or directive can receive the configuration values by injecting it as "logger.config". To enable static type checking you can create a TypeScript interface describing the settings object:

```
export interface LoggerConfig {
  logLevel?: string;
  prefix?: string;
}
```

Finally, proceed to the "LogService" code and inject the JSON object using the "logger.config" token and "LoggerConfig" interface like in the following example:

```
@Injectable({
  providedIn: 'root'
})
export class LogService {

  constructor(@Inject('logger.config') config: LoggerConfig) {
    console.log(config);
  }

  info(message: string) {
    console.log(`[info] ${message}`);
  }

}
```

For the sake of simplicity we just log the settings content to the browser console. Feel free to extend the code with configuring the log service behaviour based on the incoming setting values.

If you run the web application right now and open the browser console you should see the next output:

```
{
  logLevel: 'info',
  prefix: 'my-logger'
}
```

Registering providers with exact values is a compelling feature when it comes to global configuration and setup. Especially if you are building redistributable components, directives or services that developers can configure from the application level.

Using an alias

The next feature we are going to see in action is "provider alias". You are probably not going to use this feature frequently in applications, but it is worth taking a look at what it does if you plan to create and maintain redistributable component libraries.

Let's imagine a scenario when you have created a shared component library with an "AuthenticationService" service that performs various login and logout operations that you and other developers can reuse across multiple applications and other component libraries.

After some time you may find another service implementation with the same APIs, or let's assume you want to replace the service with a newer "SafeAuthenticationService" implementation.

The main issue you are going to come across when replacing Types is related to breaking changes. The old service might be in use in a variety of modules and applications, many files import the Type, use in constructor parameters to inject it, and so on.

For the scenario above is where "alias" support comes to the rescue. It helps you to smooth the transition period for old content and provide backwards compatibility with existing integrations.

Let's now take a look at the next example:

```
@NgModule({
  ...
  providers: [
    SafeAuthenticationService,
    { provide: AuthenticationService, useExisting: SafeAuthenticationService }
  ],
  ...
})
export class AppModule { }
```

As you can see from the example above, we register a new "SafeAuthenticationService" service and then declare an "AuthenticationService" that points to the same "SafeAuthenticationService".

Now all the components that use "AuthenticationService" are going to receive the instance of the "SafeAuthenticationService" service automatically. All the newly introduced components can now reference new service without aliases.

Difference with the "useClass"

You may wonder what's the difference with the "useClass" provider registration compared to the "useExisting" one.

When using "useClass", you are going to end up with two different instances registered at the same time. That is usually not a desirable behaviour as services may contain events for example, and various components may have issues finding the "correct" instance. The "useExisting" approach allows you to have only one singleton instance referenced by two or more injection tokens.

Injection Tokens

As you might have already understood the Angular dependency injection layer keeps a map of providers that are being identified by “keys”, also known as “injection tokens”, and uses this map to resolve, create and inject instances at runtime.

The injection tokens can be of different types. We have already tried Types and Strings in action in previous sections.

Type tokens

Type-based injection tokens are the most commonly used way to register providers. Typically you import the service type from the corresponding file and put it into the “providers” section of the module.

```
import { LogService } from './services/log.service';

@NgModule({
  ...
  providers: [
    LogService
  ],
  ...
})
export class AppModule { }
```

The same applies to custom provider registration options we tried earlier:

```
providers: [
  { provide: LogService, useClass: LogService },
  { provide: LogService, useFactory: customLogServiceFactory },
  { provide: LogService, useValue: logService },
  { provide: AuthenticationService, useExisting: SafeAuthenticationService }
]
```

In all the cases above we use a real Type reference to register a new provider.

String tokens

Another way to register a provider involves the string-based injection tokens.

Another way to register a provider involves the string-based injection tokens. Typically you are going to use strings when there is no Type reference available, for example when registering plain values or objects:

```
providers: [
  { provide: 'DATE_NOW', useFactory: dateFactory },
  { provide: 'APP_VERSION', useValue: '1.1.0' },
  {
    provide: 'logger.config',
    useValue: {
      logLevel: 'info',
      prefix: 'my-logger'
    }
  }
]
```

Generic InjectionToken

Also, Angular provides a special generic class `InjectionToken<T>` to help you create custom injection tokens backed by specific types: primitives, classes or interfaces. That enables static type checks and prevents many type-related errors at early stages.

Let's create separate file "tokens.ts" to hold our custom injection tokens, and create a simple string-based one:

```
import { InjectionToken } from '@angular/core';

export const REST_API_URL = new InjectionToken<string>('rest.api.url');
```

Now we can use this token within the main application module to register a URL value that all components and services can use when needed:

```
import { REST_API_URL } from './tokens';

@NgModule({
  ...,
  providers: [
    ...,
    { provide: REST_API_URL, useValue: 'http://localhost:4200/api' }
  ]
})
```

From this moment we can use the same token to import registered value in the service or a component like in the example below:

```
...
import { REST_API_URL } from './../tokens';

@Injectable({
  providedIn: 'root'
})
export class LogService {

  constructor(@Inject(REST_API_URL) restApiUrl: string) {
    console.log(restApiUrl);
  }

  ...
}
```

At runtime, you should see the actual value of the `REST_API_URL` provider in the browser console: `http://localhost:4200/api`.

As mentioned earlier, you can also use interfaces or classes with the `InjectionToken<T>`. That does not affect the process of dependency injection but gives you an opportunity for static compile-time checks and auto completion if your code editor supports TypeScript.

Let's create a token for the "LoggerConfig" interface we set up in this chapter earlier:

```
export interface LoggerConfig {
  logLevel?: string;
  prefix?: string;
}

export const LOGGER_CONFIG = new InjectionToken<LoggerConfig>('logger.config');
```

You can now define a type-safe configuration object and register it with the dependency injection system using main application module:

```
const loggerConfig: LoggerConfig = {
  logLevel: 'warn',
  prefix: 'warning:'
};

@NgModule({
  ...,
  providers: [
    ...,
    { provide: LOGGER_CONFIG, useValue: loggerConfig }
  ]
})
```

Finally, you can use that token to inject configuration into the LogService and use it to setup the service accordingly:

```
@Injectable({
  providedIn: 'root'
})
export class LogService {

  constructor(@Inject(LOGGER_CONFIG) config: LoggerConfig) {
    console.log(config);
  }

  ...
}
```

Injecting multiple instances

Previously we have been working with injectables backed by the singletons. That means any components, directives or other services are typically referencing the same instance created only once on the very first request.

There are cases, however, when you may want to have multiple service instances injected at runtime utilising a single injection token.

An excellent example is plugin systems and plugins support. Typically you are going to require a special contract or interface that every external plugin must implement. The service, component or an application layer need to rely on only the common and shared API, and it makes sense injecting an entire collection of the plugin instances without knowing exact types.

Let’s build a logging service that supports external plugins and injects them as a single collection.

First, create a “LogPlugin” interface for external plugin implementation, and a basic “CompositeLogService” scaffold for our service. We are going to get back to it shortly.

src/app/services/composite-log.service.ts

```
export interface LogPlugin {
  name: string;
  level: string;
  log(message: string);
}

@Injectable({
  providedIn: 'root'
})
export class CompositeLogService {

  constructor() { }

}
```

The “LogPlugin” interface contains a bare minimum of APIs, at this point we need a “name” for demo and debugging purposes, alongside the level of the messages our plugin supports and the method to write a log message.

Next, create an injection token “LOGGER_PLUGIN” backed by the interface we have just created above.

src/app/tokens.ts

```
import { LogPlugin } from './services/composite-log.service';

export const LOGGER_PLUGIN = new InjectionToken<LogPlugin>('logger.plugin');
```

We are going to use that token to register various logger plugins, and also inject existing plugin instances for the “CompositeLogService”.

After that let’s create a couple of Loggers that implement the LogPlugin interface. There is going to be one class for error messages and one for warnings.

src/app/services/loggers.ts

```
import { LogPlugin } from './composite-log.service';

export class ErrorLogPlugin implements LogPlugin {

    name = 'Error Log Plugin';
    level = 'error';

    log(message: string) {
      console.error(message);
    }
}

export class WarningLogPlugin implements LogPlugin {

  name = 'Warning Log Plugin';
  level = 'warn';

  log(message: string) {
    console.warn(message);
  }
}
```

Now you are ready to register the service and its plugins with the main application module like in the following example:

src/app/app.module.ts

```
import { LOGGER_PLUGIN } from './tokens';
import { ErrorLogPlugin, WarningLogPlugin } from './services/loggers';


@NgModule({
  providers: [
    CompositeLogService,
    { provide: LOGGER_PLUGIN, useClass: ErrorLogPlugin, multi: true },
    { provide: LOGGER_PLUGIN, useClass: WarningLogPlugin, multi: true }
  ]
})
```

Please note that the most important part that enables multiple injections is the “multi” attribute we set to “true” when registering a provider.

Now let's get back to our "CompositeLogService" and inject instances of all previously registered plugins using the following format:

```
constructor(@Inject(LOGGER_PLUGIN) plugins: LogPlugin[])
```

To demonstrate the instances, we are going to enumerate the injected collection and log all plugin names to the browser console:

src/app/services/composite-log.service.ts

```
import { Injectable, Inject } from '@angular/core';
import { LOGGER_PLUGIN } from './../tokens';

export interface LogPlugin {
  name: string;
  level: string;
  log(message: string);
}

@Injectable({
  providedIn: 'root'
})
export class CompositeLogService {

  constructor(@Inject(LOGGER_PLUGIN) plugins: LogPlugin[]) {
    if (plugins && plugins.length > 0) {
      for (const plugin of plugins) {
        console.log(`Loading plugin: ${plugin.name} (level: ${plugin.level})`);
      }
    }
  }

}
```

The service is ready for testing. The only thing we have left is to inject it somewhere. The main application component is the best place to test all the newly introduced code quickly.

src/app/app.component.ts

```
import { CompositeLogService } from './services/composite-log.service';

@Component({...})
export class AppComponent {
  constructor(private logService: CompositeLogService) {
  }
}
```

Now if you run the application the console log is going to contain the following output:

```
Loading plugin: Error Log Plugin (level: error)
Loading plugin: Warning Log Plugin (level: warn)
```

In the real-life scenario, you would most probably want the log service to use different types of plugins for certain purposes. Let's now extend our service and introduce a "log" method redirects logging calls to the plugins that support the corresponding levels.

src/app/services/composite-log.service.ts

```
@Injectable({
  providedIn: 'root'
})
export class CompositeLogService {
  ...

  log(level: string, message: string) {
    const logger = this.plugins.find(p => p.level === level);
    if (logger) {
      logger.log(message);
    }
  }
}
```

To test how it works you can even use the "log" method within the service itself. Update the constructor to send a message once all the external plugins are enumerated:

src/app/services/composite-log.service.ts

```
@Injectable({
  providedIn: 'root'
})
export class CompositeLogService {
  constructor(@Inject(LOGGER_PLUGIN) private plugins: LogPlugin[]) {
    if (plugins && plugins.length > 0) {
      for (const plugin of plugins) {
        console.log(`Loading plugin: ${plugin.name} (level: ${plugin.level})`);
      }
      this.log('warn', 'All plugins loaded');
    }
  }
}
```

For the sake of simplicity, we are going to use the "warn" level because we got only "warn" and "error" loggers registered. Feel free to extend the collection of the loggers with the "info" or "debug" one for example.

Once you run the web application, the main component should provide the following output to the browser console:

```
Loading plugin: Error Log Plugin (level: error)
Loading plugin: Warning Log Plugin (level: warn)
All plugins loaded
```

Now you are ready to deal with multiple instances injected as collections and got a basic scenario working in practice.

Optional dependencies

Previously in this chapter, we have successfully created a "CompositeLogService" service based on multiple plugins injected with the same custom token. However, what happens when there are no logger plugins registered within the application? Let's comment out the plugin registration section in the app module providers to see what happens at runtime.

```
@NgModule({
  providers: [
    CompositeLogService // ,
    // { provide: LOGGER_PLUGIN, useClass: ErrorLogPlugin, multi: true },
    // { provide: LOGGER_PLUGIN, useClass: WarningLogPlugin, multi: true }
  ]
})
```

Now if you rebuild and run your application it is going to crash with the following error in the browser console:

```
Error: No provider for InjectionToken logger.plugin!
```

The error above is an expected behaviour. Essentially, when you declare a dependency within the constructor parameters, you instruct the Angular framework to ensure the corresponding dependency indeed exists, and injection can happen.

There are scenarios when having an instance is not mandatory, and application can function without it, like in our case with logger plugins - the log service can have default fallback behaviour in case no plugins are present.

For those kinds of scenarios, the Angular framework provides us with the "@Optional" decorator that allows making particular injections "optional" rather than "mandatory" during dependency injection phase.

```
import { ..., Optional } from '@angular/core';

@Injectable({
  providedIn: 'root'
})
export class CompositeLogService {

  constructor((@Optional() @Inject(LOGGER_PLUGIN) private plugins: LogPlugin[]) {
    if (plugins && plugins.length > 0) {
      ...
    } else {
      console.log('No logger plugins found.');
    }
  }

 ...
}
```

As you can see from the code above, we now have a possibility to check whether any plugins are available, and perform the fallback behaviour if needed. Just for the demo purposes, we log the information message to the console:

```
No logger plugins found.
```

The “@Optional” decorator is a handy mechanism that helps you to prevent the runtime errors when some content is missing or is not registered correctly.

Manual injection with ReflectiveInjector

You are not limited to automatic dependency injection mechanism. The Angular provides you with a low-level APIs that allow you to resolve and create instances manually from code.

The DI utility class is called “ReflectiveInjector”, and you can import it from the “@angular/core” namespace. It helps to create the “injectors” filled with resolved and created instances of the providers, similar to those we used with the application modules.

```
import { ReflectiveInjector } from '@angular/core';

@Component({...})
export class AppComponent {
  constructor() {
    const injector = ReflectiveInjector.resolveAndCreate([ LogService ]);
    const logService: LogService = injector.get(LogService);
    logService.info('hello world');
  }
}
```

Typically you are going to use this API only for concrete scenarios like unit testing or dynamic content creation. You can get more detailed information including code examples in the following article: Reflective Injector[36].

Summary

We have covered the main scenarios for service and provider registration and tested them in action. You can also refer to the Dependency Injection[37] article for even more detailed information on how dependency injection works in Angular.

[36]https://angular.io/api/core/ReflectiveInjector
[37]https://angular.io/guide/dependency-injection#dependency-injection

Events

There are three main event cases we are going to review in this chapter. With Angular, you can raise Component events, DOM events and Service events.

Source code

You can find the source code in the “angular/events[38]” folder.

To address all three scenarios let’s create a simple Panel component that consists of the Body, Header and Footer. The Header and Footer are going to be separate components.

First, generate a new Angular application using the Angular CLI tool. Then execute the following commands to generate the prerequisites:

```
ng g component panel
ng g component panel-header
ng g component panel-footer
```

Next, update the Panel component template like in the example below:

src/app/panel/panel.component.html

```html
<app-panel-header></app-panel-header>

<p>
  panel works!
</p>

<app-panel-footer></app-panel-footer>
```

Finally, we can replace the default auto-generated content of the main application template with the Panel we have just created above:

[38] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/events

src/app/app.component.html

```html
<app-panel>
</app-panel>
```

If you make a pause at this point and run the "ng serve –open" command you should see the following output on the main page:

```
panel-header works!

panel works!

panel-footer works!
```

At this point, we got all the basic prerequisites for testing the events.

Component events

It is now time to improve our Header component. Let's provide a way to set the content text for the component to display when rendered, and a simple click event "contentClick" that gets emitted every time user clicks the content.

src/app/panel-header/panel-header.component.ts

```typescript
import { ..., Input, Output, EventEmitter } from '@angular/core';

@Component({...})
export class PanelHeaderComponent {

  @Input()
  content = 'Panel header';

  @Output()
  contentClick = new EventEmitter();

  onContentClicked() {
    console.log('panel header clicked');
    this.contentClick.next();
  }
}
```

From the earlier chapters, you already know that we use “@Input” decorator for the class properties we want to set or bind from the outside. We also need to use the “@Output” decorator to mark our events.

Output Events

You can get more details on the component events in the Output Events section of the Components chapter.

Also, note that in the example above we also add the “onContentClicked” method that is going to raise our “contentClick” event.

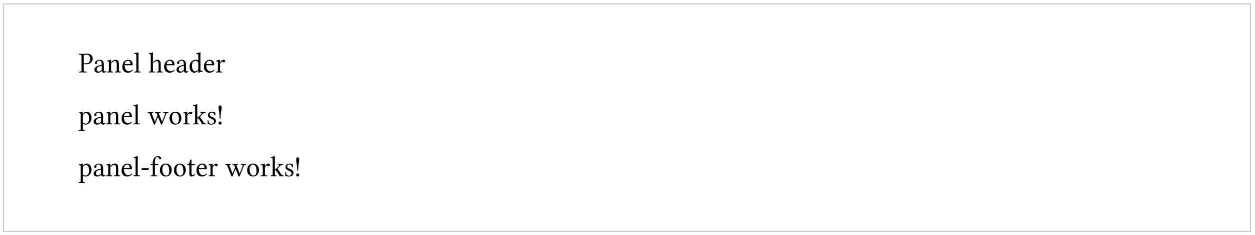
Below is an example of a minimalistic Header component template we can use to display a “content” value:

src/app/panel-header/panel-header.component.html

```html
<p (click)="onContentClicked()">
    {{ content }}
</p>
```

As you can see, we link the “click” event of the enclosed “p” element with the “onContentClicked” handler that temporarily sends a message to the console log for testing/debugging purposes and also invokes the “contentClicked” event that other components can use.

Also, we set a default value for the “content” property to the “Panel header” string. So at the runtime, the content or application main page is going to look similar to the following:



Panel header

panel works!

panel-footer works!

However, we are not going to use the Header component directly. It is the Panel component that needs it. So we should allow our Panel component to control the header content, and also react on header click events. Let’s toggle the panel content as an example.

Edit the panel component class and add the “header” input property to hold the text for the Header, and “displayBody” property to serve as a flag for showing and hiding the main panel content, like in the example below:

src/app/panel/panel.component.ts

```
import { ..., Input } from '@angular/core';

@Component({...})
export class PanelComponent {

  @Input()
  header = 'My panel header';

  displayBody = true;
}
```

For the next step, let's update the panel component template to link the Header properties with the newly introduced class members:

src/app/panel/panel.component.html

```
<app-panel-header
  [content]="header"
  (contentClick)="displayBody = !displayBody">
</app-panel-header>

<ng-container *ngIf="displayBody">
  <p>
    panel works!
  </p>
</ng-container>

<app-panel-footer></app-panel-footer>
```

You can now run the application and test your components by clicking the panel header text multiple times. The panel should toggle its body content every time a header gets clicked.

Below is how the panel should look like by default, in the expanded state:

```
My panel header

panel works!

panel-footer works!
```

Also, the next example shows how the panel looks like in the "collapsed" state:

```
My panel header

panel-footer works!
```

Congratulations, you just got the component events working, and tested them in practice. Now feel free to extend the PanelFooterComponent and add similar “content” and “contentClick” implementations.

Bubbling up child events

We have created a PanelHeader component earlier in this chapter. Aalso, we introduced a “click” event for the component and made the Panel component host it within its template, and toggle panel body content every time the Panel Header is clicked.

Imagine that the “<app-panel>” is a redistributable component, and you would like developers to have access to header clicks as well. The “<app-panel-header>” however, is a child element, and developers do not have direct access to its instance when working with the Panel. In this case, you would probably want your main Panel component re-throwing its child events.

We already got the “header” and the “footer” input properties that hold the values for the “<app-panel-header>” and “<app-panel-fooder>” elements. Let’s now introduce two new output events and call them “headerClick” and “footerClick”.

src/app/panel/panel.component.ts

```
export class PanelComponent {

  displayBody = true;

  @Input()
  header = 'My panel header';

  @Input()
  footer = 'My panel footer';

  @Output()
  headerClick = new EventEmitter();

  @Output()
  footerClick = new EventEmitter();

  onHeaderClicked() {
    this.displayBody = !this.displayBody;
    this.headerClick.next();
  }

  onFooterClicked() {
    this.footerClick.next();
  }

}
```

As you can see from the code above, we also get two methods to raise our events. The "onHeaderClicked" method is still toggling the panel body before raising the "headerClick" event.

Next, our "<app-panel> component is going to watch the "contentClick" events of the child elements, and emit events for developers. Update the HTML template and subscribe to the header and footer events like in the example below:

src/app/panel/panel.component.html

```
<app-panel-header
  [content]="header"
  (contentClick)="onHeaderClicked()">
</app-panel-header>

<ng-container *ngIf="displayBody">
    <p>
        panel works!
    </p>
</ng-container>

<app-panel-footer
  [content]="footer"
  (contentClick)="onFooterClicked()">
</app-panel-footer>
```

Finally, let's test our panel events in action. Update your main application template and subscribe to our newly introduced events for header and footer clicks:

src/app/app.component.html

```
<app-panel
  (headerClick)="onHeaderClicked()"
  (footerClick)="onFooterClicked()">
</app-panel>
```

For the sake of simplicity we are going to log messages to browser console similar to the following:

src/app/app.component.ts

```
@Component({...})
export class AppComponent {

  onHeaderClicked() {
    console.log('App component: Panel header clicked');
  }

  onFooterClicked() {
    console.log('App component: Panel footer clicked');
  }

}
```

If you compile and run your web application with the "ng serve –open" command, you should be able to see messages in the console every time a header or footer elements of the panel get clicked.

DOM events

With multiple levels of nesting, the re-raising of child events quickly turns into a challenging and time-consuming process. Like with our previous Panel example, to wrap it with another Angular component developers may have to watch for panel events and raise them for the own implementation. That is where native DOM events with bubbling support come to the rescue.

If set to bubble, a DOM event gets raised for every element up against the parent hierarchy. Developers get an opportunity reacting on events that occur in deeply nested components.

Creating and triggering events

You can get more details and examples on how to build and dispatch DOM events in the following article: Creating and triggering events[39]

[39]https://developer.mozilla.org/en-US/docs/Web/Guide/Events/Creating_and_triggering_events

First, to raise a custom DOM event we need to get access to a native element of the component. You can achieve that by injecting an "ElementRef" instance in the component constructor, and saving as a private property called "elementRef".

src/app/panel-header/panel-header.component.ts

```
import { ..., ElementRef } from '@angular/core';

@Component({...})
export class PanelHeaderComponent {

    ...

    constructor(private elementRef: ElementRef) {
    }

}
```

Next, we need updating the "onContentClicked" handler to raise an additional event. You can leave the code to raise the "contentClick" event, so that component supports raising two types of the events at the same time. Let's introduce a new "header-click" custom event that is set to bubble and contains clicked content in the "details" section.

src/app/panel-header/panel-header.component.ts

```
@Component({...})
export class PanelHeaderComponent {

  ...

  onContentClicked() {
    this.contentClick.next();

    this.elementRef.nativeElement.dispatchEvent(
      new CustomEvent('header-click', {
        detail: {
          content: this.content
        },
        bubbles: true
      })
    );
  }
}
```

We are now ready to see the newly introduced event in practice. Let's update the main application component template with a top-most "div" element that is going to listen to the "header-click" event. That is a good case to test event handling and see how event bubbles up to non-Angular elements.

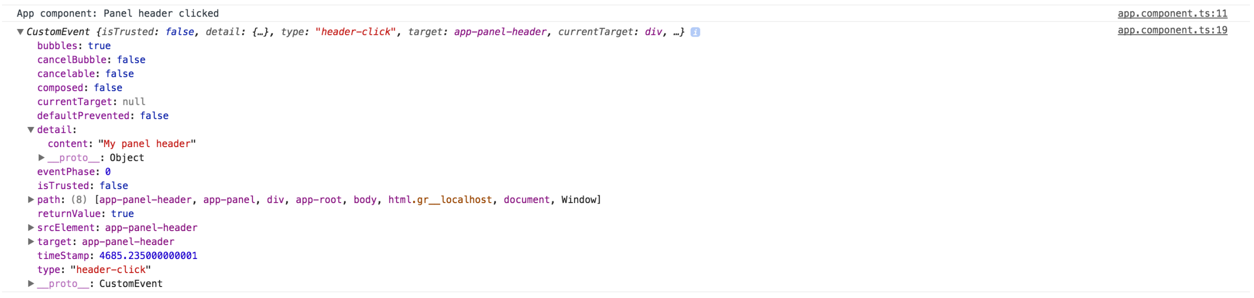
src/app/app.component.html

```html
<div (header-click)="onDomHeaderClick($event)">
  <app-panel
    (headerClick)="onHeaderClicked()"
    (footerClick)="onFooterClicked()">
  </app-panel>
</div>
```

For testing purposes, we are going just to log the event details to the browser console.

```ts
@Component({...})
export class AppComponent {

  ...

  onDomHeaderClick(event) {
    console.log(event);
  }

}
```

Finally, if you run your web application at this point, and click the panel header content, the following content should appear in the browser console output:



```
App component: Panel header clicked                                                                                app.component.ts:11
▼CustomEvent {isTrusted: false, detail: {…}, type: "header-click", target: app-panel-header, currentTarget: div, …}  app.component.ts:19
   bubbles: true
   cancelBubble: false
   cancelable: false
   composed: false
   currentTarget: null
   defaultPrevented: false
  ▼detail:
     content: "My panel header"
    ▶__proto__: Object
   eventPhase: 0
   isTrusted: false
  ▶path: (8) [app-panel-header, app-panel, div, app-root, body, html.gr__localhost, document, Window]
   returnValue: true
  ▶srcElement: app-panel-header
  ▶target: app-panel-header
   timeStamp: 4685.235000000001
   type: "header-click"
  ▶__proto__: CustomEvent
```

As you can see from the picture above you can access all data in the custom event including the "detail" object we have created earlier, and that contains our component-specific information.

Dispatching the custom DOM events is an excellent option if you want to allow developers to wrap your components, or you are using composite components and trying to avoid re-throwing multiple events.

Service events

When working with events in Angular, you can achieve a significant level of flexibility by utilising the application services and service events.

Service-based events allow multiple components to communicate with each other regardless of the component and DOM structure using the publish/subscribe approach.

Before we dive into details let's use Angular CLI and generate a new service using the following command:

```
ng g service panel
```

You need to manually register the newly generated service within one of your modules. For now, let's add the "PanelService" to the main application module in the "app.module.ts" file:

src/app/app.module.ts

```
import { PanelService } from './panel.service';

@NgModule({
  providers: [
    PanelService
  ]
})
export class AppModule { }
```

Next, extend the service with a couple of events for header and footer clicks:

src/app/panel.service.ts

```
import { Injectable } from '@angular/core';
import { Subject } from 'rxjs/Rx';

import { PanelHeaderComponent } from './panel-header/panel-header.component';
import { PanelFooterComponent } from './panel-footer/panel-footer.component';

@Injectable({
  providedIn: 'root'
})
export class PanelService {

  headerClicked = new Subject<PanelHeaderComponent>();
  footerClicked = new Subject<PanelFooterComponent>();

}
```

In the example above, we are using generic “Subject<T>” to allow both emitting and subscribing to the same event. We are going to pass either “PanelHeaderComponent” or “PanelFooterComponent” instance as the event argument.

Let’s update the “PanelHeaderComponent” class and emit the “headerClicked” event like in the following example:

src/app/panel-header/panel-header.component.ts

```
import { PanelService } from '../panel.service';

@Component({...})
export class PanelHeaderComponent {

  constructor(
    private panelService: PanelService,
    private elementRef: ElementRef) {
  }

  onContentClicked() {
    ...
    // raise service event
    this.panelService.headerClicked.next(this);
  }
}
```

As you can see, the component now injects the “PanelService” instance and saves a reference to the private “panelService” property so that click handler can use to emit the corresponding event.

Subscribing to the event is also simple. The component, in our case main application one, injects the “PanelService” and uses “headerClicked.subscribe” to wire the event handler code:

src/app/app.component.ts

```
import { PanelHeaderComponent } from './panel-header/panel-header.component';
import { PanelService } from './panel.service';

@Component({...})
export class AppComponent {

  constructor(panelService: PanelService) {
    panelService.headerClicked.subscribe(
      (header: PanelHeaderComponent) => {
        console.log(`Header clicked: ${header.content}`);
      }
    );
  }
}
```

Now if you run your web application and click the header you should see the following output in the browser console:

```
Header clicked: My panel header
```

Congratulations, you have just established a basic communication channel between header and footer components with the rest of the application content. Many other components and services now can subscribe and react to click events. Of course, we got over-simplified examples; you can imagine more complex scenarios involving different events in your application.

Source code

You can find the source code in the "angular/events[40]" folder.

[40]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/events

Modules

Directives

A directive is one of the core building blocks in Angular. It allows easy manipulation of the DOM structure of HTML elements, change their appearance and layout, or even extend the behaviour if needed.

Introduction

There are three types of directives in Angular you are going to work with:

- **Components** - also known as `Directives with Templates`, see `Components` chapter for a detailed overview;
- **Attribute Directives** - extend elements, change the look and feel of the host elements;
- **Structural Directives** - change elements, manipulate DOM layout, add or remove elements or completely change underlying view;

Let's start with a new project to host various kinds of directives we are going to experiment with:

```
ng new directive-example
cd directive-example
ng serve --open
```

Attribute Directives

Attribute directives change appearance or behaviour of a host DOM element. Usually, they look like regular HTML element attributes.

Let's create a simple clickable directive and call it 'Clickme'.

```
ng g directive directives/clickme
```

Angular CLI generates directive with unit test and updates main application module:

```
installing directive
  create src/app/directives/clickme.directive.spec.ts
  create src/app/directives/clickme.directive.ts
  update src/app/app.module.ts
```

Initial implementation should look like the following one:

src/app/directives/clickme.directive.ts

```
import { Directive } from '@angular/core';

@Directive({
  selector: '[appClickme]'
})
export class ClickmeDirective {

  constructor() { }

}
```

Directives can interact with the host by listening to events and setting properties of the target element.

Handling host events

Your newly created directive can listen to events with the help of the `HostListener` decorator. Angular invokes decorated method when the host element emits a corresponding event.

The format of the `HostListener` decorator and metadata is as following:

```
interface HostListener {
    eventName : string
    args : string[]
}
```

You can use it to decorate class methods like shown below:

src/app/directives/clickme.directive.ts

```
@HostListener('domEvent', ['$event'])
onEvent(event) {
    // ...
}
```

Angular should be listening for the 'domEvent' event (if supported by host element) and invoke `onEvent` method of the directive controller. The event handler is also going to get a reference to the original DOM event, as we instruct Angular to map specific `$event` argument to the `event` parameter. That means directive can inspect properties of the original event and even prevent default behaviour or event bubbling if necessary.

The easiest way to demonstrate `HostListener` in action is by wiring a standard `click` event.

src/app/directives/clickme.directive.ts

```
import { ..., HostListener } from '@angular/core';

...
export class ClickmeDirective {
    ...
    @HostListener('click', ['$event'])
    onClicked(e: Event) {
        console.log(e);
        alert('Clicked');
    }
}
```

Next put a `div` element to the `app.component.html` and decorate it with your `appHighlight` directive:

src/app/app.component.html

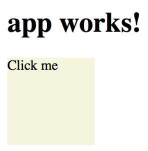
```
<h1>
  {{title}}
</h1>

<div class="click-area" appClickme>
  Click me
</div>
```

You also need to have some space to click on; this is what we are going to use `highlight-area` CSS class for:

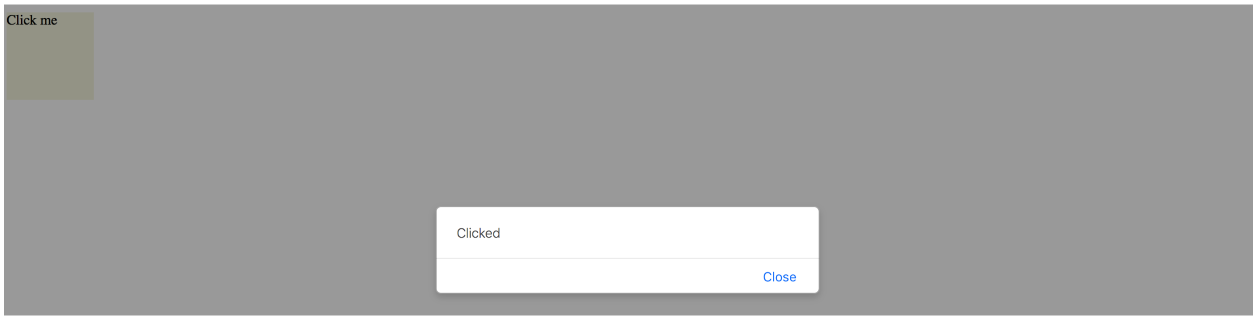
src/app/app.component.css

```css
.click-area {
  width: 100px;
  height: 100px;
  background-color: beige;
}
```

Below is how the main page looks like after your changes:



You get the default 'app works!' label generated by the Angular CLI, and coloured `div` element. Now if you click anywhere on the beige area the browser should display an alert:



So as you can see in the example above, with the help of `HostListener`, you can listen to any event emitted by host element. We have added `appClickme` directive as an attribute of the `div`, and every click on the `div` automatically triggers `onClicked` method in the `ClickmeDirective`. You can use any target for the directive, for example:

src/app/app.component.html

```html
<button appClickme>Click me</button>
<span appClickme>Click me</span>
<input type="text" appClickme>
```

Host members binding

Angular also provides a way for a directive to change host properties by using a `HostBinding` decorator. During change detection cycle Angular checks all property bindings and updates host element of the directive if bound value changes.

The format of the HostBinding decorator and metadata is as following:

```
interface HostBinding {
    hostPropertyName : string
}
```

You can use this decorator to change:

- attributes (applies to all elements)
  `@HostBinding('attr.text)`
- properties (corresponding properties must exist)
  `@HostBinding('title')`
- style values (applies to all elements)
  `@HostBinding('style.background-color')`
- class names (applies to all elements)
  `@HostBinding('class.some-class-name')`

Binding element attributes

If you want your directive to change element attributes, you can use this decorator with class methods like below:

src/app/directives/clickme.directive.ts

```
export class ClickmeDirective {

    @HostBinding('attr.propertyName')
    myProperty: string = 'hello world';

}
```

For example, if you apply directive to a `div` element, the property binding should cause the following attributes rendering at run time:

src/app/app.component.html

```
<div appclickme="" propertyName="hello world"></div>
```

Please note that if host property name parameter is not defined, then a class property name should be taken as a fallback value.

```
@HostBinding()
title: string = 'element title';
```

This time, if you apply the directive to the `input` element, for instance, you should see the `title` property name as an attribute of the host:

```
<input appclickme="" type="text" title="element title">
```

Binding element properties

Keep in mind that in this case, the property should exist for a given element. Angular should throw an error if you try to bind a missing property. Let's try to bind a `value` property to demonstrate this behaviour.

src/app/directives/clickme.directive.ts

```
...
export class ClickmeDirective {

  @HostBinding()
  value: string = 'input value';

  ...
}
```

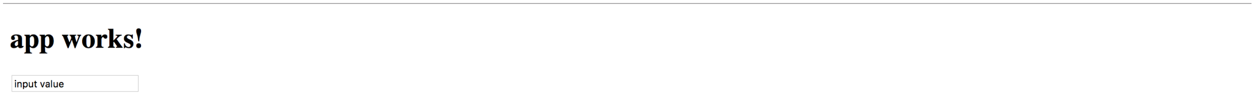
You may still have a click area example on the main page, or you can do it once again:

```
<div class="click-area" appClickme>
```

Angular should produce an error when page compiles and reloads:

```
Error: Uncaught (in promise): Error: Template parse errors:
Can't bind to 'value' since it isn't a known property of 'div'.

[ERROR ->]<div class="click-area" appClickme>
  Click me
</div>
```

However, if you replace `div` with an `input` element that natively supports `value` property, you should get it rendered properly:



You can, however, fix the issue and provide compatibility with all HTML elements by utilising `attr.value` instead of `value` for the property binding:

src/app/directives/clickme.directive.ts

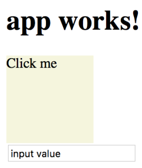
```
...
export class ClickmeDirective {

  @HostBinding('attr.value')
  value: string = 'input value';

  ...
}
```

In this case you are going to get the following HTML when both `<input>` and `<div>` are present on the page:

src/app/app.component.html

```
<div appclickme="" class="click-area" value="input value">
  Click me
</div>

<input appclickme="" type="text" value="input value">
```

Your main application component page should now render without errors.


app works!

Click me

input value

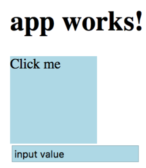
Binding style attributes

You bind single style attribute values using `@HostBinding('style.<attribute>')` format, where `<attribute>` is a valid name of the CSS style attribute.

src/app/directives/clickme.directive.ts

```
...
export class ClickmeDirective {
    ...
    @HostBinding('style.background-color')
    background: string = 'lightblue';
}
```

Now the directive is painting its host element's background into light-blue.



This is how the rendered HTML looks like:

src/app/app.component.html

```
<div appclickme="" class="click-area" value="input value"
     style="background-color: rgb(173, 216, 230);">
  Click me
</div>
```

Binding class names

Instead of binding single style attributes, you may want to operate CSS class names, to be able providing external themes, or separating presentation layer from directive implementation. It can be achieved utilising `@HostBinding('class.<class-name>')` where `<class-name>` is the name of the CSS class.

Note that having corresponding CSS class implementation is optional if you directive is not enforcing styles directly. Developers can choose whether to implement or override the class, or leave defaults.

You can bind class names to the `boolean` values or expressions. Angular appends provided CSS class name to the host element if the resulting value is `true`, and automatically removes it if value changes back to `false`.

src/app/directives/clickme.directive.ts

```
...
export class ClickmeDirective {
    ...

    @HostBinding('class.is-selected')
    isSelected: boolean = true;
}
```

This is the initial template we have been using:

src/app/app.component.html

```
<div class="click-area" appClickme>
  Click me
</div>
```

So this is how Angular renders component at run time. Note the `class` value now has both `click-area` we defined manually, and `is-selected` class provided by the directive controller.

src/app/app.component.html

```
<div appclickme="" class="click-area is-selected" value="input value"
     style="background-color: rgb(173, 216, 230);">
  Click me
</div>
```

Typically you are going to apply or change CSS classes of the host element as a response to the host events wired by `HostBinding` decorators. For example, the directive can listen to mouse events and toggle `hovered` styles:

src/app/directives/clickme.directive.ts

```
...
export class ClickmeDirective {
    ...

    @HostBinding('class.is-hovered')
    isHovered: boolean = false;

    @HostListener('mouseenter')
    onMouseEnter() {
        this.isHovered = true;
        // other code if needed
    }

    @HostListener('mouseleave')
    onMouseLeave() {
        this.isHovered = false;
        // other code if needed
    }
}
```

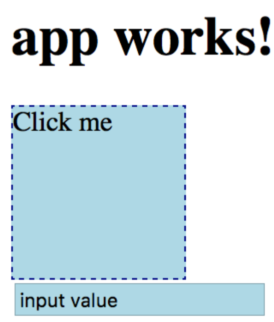
Our directive toggles the `isHovered` property value upon mouse enter and leave, but it does not directly change the way its host element looks. Instead, you or developers that use your directive can optionally add a custom `is-hovered` CSS class to alter how the element looks and behaves on mouse interaction.

The example below adds a thin dashed border to the element when a user hovers it:

src/app/app.component.css

```
.is-hovered {
  border: 1px dashed darkblue;
}
```

You can now run the application and move the mouse cursor in and out of the click area.



Of course, you can control hover styles in pure CSS. The code above is more a simple demonstration of capabilities to give you more ideas on what is possible with `HostListener` and `HostBinding` combined.

Source code

You can find the source code in the "angular/directives/directive-example[41]" folder.

[41]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/directive-example

Built-in attribute directives

Angular comes with the following ready-to-use attribute directives:

- NgStyle, updates an HTML element styles
- NgClass, adds and removes CSS classes on an HTML element
- **NgModel**, provides two-way binding to Form elements, see **Forms** chapter for more details
- NgNonBindable, prevents content from being evaluated and compiled in templates

NgStyle

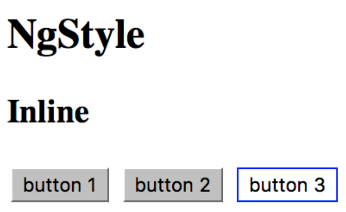
The `NgStyle` directive is used to modify CSS style attributes of the host element or component.

```
<element [ngStyle]="OPTIONS">
    ...
</element>
```

Where `OPTIONS` is an object literal `NgStyle` that binds and maps properties to style attributes. Object keys should represent style names with an optional `.<unit>` suffix, for example, `width.px`, `font-style.em`.

```
<button [ngStyle]="{ 'border-width': '1px' }">button 1</button>
<button [ngStyle]="{ 'border-width.px': '1' }">button 2</button>
<button [ngStyle]="{
  'background-color': 'white',
  'border': '1px blue solid'
}">button 3</button>
```

You should see three buttons with custom styles once you run the application:



It is also possible to bind `ngStyle` to the component property.

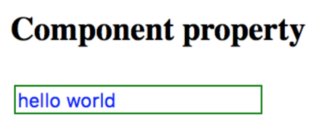
```
<input type="text" value="hello world" [ngStyle]="inputStyle">
```

In this case, you declare object literal within the component class implementation, for example:

src/app/app.component.ts

```
...
export class AppComponent {
    ...
    inputStyle = {
        'border': '1px green solid',
        'background-color': 'white',
        'color': 'blue'
    };
}
```

That allows you to compose styles based on some other conditions dynamically.



Source code

You can find the source code in the "angular/directives/attribute-directives[42]" folder.

NgClass

The `NgClass` directive allows binding CSS class names on an HTML element.

```
<element [ngClass]="OPTIONS">
    ...
</element>
```

Where `OPTIONS` value can take one of the following formats:

- string expression (single or `space` delimited)
- object literal
- array

Binding to String Expression (single):

With this format you specify a string expression that corresponds to a CSS class name:

[42] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/attribute-directives

```
<element [ngClass]="'class1'">
    ...
</element>
```

Binding to String Expression (space delimited)

You can also provide multiple class names per single `space` delimited string expression:

```
<element [ngClass]="'class1 class2 class3'">
    ...
</element>
```

Binding to Object Literal

This format is very similar to that of `NgStyle` one. All object keys are CSS class names and get added to host element only if value evaluates to a truthy value. In a case of a non-truthy value, Angular removes class names from the host.

```
<element [ngClass]="{
    'class1': true,
    'class2': false,
    'class3': true }">
    ...
</element>
```

Binding to Array

Finally you can bind `NgClass` directive to an array or class names:

```
<element [ngClass]="['class1', 'class2', 'class3']">
    ...
</element>
```

In all the cases described above you can also bind directive options to underlying controller properties or methods:

src/app/app.component.html

```html
<element [ngClass]="currentClass">...</element>
<element [ngClass]="getClassObj()">...</element>
<element [ngClass]="getClassArr()">...</element>
```

src/app/app.component.ts

```ts
export class MyComponent {

    currentClass: string = 'class1';

    getClassObj(): any {
        return {
            'class2': true,
            'class3': true
        };
    }

    getClassArr(): string[] {
        return [
            'class4',
            'class5'
        ];
    }
}
```

Source code

You can find the source code in the "angular/directives/attribute-directives[43]" folder.

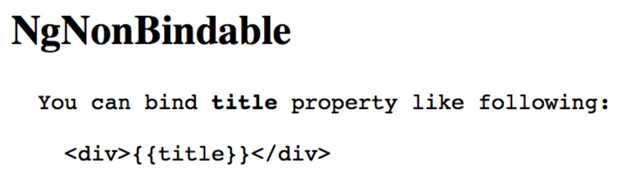
NgNonBindable

You use `NgNonBindable` directive to switch off Angular evaluating code or binding values for a particular element and its content. For example if you want displaying source code:

[43]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/attribute-directives

```
<h2>NgNonBindable</h2>
<pre>
  You can bind <strong>title</strong> property like following:
  <code ngNonBindable>
    &lt;div&gt;{{title}}&lt;/div&gt;
  </code>
</pre>
```

Which renders to the following if you run the application:



NgNonBindable

```
You can bind title property like following:

  <div>{{title}}</div>
```

Please note that NgNonBindable is a very specific directive, and typically you are not going to use it often, if at all.

Source code

You can find the source code in the "angular/directives/attribute-directives[44]" folder.

Structural Directives

Structural directives allow you to control how element renders at run time.

Built-in structural directives

Angular provides a few built-in directives you are going to use very often:

- NgIf
- NgFor
- NgSwitch

[44]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/attribute-directives

NgIf

You are going to use `NgIf` directive when you want to display or hide decorated element based on condition.

The most common usage format for this directive is

```
<element *ngIf="<condition>">
    ...
</element>
```

where `<condition>` is a valid JavaScript expression.

Let's build an example demonstrating conditional inclusion of the template. Add a boolean property `extraContent` to your `AppComponent` component controller class implementation:

src/app/app.component.ts

```
export class AppComponent {
    extraContent = false;
}
```

Next, put a `<button>` element to the component template, this button should toggle the `extraContent` value on each click.

src/app/app.component.html

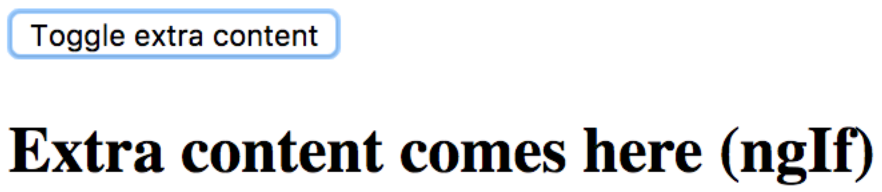
```
<button (click)="extraContent = !extraContent">
    Toggle extra content
</button>
```

Finally, let's add some content that should be displayed only when `extraContent` property value gets set to `true`

src/app/app.component.html

```
<div *ngIf="extraContent">
  <h2>Extra content comes here (ngIf)</h2>
</div>
```

Now if you run the application you should be able to toggle additional content by clicking the button multiple times.



Extra content comes here (ngIf)

Very often you may need two different templates within the component based on the condition evaluation. Traditionally developers are using separate `NgIf` directives assigned to `truthy` and `falsy` results of the same expression:

```
<element *ngIf="condition">main content</element>
<element *ngIf="!condition">alternative content</element>
```

The NgIf directive also supports `else` blocks for showing alternative content when the condition expression evaluates to a falsy value. In this case, you need to provide a reference to a separate `ng-template`:

```
<element *ngIf="condition; else alternative">
    Main template (condition is truthy)
</element>

<ng-template #alternative>
    Alternative template (condition is falsy)
</ng-template>
```

To see that on practice return to the project created earlier and add the additional template:

src/app/app.component.html

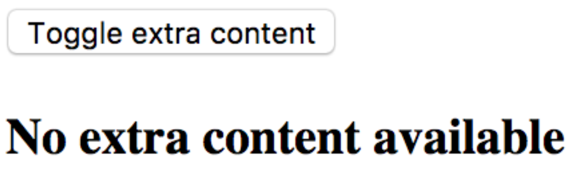
```
<ng-template #emptyView>
  <h3>No extra content available</h3>
</ng-template>
```

Template above can be referenced by `emptyView` id. Now update the main element to utilize the newly created template:

src/app/app.component.html

```html
<div *ngIf="extraContent; else emptyView">
  <h2>Extra content comes here (ngIf)</h2>
</div>
```

If you run the application right now and click the `Toggle extra content` button, you should see the content of the `emptyView` template.



It is possible to store both templates as external references. By default, Angular treats inline template as a `then` block, but you can define it explicitly using the following syntax:

```html
<element *ngIf="condition; then thenBlock else elseBlock"></element>
```

Now if updated our example can look like the following:

src/app/app.component.html

```html
<button (click)="extraContent = !extraContent">
    Toggle extra content
</button>
<div *ngIf="extraContent; then mainView else emptyView"></div>

<ng-template #mainView>
  <h2>Extra content comes here (ngIf)</h2>
</ng-template>

<ng-template #emptyView>
  <h3>No extra content available</h3>
</ng-template>
```

Source code

You can find the source code in the "angular/directives/structural-directives[45]" folder.

[45]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/structural-directives

NgFor

The main purpose of `NgFor` directive is to display iterable collections utilising a custom HTML template for each entry.

Binding to arrays

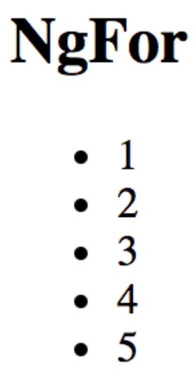
Let's start with a simple example that best demonstrates `NgFor` directive in action.

src/app/app.component.html

```
<ul>
    <li *ngFor="let num of [1,2,3,4,5]">
        <span>{{num}}</span>
    </li>
</ul>
```

In the example above we are using `NgFor` directive with a collection of five numbers to render an unordered (bulleted) list. Angular treats the content of the list item as a template and repeatedly applies to each array entry.

You should see the following HTML once application compiles and restarts:



```
NgFor

• 1
• 2
• 3
• 4
• 5
```

If you inspect the source code of the page you should see the structure similar to the one below:

```html
<ul>
    <li>
        <span>1</span>
    </li>
    <li>
        <span>2</span>
    </li>
    <li>
        <span>3</span>
    </li>
    <li>
        <span>4</span>
    </li>
    <li>
        <span>5</span>
    </li>
</ul>
```

Binding to class properties or functions

It is also possible to bind `NgFor` to class properties or functions.

src/app/app.component.ts

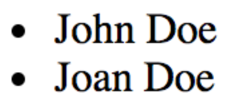
```typescript
export class AppComponent {
    ...

    users = [
        {
            id: 10,
            firstName: 'John',
            lastName: 'Doe'
        },
        {
            id: 20,
            firstName: 'Joan',
            lastName: 'Doe'
        }
    ];
}
```

We are going to have two objects in the `users` collection. The list entry template should now look like the next one:

src/app/app.component.html

```
<ul>
    <li *ngFor="let user of users">
        <div>{{user.firstName + ' ' + user.lastName}}</div>
    </li>
</ul>
```

Once your project and compiled and reloaded you should see a list of full user names:



- John Doe
- Joan Doe

Using exported variables

The `NgFor` directives exports several values that you can map to the the local template variables:

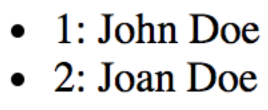
- `index: number` holds the numeric position of the current array item
- `first: boolean` indicates whether the current array item is the first one
- `last: boolean` indicates whether the current array item is the last one
- `even: boolean` indicates whether current array item's position index is even
- `odd: boolean` indicates whether current array item's position index is odd

You can use these additional values to improve the user interface. For example, let's add row numbers to the user list:

src/app/app.component.html

```
<ul>
    <li *ngFor="let user of users; let i = index">
        <div>
            <span>{{i + 1}}: </span>
            <span>{{user.firstName + ' ' + user.lastName}}</span>
        </div>
    </li>
</ul>
```

Note the use of `let i = index`, this is where you bind `index` property to a local template variable `i`. That allows you displaying it via `<span>{{i + 1}}: </span>`



- 1: John Doe
- 2: Joan Doe

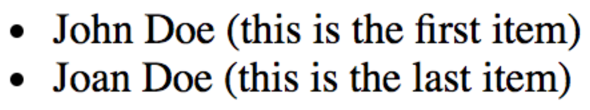
You can use all local variables for conditional styling and layout. For example, you may want drawing a table or a list with stripes based on `even` and `odd` value, rendering some header or footer for the `first` and `last` items.

It is possible to use all variables at the same time separating them by semicolons:

src/app/app.component.html

```
<ul>
    <li *ngFor="let user of users; let isFirst = first; let isLast = last;">
        <span>{{user.firstName + ' ' + user.lastName}}</span>
        <span *ngIf="isFirst">(this is the first item)</span>
        <span *ngIf="isLast">(this is the last item)</span>
  </li>
</ul>
```

When running the application, you should notice that first and last items in the list get different text appended to them based on the condition expression.



- John Doe (this is the first item)
- Joan Doe (this is the last item)

Improving performance with `trackBy`

Every time a collection changes Angular drops existing DOM elements and the renders entire set of new ones. That is fine when you are dealing with static collections. However, you may see significant performance drops when using frequently changed arrays, for example when using dynamic editing or populating collections from the server. The complexity of item templates can also slow down rendering and affect overall application performance.

Angular provides a special `trackBy` feature that allows you to track underlying objects by unique `id` values and to rebuild DOM elements only for the entries that change. For many scenarios that often ends up with a huge performance boosts as large portions of the DOM remain unchanged.

The `trackBy` value should go after the main `ngFor` expression and must be separated by a semicolon:

src/app/app.component.html

```
<ul>
    <li *ngFor="let user of users; trackBy: trackByUserId">
        <span>{{user.firstName + ' ' + user.lastName}}</span>
    </li>
</ul>
```

The `trackBy` always binds to a component method having a numeric `index` and a current collection object as parameters:

src/app/app.component.ts

```
trackByUserId(index: number, user: any) {
    return user.id;
}
```

In the example above we tell Angular to keep track of users in the list based on the `id` property value so that it can better detect what item has been added or removed.

NgSwitch

The `NgSwitch` directive is used for conditional rendering of element templates depending on the expression value. You can treat it as an advanced `NgIf` directive with multiple `else` clauses.

You need three separate directives to make `NgSwitch` work:

- `NgSwitch`: an attribute directive holding main expression body
- `NgSwitchCase`: a structural directive, renders corresponding template if its condition matches that of the `NgSwitch` one
- `NgSwitchDefault`: a structural directive, works like a fallback mechanism and renders a template if none of the `NgSwitchCase` values matches the `NgSwitch` one

Here's the basic example of the `NgSwitch` format:

```
<element [ngSwitch]="expression">
    <element *ngSwitchCase="condition1">...</element>
    <element *ngSwitchCase="condition2">...</element>
    <element *ngSwitchDefault>...</element>
</element>
```

To check how `NgSwitch` operates in practice let's build a simple component that displays different UI layouts based on the selected role of the user. Open the `app.component.ts` and add the `roles` and `selectedRole` properties like below:

src/app/app.component.ts

```
roles = [
    { id: 0, name: 'empty' },
    { id: 1, name: 'unknown' },
    { id: 2, name: 'user' },
    { id: 3, name: 'guest' },
    { id: 4, name: 'administrator' }
];

selectedRole = 'empty';
```

Next place a `<select>` element to be able to select a role from the dropdown list:

src/app/app.component.html

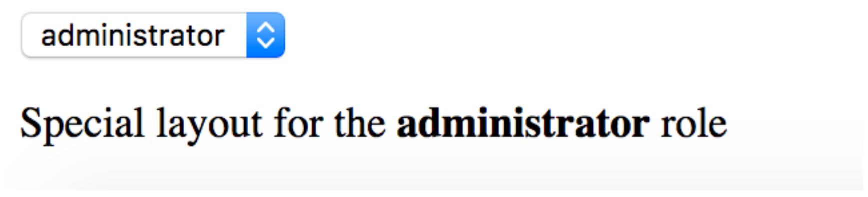
```
<select [(ngModel)]="selectedRole">
    <option *ngFor="let role of roles">{{role.name}}</option>
</select>
```

Finally we are going to build our simple role template selector:

src/app/app.component.html

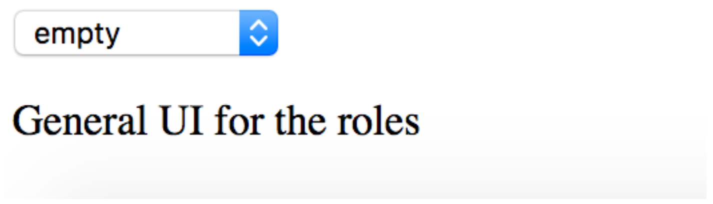
```
<div [ngSwitch]="selectedRole">

    <div *ngSwitchCase="'administrator'">
        Special layout for the <strong>administrator</strong> role
    </div>

    <div *ngSwitchCase="'guest'">
        Special layout for the <strong>guest</strong> role
    </div>

    <div *ngSwitchDefault>
        General UI for the roles
    </div>

</div>
```

As a result, we are going to use dedicated UI templates for `administrator` and `guest` roles:



Special layout for the **administrator** role

The rest of the roles should receive a generic template.



General UI for the roles

As you can see from the examples above, the `NgSwitch` directive is a poweful and flexible way for conditional element rendering in Angular.

Creating a Structural Directive

Let's create a simple structural directive called `RepeatDirective` that is going to repeat specified HTML template certain number of times. You can use Angular CLI to generate a working directive skeleton quickly.

```
ng g directive repeat
```

The command above gives you a basic `RepeatDirective` implementation and a simple unit test. It also modifies the main application module `app.module.ts` to register new directive within module declarations.

```
installing directive
  create src/app/repeat.directive.spec.ts
  create src/app/repeat.directive.ts
  update src/app/app.module.ts
```

Here's the content of the `repeat.directive.ts` we are going to work with:

src/app/repeat.directive.ts

```
import { Directive } from '@angular/core';

@Directive({
  selector: '[appRepeat]'
})
export class RangeDirective {

  constructor() { }

}
```

Note that Angular CLI automatically prepends default `app` prefix to the directive selector value. This helps us to avoid name conflicts with the existing directives from either standard Angular or third party libraries.

You can use your new directive with any HTML element like the following:

```
<element *appRepeat>...</element>
```

It is also possible to use the plain format without Angular's syntactic sugar:

```
<ng-template [appRepeat]>...</ng-template>
```

Now let's update our directive to repeat the content.

src/app/repeat.directive.ts

```
import { Directive, TemplateRef, ViewContainerRef, Input } from '@angular/core';

@Directive({
  selector: '[appRepeat]'
})
export class RepeatDirective {

  constructor(private templateRef: TemplateRef<any>,
              private viewContainer: ViewContainerRef) { }

  @Input()
  set appRepeat(times: number) {
    for (let i = 0; i < times; i++) {
      this.viewContainer.createEmbeddedView(this.templateRef);
    }
  }

}
```

First of all, you get access to the underlying template by injecting `TemplateRef` instance and using it as a local reference. You also save a reference to the `ViewContainerRef` instance as you need it to turn the template reference to a real HTML element.

As a second step, we define an `appRepeat` setter that is going to receive configuration settings from the directive value. Note that to map an attribute value to a function parameter the directive setter must have the same name as the HTML selector value. In our case, it is `appRepeat` one. That gives you the possibility using the `*directive="expression"` format similar to the one below:

```
<element *appRepeat="5">...</element>
```

The child content of the decorated element gets treated as a template. With the help of `ViewContainer` and `Template` references we turn it into the HTML DOM multiple times:

```
for (let i = 0; i < times; i++) {
    this.viewContainer.createEmbeddedView(this.templateRef);
}
```

You can test the directive with the following layout:

```
<div *appRepeat="5">
    <div>Hello</div>
</div>
```

It is going to render the following output once the application runs:

```
Hello
Hello
Hello
Hello
Hello
```

The `Hello` template is rendered 5 times as we expect it. However, rendering HTML elements without data context is not very useful. Let's extend our directive with a custom context set to the position index of the element:

```
for (let i = 0; i < times; i++) {
    this.viewContainer.createEmbeddedView(this.templateRef, {
        $implicit: i
    });
}
```

Now you can define a local variable for your template bound to the data context:

```
<div *appRepeat="5; let idx">
    <div>Hello {{idx}}</div>
</div>
```

You can also change example able to be like the next one:

```
<ng-template [appRepeat]="5" let-idx>
    <div>Hello {{idx}}</div>
</ng-template>
```

This time the application output when using any of these formats is going to be as following:

```
Hello 0
Hello 1
Hello 2
Hello 3
Hello 4
```

Let's get back to the data context again. Any local variable that has no value defined is going to point to the default `$implicit` value. You can define as many variables as needed within your directive implementation. For example, try to expose `first` and `last` variables similar to those of the `NgFor` directive:

```
for (let i = 0; i < times; i++) {
    this.viewContainer.createEmbeddedView(this.templateRef, {
        $implicit: i,
        first: i === 0,
        last: i === times - 1
    });
}
```

Next you can wire newly created local variables and reuse them within the template:

src/app/app.component.html

```
<div *appRepeat="5; let idx; let isFirst = first; let isLast = last;">
    <div>
      Hello {{idx}}
      <span *ngIf="isFirst">(first)</span>
      <span *ngIf="isLast">(last)</span>
    </div>
</div>
```

Once the application compiles and runs you should see the following result:

```
Hello 0 (first)
Hello 1
Hello 2
Hello 3
Hello 4 (last)
```

You can keep enhancing your directive with more complex layout and behaviour.

Modifying host element layout

Directives can extend or modify host element layout at run time. Let's create an `AttachDirective` directive that invokes an open file dialogue, once the user clicks the host element.

Due to security reasons, modern browsers do not allow invoking file dialogues from code, unless caused by a user action, like clicking a button or hyperlink. Traditionally developers use a hidden `<input type="file">` element to trigger its native behaviour programmatically. So as part of its implementation, our directive is going to create an additional `<input>` element and interact with it from code.

Using Angular CLI create a new project to develop and test the directive.

```
ng new app-attach-directive
cd app-attach-directive/
ng g directive attach
```

The commands above result in a new `app-attach-directive` project containing `attach.directive.ts` and `attach.directive.spec.ts` in the `src/app` folder. You can see the content of the new `AttachDirective` below:

src/app/attach.directive.ts

```
import { Directive } from '@angular/core';

@Directive({
  selector: '[appAttach]'
})
export class AttachDirective {

  constructor() { }

}
```

Angular CLI automatically prepended the name with the default `app` prefix to avoid naming conflicts, so you are going to use `appAttach` in HTML. Before implementing the directive let's prepare the testing environment. We are going to use main application component to see all the changes in action.

src/app/app.component.ts

```
export class AppComponent {
  title = 'Attach directive';
}
```

Add the following block to the application component's template:

src/app/app.component.html

```
<div appAttach class="attach-area">
    <div>
        Click me to upload files
    </div>
</div>
```

For demonstration and testing purposes we also provide some basic styling via `attach-area` CSS class. The light blue box on the page shows the 'clickable' area wired with the `appAttach` directive.

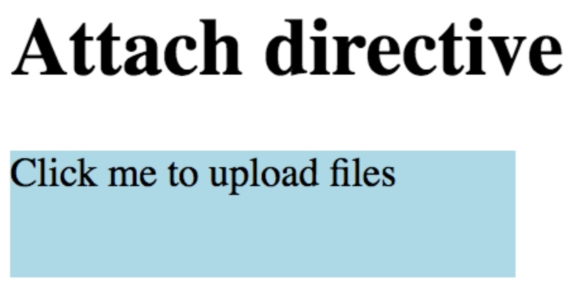
src/app/app.component.css

```css
.attach-area {
  width: 200px;
  height: 50px;
  background-color: lightblue;
  cursor: pointer;
}
```

Now you can run the app with

```
ng serve --open
```

The application compiles and runs inside your default browser.



You can leave the terminal running in the background. Angular CLI keeps watching for files and automatically recompiles and reloads application upon any changes.

Now provide the initial directive implementation like the following:

src/app/attach.directive.ts

```typescript
import { Directive, OnInit, ElementRef, Renderer, HostListener } from '@angular/core\
';

@Directive({
  selector: '[appAttach]'
})
export class AttachDirective implements OnInit {
    private upload: HTMLInputElement;

    constructor(
        private el: ElementRef,
        private renderer: Renderer) {
    }

    ngOnInit(): void {
        this.upload = this.renderer.createElement(
            this.el.nativeElement.parentNode, 'input')
            as HTMLInputElement;

        this.upload.type = 'file';
        this.upload.style.display = 'none';
    }
}
```

First of all, you reserve a private property `upload` to store reference on the original `<input>` element. The directive also needs a reference to its host element and an instance of the `Renderer` class, to modify HTML layout. We inject both in the constructor and store as private properties `el` and `renderer`.

Once directive gets initialized it creates a new hidden `<input type="file">` HTML element next to the host one. You can invoke its methods from the code, for example, a `click` event that causes a file dialogue to appear. Let's listen to the host's `click` event and redirect it to the hidden input element like below:

src/app/attach.directive.ts

```
@HostListener('click', ['$event'])
onClick(event: Event) {
    if (this.upload) {
        event.preventDefault();
        this.upload.click();
    }
}
```

Once the user selects a file in the dialogue, our directive should know about that. We can achieve that by listening to the `change` event of the input element and accessing the file list as soon as the event occur.

src/app/attach.directive.ts

```
ngOnInit(): void {
    ...
    this.upload.addEventListener('change', e => this.onAttachFiles(e));
}

private onAttachFiles(e: Event): void {
    const input = (<HTMLInputElement>e.currentTarget);
    const files = this.getFiles(input.files);
    this.raiseEvent(files);
}
```

Inside the handler, you extract the list of File objects from the event using the `getFiles` method with the following implementation:

src/app/attach.directive.ts

```
private getFiles(fileList: FileList): File[] {
    const result: File[] = [];
    if (fileList && fileList.length > 0) {
        for (let i = 0; i < fileList.length; i++) {
            result.push(fileList[i]);
        }
    }
    return result;
  }
```

Typically you may want to create an array of Model classes based on the File instances, or wrapping files into some other components. For the sake of simplicity let's just return File objects as they are.

There can be multiple approaches to handling file uploads. The directive might be doing all the upload work itself, it could be triggering some application service, or it can raise DOM events for other components react on them. We are going to take the latter approach and raise a custom `attach-files` event.

The `raiseEvent` method receives an array of `File` instances and raises `attach-files` event like below:

src/app/attach.directive.ts

```typescript
private raiseEvent(files: File[]): void {
    if (files.length > 0) {
        const event = new CustomEvent('attach-files', {
            detail: {
                sender: this,
                files: files
            },
            bubbles: true
        });

        this.el.nativeElement.dispatchEvent(event);
    }
}
```

You can now handle this custom event from either host element or any other HTML element up against the parent hierarchy. Let's create a list of files the user attaches using our directive.

src/app/app.component.html

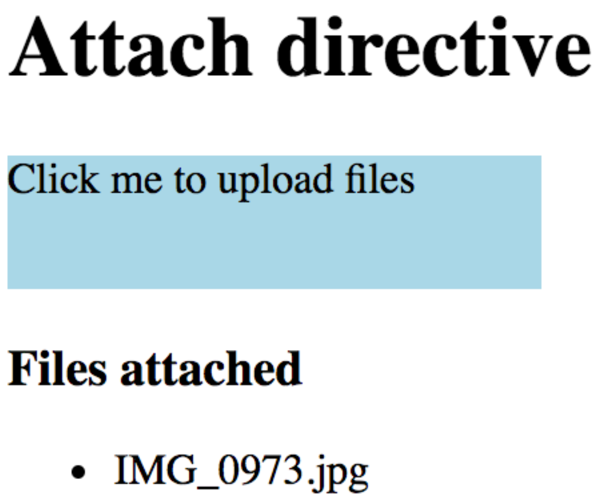
```html
<div class="attach-area" appAttach
    (attach-files)="onAttachFiles($event)">
    <div>
        Click me to upload files
    </div>
</div>

<h3>Files attached</h3>
<ul>
    <li *ngFor="let file of files">
        {{file.name}}
    </li>
</ul>
```

As you can see from the layout above, we wire `attach-files` event with the `onAttachFiles` method of main application component class and are going to store attached files in the `files` collection.

src/app/app.component.ts

```
export class AppComponent {
    title = 'Attach directive';

    files: File[];

    onAttachFiles(e: CustomEvent) {
        this.files = e.detail.files || [];
    }
}
```

Once application recompiles and reloads you can to test new behaviour by attaching a file to see its name appear in the list:



Another feature you may want to add to the directive is the ability to toggle single and multiple file selection support. The standard `<input type="file">` element allows this via the `multiple` HTML attribute. We can introduce the same property for the directive and propagate its value to the enclosed `upload` element like this:

src/app/attach.directive.ts

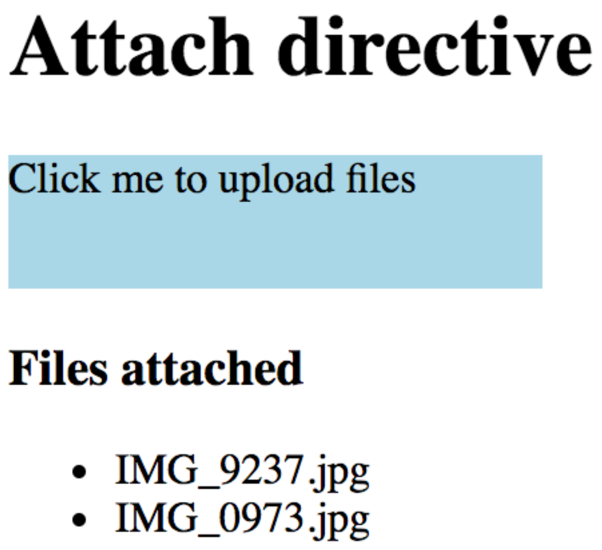
```
...
export class AttachDirective implements OnInit {
    ...

    @Input()
    multiple: boolean;

    ngOnInit(): void {
        ...
        if (this.multiple) {
            this.upload.setAttribute('multiple', '');
        }
    }
}
```

That allows us binding to or setting `[multiple]` property value on an HTML element alongside `appAttach` directive.

src/app/app.component.html

```
<div class="attach-area" appAttach [multiple]="true"
    (attach-files)="onAttachFiles($event)">
    ...
</div>
```

Now if you run the application you should be able to select multiple files in the file dialogue. The list at the bottom should display names for all of them.


Attach directive

Click me to upload files

Files attached

- IMG_9237.jpg
- IMG_0973.jpg

So we got a directive that attaches to an HTML element, alters its behaviour and even redirects user events to an additional hidden content. You can keep extending the implementation if needed, for example adding new properties, or controlling the types of files to be selected.

Source code

You can find the source code in the "angular/directives/app-attach-directive[46]" folder.

[46]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/app-attach-directive

Walkthrough: Upload Directive

In this walkthrough, we are going to create a directive that turns its host element into a drop target for files.

Our directive itself does not upload files to a server, but instead, it is going to be responsible for detecting dropped Files and raising special DOM events. Other parts of the application (components, directives, services) can then react on those events and perform additional actions if needed.

Let's start by generating a new application and calling it `app-upload-directive`:

```
ng new app-upload-directive
cd app-upload-directive/
```

You can test application was created successfully by running it with the default browser:

```
ng serve --open
```

Now let's create an `upload` directive from the Angular CLI blueprint:

```
ng g directive directives/upload
```

The `ng` tool should put the code and unit tests into the `src/app/directives` folder, and should also update main application module.

```
installing directive
  create src/app/directives/upload.directive.spec.ts
  create src/app/directives/upload.directive.ts
  update src/app/app.module.ts
```

Angular CLI generates the following code for the new directive:

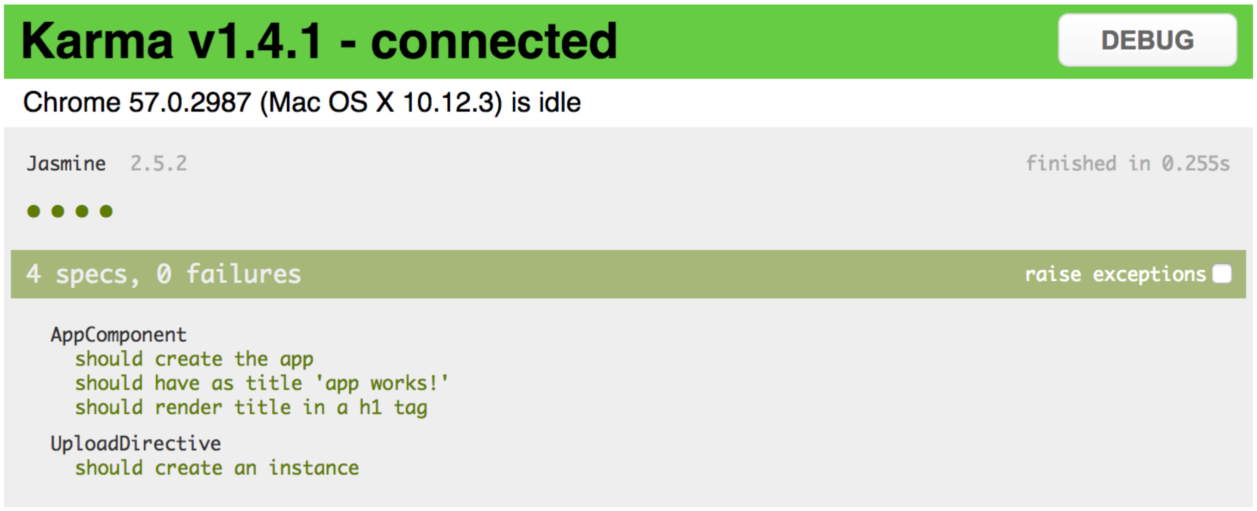
upload.directive.ts

```
import { Directive } from '@angular/core';

@Directive({
  selector: '[appUpload]'
})
export class UploadDirective {

  constructor() { }

}
```

All application and directive tests should be working properly

```
ng test
```

There should be an additional test for UploadDirective class: `should create an instance`. This test is a good starting point for unit testing your future directive.



```
Chrome 57.0.2987 (Mac OS X 10.12.3) is idle

Jasmine  2.5.2                                   finished in 0.255s
••••
4 specs, 0 failures

  AppComponent
    should create the app
    should have as title 'app works!'
    should render title in a h1 tag
  UploadDirective
    should create an instance
```

We are going to decorate a simple `<div>` element and turn it into a file drop area.

app.component.html

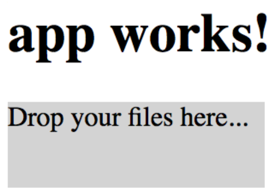
```html
<h1>
  {{title}}
</h1>

<div class="my-drop-area">
  <span>Drop your files here...</span>
</div>
```

As it is a `<div>` element let's add some style to be able distinguishing it. Setting fixed size and background colour should be more than enough for now.

app.component.css

```css
.my-drop-area {
  width: 150px;
  height: 50px;
  background-color: lightgray;
}
```

The main application page now should look like the following:



upload.directive.ts

```ts
import { ..., HostBinding, HostListener } from '@angular/core';

export class UploadDirective {

    @HostBinding('class.app-upload__dragover')
    isDragOver: boolean;

}
```

Every time `isDragOver` becomes `true` the host element gets a CSS class `app-upload__dragover` applied to it. Once it is set back to `false` the CSS class is automatically removed.

Now add the following code to the directive implementation:

upload.directive.ts

```
@HostListener('dragenter')
onDragEnter() {
    this.isDragOver = true;
}

@HostListener('dragover', ['$event'])
onDragOver(event: Event) {
    if (event) {
        event.preventDefault();
    }
    this.isDragOver = true;
}

@HostListener('dragleave')
onDragLeave() {
    this.isDragOver = false;
}
```

The code above performs a simple drag management to update `isDragOver` state and so host element style. For `dragenter` and `dragover` events we are going to enable additional styles, and disable on `dragleave`.

In order to turn host element into a drop zone you also need handling `drop` event:

upload.directive.ts

```
@HostListener('drop', ['$event'])
onDrop(event: DragEvent) {
    event.preventDefault();
    event.stopPropagation();
    this.isDragOver = false;
}
```

Keep in mind that directive only adds `app-upload__dragover` class to the host element, it does not modify element's style attributes directly. Developers that are using your directive should be able to define look and feel of the decorated element at the application level.

Traditionally file drop areas use dashed borders when being dragged over, let's make our element draw a thin blue border and also change background colour:

app.component.css

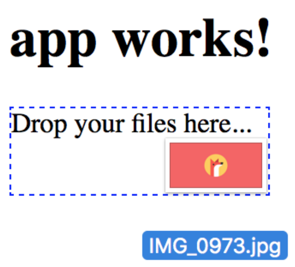
```css
.app-upload__dragover {
  border: 1px dashed blue;
  background-color: white;
}
```

And you need decorating `div` element with the directive to see it in action:

app.component.html

```html
<div class="my-drop-area" appUpload>
  <span>Drop your files here...</span>
</div>
```

The element should be changing the style when you drag a file over its area:



Now that we have `drag` events wired with element styles, it is time to implement `drop` handling. Find the `onDrop` method we have introduced earlier and replace with the following code:

upload.directive.ts

```typescript
@HostListener('drop', ['$event'])
onDrop(event: DragEvent) {
    event.preventDefault();
    event.stopPropagation();
    this.isDragOver = false;

    const files = this.collectFiles(event.dataTransfer);
    console.log(files);
    this.onFilesDropped(files);
}
```

Once user drops files on the host element, the directive is going extract information on files from the DataTrasfer instance (`collectFiles`), and pass discovered files to the `onFilesDropped` method to raise corresponding DOM events.

DataTransfer

The DataTransfer object is used to hold the data that is being dragged during a drag and drop operation. It may hold one or more data items, each of one or more data types. For more information see DataTranfer[47] article.

Essentially we need to extract `File` objects into a separate collection in a safe manner:

upload.directive.ts

```
private collectFiles(dataTransfer: DataTransfer): File[] {
    const result: File[] = [];

    if (dataTransfer) {
      const items: FileList = dataTransfer.files;

      if (items && items.length > 0) {
        for (let i = 0; i < items.length; i++) {
          result.push(items[i]);
        }
      }
    }

    return result;
}
```

Finally, we need to raise an `upload-files` event to allow other components handling it. We are going to create an instance of the `CustomEvent` for that purpose.

CustomEvent

The CustomEvent interface represents events initialized by an application for any purpose. For more information see CustomEvent[48] article.

The directive also needs access to the native DOM element of the host to raise a custom event, so importing `ElementRef` instance for the constructor is required. Reference to the native HTML element should be injected as a constructor parameter and used as private property `el`.

[47]https://developer.mozilla.org/en-US/docs/Web/API/DataTransfer
[48]https://developer.mozilla.org/en-US/docs/Web/API/CustomEvent

upload.directive.ts

```
import { ..., ElementRef } from '@angular/core';

export class UploadDirective {
    ...

    constructor(private el: ElementRef) {}

    ...
}
```

You need using `Element.dispatchEvent()` to raise the `upload-files` event. As part of the `CustomEvent` interface, we can define custom `detail` value, so that external event handlers can get additional information.

We are going to provide an object containing a list of files (`files`) the user has dropped on the host element, and reference to the directive (`sender`) instance that raised the event.

upload.directive.ts

```
private onFilesDropped(files: File[]) {
    if (files && files.length > 0) {
        this.el.nativeElement.dispatchEvent(
            new CustomEvent('upload-files', {
                detail: {
                    sender: this,
                    files: files
                },
                bubbles: true
            })
        );
    }
}
```

Note the `bubbles` property being set to `true` to enable event bubbling. It indicates whether the given event bubbles up through the DOM or not. In our case we allow any HTML element up the visual tree handle this event or stop its propagation.

You can get more details on custom events in the article Creating and triggering events[49].

Now it is time to handle `upload-files` event at the application level. Open the `app.component.html` file and add `onUploadFiles` event handler like shown below:

[49]https://developer.mozilla.org/en-US/docs/Web/Guide/Events/Creating_and_triggering_events

app.component.html

```html
<div class="my-drop-area" appUpload (upload-files)="onUploadFiles($event)">
    <span>Drop your files here...</span>
</div>
```

Given that our event supports bubbling any element in the parent hierarchy can handle it. You could also define the handler as following:

app.component.html

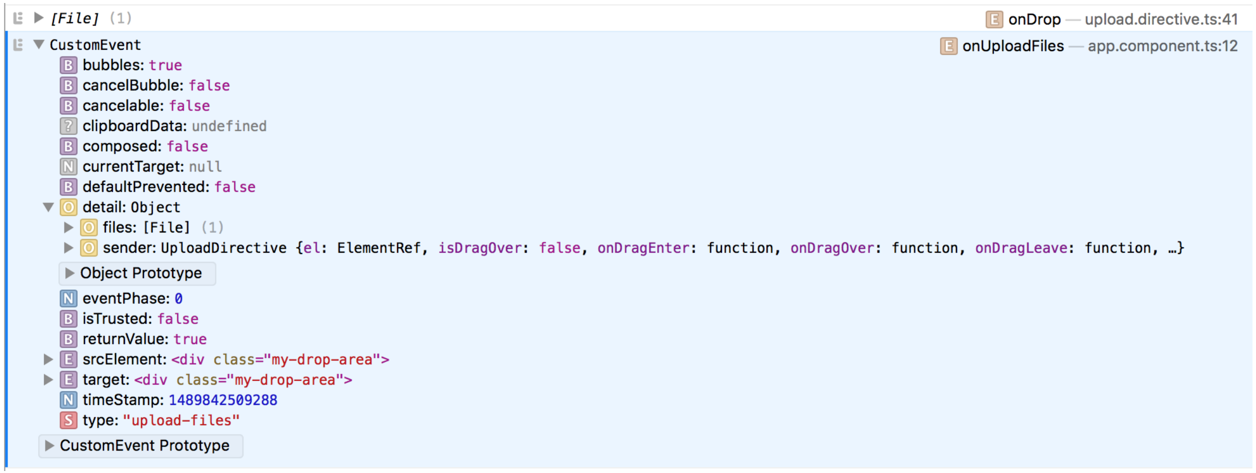
```html
<div (upload-files)="onUploadFiles($event)">
    <div class="my-drop-area" appUpload>
        <span>Drop your files here...</span>
    </div>
</div>
```

To see the content of the event, we are going to put the `console.log` for now:

app.component.ts

```ts
onUploadFiles(event: CustomEvent) {
    console.log(event);
}
```

Now if you compile and run the web application, and drop one or multiple files on the drop are, the console output should be similar to the following one:



```
▶ [File] (1)                                                        onDrop — upload.directive.ts:41
▼ CustomEvent                                               onUploadFiles — app.component.ts:12
    bubbles: true
    cancelBubble: false
    cancelable: false
    clipboardData: undefined
    composed: false
    currentTarget: null
    defaultPrevented: false
  ▼ detail: Object
    ▶ files: [File] (1)
    ▶ sender: UploadDirective {el: ElementRef, isDragOver: false, onDragEnter: function, onDragOver: function, onDragLeave: function, …}
    ▶ Object Prototype
    eventPhase: 0
    isTrusted: false
    returnValue: true
  ▶ srcElement: <div class="my-drop-area">
  ▶ target: <div class="my-drop-area">
    timeStamp: 1489842509288
    type: "upload-files"
  ▶ CustomEvent Prototype
```

As you may see from the picture above, the handler is getting `CustomEvent` that holds `details` value with a `File` collection, reference to the directive instance, and several standard properties.

Let's try adding some visualisation and display a list of previously uploaded files on the main page. Append the following HTML to the `app.component.html` file content:

app.component.html

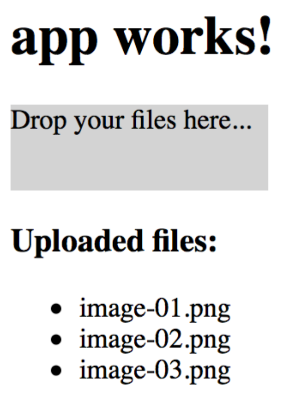
```
...
<div>
    <h3>Uploaded files:</h3>
    <ul>
        <li *ngFor="let file of uploadedFiles">
            {{file}}
        </li>
    </ul>
</div>
```

List element binds to the `uploadedFiles` collection holding uploaded file names. The `upload-files` event handler just collects the file names and fills the collection.

app.component.ts

```
export class AppComponent {
    ...
    uploadedFiles: string[] = [];

    onUploadFiles(event: CustomEvent) {
        console.log(event);
        const files: File[] = event.detail.files;
        if (files) {
            for (const file of files) {
                this.uploadedFiles.push(file.name);
            }
        }
    }
}
```

Now run your web application or switch to the browser if running the live development server, and try dropping one or multiple files several times. You should see file names appear in the list below the drop area like shown on the picture below:



app works!

Drop your files here...

Uploaded files:

- image-01.png
- image-02.png
- image-03.png

Source code

You can find the source code in the "angular/directives/app-upload-directive[50]" folder.

When working on your Angular web application, you may want some other component or service handle the `upload-files` event and perform actual uploading to a backend server, preferably utilising the injectable service. It is always a good practice splitting functionality into small interchangeable building blocks, each doing one thing at a time.

[50]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/directives/app-upload-directive

Pipes

Pipes transform template data into display values at runtime.

Source code

You can find the source code in the "angular/pipes/standard-pipes[51]" folder.

Introduction

There are many cases when you may want to perform minor changes to the values that users see when the application is running. Text transformation is an excellent example. Imagine that you need to display a text label or field in the upper case, regardless of how the user originally typed it. You can do that with the help of CSS by wrapping the text into some HTML element with style or class applied. Alternatively, you can use the `UpperCasePipe`, a built-in Angular pipe that transforms text values to upper case.

Pipes have the following usage formats:

```
<element>{{ <expression> | <pipe> }}</element>
<element [propertyName]="<expression> | <pipe>"></element>
```

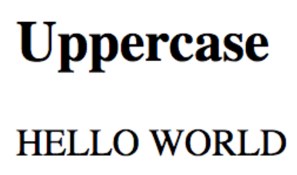
You append the name of the pipe to the expression separating them with the **pipe operator** (|).

Let's now build a quick example to see the `UpperCasePipe` in action:

```
<h2>Uppercase</h2>
<div>
  {{'Hello world' | uppercase }}
</div>
```

The `Hello world` example above renders to the following result at runtime:

[51] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/pipes/standard-pipes


Uppercase

HELLO WORLD

No matter how you define the text value, for instance, “hEllo worlD” or “hello WOLRD”, it is going to be `uppercased` when the application runs.

Pipes with Parameters

The pipes in Angular can also have input parameters. That allows passing options to pipes is they support multiple output transformations. You define pipe parameters by appending a **colon** (:) symbol to the pipe name followed by the parameter value:

```
<element>{{ <expression> | <pipe>:<parameter> }}</element>
```

It is also possible to provide multiple parameters given the pipe supports that. In this case you are going to separate all values by a **colon** (:) symbol, for example:

```
<element>{{ <expression> | <pipe>:<parameter-1>:<parameter-2>:<parameter-N> }}</elem\
ent>
```

The simplest example is date value conversion. There are many different formats you can choose to display a date on the HTML page. Angular provides a `DatePipe` pipe out of the box that helps you converting dates to various string representations.

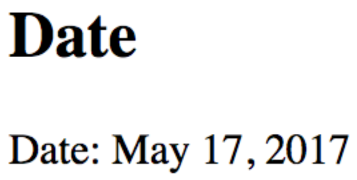
Add the following `currentDate` property to the `AppComponent` class in the `app.component.ts`:

```
...
export class AppComponent {
    ...
    currentDate: number = Date.now();
}
```

The property holds the current date value evaluated with the `Date.now()` function. You can take the next HTML template to display the date:

```
<h2>Date</h2>
<div>
    Date: {{ currentDate | date }}
</div>
```

We transform `currentDate` value with a `DatePipe` pipe using default parameters. If you run the application right now the output should be similar to the following one:



Date

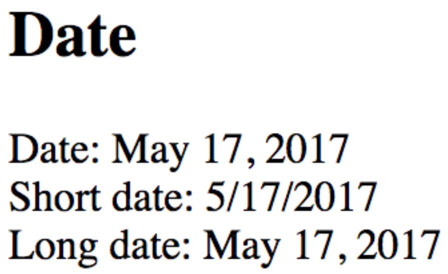
Date: May 17, 2017

Note that the value of the date depends on your current date.

Typically you may want to render dates in short or long forms, or even with a custom format. For that purpose the `DatePipe` in Angular supports `format` parameter to fine-tune the resulting output.

Let’s add two more examples to the page:

```
<div>
    Short date: {{ currentDate | date:'shortDate' }}
</div>
<div>
    Long date: {{ currentDate | date:'longDate' }}
</div>
```



Date

Date: May 17, 2017
Short date: 5/17/2017
Long date: May 17, 2017

Chaining Pipes

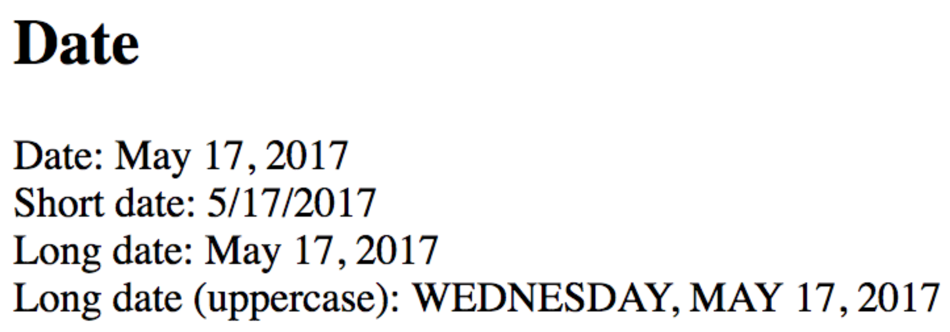
You can use multiple value transformations by chaining pipes together. The pipes are combined utilising the same **pipe operator** (|), and every pipe can optionally have own properties to alter its behaviour.

```
<element>{{ <expression> | <pipe-1> | <pipe-2> | <pipe-N> }}</element>
```

The simple use case to demonstrate the chaining is using `Date` and `Uppercase` pipes at the same time. Append the following code to the main application template:

```
<div>
    Long date (uppercase): {{ currentDate | date:'fullDate' | uppercase }}
</div>
```

The main page now looks like below:



```
Date

Date: May 17, 2017
Short date: 5/17/2017
Long date: May 17, 2017
Long date (uppercase): WEDNESDAY, MAY 17, 2017
```

So you can have quite powerful combinations of pipes transforming your data values as you need them to be.

Built-in Pipes

Angular provides a set of handy pipes out of the box. All of them can save your time and significantly reduce coding efforts related to values transformation and formatting.

You can notice that many pipes have similar usage format, so it should be pretty easy to remember most of the use cases. Let's start with simple pipes and proceed to more complex by the end of this chapter.

UpperCase

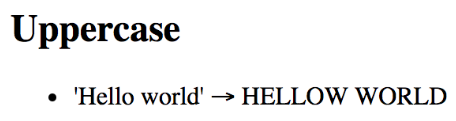
The `UpperCasePipe` pipe transforms text to upper case and has the following usage format:

```
<element>
  {{ <string_expression> | uppercase }}
</element>
```

You can use it with text expressions inside HTML element body or property binding:

```
<h2>Uppercase</h2>
<ul>
  <li>'Hello world' => {{ 'Hellow world' | uppercase }}</li>
</ul>
```

You can see the result of the rendering below:



Uppercase

- 'Hello world' → HELLOW WORLD

This pipe does not have any additional parameters.

LowerCase

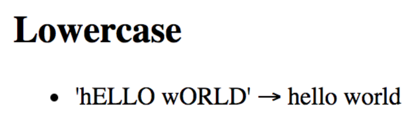
The `LowerCasePipe` pipe transforms text to lower case and has the following usage format:

```
<element>
  {{ <string_expression> | lowercase }}
</element>
```

Here's the basic example of using `LowerCasePipe` in practice:

```
<h2>Lowercase</h2>
<ul>
  <li>'hELLO wORLD' => {{ 'hELLO wORLD' | lowercase }}</li>
</ul>
```

Which gives you the following result once application runs:



Lowercase

- 'hELLO wORLD' → hello world

This pipe does not have any additional parameters.

TitleCase

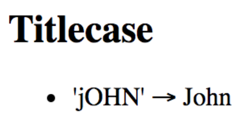
The `TitleCasePipe` converts input text to the title case. That means that first character gets converted to upper case while the rest of the string becomes lowercased.

```
<element>
  {{ <text_expression> | titlecase }}
</element>
```

Converting to title case becomes handy when dealing with usernames. Your application may have an input form, like a personal profile, where users can enter their first and last names for instance. Regardless of the actual value, whether it is “john” or “jOHN”, you can render it like a “John” at run time:

```
<h2>Titlecase</h2>
<ul>
  <li>'jOHN' => {{ 'jOHN' | titlecase }}</li>
</ul>
```

That turns into the following once your application runs:



Titlecase

- 'jOHN' → John

This pipe does not have any additional parameters.

Date

You have already seen the `DatePipe` usage earlier in this chapter. This pipe allows you to format a date value using a custom or one of the predefined locale rules.

```
<element>
  {{ <date_expression> | date[:format] }}
</element>
```

Where `date_expression` is date represented by an `object`, a `number` holding amount of milliseconds since UTC epoch, an ISO string[52], or a function or method call evaluating to these values at run time.

Custom formatting rules

According to the Angular documentation you can provide a custom date format based on the following rules:

[52] https://www.w3.org/TR/NOTE-datetime

Component	Symbol	Narrow	Short	Long	Numeric	2-digit
era	G	G (A)	GGG (AD)	GGGG (Anno Domini)	—	—
year	y	—	—	—	y (2015)	yy (15)
month	M	L (S)	MMM (Sep)	MMMM (September)	M (9)	MM (09)
day	d	—	—	—	d (3)	dd (03)
weekday	E	E (S)	EEE (Sun)	EEEE (Sunday)	—	—
hour	j	—	—	—	j (13)	jj (13)
hour12	h	—	—	—	h (1 PM)	hh (01 PM)
hour24	H	—	—	—	H (13)	HH (13)
minute	m	—	—	—	m (5)	mm (05)
second	s	—	—	—	s (9)	ss (09)
timezone	z	—	—	z (Pacific Standard Time)	—	—
timezone	Z	—	Z (GMT-8:00)	—	—	—
timezone	a	—	a (PM)	—	—	—

As you can see from the table above, there may be plenty of different combinations depending on how you want a date and time presented. If you want to get a year portion as a full 4-digit value you are going to take `y` symbol (`2017`), or `yy` for a 2-digit only (`17`). Some of the date components support multiple presentations. Assuming your browser is set to `en-UK` locale, for example, you can display `September` month as `S` using its narrow form via `L` symbol, short form `Sep` using `MMM` symbol, long `September` form with `MMMM`, or numeric forms `9` and doble-digit `09` by means of `M` and `MM` symbols respectively.

Note that you can use any other symbol as a date component separator, for instance:

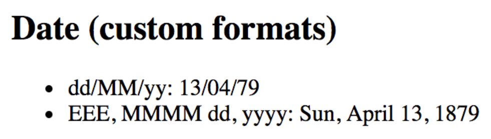
- dd/MM/yy ⇒ 13/04/79
- dd-MM-yy ⇒ 13-04-79
- dd=MM=yy ⇒ 13=04=79

Here's a basic example you can try with the main application component:

```
export class AppComponent {
  ...
  birthday = new Date(1879, 3, 14);
}
```

```
<h2>Date (custom formats)</h2>
<ul>
  <li>{{'1879-03-14' | date:'yMMMdjms'}}</li>
  <li>dd/MM/yy: {{ birthday | date:'dd/MM/yy' }}</li>
  <li>EEE, MMMM dd, yyyy: {{ birthday | date:'EEE, MMMM dd, yyyy' }}</li>
</ul>
```

The result should be something like the following:



Date (custom formats)

- dd/MM/yy: 13/04/79
- EEE, MMMM dd, yyyy: Sun, April 13, 1879

The `Date` pipe is going to use the end user's locale when formatting time zones. Note that when you use an ISO string[53] with no time portion, for example, `1879-03-14`, the pipe does not apply time zone offset.

```
<element{{'1879-03-14' | date:'yMMMdjms'}}</element>
<!-- Mar 14, 1879, 12:00:00 AM -->
```

Internationalisation API

This pipe is using Internationalisation API that may not be fully supported by all modern browsers. You can use Polyfill.io[54] service to get the `Intl` polyfill only if your user's current browser needs it.

Also, you can see details and additional options at the project side: Intl.js[55]

Predefined formatting rules

The `DatePipe` pipe comes with the following predefined rules to help you formatting the dates:

[53]https://www.w3.org/TR/NOTE-datetime
[54]https://cdn.polyfill.io/v2/docs/
[55]https://github.com/andyearnshaw/Intl.js/

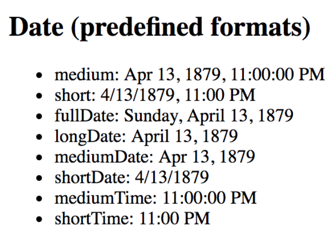
Name	Value	Example output (`en-UK`)
medium	yMMMdjms	`Apr 13, 1879, 11:00:00 PM`
short	yMdjm	`4/13/1879, 11:00 PM`
fullDate	yMMMMEEEEd	`Sunday, April 13, 1879`
longDate	yMMMMd	`April 13, 1879`
mediumDate	yMMMd	`Apr 13, 1879`
shortDate	yMd	`4/13/1879`
mediumTime	jms	`11:00:00 PM`
shortTime	jm	`11:00 PM`

You can use the following HTML template and corresponding component property `birthday` to test all the rules:

```
<h2>Date (predefined formats)</h2>
<ul>
  <li>medium: {{ birthday | date:'medium' }}</li>
  <li>short: {{ birthday | date:'short' }}</li>
  <li>fullDate: {{ birthday | date:'fullDate' }}</li>
  <li>longDate: {{ birthday | date:'longDate' }}</li>
  <li>mediumDate: {{ birthday | date:'mediumDate' }}</li>
  <li>shortDate: {{ birthday | date:'shortDate' }}</li>
  <li>mediumTime: {{ birthday | date:'mediumTime'}}</li>
  <li>shortTime: {{ birthday | date:'shortTime' }}</li>
</ul>
```

```
export class AppComponent {
  ...
  birthday = new Date(1879, 3, 14);
}
```

So that should give you the following result at run time:


Date (predefined formats)

- medium: Apr 13, 1879, 11:00:00 PM
- short: 4/13/1879, 11:00 PM
- fullDate: Sunday, April 13, 1879
- longDate: April 13, 1879
- mediumDate: Apr 13, 1879
- shortDate: 4/13/1879
- mediumTime: 11:00:00 PM
- shortTime: 11:00 PM

Decimal

The `DecimalPipe` pipe formats a number as text, taking into account user's locale and optionally custom display format.

The usage format of the pipe is as follows:

```
<element>
  {{ <number_expression> | number[:digitFormat] }}
</element>
```

Where the `digitFormat` value is represented by the following formatting rule:

```
minIntegerDigits.minFractionDigits-maxFractionDigits
```

Component	Default Value	Description
minIntegerDigits	1	Minimum number of digits to use when converting to text.
minFractionDigits	0	Minimum number of digits after fraction.
maxFractionDigits	3	Maximum number of digits after fraction.

Minimum numbers

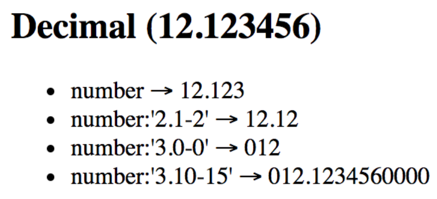
By setting the minimum numbers like `minIntegerDigits` and `minFractionDigits`, you enforce resulting value to have a certain size. The pipe automatically adds leading or trailing zeros if the actual value is less than expected.

For example applying a minimum number of `3` to the value `1` results in `003` text rendered by the pipe.

Let's now see how this pipe works in practice. Open existing or create a new Angular application and put the following block to the main application component template:

```
<h2>Decimal (12.123456)</h2>
<ul>
  <li>number => {{ 12.123456 | number }}</li>
  <li>number:'2.1-2' => {{ 12.123456 | number:'2.1-2' }}</li>
  <li>number:'3.0-0' => {{ 12.123456 | number:'3.0-0' }}</li>
  <li>number:'3.10-15' => {{ 12.123456 | number:'3.10-15' }}</li>
</ul>
```

The example above renders to the following:



Decimal (12.123456)

- number → 12.123
- number:'2.1-2' → 12.12
- number:'3.0-0' → 012
- number:'3.10-15' → 012.1234560000

Please note the last case in the example above. It demonstrates how leading, and trailing zeros get added to the output based on conditions.

Internationalisation API

This pipe is using Internationalisation API that may not be fully supported by all modern browsers. You can use Polyfill.io[56] service to get the `Intl` polyfill only if your user's current browser needs it.

Also, you can see details and additional options at the project side: Intl.js[57]

Currency

The `CurrencyPipe` pipe formats a number as a currency text, taking into account user's locale and optionally custom display format.

You can use this pipe with three optional parameters utilising the following format:

```
<element>
  {{ <number_expression> | currency[:code[:symbol[:digitFormat]]] }}
</element>
```

The `code` is a parameter of `string` type that refers to ISO 4217[58] currency code. For example, you can use `GBP` for the Great Britain Pound Sterling, or `USD` for United States Dollar.

The `symbol` parameter holds `boolean` value to indicate whether pipe needs to render currency symbol like `£` or just use the currency code value, in this case, `GBP`. This parameter defaults to `false` and `CurrencyPipe` is going to use currency codes if `symbol` parameter is not defined explicitly.

Finally, the `digitFormat` value is the same as of the `DecimalPipe`, and is represented by the following formatting rule:

```
minIntegerDigits.minFractionDigits-maxFractionDigits
```

[56]https://cdn.polyfill.io/v2/docs/
[57]https://github.com/andyearnshaw/Intl.js/
[58]https://en.wikipedia.org/wiki/ISO_4217

Component	Default Value	Description
minIntegerDigits	1	Minimum number of digits to use when converting to text.
minFractionDigits	0	Minimum number of digits after fraction.
maxFractionDigits	3	Maximum number of digits after fraction.

Minimum numbers

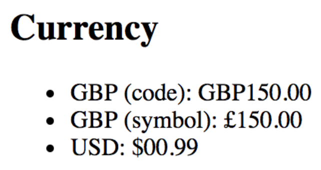
By setting the minimum numbers like `minIntegerDigits` and `minFractionDigits`, you enforce resulting value to have a certain size. The pipe automatically adds leading or trailing zeros if the actual value is less than expected.

For example applying a minimum number of `3` to the value `1` results in `003` text rendered by the pipe.

Below is a set of examples to demonstrate the pipe in action:

```
<h2>Currency</h2>
<ul>
  <li>GBP (code): {{ 150 | currency:'GBP' }}</li>
  <li>GBP (symbol): {{ 150 | currency:'GBP':true }}</li>
  <li>USD: {{ 0.9876 | currency:'USD':true:'2.2-2' }}</li>
</ul>
```

Once your application starts you should see the following output:



Currency

- GBP (code): GBP150.00
- GBP (symbol): £150.00
- USD: $00.99

Internationalisation API

This pipe is using Internationalisation API that may not be fully supported by all modern browsers. You can use Polyfill.io[59] service to get the `Intl` polyfill only if your user's current browser needs it.

Also, you can see details and additional options at the project side: Intl.js[60]

[59]https://cdn.polyfill.io/v2/docs/
[60]https://github.com/andyearnshaw/Intl.js/

Percent

The `PercentPipe` formats a number input as a percentage, where "1" corresponds to "100%", and "0.5" for instance corresponds to "50%". This pipe also takes into account user's locale and allows you to customise resulting numeric format if needed.

The usage format is similar to that of the `DecimalPipe`, `CurrencyPipe` and many other number-based pipes Angular provides out of the box:

```
<element>
  {{ <number_expression> | percent[:digitFormat] }}
</element>
```

Where the `digitFormat` value is represented by the following formatting rule:

```
minIntegerDigits.minFractionDigits-maxFractionDigits
```

Component	Default Value	Description
minIntegerDigits	1	Minimum number of digits to use when converting to text.
minFractionDigits	0	Minimum number of digits after fraction.
maxFractionDigits	3	Maximum number of digits after fraction.

Minimum numbers

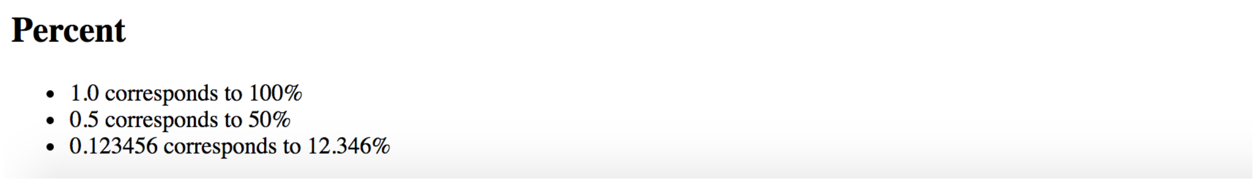
By setting the minimum numbers like `minIntegerDigits` and `minFractionDigits`, you enforce resulting value to have a certain size. The pipe automatically adds leading or trailing zeros if the actual value is less than expected.

For example applying a minimum number of `3` to the value `1` results in `003` text rendered by the pipe.

Now create a new Angular project or open an existing one and append the following block to the main application component template:

```
<h2>Percent</h2>
<ul>
  <li>1.0 equals to {{ 1.0 | percent }}</li>
  <li>0.5 equals to {{ 0.5 | percent }}</li>
  <li>0.123456 equals to {{ 0.123456 | percent }}</li>
</ul>
```

If you run the application with the code above you should see the following output:


Percent

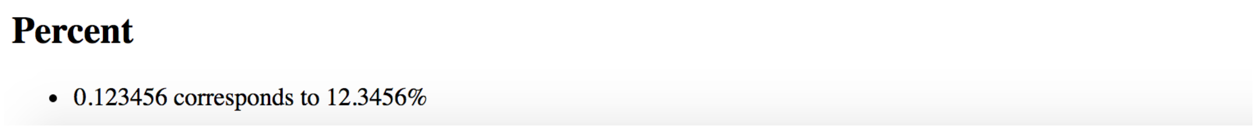
- 1.0 corresponds to 100%
- 0.5 corresponds to 50%
- 0.123456 corresponds to 12.346%

Notice that by default `PercentPipe` displays three digits after the fraction, so `0.123456` gets rounded and shown as `12.346`.

As with other number conversion pipes, you are also able to control how `PercentPipe` displays digits after fraction. For example, let's make the transformed output more precise and render five numbers instead of the default three:

```
<h2>Percent</h2>
<ul>
  <li>0.123456 corresponds to {{ 0.123456 | percent:'1.1-5' }}</li>
</ul>
```

This time we should see the full number as we define it initially, and without rounding:

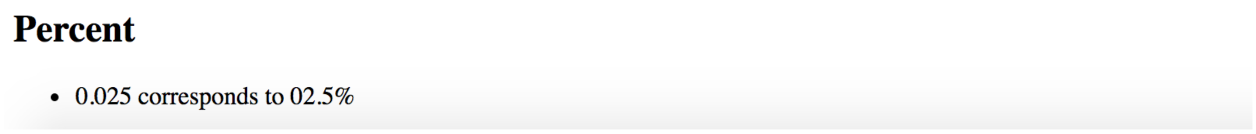

Percent

- 0.123456 corresponds to 12.3456%

It is also possible to add leading zero to the final output by putting a minimum threshold for the number of digits:

```
<h2>Percent</h2>
<ul>
  <li>0.025 corresponds to {{ 0.025 | percent:'2.1' }}</li>
</ul>
```

The example above shows how to force `PercentPipe` always to use two numbers during conversion, so you are going to get a leading zero for small values.


Percent

- 0.025 corresponds to 02.5%

Internationalisation API

This pipe is using Internationalisation API that may not be fully supported by all modern browsers. You can use Polyfill.io[61] service to get the `Intl` polyfill only if your user's current browser needs it.

Also, you can see details and additional options at the project side: Intl.js[62]

Json

The `JsonPipe` pipe often helps with debugging your Angular code. Its main purpose is converting JavaScript objects into JSON strings.

```
<element>
  {{ <object_expression> | json }}
</element>
```

You are going to use this pipe if you want to peek inside a payload or response object coming from HTTP service call for instance. Let's start by adding a `complexObject` property to the main application component:

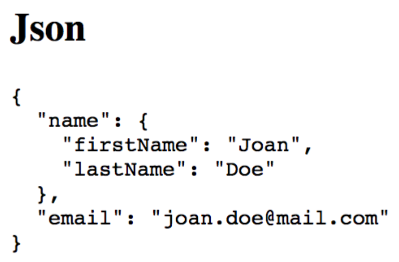
```
export class AppComponent {
  ...
  complexObject = {
    name: {
      firstName: 'Joan',
      lastName: 'Doe'
    },
    email: 'joan.doe@mail.com'
  };
}
```

As you see the property holds a User object with some nested properties. You can now render it using the `JsonPipe` pipe as below:

```
<h2>Json</h2>
<pre>{{ complexObject | json }}</pre>
```

That gives you the following output once application reloads:

[61] https://cdn.polyfill.io/v2/docs/
[62] https://github.com/andyearnshaw/Intl.js/



Json

```
{
  "name": {
    "firstName": "Joan",
    "lastName": "Doe"
  },
  "email": "joan.doe@mail.com"
}
```

This pipe does not have any additional parameters.

Slice

The `SlicePipe` pipe extracts a section of a string or array into a new object. It performs a selection from a "begin" to an "end" index where the "end" does not get included in the resulting set. Note that the original string or array is not modified.

Slice behaviour

The implementation of this pipe is based on the standard Array.prototype.slice()[63] method for JavaScript Arrays, and String.prototype.slice()[64] method for JavaScript Strings.

If needed, please refer to the corresponding API documentation for more details on how `slice` gets performed.

Using with Arrays

The format when using the pipe with arrays and collections is the following:

```
<element>
  {{ array_expression | slice:begin[:end] }}
</element>
```

First, add an initial collection of numbers to the main application component class, to be able testing the pipe:

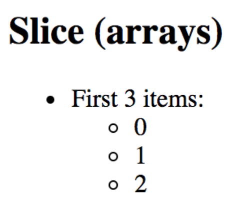
[63]https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Global_Objects/Array/slice
[64]https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Global_Objects/String/slice

```
...
export class AppComponent {
  ...
  numberCollection = [0, 1, 2, 3, 4, 5, 6];
}
```

As the next, try displaying first three items from the array by setting `begin` index to `0` to point to the start of the collection, and the `end` index to 3.

```
<h2>Slice (arrays)</h2>
<ul>
  <li>
    First 3 items:
    <ul>
      <li *ngFor="let num of numberCollection | slice:0:3">{{num}}</li>
    </ul>
  </li>
</ul>
```

Given the ending index is not included, the resulting subset should have the following items rendered: 0, 1, 2



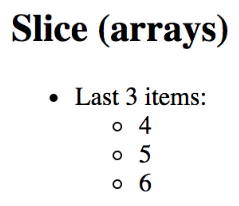
```
Slice (arrays)

• First 3 items:
    ◦ 0
    ◦ 1
    ◦ 2
```

You can also count items from the end of the array. For this purpose, you are going to use negative values for the `start` option. For example value `3` signals the pipe to start taking items from the third position from the beginning. Using value `-3` makes the pipe count items from the end of the array.

Let's now try negative values in action and display last `3` items from the numbers collection:

```
<h2>Slice (arrays)</h2>
<ul>
  <li>
    Last 3 items:
    <ul>
      <li *ngFor="let num of numberCollection | slice:-3">{{num}}</li>
    </ul>
  </li>
</ul>
```

This time we do not need to specify the `end` index as we are going to take all array values starting with the third one from the end.



Slice (arrays)

- Last 3 items:
  - 4
  - 5
  - 6

Feel free to experiment with `start` and `end` index values more to see how `SlicePipe` works with arrays depending on your conditions.

Using with Strings

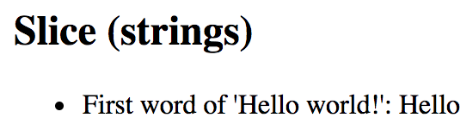
The format when using the pipe with strings is identical to that of the arrays. The `SlicePipe` pipe treats strings as arrays of characters, so you can apply the same `begin` and `end` parameters as you did earlier.

```
<element>
  {{ string_expression | slice:begin[:end] }}
</element>
```

Let's test this pipe with the "Hello world!" string and extract the first word:

```
<h2>Slice (strings)</h2>
<ul>
  <li>
    First word of 'Hello world!':
    {{ 'Hello world!' | slice:0:5 }}
  </li>
</ul>
```

Upon application start, you should see that pipe successfully transformed the string value and rendered only the word “Hello”.



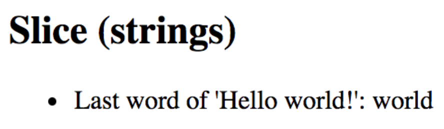
Slice (strings)

- First word of 'Hello world!': Hello

We can also take the last word by using negative number for the `begin` parameter value:

```html
<h2>Slice (strings)</h2>
<ul>
  <li>
    Last word of 'Hello world!':
    {{ 'Hello world!' | slice:-6:-1 }}
  </li>
</ul>
```

You should see the word “world” rendered by the pipe as soon as your application reloads.



Slice (strings)

- Last word of 'Hello world!': world

Note that we use `-1` for the `end` value because sentence ends with an exclamation mark that we want to exclude from the final output. Otherwise, you can omit the `end` setting entirely and leave just `-6` for the `start` value.

I18nSelect

For the time being the `I18nSelectPipe` is an experimental pipe that allows you to render different strings from the object depending on the input value.

Experimental

Please note that this pipe is an experimental one and its functionality may change. We are going to update this section with new features for the `I18nSelectPipe` if they appear, or remove this warning if the pipe gets updated to the stable state.

The usage format for this pipe is the following:

```
<element>
  {{ <expression> | i18nSelect:mapping }}
</element>
```

The `mapping` is an object literal with properties.

To see that in action you need to create two properties `titleMode` and `titleValues`. The `titleMode` property should be responsible for different title rendering modes, while `titleValues` contains different values for title content.

```
export class AppComponent {
  titleMode = 'primary';
  titleValues = {
    primary: 'This is a primary title',
    secondary: 'This is a secondary title',
    other: 'This is an alternative title'
  };
}
```

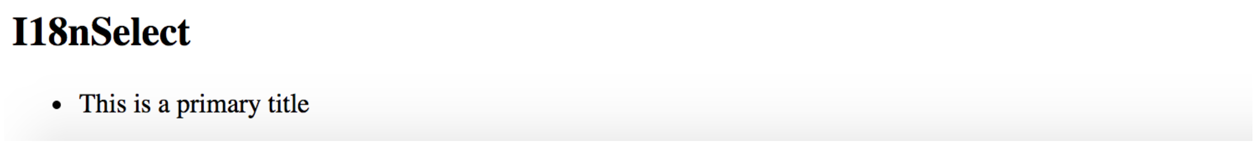
Now we can wire both properties together in the component HTML template as below:

```
<h2>I18nSelect</h2>
<ul>
  <li>{{ titleMode | i18nSelect:titleValues }}</li>
</ul>
```

Based on settings above there are four different values you can see on the screen at runtime:

- `titleValues.primary` if `titleMode` property value equals to `primary`;
- `titleValues.secondary` if `titleMode` property value equals to `secondary`;
- `titleValues.other` as a fallback value if `titleMode` does not contain any of the values above;
- empty string, if `titleValues` object literal does not have `other` property defined, and `titleMode` contains “unknown” value;

Given that by default `titleMode` property value is set to `primary`, you should see the following content once the application starts:

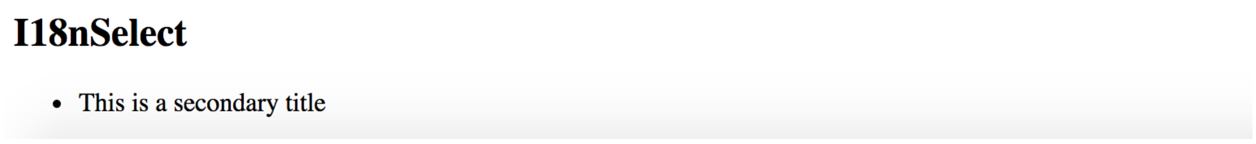

I18nSelect

- This is a primary title

Now try changing the value of the `titleMode` property to `secondary` like in the example below:

```
export class AppComponent {
  titleMode = 'secondary';
  ...
}
```

This time `I18nSelectPipe` is going to select and display `titleValues.secondary` value:

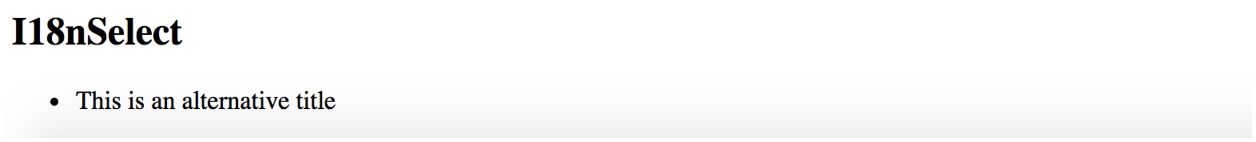

I18nSelect

- This is a secondary title

For the next experiment, let's try setting `titleMode` to something `titleValues` does not contain a property for. For example, change the value to a "something else" string.

```
export class AppComponent {
  titleMode = 'something else';
  ...
}
```

As soon as your page reloads you can see that `I18nSelectPipe` this time takes the `titleMode.other` content as a fallback value.


I18nSelect

- This is an alternative title

Another good scenario for `I18nSelectPipe` is rendering text that gets adopted to some input criteria, for instance, `gender` value of the current user can be a good example:

```
export class AppComponent {
  gender: string = 'male';
  inviteMap: any = {
    'male': 'Invite him.',
    'female': 'Invite her.',
    'other': 'Invite them.'
  };
}
```

Your component may display different user interface and content based on the `gender` value at run time.

Finally, you an use the `I18nSelectPipe` pipe for localising text, the `i18n` prefix in its name stands for `internationalisation`. Imagine you are implementing a colour picker button component, and you need to support multiple languages. You can easily split the translation support into two pieces: `currentLanguage` property holding currently used language code and a `buttonLabels` object containing all supported translations.

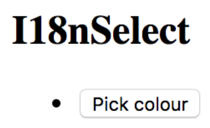
Let's see that in practice by providing tree "Pick colour" labels translated into British English (`en-GB`), American English (`en-US`) and Ukrainian (`uk`). For all other languages that our component does not support out of the box, we are going to use `en-GB` locale via `other` property as a fallback option.

```
export class AppComponent {
  currentLanguage = 'en-GB';
  buttonLabels = {
    'en-US': 'Pick a color',
    'en-GB': 'Pick a colour',
    'uk': 'Вибрати колір',
    'other': 'Pick a colour'
  };
}
```

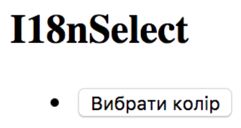
Now switch to the HTML template of your application component or any other component you are using for testing purposes, and add the following content:

```
<h2>I18nSelect</h2>
<ul>
  <li>
    <button>{{ currentLanguage | i18nSelect:buttonLabels }}</button>
  </li>
</ul>
```

You should see the `en-GB` translation by default as per `currentLanguage` property value we set earlier:



Now if you change the `currentLanguage` to "uk" code the button should have the following content rendered by `I18nSelectPipe`:



Finally, if you change your `currentLanguage` property value to something that is not supported by default, like "fr" or "it" for instance, the pipe is going to switch to the "other" value at run time.

I18nPlural

This pipe helps you with pluralizing your string values based on a number input value and optionally taking into account the current user's locale.

Experimental

Please note that this pipe is an experimental one and its functionality may change. We are going to update this section with new features for the `I18nPluralPipe` if they appear, or remove this warning if the pipe gets updated to the stable state.

The usage format for the `I18nPluralPipe` is as following:

```
<element>
  {{ <number_expression> | i18nPlural:mapping }}
</element>
```

The `mapping` is an object literal with properties, represented in TypeScript by a dictionary containing key/value pairs of a string type.

Let's imagine we have a list of posts to render on the page. Each post may also contain comments, so we are also going to show a list of comment instances in a user-friendly manner.

Create a new application with Angular CLI or open an existing one, and append the following content to the main application controller:

```
export class AppComponent {
  ...
  posts = [
    {
      content: 'Post 1 content',
      commentsCount: 0,
    },
    {
      content: 'Post 2 content',
      commentsCount: 1
    },
    {
      content: 'Post 3 content',
      commentsCount: 10
    }
  ];
}
```

We have a collection of three simple posts with comment counters as `commentsCount` properties holding different number values.

There are at least three different cases for display value formatting in our case:

- 0 comments: special message for zero values
- 1 comment: singular form of the message
- 2+ comments: plural form of the message

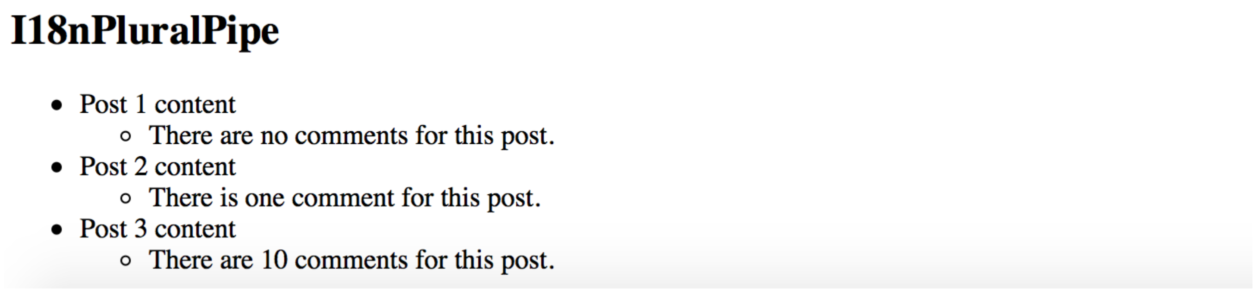
Now let's create a mapping dictionary to hold string values for all the use cases above:

```
export class AppComponent {
  ...
  commentLabels: { [key: string]: string } = {
    '=0': 'There are no comments for this post.',
    '=1': 'There is one comment for this post.',
    'other': 'There are # comments for this post.'
  };
}
```

Finally we are ready to see `I18nPluralPipe` in action. Append the following HTML to the component template:

```
<h2>I18nPluralPipe</h2>
<ul>
  <li *ngFor="let post of posts">
    {{ post.content }}
    <ul>
      <li>{{ post.commentsCount | i18nPlural: commentLabels }}</li>
    </ul>
  </li>
</ul>
```

So this is how the output result should look like when the application starts:


I18nPluralPipe

- Post 1 content
  - There are no comments for this post.
- Post 2 content
  - There is one comment for this post.
- Post 3 content
  - There are 10 comments for this post.

Async

The `AsyncPipe` pipe subscribes to an instance of a `Promise` or `Observable` and transforms the underlying value upon every change.

```
<element>
  {{ <expression> | async }}
</element>
```

The `expression` can take a value of either `Observable` or a `Promise` type.

Unsubscribing

When the component gets destroyed, the async pipe unsubscribes automatically to avoid potential memory leaks.

Using with NgFor directive

Let's try to display a list of comments based on an `Observable`. First, create a `comments` property in your application component class:

```
export class AppComponent {
  ...
  comments: Observable<string[]>;
}
```

We are going to render an unordered list of comments; we also need a button to fetch comments from the server and update `comments` observable with new values.

Open the HTML template of the main application component and append the following:

```
<h2>Async</h2>
<ul>
  <li *ngFor="let comment of comments | async">
    {{ comment }}
  </li>
</ul>
<button (click)="checkComments()">Check comments</button>
```

For the sake of simplicity, we are not going to make any HTTP calls on the `checkComments` call. Let's just return a predefined set of comments after a short delay to emulate delays with a response.

```
export class AppComponent {
  ...
  comments: Observable<string[]>;

  checkComments() {
    this.comments = new Observable(observer => {
      observer.next([
        'Comment 1',
        'Comment 2',
        'Comment 3'
      ]);
    }).delay(1000);
  }
}
```

The `checkComments` method sets `comments` variable value to an observable that evaluates with 1-second delay and returns a set of sample comments.

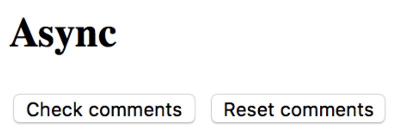
For testing purposes you can also add a button to reset comments:

```
<button (click)="resetComments()">Reset comments</button>
```

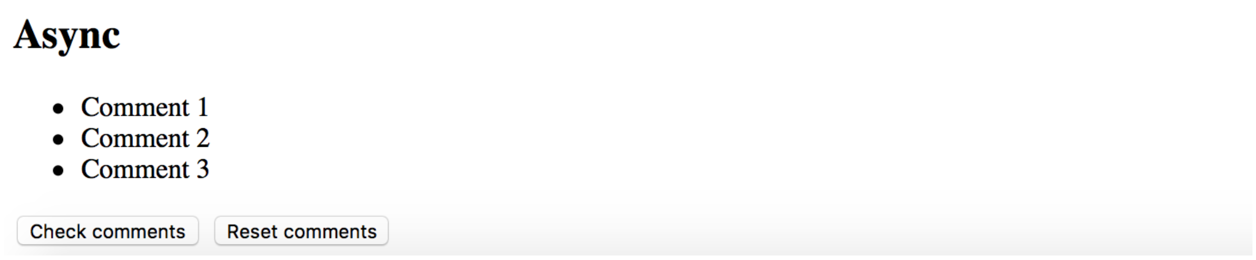
The corresponding `resetComments` method is going to just set the `comments` value to `null`.

```
export class AppComponent {
  ...

  resetComments() {
    this.comments = null;
  }
}
```

If you now run the application the main page should look like the following:



Try clicking the `Check comments` button and the results should get displayed in 1 second:



Using with Date object

Another good example to demonstrate the 'AsyncPipe `in action is displaying current time on the page. Our component needs to implement standard` OnInit `interface to setup` currentTime' observable once it is ready.

```
import { ..., OnInit } from '@angular/core';

export class AppComponent implements OnInit {
  ...

  currentTime: Observable<Date>;

  ngOnInit() {
    this.currentTime = new Observable<Date>(observer => {
      setInterval(_ => observer.next(new Date()), 1000);
    });
  }
}
```

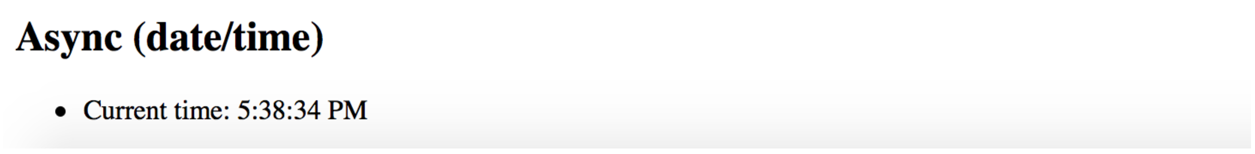
Upon initialization, the component assigns an `Observable` of `Date` type to the `currentTime` property. The Observable instance updates the underlying value to a new `Date` object every second, that causes `AsyncPipe` to render new date automatically.

As Angular allows chaining multiple pipes together, you can also use a `DatePipe` to format resulting output to display only the time portion of the date.

You can get the basic HTML template for the application component below:

```html
<h2>Async (date/time)</h2>
<ul>
  <li>
    Current time: {{ currentTime | async | date:'mediumTime' }}
  </li>
</ul>
```

Once application compiles and starts you should get a time value updated every second:


Async (date/time)

- Current time: 5:38:34 PM

Source code

You can find the source code in the "angular/pipes/standard-pipes[65]" folder.

Custom Pipes

Besides providing a set of standard out-of-box pipes the Angular framework provides support for creating your custom ones.

To create a custom pipe you need to import the `@Pipe` decorator and apply it to your class.

```typescript
import { Pipe } from '@angular/core';

@Pipe({
  name: 'customDate'
})
export class CustomDatePipe {
  ...
}
```

You can give your class any name you want. The Angular is going to use the `@Pipe` decorator metadata when parsing component templates, in our case the pipe gets used as `customDate`:

[65]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/pipes/standard-pipes

```
<element>
  {{ <expression> | customDate }}
</element>
```

Also, your class should implement a `PipeTransform` interface with a `transform` method:

```
interface PipeTransform {
  transform(value: any, ...args: any[]) : any
}
```

At runtime, the Angular calls your pipe's transform method providing original input value together with optional pipe parameters. For example, if your `myPipe` pipe expects to receive 3 additional parameters you can declare your `transform` method like the following:

```
transform(value: string, p1: number, p2: number, p3: number) : string {
  return value;
}
```

To get type checking support from TypeScript, you can also provide type definitions for your parameters and method return type.

You can now use your pipe in HTML templates like in the example below:

```
<element>
  {{ 'hello world' | myPipe:1:2:3 }}
</element>
```

Implementing Custom Pipe

We are going to create a simple pipe that takes a numeric input value for a size of the file in bytes and produces a user-friendly output by transforming it to Kilobytes, Megabytes or greater units.

Let's start creating a custom pipe with a new project `custom-pipes` by utilising the Angular CLI tool.

```
ng new custom-pipes
```

You can use Angular CLI to generate the `file-size` pipe scaffold.

```
ng g pipe pipes/file-size
```

The command above generates a pipe, basic unit test and updates main application module so that you can use this pipe across all the application components.

```
installing pipe
  create src/app/pipes/file-size.pipe.spec.ts
  create src/app/pipes/file-size.pipe.ts
  update src/app/app.module.ts
```

The default pipe scaffold already contains a `@Pipe` decorator applied and inherits the `PipeTransform` interface:

src/app/pipes/file-size.pipe.ts

```
import { Pipe, PipeTransform } from '@angular/core';

@Pipe({
  name: 'fileSize'
})
export class FileSizePipe implements PipeTransform {

  transform(value: any, args?: any): any {
    return null;
  }

}
```

First, let's change the signature of the `transform` method to accept `bytes` and `decimals` parameters of a `number` type. We also make both of them optional by providing default values and change the return type of the method to a `string`.

src/app/pipes/file-size.pipe.ts

```
@Pipe({
  name: 'fileSize'
})
export class FileSizePipe implements PipeTransform {

  transform(bytes: number = 0, decimals: number = 2): string {
    return null;
  }

}
```

Converting Bytes

There are many different ways to convert a file size from bytes to other units of measurement. For this example we are going to take the accepted answer from the following Stackoverflow question: Correct way to convert size in bytes to KB, MB, GB in Javascript[66]

[66]https://stackoverflow.com/questions/15900485/correct-way-to-convert-size-in-bytes-to-kb-mb-gb-in-javascript

You can see the final implementation of the pipe below:

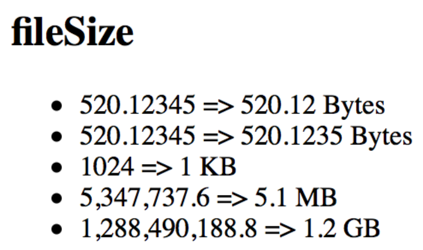
```
@Pipe({
  name: 'fileSize'
})
export class FileSizePipe implements PipeTransform {

  transform(bytes: number = 0, decimals: number = 2): string {
    if (bytes === 0) {
      return '0 Bytes';
    }
    const k = 1024,
       dm = decimals || 2,
       sizes = ['Bytes', 'KB', 'MB', 'GB', 'TB', 'PB', 'EB', 'ZB', 'YB'],
       i = Math.floor(Math.log(bytes) / Math.log(k));
    return parseFloat((bytes / Math.pow(k, i)).toFixed(dm)) + ' ' + sizes[i];
  }

}
```

If no `bytes` value provided the pipe returns a "0 Bytes" string, for all other cases if converts input number to the most appropriate measuring unit. The `transform` method also takes into account the number of decimals to use after the point, provided within the second `decimals` parameter. By default, it is going to take two numbers.

In order to see the pipe in action open the main application component template and append the following HTML block:

```
<h2>fileSize</h2>
<ul>
  <li>520.12345 => {{ 520.12345 | fileSize }}</li>
  <li>520.12345 => {{ 520.12345 | fileSize:4 }}</li>
  <li>1024 => {{ 1024 | fileSize }}</li>
  <li>5,347,737.6 => {{ 5347737.6 | fileSize }}</li>
  <li>1,288,490,188.8 => {{ 1288490188.8 | fileSize }}</li>
</ul>
```

Now run the application with `ng serve --open` command and you should see the following output:



fileSize

- 520.12345 => 520.12 Bytes
- 520.12345 => 520.1235 Bytes
- 1024 => 1 KB
- 5,347,737.6 => 5.1 MB
- 1,288,490,188.8 => 1.2 GB

Pure And Impure Pipes

Angular supports two different categories of pipes - "pure" and "impure". Every custom pipe is `pure` by default, but you can change that when using the `@Pipe` decorator:

```
@Pipe({
  name: 'myCustomPipe',
  pure: false
})
```

Before diving into details on category differences, let's prepare the testing project.

We are going to display a list of short blog posts filtered by a `pure` or `impure` pipe and allow creating a new simple blog post entry with various properties like creation date, content or public state.

Preparing Project

Use Angular CLI to generate a new project called "pure-impure".

```
ng new pure-impure
cd pure-impure
```

As we are going to filter and display Posts let's create a `Post` interface that defines the main attributes of a Post instance. You can do that by utilising Angular CLI that supports generating interface classes as well.

```
ng g interface post
```

The Angular CLI puts interfaces classes to the `src/app` folder by default:

```
installing interface
  create src/app/post.ts
```

The bare minimum of properties we need to visualise a post is:

- the text content of the post
- creation date
- a flag indicating whether the post is public or private

Open the newly generated `post.ts` file and update it according to the list above:

src/app/post.ts

```
export interface Post {
  created: Date;
  content: string;
  isPublic: boolean;
}
```

For the next step let's update the main application component class. We need a `posts` property to hold a collection of created `Post` instances. Also, the `newPostContent` and `newPostPublic` properties of `string` and `boolean` types are going to power our simple post editor.

src/app/app.component.ts

```
import { Post } from './post';

@Component({ ... })
export class AppComponent {
  ...

  posts: Post[] = [];

  newPostContent = '';
  newPostPublic = true;

  createPost(): void {
    if (this.newPostContent) {
      const newPost = <Post> {
        content: this.newPostContent,
        isPublic: this.newPostPublic,
        created: new Date()
      };
      this.posts.push(newPost);
      this.newPostContent = '';
    }
  }
}
```

The `createPost` method performs some basic validation for content to be defined and creates a new post. The creation date is assigned automatically to current date and time. Upon pushing the new post to the `posts` collection, our `createPost` method also clears the input field.

Note that `posts` collection is defined and initialized with an empty array by default. We add items to it via `createPost` method, but the initial collection is always the same. To better demonstrate capabilities of both pipes we also need to change the object reference for the `posts` collection, for example creating a new collection of Post instances, or resetting it by assigning an empty array value.

For the sake of simplicity let's just be making a copy of the existing collection and reassigning `posts` property, all we need so far is changing the object reference. Append the following `mutateArray` method to the main application component class:

```
@Component({ ... })
export class AppComponent {
  ...

  mutateArray() {
    this.posts = this.posts.concat();
  }
}
```

Finally edit the component template and add the following HTML content:

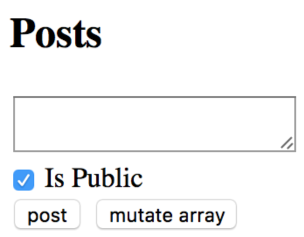
src/app/app.component.html

```
<h2>Posts</h2>
<div>
  <textarea [(ngModel)]="newPostContent"></textarea>
</div>
<div>
  <label>
    <input type="checkbox" [(ngModel)]="newPostPublic">
    Is Public
  </label>
</div>
<div>
  <button (click)="createPost()">post</button>
  <button (click)="mutateArray()">mutate array</button>
</div>

<ul>
  <li *ngFor="let post of posts">
    {{ post.content }} ({{ post.created | date:'short' }})
  </li>
</ul>
```

The layout above is pretty simple. You get a text area element to enter a content for a new post, a checkbox to toggle the public state, and two buttons `post` and `mutate array`. Under the post editor there is a list of previously created posts, by default it is empty.

Once you compile and start the application you should see the following:

```
ng serve --open
```



Now you are ready testing `pure` and `impure` pipes in action.

Pure Pipes

A "pure pipe" is a pipe that gets executed by Angular only when a "pure change" happens to the underlying input value, for example:

- a "primitive" value changes, for example of a `String`, `Number`, `Boolean` or other `primitive` types;
- object reference changes, for instance an entire `Array`, `Date`, `Object` and other reference-based types;

When you use a "pure pipe", the Angular ignores all changes to the complex objects it gets as input parameters for the pipe. For example, when using with arrays, the pipe renders data if your component class initializes default collection of items. However, the pipe does not update the view if you add new items to the collection at run time.

Object reference checks

Concerning performance and memory consumption, it is much faster for Angular to perform an object reference check rather than initiating a deep check for complex object differences. So "pure" pipes are extremely fast if you deal with primitives or change entire input value in your component. Angular change detection mechanisms take care of values and execute pipes when needed.

Let's use Angular CLI to generate our simple pure pipe and call it "public-posts".

```
ng g pipe pipes/public-posts
```

You should get your pipe scaffold and a basic unit test in the `src/app/pipes` folder:

```
installing pipe
  create src/app/pipes/public-posts.pipe.spec.ts
  create src/app/pipes/public-posts.pipe.ts
  update src/app/app.module.ts
```

Edit the `public-posts.pipe.ts` according to the following example:

src/app/pipes/public-posts.pipe.ts

```
import { Pipe, PipeTransform } from '@angular/core';
import { Post } from '../post';

@Pipe({
  name: 'publicPosts'
})
export class PublicPostsPipe implements PipeTransform {

  transform(posts: Post[]): any {
    return posts.filter(p => p.isPublic);
  }

}
```

Essentially the pipe takes a collection of `Post` instances as an input parameter `posts` and returns a filtered result using `isPublic` property.

Pipe name

Note that your pipe's public name is going to be `publicPosts`. You can give the component class any name you want, in our case, it is `PublicPostsPipe`, but Angular is going to use `@Pipe` metadata when parsing component templates.

Now let's add a couple of initial posts for our pipe to filter at run time:

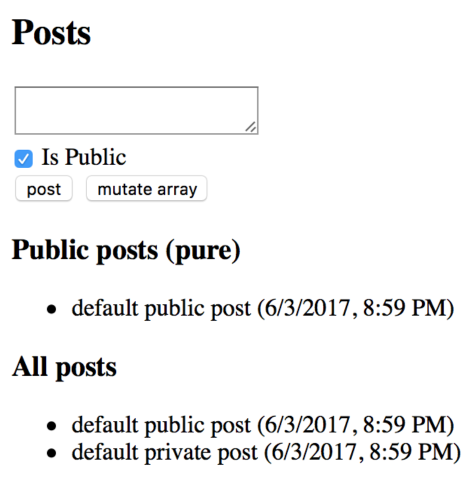
```
@Component({ ... })
export class AppComponent {

  posts: Post[] = [
    <Post> {
      content: 'default public post',
      isPublic: true,
      created: new Date()
    },
    <Post> {
      content: 'default private post',
      isPublic: false,
      created: new Date()
    }
  ];

}
```

The first post is going to be public while the second one is configured to be private by default.

For the next step, please update the application component template to show the `posts` collection, filtered by our `publicPosts` pipe, in a separate unstructured list element.

```
<h3>Public posts (pure)</h3>
<ul>
  <li *ngFor="let post of posts | publicPosts">
    {{ post.content }} ({{ post.created | date:'short' }})
  </li>
</ul>

<h3>All posts</h3>
<ul>
  <li *ngFor="let post of posts">
    {{ post.content }} ({{ post.created | date:'short' }})
  </li>
</ul>
```

If you run your application right now, you should see one entry in the "Public posts" list and two entries in the "All posts" one.



Public posts (pure)

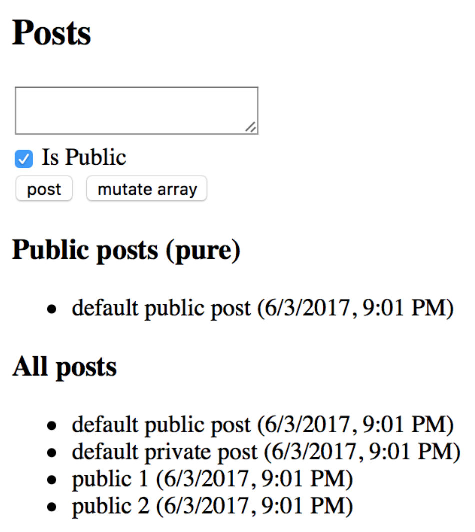
- default public post (6/3/2017, 8:59 PM)

All posts

- default public post (6/3/2017, 8:59 PM)
- default private post (6/3/2017, 8:59 PM)

So the pipe is working with predefined data as we expect it. Now try adding couple more posts by entering content into the input area and clicking the "post" button. Please ensure that "Is Public" checkbox element is set to "checked" state.

You should see the "All posts" list is getting updated, while "Public posts" one remains the same. That is the expected behaviour as we are modifying a complex object, in this case, an array of Post instances, without actually changing object reference for the pipe.



Public posts (pure)

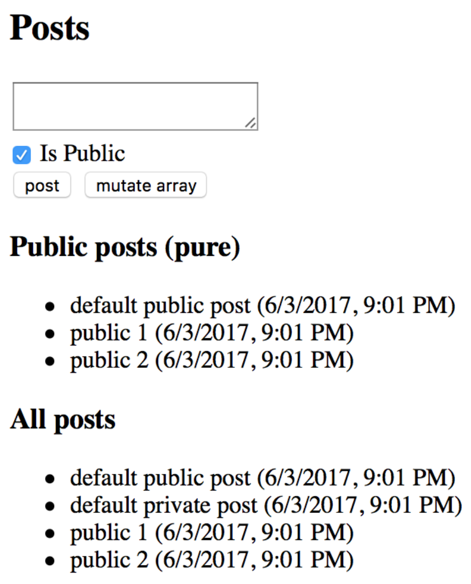
- default public post (6/3/2017, 9:01 PM)

All posts

- default public post (6/3/2017, 9:01 PM)
- default private post (6/3/2017, 9:01 PM)
- public 1 (6/3/2017, 9:01 PM)
- public 2 (6/3/2017, 9:01 PM)

The "All posts" list uses the `ngFor` directive, so Angular detects the change and updates it accordingly. During the preparation phase, we have created a "mutate array" button that modifies `posts` by replacing the collection with its copy.

If you click this button right now the "Public posts" should instantly update the view with new values:



Posts

Public posts (pure)

- default public post (6/3/2017, 9:01 PM)
- public 1 (6/3/2017, 9:01 PM)
- public 2 (6/3/2017, 9:01 PM)

All posts

- default public post (6/3/2017, 9:01 PM)
- default private post (6/3/2017, 9:01 PM)
- public 1 (6/3/2017, 9:01 PM)
- public 2 (6/3/2017, 9:01 PM)

Impure Pipes

An "impure pipe" is a pipe that gets executed by Angular during every component change detection cycle. All custom pipes are "pure" by default, in order to change its state to "impure" you need to explicitly define that in the `@Pipe` decorator metadata:

```
@Pipe({
  name: 'myCustomPipe',
  pure: false
})
```

Performance

A single component may cause many change detection cycles based on various factors, for example, user interaction, keyboard or mouse events. Keep in mind that you pipe may affect overall application performance if it is slow, or not optimised for frequent runs (data caching for instance).

Let's create another pipe scaffold called "public-posts-impure" in the same project using Angular CLI:

```
ng g pipe pipes/public-posts-impure
```

The command above should produce a new pipe next to the existing one in the `src/app/pipes` folder.

```
installing pipe
  create src/app/pipes/public-posts-impure.pipe.spec.ts
  create src/app/pipes/public-posts-impure.pipe.ts
  update src/app/app.module.ts
```

Next, update the pipe code like in the example below:

src/app/pipes/public-posts-impure.pipe.ts

```
import { Pipe, PipeTransform } from '@angular/core';
import { Post } from '../post';

@Pipe({
  name: 'publicPostsImpure',
  pure: false
})
export class PublicPostsImpurePipe implements PipeTransform {

  transform(posts: Post[]): any {
    return posts.filter(p => p.isPublic);
  }

}
```

The implementation of the pipe is pretty much the same we used before. It takes a collection of posts as an input and returns a filtered result based on public state via `isPublic` property values.

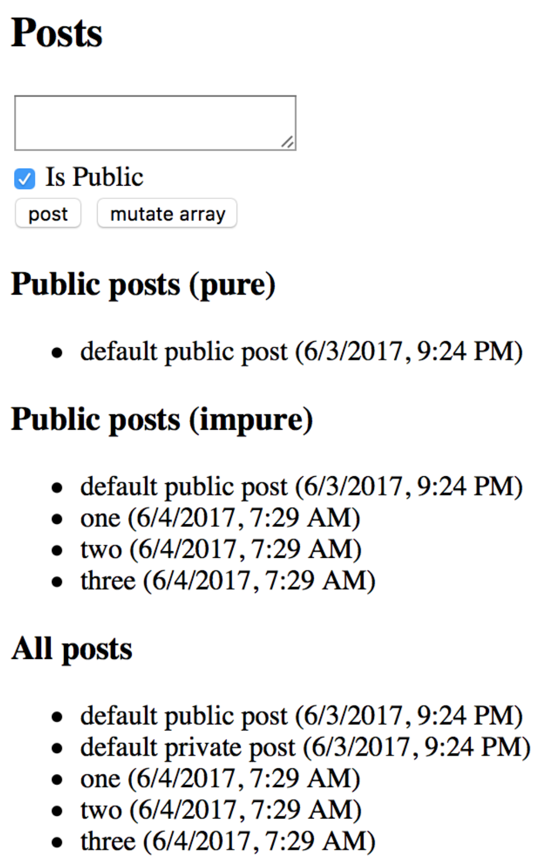
We are going to use this pipe as "publicPostsImpure" in the HTML templates, and we also explicitly set the `pure` property value in the `@Pipe` decorator metadata to false:

```
@Pipe({
  name: 'publicPostsImpure',
  pure: false
})
```

Finally extend the main application component template with the list showing all public posts filtered by the `publicPostsImpure` pipe:

```
<h3>Public posts (impure)</h3>
<ul>
  <li *ngFor="let post of posts | publicPostsImpure">
    {{ post.content }} ({{ post.created | date:'short' }})
  </li>
</ul>
```

This time if you run the application and add several posts with "Is Public" element checked, you should see the "Public posts (impure)" list gets updated at real-time. That happens because our custom `publicPostsImpure` pipe gets executed by Angular during each change detection cycle.



Public posts (pure)

- default public post (6/3/2017, 9:24 PM)

Public posts (impure)

- default public post (6/3/2017, 9:24 PM)
- one (6/4/2017, 7:29 AM)
- two (6/4/2017, 7:29 AM)
- three (6/4/2017, 7:29 AM)

All posts

- default public post (6/3/2017, 9:24 PM)
- default private post (6/3/2017, 9:24 PM)
- one (6/4/2017, 7:29 AM)
- two (6/4/2017, 7:29 AM)
- three (6/4/2017, 7:29 AM)

Global Application Configuration

In this chapter, we are going to focus on application settings and configuration files.

If you are building a large application or an application that performs the server side or RESTful APIs calls, sooner or later you will come across the need to store global application settings somewhere. For example the APIs URL string, you may hardcode it somewhere in the application or service, but that will require rebuilding and redeploying your application every time the URL value needs changes. It is much easier storing and loading configuration parameters in a separate file that developers can maintain without changing the main application code.

Let's create an Application Configuration service that loads global settings from the external server-side file before all other services get loaded, and provides access to configuration properties for all other application components and services.

Preparing the configuration file

We are going to use the JSON format for configuration files. The name of the file can be anything as we need only the content.

As a first step, create an "app.config.json" file in the "src" folder with the following content:

src/app.config.json

```json
{
  "title": "My application"
}
```

Configuration content

Theoretically, you could even dynamically generate the file if necessary, for example building the output based on some database values.

In our case, we just store the custom application title in the config file to see the basic flow in action. You can extend the file content later on with more properties and values.

We also need configuring Angular CLI to copy the newly created file to the application output directory upon every build. Edit the "apps" section of the ".angular-cli.json" file and append the name of the settings file to the "assets" collection like in the example below:

.angular-cli.json

```json
{
    "apps": {
        "assets": [
            "app.config.json"
        ]
    }
}
```

Updating file content

One of the greatest features of Angular CLI is automatic rebuilding and live-reloading upon file changes. If you start your application in the development mode, the runner should also be watching for the "app.config.json" changes, and automatically reloading your application every time you update your settings.

Creating the configuration service

We now need two things to be created: an "AppConfig" interface to provide a type-safe access to our configuration properties, and "AppConfigService" service that is going to load the remote file, store the resulting settings and expose them to external components and services.

Use the following commands to generate both an interface and a service scaffolds:

```
ng g interface app-config
ng g service app-config
```

Don't forget to register the newly generated service with the main application module, as Angular CLI does not do that by default.

Now, edit the "AppConfig" interface and add the "title" property we have declared in the server-side config earlier in this chapter:

src/app/app-config.ts

```
export interface AppConfig {

  title?: string;

}
```

Next, let’s wire our “AppConfigService” with the “Http” service to be able making HTTP calls and fetching remote files:

src/app/app-config.service.ts

```
import { Injectable } from '@angular/core';
import { HttpClient } from '@angular/common/http';

@Injectable({
  providedIn: 'root'
})
export class AppConfigService {

  constructor(private http: HttpClient) {}

}
```

We are now ready to load the configuration from the server.

Loading server-side configuration file

Let’s introduce the “load” method that fetches the “app.config.json” file and exposes its content as a “data” property.

For the convenience purposes, the method is going to return a Promise instance that resolves to the loaded configuration file or falls back to the default values upon loading errors. We also provide support for the optional default values that you can pass as part of the “load” call.

Below you can see the full code for the service implementation:

src/app/app-config.service.ts

```
import { Injectable } from '@angular/core';
import { HttpClient } from '@angular/common/http';
import { AppConfig } from './app-config';

@Injectable({
  providedIn: 'root'
})
export class AppConfigService {

  data: AppConfig = {};

  constructor(private http: HttpClient) {}

  load(defaults?: AppConfig): Promise<AppConfig> {
    return new Promise<AppConfig>(resolve => {
      this.http.get('app.config.json').subscribe(
        response => {
          console.log('using server-side configuration');
          this.data = Object.assign({}, defaults || {}, response || {});
          resolve(this.data);
        },
        () => {
          console.log('using default configuration');
          this.data = Object.assign({}, defaults || {});
          resolve(this.data);
        }
      );
    });
  }

}
```

As you can see from the code above, we also add a basic debugging output to the browser console log. It should help us to see whether the application is using an external configuration file or fallback values. Logging to console is a fully optional step, and you may want to remove that code at the later stages.

Registering configuration service

Next, we need registering our configuration service with the main application module. However, given that many other services and components may depend on the external settings, we should ensure the application configuration service gets the "app.config.json" file loaded and applied before others.

The Angular framework provides a special injection token called "APP_INITIALIZER" that you should use to execute your code during the application startup. That also helps to register providers and to use provider factories.

For the sake of simplicity the example below shows only the newly added content:

src/app/app.module.ts

```
import { ..., APP_INITIALIZER } from '@angular/core';
import { HttpClientModule } from '@angular/common/http';

export function setupAppConfigServiceFactory(
  service: AppConfigService
): Function {
  return () => service.load();
}

@NgModule({
  imports: [
    ...,
    HttpClientModule
  ],
  providers: [
    {
        provide: APP_INITIALIZER,
        useFactory: setupAppConfigServiceFactory,
        deps: [
            AppConfigService
        ],
        multi: true
    }
  ]
})
export class AppModule { }
```

So how the code above works and how do we load an external configuration at the application startup?

First of all, we declare the "AppConfigService" in the "providers" section of the module. Then we use the "APP_INITIALIZER" injection token to declare a custom provider based on the "setupAppConfigServiceFactory" factory; the provider also references the "AppConfigService" as a dependency to inject when the factory gets invoked.

At the runtime, the Angular resolves and creates an instance of the “AppConfigService”, and then uses it when calling the “setupAppConfigServiceFactory”. The factory itself calls the “load” method to fetch the “app.config.json” file.

If you run the web application right now the browser console output should be as following:

```
using server-side configuration
```

The settings service is up and running correctly, and we are now able to use configuration settings in the components.

Using configuration settings

It is now time to see the application configuration service in action. Let’s use the “title” value to update the similar property in the main application component.

We get the following controller class generated by the Angular CLI:

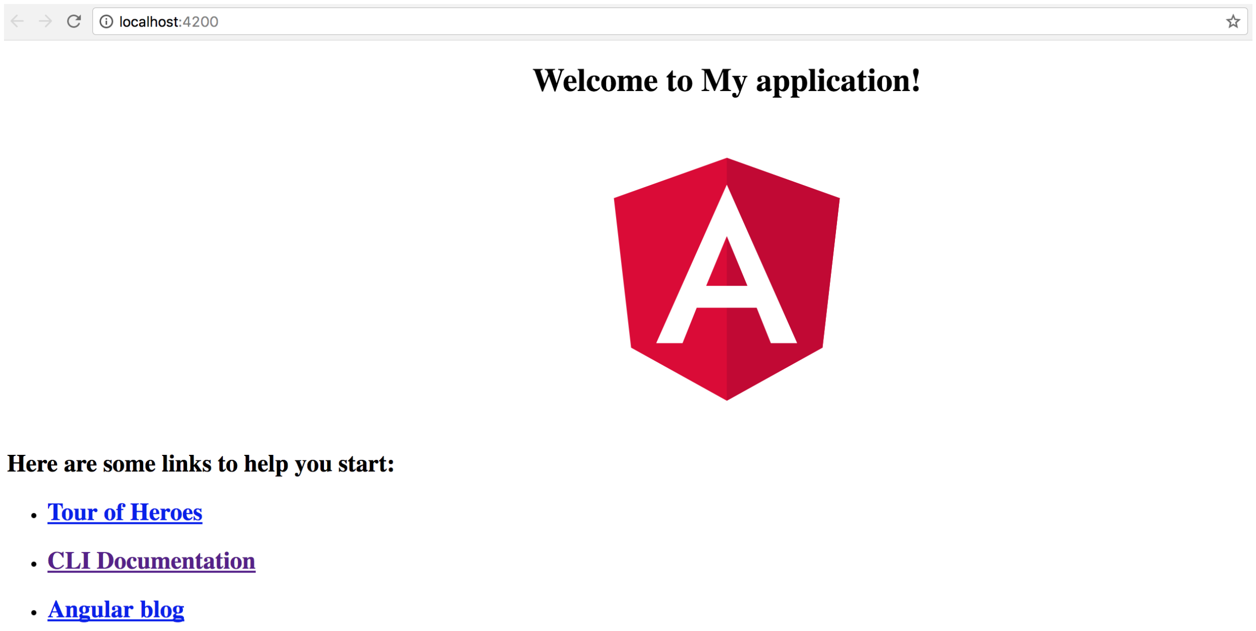
src/app/app.component.ts

```
import { Component } from '@angular/core';

@Component({
  selector: 'app-root',
  templateUrl: './app.component.html',
  styleUrls: ['./app.component.css']
})
export class AppComponent {
  title = 'app';
}
```

All we need at this point is to inject the “AppConfigService” as an “appConfig” parameter and assign the title property to the “appConfig.data.title” value. Don’t forget that at this point the JSON file is already loaded and configuration properties are ready for use.

```
import { AppConfigService } from './app-config.service';

@Component({...})
export class AppComponent {
  title = 'app';

  constructor(appConfig: AppConfigService) {
    this.title = appConfig.data.title;
  }
}
```

If you run the web application now, the main page should contain the title value fetched from the external file. Try editing the "title" value in the "app.config.json" and you should see the Angular CLI automatically reload the page. The page automatically reflects new values.



Welcome to My application!

Here are some links to help you start:

- Tour of Heroes
- CLI Documentation
- Angular blog

We just got a working example of the configuration service. We have also checked the external settings being successfully fetched and applied to component properties. The examples in the chapter should help you building configuration support for your applications.

Source code

You can find the source code as an Angular CLI project in the "angular/app-settings[67]" folder.

[67]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/app-settings

Internationalisation (i18n)

In this chapter, we are going to build a simple multi-language support for an application. We are about to create services to translate application strings, switch languages based on user interactions, and also using third-party libraries for more sophisticated translation scenarios.

For a basic multi-language support we need at least three blocks:

- language files, preferably in the JSON format
- Angular service to load one or multiple language files
- Angular pipe for a convenient mapping of resource keys to translated values

We start with generating a new Angular application called "app-i18n":

```
ng new app-i18n
cd app-i18n
```

Let's also use Angular CLI to generate our translation layer blocks, the TranslateService and the TranslatePipe:

```
ng g service translate
ng g pipe translate
```

We also need at least a single language file to demonstrate the translation process in action, and optionally use as a default or fallback locale. Create a new "i18n" folder in the "src/assets" one, and put an "en.json" file there with the following content:

src/assets/i18n/en.json

```
{
  "TITLE": "My i18n Application (en)"
}
```

Creating Translate Service

As a second step, we need to make our TranslateService load the language file.

As a second step, we need to make our TranslateService load the language file. We are going to implement a "use" method that performs the loading process over the HTTP. It takes the "lang" parameter holding the name of the locale and falls back to the "en" value.

src/app/translate.service.ts

```
import { Injectable } from '@angular/core';
import { HttpClient } from '@angular/common/http';

@Injectable({
  providedIn: 'root'
})
export class TranslateService {

  data: any = {};

  constructor(private http: HttpClient) {}

  use(lang: string): Promise<{}> {
    return new Promise<{}>(resolve => {
      const langPath = `assets/i18n/${lang || 'en'}`;

      this.http.get(langPath).subscribe(
        response => {
          this.data = response || {};
          resolve(this.data);
        },
        err => {
          this.data = {};
          resolve(this.data);
        }
      );
    });
  }
}
```

Loading server-side files

The process of loading of the translation file is very similar to that of the global configuration files we have used earlier in this book. Please refer to the Global Application Configuration chapter for more details and examples.

Next, let's register our service provider and a custom factory that triggers the TranslateService to load default or predefined locale file before all other services and components get created. That helps us ensure that all other elements of the application get access to translation feature at startup.

src/app/app.module.ts

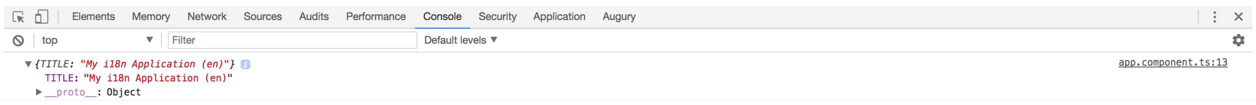
```
export function setupTranslateServiceFactory(
    service: TranslateService): Function {
  return () => service.use('en');
}

@NgModule({
  providers: [
    TranslateService,
    {
      provide: APP_INITIALIZER,
      useFactory: setupTranslateServiceFactory,
      deps: [
        TranslateService
      ],
      multi: true
    }
  ]
})
export class AppModule { }
```

Now we can have a quick test to ensure the file got loaded and translation service has the data preserved. Inject the service into the main application component and dump the entire data set to the browser console output.

src/app/app.component.ts

```
import { TranslateService } from './translate.service';

@Component({...})
export class AppComponent {
  title = 'app';

  constructor(translateService: TranslateService) {
    console.log(translateService.data);
  }
}
```

Once you run the web application and head to the browser console, you should see the following output:



```
▼{TITLE: "My i18n Application (en)"}                app.component.ts:13
   TITLE: "My i18n Application (en)"
 ▶__proto__: Object
```

We got the translation service working as expected; now we can proceed to create the corresponding pipe.

Creating Translate Pipe

The pipe we have generated at the beginning of this chapter needs to inject the translation service instance in the constructor like in the code below:

src/app/translate.pipe.ts

```
import { Pipe, PipeTransform } from '@angular/core';
import { TranslateService } from './translate.service';

@Pipe({
  name: 'translate'
})
export class TranslatePipe implements PipeTransform {

  constructor(private translate: TranslateService) {}

  transform(value: any, args?: any): any {
    return null;
  }

}
```

Now the pipe needs to map the key to the underlying resource string. Let's get also provide a fallback behaviour and return the resource key if the corresponding translation is missing. That should help you to identify the problems with translation earlier.

src/app/translate.pipe.ts

```
@Pipe({...})
export class TranslatePipe implements PipeTransform {
  ...

  transform(key: any): any {
    return this.translate.data[key] || key;
  }

}
```

Don't forget that your newly created pipe needs to be present in the main application module. The Angular CLI tool automatically registers it, if you have added the pipe manually then see the following code for example:

src/app/app.module.ts

```
import { TranslatePipe } from './translate.pipe';

@NgModule({
  declarations: [
    ...,
    TranslatePipe
  ],
  ...
})
export class AppModule { }
```

Using Translate Pipe

It is time to see our translation pipe in action. Let's update the main application controller class and set the "title" property value to the "TITLE" resource key like below:

src/app/app.component.ts

```
@Component({...})
export class AppComponent {

  title = 'TITLE';

  ...
}
```

If you open the "app.component.html" template file, you should see the "title" property referenced in the welcome message:

src/app/app.component.html

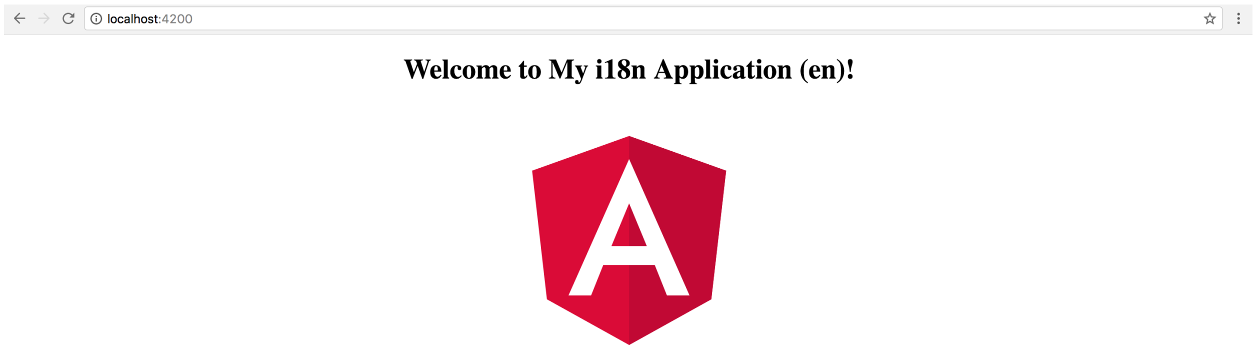
```
<h1>
    Welcome to {{ title }}!
</h1>
```

We can just append the pipe to the "title" value to enable automatic translation of the value based on the resource strings in the translation file.

src/app/app.component.html

```
<h1>
    Welcome to {{ title | translate }}!
</h1>
```

Once you compile and run the web application, you should see the welcome message getting the text directly from the language file.



Welcome to My i18n Application (en)!

Switching languages

We have the default locale working so far, but switching languages at runtime require some extra configuration steps.

First, let's create an additional file "ua.json" in the "assets/i18n" folder. For testing purposes, you can just copy the contents of the "en.json" file and slightly modify the strings to be able to see the difference at runtime.

src/assets/i18n/ua.json

```json
{
  "TITLE": "My i18n Application (ua)"
}
```

The main application controller class needs a new "setLang" method so that we can switch to a different language with, for instance, a button click. With our current TranslateService implementation we need just the name of the locale:

src/app/app.component.ts

```ts
@Component({...})
export class AppComponent {
  title = 'TITLE';

  constructor(private translateService: TranslateService) {
    console.log(translateService.data);
  }

  setLang(lang: string) {
    this.translateService.use(lang);
  }
}
```

Get back to the application component template and add a couple of buttons to switch between the languages like in the example below:

src/app/app.component.html

```
<div>
  <button (click)="setLang('ua')">Language: UA</button>
  <button (click)="setLang('en')">Language: EN</button>
</div>
```

If you try running the application right now, you should notice that buttons do not work. If you run the Dev Tools and inspect the Network tab, you are going to see that a corresponding language file is, in fact, fetched every time you click the buttons. You do not see the changes on the page because of how the pipes in Angular work by default. For the performance reasons, they cache the result once the value is transformed and always use evaluated values in subsequent calls.

In our particular case, we need the pipe to refresh, so the caching needs to be switched off. You can achieve that by setting the "pure" attribute of the `@Pipe` decorator metadata to "false".

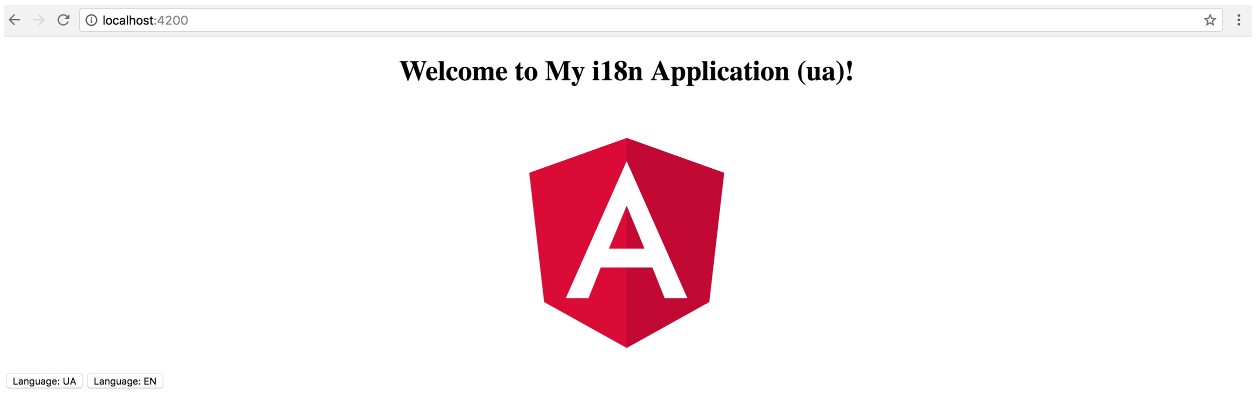
src/app/translate.pipe.ts

```
@Pipe({
  name: 'translate',
  pure: false
})
export class TranslatePipe implements PipeTransform {

 ...

}
```

Pure and impure pipes

You can get more details in the "Pipes" chapter, specifically in the "Pure And Impure Pipes" section.

Try rerunning your web application, and clicking the buttons to switch between languages. You should see the label text getting updated each time the button gets clicked.



Welcome to My i18n Application (ua)!

Summary

You just have got a basic lightweight multi-language functionality that you can use in your web application. Note, however, that translation layer may require many code enhancements and performance optimisations, for you to be ready to use it for production purposes.

Source code

You can find the source code as an Angular CLI project in the "angular/i18n[68]" folder.

You can also check out one of my Angular projects "@ngstack/translate[69]" that provides i18n-features for Angular applications and components. That library can save a lot of your time and effort required to build a multi-lingual web application.

[68]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/app-i18n
[69]https://www.npmjs.com/package/@ngstack/translate

Advanced Angular

This chapter assumes you are already familiar with the Angular development and want to advance your experience further to specific areas. We are going to review various practical scenarios and challenges that you can come across, and provide example solutions.

Dynamic Content in Angular

In this section, we are going to see in practice different ways of dynamically creating and modifying content in Angular at runtime. You are about to get examples of custom entry templates in a List component, see how Component and Module compilation works.

List item templates

In this part, we are going to see how you can enrich Angular components with custom templating support. We start by building a simple List component that supports external entry templates that a developer defines as part of the application.

List component

First, let's create a simple component to render an unordered list of bound items, and call it "TemplatedListComponent".

With the Angular CLI the command should look like the following:

```
ng g component templated-list
```

The Angular CLI generates all required scaffold for your component and updates main application module, so you are strongly recommended using it to save your time.

As you can remember from the Angular CLI chapter, all generated artefacts should have prefixes to avoid conflicts with standard HTML elements or third party components. In our case, the Angular CLI tool automatically prepends the default "app-" prefix to the component selector value:

src/app/templated-list/templated-list.component.ts

```
@Component({
  selector: 'app-templated-list',
  templateUrl: './templated-list.component.html',
  styleUrls: ['./templated-list.component.css']
})
export class TemplatedListComponent { ... }
```

For now, the only property that our newly created list needs is an array of items to display. Every item must have at least a “title” property, so we use a generic Array type with the corresponding constraints.

src/app/templated-list/templated-list.component.ts

```
@Component({...})
export class TemplatedListComponent {

  @Input()
  items: Array<{title: string}> = [];

}
```

Note that array is empty by default. By our design, the items are not hard coded into the component and should be coming from the application instead.

For the template part, a simple unordered list with “ngFor” directive should be more than enough to demonstrate the content:

src/app/templated-list/templated-list.component.html

```
<ul>
  <li *ngFor="let item of items">
    {{ item.title }}
  </li>
</ul>
```

Next, let’s provide our List with some data and see it working. Edit your main application component class and add the “listItems” property with some basic entries:

src/app/app.component.ts

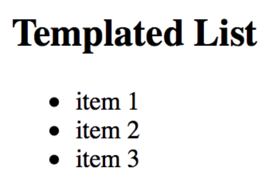
```
@Component({...})
export class AppComponent {
    ...

    listItems: Array<{title: string}> = [
        { title: 'item 1' },
        { title: 'item 2' },
        { title: 'item 3' }
    ]
}
```

Don't forget to modify the HTML template of the component and declare the `<app-templated-list>` component with the corresponding bindings:

src/app/app.component.html

```
<h2>Templated List</h2>
<app-templated-list [items]="listItems">
</app-templated-list>
```

If you run your web application right now you should see the HTML unordered list element with three entries like on the picture below:


Templated List

- item 1
- item 2
- item 3

Row templates

So we got a simple list component that binds to an array of objects and renders standard unordered HTML element where every entry binds its content to the "title" property of the underlying object.

Now let's update the code to provide support for external templates.

First, you need a property to hold custom template reference. That requires importing a `@ContentChild` decorator and `TemplateRef` type.

src/app/templated-list/templated-list.component.ts

```
import { ..., ContentChild, TemplateRef } from '@angular/core';

@Component({...})
export class TemplatedListComponent {

    @ContentChild(TemplateRef)
    template: TemplateRef<any>;

    @Input()
    items: Array<{title: string}> = [];

}
```

The @ContentChild decorator helps you to bind the property value to the first child element of the specific type in out List component at run time. In our particular case, we are instructing decorator to look for the first `<ng-template>` instance exposed via TemplateRef reference.

For example:

```
<app-templated-list>
    <ng-template>
        ...
    </ng-template>
</app-templated-list>
```

For the next step, let's update our List component template to use provided template property value for each entry.

src/app/templated-list/templated-list.component.html

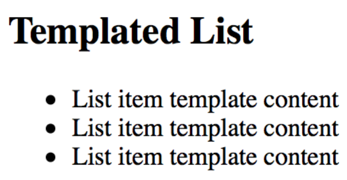
```
<ul>
    <ng-template ngFor [ngForOf]="items" [ngForTemplate]="template">
    </ng-template>
</ul>
```

Now the "TemplatedListComponent" expects a "template" instance as its child element in the form of `<ng-template>`. It then takes the content of the template and applies to each "*ngFor" entry. So application developers can define entire row template like the following:

src/app/app.component.html

```
<h2>Templated List</h2>
<app-templated-list [items]="listItems">
    <ng-template>
        <li>
            List item template content
        </li>
    </ng-template>
</app-templated-list>
```

If you now run your web app you should see the following output:



Templated List

- List item template content
- List item template content
- List item template content

As you can see on the picture above the template works as expected. We define a static content and see it rendered three times. Now to see the data change across the list entries update component template like in the next example:

```
<h2>Templated List</h2>
<app-templated-list [items]="listItems">
    <ng-template let-item="$implicit" let-i="index">
        <li>[{{i}}] Hello: {{item.title}}</li>
    </ng-template>
</app-templated-list>
```

Upon building the elements, the "ngFor" directive takes each object in the collection and uses it as a data context for every corresponding list item and its custom template. To get direct access to this object we are using the `let-item="$implicit"` attribute. That reads as "bind the object to the template variable called 'item'".

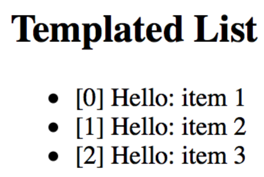
You can omit the "$implicit" value and use just the "let-item" attribute if you like. You can also give the template variable any name; it can be "let-data", "let-context" or any name of your choice.

The "ngFor" directive provides us with the numeric index for each item in the collection. We bind it inside the template to the "i" variable using the `let-i="index"` syntax.

So to demonstrate both data context bindings, we used the following list item template:

```html
<ng-template let-item="$implicit" let-i="index">
    <li>[{{i}}] Hello: {{item.title}}</li>
</ng-template>
```

Once your web application runs you should see the following result:



Templated List

- [0] Hello: item 1
- [1] Hello: item 2
- [2] Hello: item 3

We are now able to see index value, static "Hello" text and "title" property of the underlying object.

Typical use cases

You are going to use the above approach when building list-like or grid-like components that hide all complexity from the developers but at the same time allow customising entries or rows using templates.

Source code

You can find the source code in the "angular/components/dynamic-content[70]" folder.

Dynamic Components

Another interesting scenario involves changing the content of the component based on some condition evaluation result. For example, rendering different child component depending on the value of the "type" property:

```html
<component type="my-type-1"></component>
<component type="my-type-2"></component>
```

Let's start with a component scaffold generated by the Angular CLI using the following command:

```
ng g component dynamic-content
```

For the first step, update the HTML template of the newly generated component with the following one:

[70] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/dynamic-content

src/app/dynamic-content/dynamic-content.component.html

```html
<div>
    <div #container></div>
</div>
```

Note how we declare a separate `<div>` element with the "#container" id. We are going to use it as the injection point. All dynamic content should get inserted in the DOM below this element. The component maps it to the "container" property of the "ViewContainerRef" type to allow you access container element from the code.

```typescript
import { ..., Input, ViewChild, ViewContainerRef } from '@angular/core';

@Component({...})
export class DynamicContentComponent {

  @ViewChild('container', { read: ViewContainerRef })
  container: ViewContainerRef;

  @Input()
  type: string;

}
```

Later on, you should be able to use this component similar to the following example:

```html
<dynamic-content type="some-value"></dynamic-type>
```

Now let's introduce two more components to display depending on the "type" property value. We also are going to need an additional "fallback" component to use for all the "unknown" types.

For the sake of simplicity, you can append new components to the same "dynamic-content" component file.

src/app/dynamic-content/dynamic-content.component.ts

```
@Component({
    selector: 'app-dynamic-sample-1',
    template: `<div>Dynamic sample 1</div>`
})
export class DynamicSample1Component {}

@Component({
    selector: 'app-dynamic-sample-2',
    template: `<div>Dynamic sample 2</div>`
})
export class DynamicSample2Component {}

@Component({
    selector: 'app-unknown-component',
    template: `<div>Unknown component</div>`
})
export class UnknownDynamicComponent {}
```

Developers are going to use the “type” property that has the type of “string” and gets used as an alias for real component types. You are going to need some mapping of string values to types, either in the form of separate injectable service (recommended approach) or just a part of the component implementation like in the example below:

```
@Component({...})
export class DynamicContentComponent {
    ...

    private mappings = {
        'sample1': DynamicSample1Component,
        'sample2': DynamicSample2Component
    };

    getComponentType(typeName: string) {
        const type = this.mappings[typeName];
        return type || UnknownDynamicComponent;
    }

}
```

As you can see from the code above, for “sample1” and “sample2” values the newly introduced components “DynamicSample1Component” and “DynamicSample2Component” are returned. For all other cases, we are going to take the “UnknownDynamicComponent” component.

Finally, we are ready to create components dynamically. Below is the simplified version of component class implementation that shows the main blocks of interest:

```
import {
    ...,
    OnInit, OnDestroy,
    ComponentRef, ComponentFactoryResolver
} from '@angular/core';

@Component({...})
export class DynamicContentComponent implements OnInit, OnDestroy {
    ...

    private componentRef: ComponentRef<{}>;

    constructor(private resolver: ComponentFactoryResolver) { }

    ngOnInit() {
        if (this.type) {
            const componentType = this.getComponentType(this.type);
            const factory = this.resolver.resolveComponentFactory(componentType);
            this.componentRef = this.container.createComponent(factory);
        }
    }

    ngOnDestroy() {
        if (this.componentRef) {
            this.componentRef.destroy();
            this.componentRef = null;
        }
    }

}
```

We inject the "ComponentFactoryResolver" into the component at runtime and use it to build the dynamic content upon initialization, and tear down when our parent component gets destroyed.

The process of content creation is quite straightforward. First, we resolve the component type by the string value. Second, we resolve a component factory for the given component type. Finally, we use that factory to build a component. Newly created content gets automatically appended to the DOM after the "#container" element.

Please note that you must register every component you create dynamically within the "entryComponents" section of your module. That instructs the Angular framework to maintain corresponding factories at runtime.

src/app.module.ts

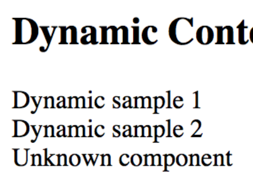
```
@NgModule({
  imports: [ ... ],
  declarations: [ ... ],
  entryComponents: [
    DynamicSample1Component,
    DynamicSample2Component,
    UnknownDynamicComponent
  ],
  bootstrap: [AppComponent]
})
export class AppModule { }
```

You can now test all three cases with the following layout:

src/app/app.component.html

```
<h2>Dynamic Content</h2>
<app-dynamic-content type="sample1"></app-dynamic-content>
<app-dynamic-content type="sample2"></app-dynamic-content>
<app-dynamic-content type="some-other-type"></app-dynamic-content>
```

The main application page should look like the following:



```
Dynamic Content

Dynamic sample 1
Dynamic sample 2
Unknown component
```

Runtime context

The easiest way to maintain different types of dynamic components in the code is to build a common interface or an abstract class with a shared API. For example:

```
abstract class DynamicComponent {
   context: any;
}
```

Note that for the sake of simplicity we are declaring “context” property of “any” type. In real-life scenarios, however, you may want to use some particular type to benefit from the static checks the Typescript compiler provides.

Now you can update all previously created components to expose the “DynamicComponent” class and take “context” into account.

```
@Component({
    selector: 'app-dynamic-sample-1',
    template: `<div>Dynamic sample 1 ({{context?.text}})</div>`
})
export class DynamicSample1Component extends DynamicComponent {}

@Component({
    selector: 'app-dynamic-sample-2',
    template: `<div>Dynamic sample 2 ({{context?.text}})</div>`
})
export class DynamicSample2Component extends DynamicComponent {}

@Component({
    selector: 'app-unknown-component',
    template: `<div>Unknown component ({{context?.text}})</div>`
})
export class UnknownDynamicComponent extends DynamicComponent {}
```

Next, the “DynamicContentComponent” needs updates to receive the value of the “context” from the outside using bindings, and pass it to the underlying child component.

```
export class DynamicContentComponent implements OnInit, OnDestroy {
    ...

    @Input()
    context: any;

    ngOnInit() {
        if (this.type) {
            ...
            let instance = <DynamicComponent> this.componentRef.instance;
            instance.context = this.context;
        }
    }
}
```

That is it, and we are ready to test the whole flow. Add a simple object to the main application component class to use as a "context" value for the dynamic elements:

src/app.component.ts

```
export class AppComponent {

    context: { text: string } = {
        text: 'test'
    }
}
```

Now bind this context to all three components we declared earlier in the template:

src/app.component.html

```
<h3>Context: <input type="text" [(ngModel)]="context.text"></h3>
<app-dynamic-content type="sample1" [context]="context"></app-dynamic-content>
<app-dynamic-content type="sample2" [context]="context"></app-dynamic-content>
<app-dynamic-content type="some-other-type" [context]="context"></app-dynamic-conten\
t>
```

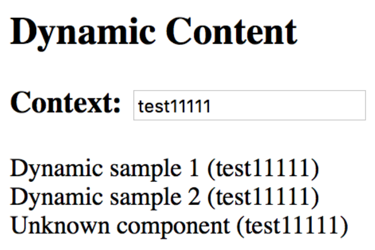
To demonstrate "live updates" feature, we add an input element to the page. The element is using "two-way" binding to the "context.text" property. According to our setup, all dynamically created components should automatically reflect the new value as we type.

Note that to use "ngModel" directive you need to import and reference the "FormModule" within your main application module like in the example below:

src/app/app.module.ts

```
...
import { FormsModule } from '@angular/forms';

@NgModule({
  ...
  imports: [
    BrowserModule,
    FormsModule
  ],
  ...
})
export class AppModule { }
```

The setup is ready, and you can run your web application to see it in action. By default, it should be displaying the “test” value within each dynamically created component. Try typing some text in the “context” input to see all of those components’ titles change on the fly.



Dynamic Content

Context: test11111

Dynamic sample 1 (test11111)
Dynamic sample 2 (test11111)
Unknown component (test11111)

Typical use cases

Dynamic forms and form persistence is the best example of where you might need the features we tried above. If you need displaying a form or a complex component based on some definition file (JSON, XML, or other), you may end up creating a dynamic component that builds final content based on the schema and/or persisted state, and a form component built from multiple dynamic content containers.

Source code

You can find the source code in the “angular/components/dynamic-content[71]” folder.

Runtime Compilation

For some advanced scenarios, you might want to take full control over Angular component and template compilation.

In this part, we are going to implement the following features:

- allow a user to define the component template
- compile a “Component” on the fly with user defined template and the underlying class
- compile a “NgModule” on the fly with the component created in the previous step
- display newly created component on the page

Let’s start by generating a separate scaffold for the component utilising the Angular CLI tools:

```
ng g component runtime-content
```

You can take initial implementation from the “DynamicContentComponent” we created in previous chapters.

The component template needs a predefined injection point:

[71] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/dynamic-content

src/app/runtime-content/runtime-content.component.html

```
<div>
    <div #container></div>
</div>
```

Also, we map "#container" element to the underlying "container" property of the component class.

src/app/runtime-content/runtime-content.component.ts

```
import { ..., ViewChild, ViewContainerRef } from '@angular/core';

@Component({...})
export class RuntimeContentComponent {

    @ViewChild('container', { read: ViewContainerRef })
    container: ViewContainerRef;

}
```

The main idea behind the new component we introduce is to allow a user to define HTML template on the fly. So let's add a basic UI for editing:

src/app/runtime-content/runtime-content.component.html

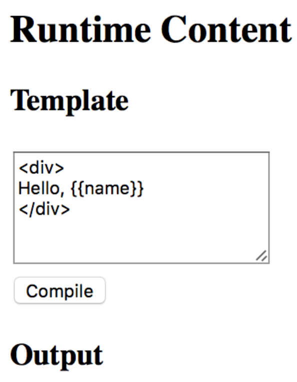
```
<div>
  <h3>Template</h3>
  <div>
    <textarea rows="5" [(ngModel)]="template"></textarea>
  </div>
  <button (click)="compileTemplate()">Compile</button>

  <h3>Output</h3>
  <div #container></div>
</div>
```

Note that to use "ngModel" directive you must import a "FormsModule" into your main application module. You should have it already configured from the previous part of the chapter where we created the DynamicContent component.

Set the default template value to something the user can compile without typing beforehand. That should help us testing the flow as well:

```
@Component({...})
export class RuntimeContentComponent {
    ...

    template = '<div>\nHello, {{name}}\n</div>';

}
```

When the main page gets rendered it should look similar to the following:


Runtime Content

Template

```
<div>
Hello, {{name}}
</div>
```

Output

Now the most important part of the component implementation, the runtime compilation:

src/app/runtime-content/runtime-content.component.ts

```
import {
    ...,
    Compiler, ComponentFactory,
    NgModule, ModuleWithComponentFactories
} from '@angular/core';
import { CommonModule } from '@angular/common';

@Component({...})
export class RuntimeContentComponent {
    ...

    private createComponentFactorySync(
            compiler: Compiler,
            metadata: Component,
            componentClass: any): ComponentFactory<any> {

        const cmpClass = componentClass || class RuntimeComponent {
            name = 'Denys'
        };
        const decoratedCmp = Component(metadata)(cmpClass);

        @NgModule({
            imports: [CommonModule],
            declarations: [decoratedCmp] }
        )
        class RuntimeComponentModule { }

        const module: ModuleWithComponentFactories<any> =
          compiler.compileModuleAndAllComponentsSync(RuntimeComponentModule);

        return module.componentFactories.find(
            f => f.componentType === decoratedCmp
        );
    }

}
```

The code above takes custom metadata and optionally a component class reference via "componentClass" parameter. If you do not provide the class as part of the "createComponentFactorySync" call, the fallback "RuntimeComponent" one gets used instead. The fallback class also has a "name" property predefined. That is what we are going to use for testing.

```
const cmpClass = componentClass || class RuntimeComponent {
    name = 'Denys'
};
```

The resulting component also gets decorated with the metadata we provide:

```
const decoratedCmp = Component(metadata)(cmpClass);
```

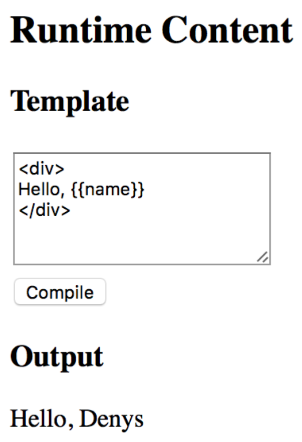
Next, a component gets created with the predefined "CommonModule" import. You may extend the list if you want to support more functionality. We also put our component as part of the module's "declarations" section as per Angular requirements.

Finally, the function uses Angular "Compiler" service to compile the module and all included components. Compiled module provides access to the underlying component factories, and this is exactly the feature we need.

For the last step, we need to wire the "Compile" button with the following method:

```
@Component({...})
export class RuntimeContentComponent {
    ...

    compileTemplate() {

        let metadata = {
            selector: `runtime-component-sample`,
            template: this.template
        };

        let factory = this.createComponentFactorySync(
            this.compiler,
            metadata,
            null
        );

        if (this.componentRef) {
            this.componentRef.destroy();
            this.componentRef = null;
        }
        this.componentRef = this.container.createComponent(factory);
    }
}
```

Every time the user clicks the “Compile” button our “RuntimeContentComponent” component takes the template value, compiles it to a new component backed by the RuntimeComponent class (with the predefined “name” property), and renders:


Runtime Content

Template

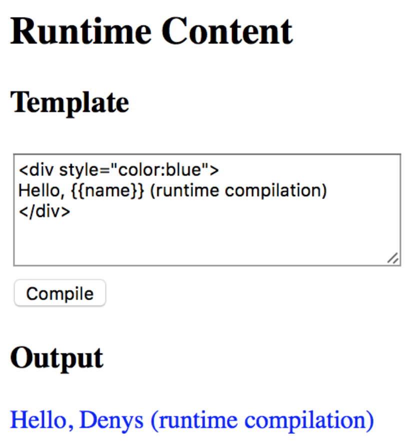
```
<div>
Hello, {{name}}
</div>
```

Output

Hello, Denys

To fully test the flow in action now change the default HTML template value and provide some custom content, for example changing the colour style of the root “div” element to “blue”. Modify the text content as well.

Click “Compile” button once again, and you should see the following result now:



Runtime Content

Template

```
<div style="color:blue">
Hello, {{name}} (runtime compilation)
</div>
```

Output

Hello, Denys (runtime compilation)

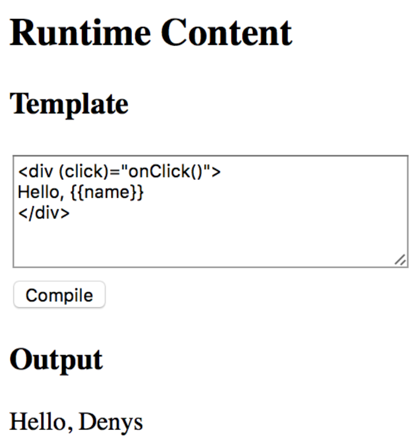
Binding events

Your component users are not limited to user property bindings. The template supports event binding as well. All event handlers have to be defined in the underlying class or be present in the “RuntimeComponent” class we use as a fallback value.

To see events in action let’s modify the fallback class and add the “onClick” method like in the following example:

```
@Component({...})
export class RuntimeContentComponent {
    ...

    private createComponentFactorySync(...): ComponentFactory<any> {

        const cmpClass = componentClass || class RuntimeComponent {
            name = 'Denys';

            onClick() {
                alert('Clicked');
            }
        };

        ...
    }
}
```

Now you can wire the click events in the template with the “onClick” method like in the next picture:



Runtime Content

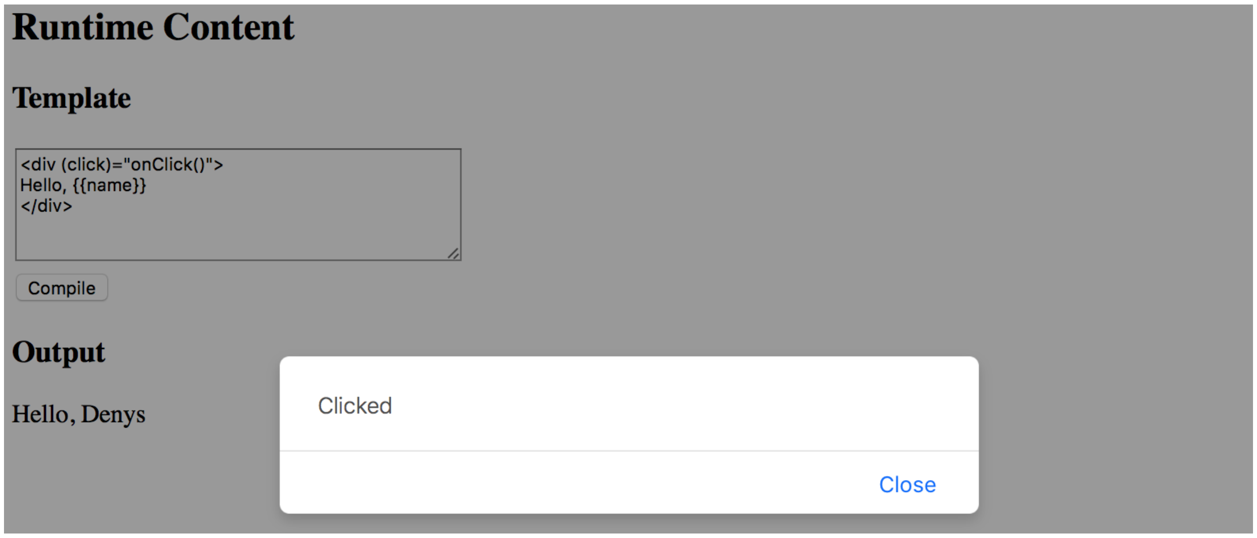
Template

```
<div (click)="onClick()">
Hello, {{name}}
</div>
```

Output

Hello, Denys

If you press the “Compile” button once again and then click the “div” element you should see the browser alert dialogue:



Runtime Content

Template

```
<div (click)="onClick()">
Hello, {{name}}
</div>
```

Output

Hello, Denys

Clicked

Typical use cases

The best scenario for this feature is when you want to store component templates somewhere in the external storage, and then build components on the fly, similar to how it gets performed in various RAD environments, online layout builders, and other design tools.

Source code

You can find the source code in the “angular/components/dynamic-content[72]” folder.

[72]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/components/dynamic-content

Plugins

Plugins are used to allow third-party developers extend your application by utilising the redistributable extensions that provide new features for the application without recompiling its code.

In this section, we are going to use multiple ways to extend your application, starting from the string-based configurations to build and compose components at runtime, and finishing with the complete drop-in plugins you can put into the folder to add new features to the running application.

Preparing new project

Use the following Angular CLI command to generate a project with initial Routing support.

```
ng new plugins --routing
```

It is essential to have Routing enabled as later in this section we are also going to see how to create new routes dynamically at runtime, and how a plugin can contribute new application routes with external content presented to a user.

Edit the main application component template and replace the HTML markup that Angular CLI generates by default with the following one:

src/app/app.component.html

```html
<h1>Plugins</h1>

<router-outlet></router-outlet>
```

That is pretty much all to get started with extensibility. You can test the project by running “ng start –open” command, to see that everything compiles and runs fine. After that, proceed to the next section below.

Source code

You can find the source code in the “angular/plugins[73]” folder.

Building components based on string names

The first thing we are going to start with is related to creating components based on their string names, either types or aliases.

[73]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/plugins

This feature allows to you have configurable configuration files or custom layout definitions that instruct your application what components to use for the particular scenarios.

A good example is a dynamic sidebar that can contain various components or mini-widgets based on the configuration file. Users or developers can change the settings to display only individual components, like a “weather widget” or “notification panel”, can provide a different order of rendering, and many other options.

The example above is not a fully-fledged plugin approach, as our application still “knows” about all possible component types, and all components and templates get compiled and bundled as part of the application. However, we are taking that scenario as a simplified case to see how to use the Angular compiler at runtime. That should give us a base experience for more advanced scenarios that we are going to implement later in this chapter.

I strongly recommend creating a separate module that contains all the configurable components that you plan to create at runtime. That should significantly simplify future maintenance and discovery of such components, and you are going to see that shortly in practice.

Let’s use Angular CLI once again to generate a new flat module and call it “plugins”:

```
ng g module plugins --flat --module=app
```

Note the “–module=app” switch we are using in this case. It instructs Angular CLI to also include our newly generated module into the main application module. The “–flat” switch forces the CLI to generate module file in the application source folder, without creating a separate subfolder as it does for components, directives and other Angular entities.

The console output in your case should look similar to the next example:

```
create src/app/plugins.module.ts (191 bytes)
update src/app/app.module.ts (465 bytes)
```

While we are at the command line, let’s also create two components “page1” and “page2”. These are the components we would like to create dynamically. Moreover, you can save some time by using the “–module” switch to include both components into the “plugins” module like in the code below:

```
ng g component page1 --module=plugins
ng g component page2 --module=plugins
```

Now, feel free to inspect what you have as a result in the “plugins” module that should reside in the “src/app” folder and contain references to both “Page1Component” and “Page2Component” components. The Angular CLI also imports the most frequently used “CommonModule” module for you:

src/app/plugins.module.ts

```
import { NgModule } from '@angular/core';
import { CommonModule } from '@angular/common';
import { Page1Component } from './page1/page1.component';
import { Page2Component } from './page2/page2.component';

@NgModule({
  imports: [
    CommonModule
  ],
  declarations: [Page1Component, Page2Component]
})
export class PluginsModule { }
```

Both “page” component classes should be almost identical and look similar to the following:

src/app/page1/page1.component.ts

```
import { Component, OnInit } from '@angular/core';

@Component({
  selector: 'app-page1',
  templateUrl: './page1.component.html',
  styleUrls: ['./page1.component.css']
})
export class Page1Component implements OnInit {

  constructor() { }

  ngOnInit() {
  }

}
```

The Angular CLI provides dummy HTML templates in the form of “<component-name> works!” for every component it generates. That saves much time when you are preparing project structure or have a quick prototyping phase. As we focus on the architecture and dynamic compilation, it is not very important what templates component have. Let’s leave the default values for now, and you can revisit that later.

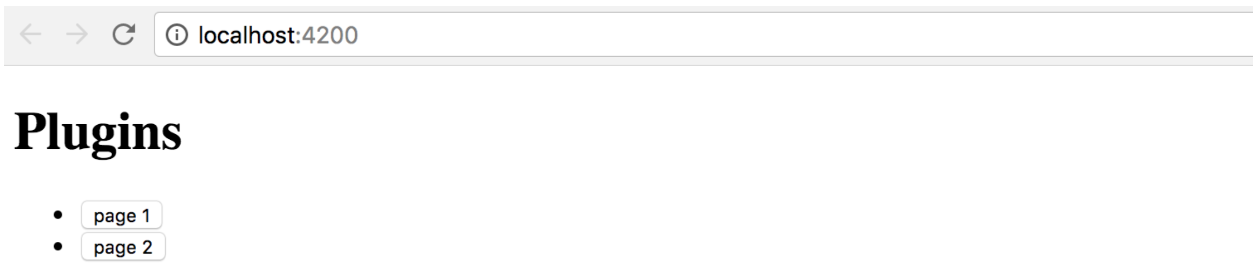
Next, we need to create a couple of buttons to trigger component creation, and a placeholder to insert the newly compiled content. Update the main application component template like in the example below.

src/app/app.component.html

```
<h1>Plugins</h1>

<ul>
  <li>
    <button (click)="createView('app-page1')">page 1</button>
  </li>
  <li>
    <button (click)="createView('app-page2')">page 2</button>
  </li>
</ul>

<div #content></div>

<router-outlet></router-outlet>
```

Pay attention to the empty "div" element: "<div #content></div>". That is the place we are going put our dynamic components. You can put this element to any other places, as long as it has the "content" Angular reference name, the component controller is going to find it.

Now, if you run the application, the main page should look like in the next picture:



List of plugins

We also need to finish the component controller preparation. The class should get the reference to the "content" placeholder and have the "createView" handler for the buttons:

src/app/app.component.ts

```
import { Component, Compiler, ViewChild, ViewContainerRef } from '@angular/core';
import { PluginsModule } from './plugins.module';

@Component({
  selector: 'app-root',
  templateUrl: './app.component.html',
  styleUrls: ['./app.component.css']
})
export class AppComponent {

  @ViewChild('content', { read: ViewContainerRef })
  content: ViewContainerRef;

  constructor(private compiler: Compiler) {
  }

  createView(name: string) {
  }
}
```

Note that we also import the "PluginsModule", as it contains all the components we would like to find and create according to our initial scenario.

We inject the instance of the "Compiler" class into the component constructor and use it to compile the "PluginsModule" on the fly. The private "module" variable is going to hold the resulting instance so that we do not compile the module more times than it is needed.

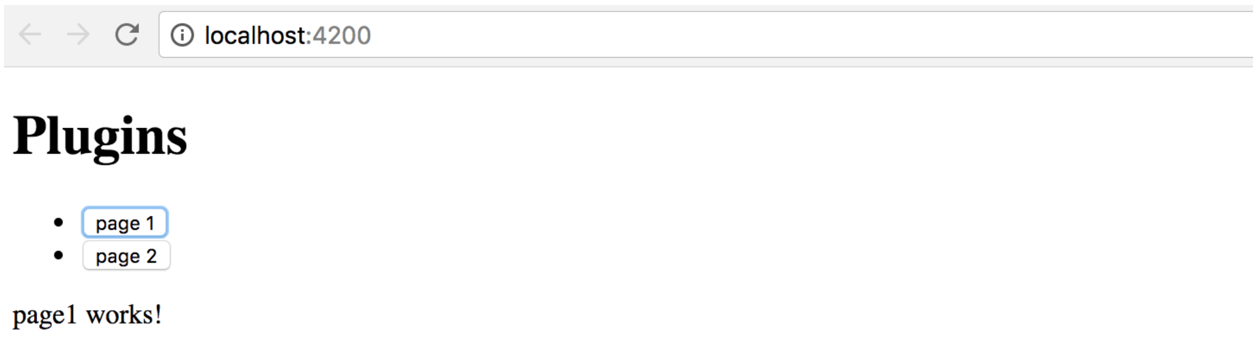
src/app/app.component.ts

```
import { Component, Compiler, ViewChild, ViewContainerRef } from '@angular/core';
import { PluginsModule } from './plugins.module';

@Component({...})
export class AppComponent {

  @ViewChild('content', { read: ViewContainerRef })
  content: ViewContainerRef;

  private module;

  constructor(private compiler: Compiler) {
    this.module = this.compiler.compileModuleAndAllComponentsSync(
      PluginsModule
    );
  }

  createView(name: string) {
    const factory = this.module.componentFactories.find(
      f => f.selector === name
    );

    this.content.clear();
    this.content.createComponent(factory);
  }
}
```

As you can see above, as long as we have the compiled module instance, we can perform searches to find a component factory based on specific metadata. In the particular case, we are interested in the selector names.

As soon as factory got found, we can clear the "content" placeholder, and create a new instance of the component in that place.

Run the application and click the first button "page 1" on the main page. You should see the "page1 works!" label immediately appear at the bottom of the page.



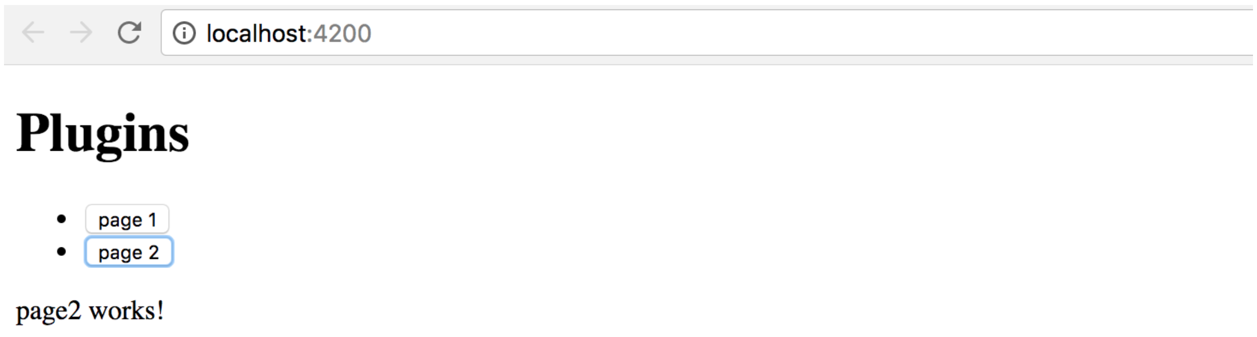
Plugins

- page 1
- page 2

page1 works!

Plugin 1

Now click the second button, and this time the placeholder content is replaced with the "page2 works!" text that comes with the "Page2Component" instance our application component creates on the fly.



Plugins

page2 works!

Plugin 2

Congratulations on having the first step complete. You are now able to take a string, map it to the component selector, and build the corresponding component at runtime.

Loading configuration from external sources

The whole idea of string to component type mapping usually arises when the exact values are coming from the external sources, like configuration files. Otherwise, you could just declare the needed component tags in the HTML template without any compilation.

As we have started this chapter with the example of the configurable Sidebar component, let's go ahead and introduce a barebone implementation that takes external "plugins.config.json" file as a configuration, and builds a set of components.

Below is our configuration file that is going to reside in the "src/assets" folder. Upon startup, the Angular server automatically exposes this folder to the application access and also copies its content to the output directory during production builds.

src/assets/plugins.config.json

```json
{
  "sidebar": {
    "components": [
      "app-page1",
      "app-page2"
    ]
  }
}
```

So we got the "sidebar" with two components "app-page1" and "app-page2" defined by default. Let's now generate the corresponding component by utilising the following command:

```
ng g component sidebar --module=app
```

As we now have more than one module, we need to tell Angular CLI where to put the resulting component. In our case, it is “app” that corresponds to the “app.module.ts” file.

In the main application template, append the “Configurable Sidebar” header element together with the newly introduced “app-sidebar” tag:

src/app/app.component.html

```
...

<h1>Configurable Sidebar</h1>
<app-sidebar></app-sidebar>
```

You also need to import the “HttpClientModule” to allow your application components and services make Http calls with the help of the HttpClient instance.

src/app/app.module.ts

```
...
import { HttpClientModule } from '@angular/common/http';

@NgModule({
  declarations: [
    ...,
    SidebarComponent
  ],
  imports: [
    ...,
    HttpClientModule
  ],
  entryComponents: [
    ...
  ],
  providers: [],
  bootstrap: [AppComponent]
})
export class AppModule { }
```

Next, edit the SidebarComponent template, and update the default auto-generated content with the following snippet:

src/app/sidebar/sidebar.component.html

```html
<p>
  Sidebar
</p>

<div #content></div>
```

Similar to previous examples, we have the placeholder “div” element that we reference as “content”, and we compile the “PluginsModule” module to get access to all its factories at the runtime:

src/app/sidebar/sidebar.component.ts

```typescript
import {
  ...,
  ViewChild, ViewContainerRef, AfterViewInit, Compiler
} from '@angular/core';
import { HttpClient } from '@angular/common/http';
import { PluginsModule } from '../plugins.module';

@Component({...})
export class SidebarComponent implements AfterViewInit {

  @ViewChild('content', { read: ViewContainerRef })
  content: ViewContainerRef;

  private module;

  constructor(private http: HttpClient,
              private compiler: Compiler) {
    this.module = compiler.compileModuleAndAllComponentsSync(
      PluginsModule
    );
  }

  ngAfterViewInit() {
  }

}
```

We use the “ngAfterViewInit” lifecycle hook as we need access to the “content” placeholder. You can also mark the handler as “async” to get the benefits of the “async / await” support that Typescript provides:

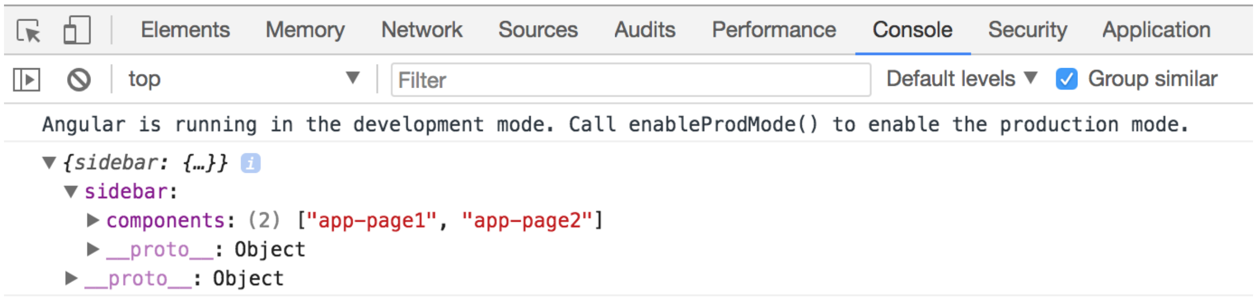
src/app/sidebar/sidebar.component.ts

```
export class SidebarComponent implements AfterViewInit {
    ...

    async ngAfterViewInit() {
        const url = '/assets/plugins.config.json';
        const config = await this.http.get(url).toPromise();

        console.log(config);
    }
}
```

Optimisation

Typically you should be aiming to have a separate application service to deal with HTTP and configuration loading. In that case, you do not repeat the same calls in every component, get a better separation of concerns and improved unit testing support.

If you now switch to the browser tab with your application and run the developer tools, the console output should be similar to the next one:



```
Angular is running in the development mode. Call enableProdMode() to enable the production mode.
▼{sidebar: {…}}
  ▼sidebar:
    ▶components: (2) ["app-page1", "app-page2"]
    ▶__proto__: Object
  ▶__proto__: Object
```

Configuration file

I strongly recommend introducing a separate interface that describes the content of the configuration file. In the long run, it is going to help you with type checks, addresses typos and errors at early stages.

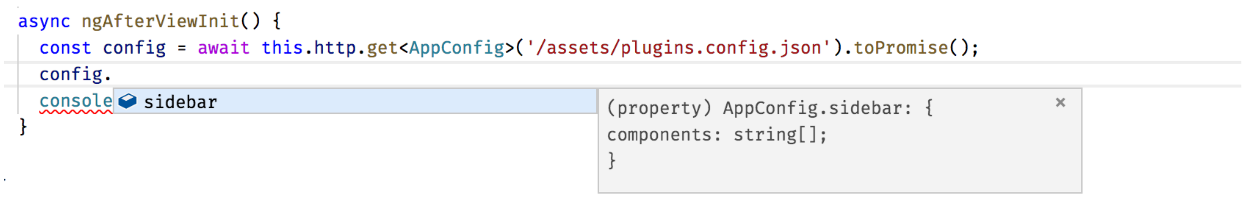
For the sake of simplicity, let's create an interface called "AppConfig" in the same "sidebar.component.ts" file. You can later extract it to a separate file if there's more than one place to use it.

```
interface AppConfig {
  sidebar: {
    components: string[]
  };
}
```

Now you can use this interface with HttpClient like this:

```
export class SidebarComponent implements AfterViewInit {
    ...

    async ngAfterViewInit() {
        const url = '/assets/plugins.config.json';
        const config = await this.http.get<AppConfig>(url).toPromise();

        console.log(config);
    }
}
```

As a bonus, you are going to get automatic completion for your configuration files when working with typed variables:



```
async ngAfterViewInit() {
  const config = await this.http.get<AppConfig>('/assets/plugins.config.json').toPromise();
  config.
  console  sidebar
}
```

```
(property) AppConfig.sidebar: {
components: string[];
}
```

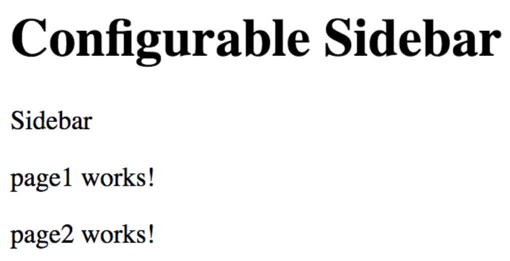
Automatic completion in VS Code

We have already covered how to search for the component factories using selector values; this can be easily used now with the external configuration to build multiple components and inject them into the placeholder in the specific order:

```
export class SidebarComponent implements AfterViewInit {
    ...

    async ngAfterViewInit() {
        const url = '/assets/plugins.config.json';
        const config = await this.http.get<AppConfig>(url).toPromise();

        this.createSidebarComponents(config.sidebar.components);
    }

    private createSidebarComponents(selectors: string[]) {
        this.content.clear();

        for (let i = 0; i < selectors.length; i++) {
            const factory = this.module.componentFactories.find(
                f => f.selector === selectors[i]
            );
            this.content.createComponent(factory, i);
        }
    }
}
```

The “ViewContainerRef.createComponent” method handles the correct positioning of all generated instances. It accepts the exact index of the entry as the second parameter.

Run or reload the project and you are going to see the following content on the main page:



Configurable Sidebar

Sidebar

page1 works!

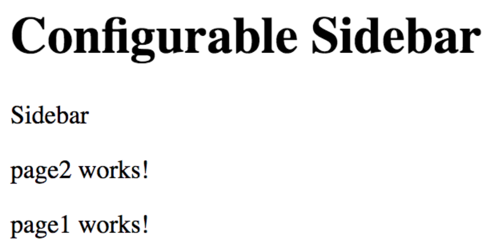
page2 works!

Sidebar with Components

Let’s try to test the configuration is indeed dynamic. Edit the JSON file and change the order of the components like in the following example:

```json
{
  "sidebar": {
    "components": [
      "app-page2",
      "app-page1"
    ]
  }
}
```

Next, reload the application page or wait till the Angular CLI web server automatically reloads. You should now see components created in the order we configured:



Different order in config

That means you are now ready to build composite components driven by the external configuration. With the approach above, you can quickly create applications that change the layout without rebuilding and re-deploying new version to the server.

> **Source code**
>
> You can find the source code in the "angular/plugins[74]" folder.

Dynamically changing application routes

If you are building a scalable web application, then you are most probably already using routing feature and application Router that Angular provides.

Besides the navigation patterns, Angular Router provides a way to partition your application into smaller chunks, load them on demand using Lazy Loading feature. We are going to dwell on Lazy Loading in the separate chapter, and meanwhile, let's see how you can extend the router on the fly, and inject new, or modify existing routes in the running application.

If you remember, at the beginning of the chapter, we have enabled the routing support via the "–routing" switch. With that switch, Angular CLI automatically generates a separate "AppRouting-Module" module file with the necessary scaffold, stored in the "app-routing.module.ts" file.

Let's generate a couple of components to use for navigation. We are going to call them "Home" and "About":

```
ng g component home --module=app
ng g component about --module=app
```

Now edit the "app-routing.module.ts" file and introduce new routes backed by the components we have just generated. The 'about' route corresponds to the "/about" URL and displays the "AboutComponent" component. By default, when the application starts, we are going to render the "HomeComponent".

[74]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/plugins

src/app/app-routing.module.ts

```typescript
import { NgModule } from '@angular/core';
import { Routes, RouterModule } from '@angular/router';

import { HomeComponent } from './home/home.component';
import { AboutComponent } from './about/about.component';

const routes: Routes = [
  {
    path: '',
    component: HomeComponent
  },
  {
    path: 'about',
    component: AboutComponent
  }
];

@NgModule({
  imports: [RouterModule.forRoot(routes)],
  exports: [RouterModule]
})
export class AppRoutingModule { }
```

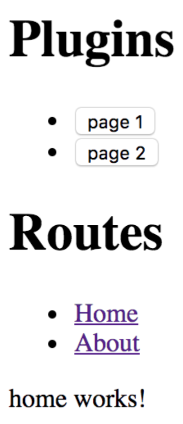
Next, we create the links on the home page to allow the users navigate to the corresponding pages. Find the “router-outlet” tag on the main application template, and replace it with the following snippet:

src/app/app.component.html

```html
...

<h1>Routes</h1>

<ul>
  <li>
    <a routerLink="/">Home</a>
  </li>
  <li>
      <a routerLink="/about">About</a>
  </li>
</ul>
```

```

<router-outlet></router-outlet>
```

Start the application, and you should see two links together with the label “home works!” underneath. That is our default “Home” component already loaded in the router outlet area.



Basic routes

Click the “About” link to see the “AboutComponent”, that proves the router is up and running, and ready for our further customisations.

For the next step, we need one more component that we are going to create dynamically at runtime. Let’s imagine that we have a configuration switch or settings that allows us to enable the “Settings” feature for our application.

Use Angular CLI to create a new “SettingsComponent” and automatically declare it within the “App” module:

```
ng g component settings --module=app
```

Note that “Settings” component is part of the application, but it gets created dynamically. According to Angular rules we need to register in the module’s “entryComponents” section all the components that we are going to create dynamically by using their factories.

Update the main application module according to the example of the code below:

src/app/app.module.ts

```
...
import { SettingsComponent } from './settings/settings.component';

@NgModule({
  declarations: [
    ...,
    SettingsComponent
  ],
  imports: [
    ...
  ],
  entryComponents: [
    SettingsComponent
  ],
  providers: [],
  bootstrap: [AppComponent]
})
export class AppModule { }
```

We also need a way to render and test all dynamic routes. Let's create the collection variable to hold the information we need to create the list of links on the main page, similar to "Home" and "About" we have created earlier. Our main component class also needs importing and injecting the Router instance.

src/app/app.component.ts

```
...
import { Router } from '@angular/router';

@Component({...})
export class AppComponent {

  ...

  links: { text: string, path: string }[] = [];

  constructor(..., private router: Router) {
    ...
  }

  ...
}
```

To display a link, we need a title and a route path value. For a minimal Router entry, we also need the type of the component to associate with the given route. That means we can create the following method to register a new route and also fill the "links" collection:

src/app/app.component.ts

```
createRoute(text: string, path: string, componentType: any) {
    this.router.config.unshift({
        path: path,
        component: componentType
    });

    this.links.push({ text, path });
}
```

The main point of interest for us, in this case, is the "router.config" property that holds a collection of all registered routes available to the application and Router. The "createRoute" method inserts a new record containing a path and the component Type.

Why is it essential to use "unshift" instead of the "push" method for the routes array? Very often the last route in the collection is a "catch-all" fallback path that handles missing pages and redirects to some error or "page not found" component, like in the following example:

```
const appRoutes: Routes = [
  {
    path: '',
    component: HomeComponent
  },
  { path: '**', component: PageNotFoundComponent }
];
```

By pushing new content to the routes collection we risk adding it after the "catch-all" path, and so the routes are not going to be available at runtime. That is why we "prepend" new routes by using "Array.prototype.unshift" rather than append them with "Array.prototype.push" function.

Let's try the route generator out with the SettingsComponent we have recently created. Update the main application component class with the necessary imports, and call the "createRoute" method in the class constructor to prepend the "Settings" route pointing to the "/settings" URL like in the next snippet:

src/app/app.component.ts

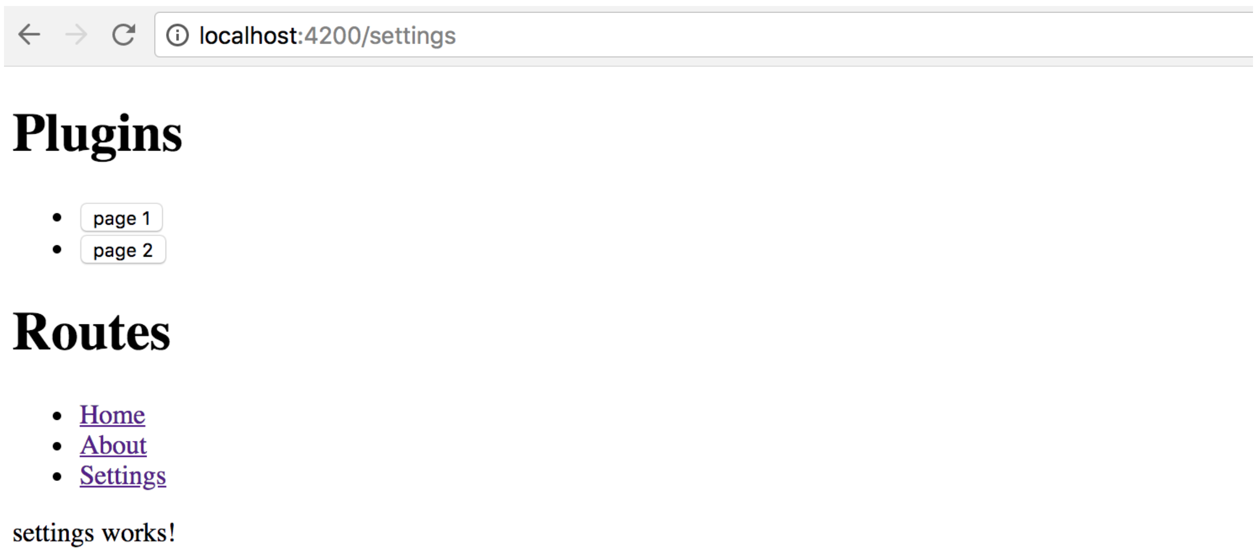
```
...
import { SettingsComponent } from './settings/settings.component';

@Component({...})
export class AppComponent {
  ...

  constructor(private compiler: Compiler, private router: Router) {
    ...
    this.createRoute('Settings', 'settings', SettingsComponent);
  }

  createView(name: string) {
    ...
  }

  createRoute(text: string, path: string, componentType: any) {
    this.router.config.unshift({
      path: path,
      component: componentType
    });

    this.links.push({ text, path });
  }
}
```

Finally, we need to create a list of new routes on the main page. You should already have an unordered list with the “Home” and “About” links, let’s update it with the dynamic portion now:

src/app/app.component.html

```
...

<h1>Routes</h1>

<ul>
  <li><a routerLink="/">Home</a></li>
  <li><a routerLink="/about">About</a></li>

  <li *ngFor="let link of links">
    <a [routerLink]="link.path">
      {{ link.text }}
    </a>
  </li>
</ul>

<router-outlet></router-outlet>
```

As soon as you reload the page, you are going to see three links in the "Routes" section: "Home", "About" and newly introduced "Settings". Click on the "Settings" one, and you are going to see the "setting works!" label in the router outlet area. That means your application successfully renders the content you provide at runtime, congratulations!



Dynamic route

We have walked through a simplified scenario for route creation. As you can now imagine, that approach can be used in more sophisticated cases, when you store route names, paths and component aliases in the external configuration files, and load them on demand together with new route generation, as we did earlier in this chapter.

> **Source code**
>
> You can find the source code in the "angular/plugins[75]" folder.

External plugins

We have finally approached the most advanced and the most valuable area - plugins that are loaded by the application at runtime from external sources, and provide new features based on specific extension points.

[75]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/plugins

For generic plugin capabilities we need to have application support at least for the following items:

- defining an extension point in the application
- essential plugin registration and management APIs
- loading external modules at runtime
- executing or instantiating external components

Traditionally, application or framework developers provide a set of extension points that third-party developers can use to build plugins or extensions. Let's take the Routing example we used across this chapter as a perfect scenario for extensibility.

We are going to enable other developers to build extra components and register new routes in our application. Ultimately it should be possible to drop the JavaScript file in some specialised "modules" folder and register the module in the application configuration file. The application should not "know" about loaded types, and the whole plugin integration should happen dynamically, without recompiling the application or even restarting the web server.

Extension decorator

It is essential to keep the plugin feature as simple as possible so that your third-party developers do not study a new programming language or the practices and patterns that are relevant only to your particular implementation. The ES2016 "decorator" pattern might be the best choice, as Angular developers are already familiar with decorators and annotations.

Let's imagine we have a unique "@Extension" decorator to mark all the components we want the target application to discover and use. We could also provide some extra metadata for such a decorator, for example, public alias to use in the configuration files, maybe an icon or even a list of dependencies on other plugins or modules.

For example, it can look like the following when applied to a class:

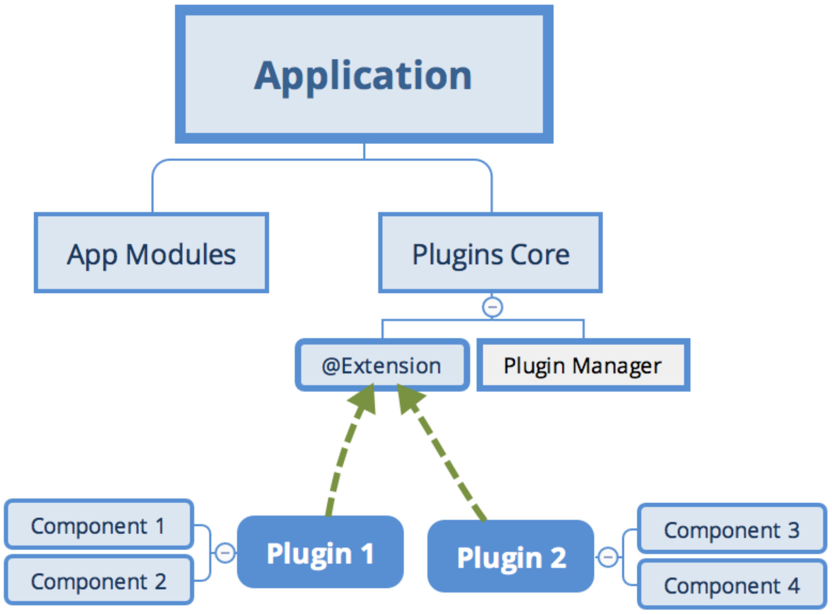
```
@Extension('my-extension')
class MyExtension {
  ...
}
```

Decorators can be chained, so that means we can use them with Angular components like this as well:

```
@Extension('my-button')
@Component({
  selector: 'my-button,
  templateUrl: 'my-button.html'
})
export class MyButtonComponent {
  ...
}
```

As you can see, we need at least one project to hold the Extension and other APIs that we share across all plugin implementations, let's call it "Plugins Core". It can also contain some management services, like "Plugin Manager" to help the end application maintain plugins easily.

Finally, we are going to extend the main application to allow adding new routes and components via the configuration file. For the current scenario, our simple extension point is a Router extension and new pages for the application, but there can be many different extension points in the future.



Simple dependency flow

Creating a Plugins Core library

Create a separate "plugins-core" folder for the shared Extension APIs to use with all new plugins. I am going to use the Rollup.js to build and bundle the code. However, you can use any other means to create a redistributable Angular library. You can refer to the Reusable component libraries chapter for more details.

Rollup.js

Rollup is a module bundler for JavaScript which compiles small pieces of code into something larger and more complex, such as a library or application.

To get more information about Rollup, please refer to the official documentation: https://rollupjs.org[76]

Note, however, that "Rollup" is not the only option for building redistributable libraries. You can also check the following alternatives:

- ng-packagr[77]
- Nx extensions for Angular[78]

Create a new "package.json" file with the following content to configure dependencies for the new project:

package.json

```
{
    "name": "plugins-core",
    "version": "1.0.0",
    "main": "dist/bundle.js",
    "license": "MIT",
    "scripts": {
      "build": "rimraf dist/bundle.js && rollup -c"
    },
    "devDependencies": {
      "babel-core": "^6.26.0",
      "babel-plugin-external-helpers": "^6.22.0",
      "babel-plugin-transform-decorators-legacy": "^1.3.4",
      "babel-preset-env": "^1.6.1",
      "rimraf": "^2.6.2",
      "rollup-plugin-babel": "^3.0.3",
      "rollup-plugin-json": "^2.3.0",
```

[76]https://rollupjs.org
[77]http://spektrakel.de/ng-packagr
[78]https://nrwl.io/nx

```
        "rollup-plugin-node-resolve": "^3.0.2"
    }
}
```

Note the “scripts” section and the “build” command. You are going to need it later to produce the bundle to use with the main application.

Run the following command now to install all dependencies:

```
npm install
```

The Rollup is using Babel libraries under the hood. We need to provide the following configuration to enable support for decorators:

.babelrc

```
{
    "presets": [
      ["env", {
        "modules": false
      }]
    ],
    "plugins": [
      "external-helpers",
      "transform-decorators-legacy"
    ]
}
```

The last project preparation step is the configuration file for the Rollup itself. Use the following source code for the minimal working configuration that takes “src/main.js” file as an input, and produces “dist/bundle.js” file as the bundled output.

rollup.config.js

```
import json from 'rollup-plugin-json';
import resolve from 'rollup-plugin-node-resolve';
import babel from 'rollup-plugin-babel';

export default {
    input: 'src/main.js',
    output: {
        file: 'dist/bundle.js',
        format: 'system'
    },
    plugins: [
        json(),
        resolve({
            // pass custom options to the resolve plugin
            customResolveOptions: {
                moduleDirectory: 'node_modules'
            }
        }),
        babel({
            exclude: 'node_modules/**' // only transpile our source code
        })
    ]
}
```

Finally, we are ready to start implementing our “Extension” decorator. The code is pretty simple, given that decorators are JavaScript functions:

src/extension.js

```
export function Extension(name, deps) {
    return (constructor) => {
        Extension.prototype.registry[name] = {
            ctor: constructor,
            deps: deps || []
        };
    };
}

Extension.prototype.registry = {};
```

As per our design, the “Extension” decorator is going to keep a registry of all the classes it has decorated. That enables quick access to all the “registered” extensions at runtime without extra initialisation overhead for each decorated class or component.

Our decorator requires a public name of the decorated element, to use within application configurations. We also reserve an optional array of dependencies that our plugin requires when loaded into the application. Feel free to add more properties later on when your plugin architecture evolves.

While we are here, let’s also provide a couple of utility functions to generate a list of providers. One is “getProviders”, to be able using it within the Angular Injectors and modules. Another one is “getExtensionType” to allow us quickly resolving extension type (or constructor) based on the public name. You are going to see both of them in action shortly.

src/extension.js

```
...

Extension.prototype.getProviders = function () {
    var registry = this.registry;
    return Object.keys(registry).map(function (key) {
        return {
            provide: key,
            useClass: registry[key].ctor,
            deps: registry[key].deps
        };
    });
};

Extension.prototype.getExtensionType = function (name) {
    return this.registry[name].ctor;
}
```

For the next step, we introduce a "PluginManager" class to provide a single place for controlling and using our plugins at runtime. Typically it is the end application that calls these methods when setting up the extension points or resolving and compiling components coming from the plugin library.

src/plugin-manager.js

```
import { Extension } from './extension';

export class PluginManager {

    getType(name) {
        return Extension.prototype.getExtensionType(name);
    }

    getProviders() {
        return Extension.prototype.getProviders();
    }
}
```

Finally, create the "main" library entry point and export the classes and functions we have created. Note that we export the instance of the PluginManager as a singleton. That is not mandatory but saves time for creating new instances at the application level, especially when accessing plugins from multiple places and files in the code.

src/main.js

```
import { PluginManager } from './plugin-manager';

export { Extension } from './extension';

export const pluginManager = new PluginManager();
```

That is pretty much all. You can now build the redistributable bundle with the "build" script:

```
npm run build
```

The console output should be similar to the following one:

```
src/main.js => dist/bundle.js...
created dist/bundle.js in 369ms
```

For real-life scenarios, you may probably want to publish your redistributable library to NPM, so that developers can install it as part of the application and use as a third party addon. For demonstration and quick testing purposes let's emulate the NPM deployment behaviour by running "npm link" in the root project folder:

```
npm link
```

Now you can run "npm link plugins-core" in any of your local projects folders, and emulate the process of installing from NPM. The main benefit is that you can keep working on the library code, all applications and libraries that link it are going to get updates automatically. Once you are have finished with the development, you can, of course, use the real publishing via "npm publish" commands, but this is out of our current scope.

You shall see the linking example later in this chapter.

Source code

You can find the source code in the "angular/plugins-core[79]" folder.

Creating an example Plugin library

We have created a shared Plugins Core library with the previous steps. It is now time to build our first plugin library.

Create a separate "plugins-example" folder and place the following "package.json" file there:

[79] https://github.com/DenysVuika/developing-with-angular/tree/master/angular/plugins-core

package.json

```
{
  "name": "plugins-example",
  "version": "1.0.0",
  "main": "dist/bundle.js",
  "license": "MIT",
  "scripts": {
    "build": "rimraf dist && rollup -c"
  },
  "devDependencies": {
    "rimraf": "^2.6.2",
    "rollup-plugin-node-resolve": "^3.0.2",
    "rollup-plugin-typescript": "^0.8.1",
    "rollup-plugin-typescript2": "^0.10.0",
    "typescript": "^2.6.2"
  },
  "dependencies": {
    "@angular/core": "^5.2.2",
    "rollup": "^0.55.1"
  }
}
```

As with the previous project, install the dependencies running the command below:

```
npm install
```

Our project needs to depend on the “plugins-core” library. Typically we should be adding it to the package file and installing with all other dependencies, however for the sake of simplicity we are going to use “npm link” feature to provide a live link to the library. That helps to work on both projects at the same time without publishing to NPM.

Run the following command in the project root to establish a link:

```
npm link plugins-core
```

As we are going to create Angular components, we need to setup the TypeScript integration for the Rollup. Put the following “tsconfig.json” file in the project root to enable basic support we need right now:

tsconfig.json

```json
{
    "compilerOptions": {
        "target": "es5",
        "module": "system",
        "lib": ["es2017", "dom"],
        "declaration": true,
        "sourceMap": true,
        "removeComments": true,
        "moduleResolution": "node",
        "typeRoots": [ "node_modules/@types" ],
        "experimentalDecorators": true,
        "emitDecoratorMetadata": true
    }
}
```

TypeScript Configuration

You can always generate a recommended configuration file by running the "tsc –init" command in any folder. That requires, however, a TypeScript to be installed globally via "npm install -g typescript" command.

Now finish the project scaffold setup by also adding the Rollup configuration file like below:

rollup.config.js

```js
import resolve from 'rollup-plugin-node-resolve';
import typescript from 'rollup-plugin-typescript2';

export default {
    input: 'src/main.ts',
    output: {
        file: 'dist/bundle.js',
        format: 'system'
    },
    plugins: [
        resolve({
            // pass custom options to the resolve plugin
            customResolveOptions: {
                moduleDirectory: 'node_modules'
            }
        }),
        typescript({
            typescript: require('typescript')
        })
    ],
    external: [
        'plugins-core',
        '@angular/core'
    ]
}
```

Please pay attention to the “external” section of the Rollup configuration. It contains references to the libraries in your “package.json” that should never get bundled into the resulting output. That means that every plugin library is not going to contain the full copy of the Angular or another version of the “plugins-core”. Having such dependencies marked as “external”, however, requires the main application to import them alongside our plugins.

If your library depends on other Angular libraries, like “@angular/forms” or “@angular/http”, include those in the “external” section too.

Let’s now create the first plugin component marked with our “Extension” decorator. It is going to be a dummy button element that we reference as “my-button” extension.

src/my-button/my-button.component.ts

```
import { Component, OnInit, NgModule } from '@angular/core';
import { Extension } from 'plugins-core';

@Extension('my-button', [])
@Component({
    selector: 'my-button',
    template: `<button>My Button</button>`
})
export class MyButtonComponent implements OnInit {

    ngOnInit() {
        console.log('My Button Init');
    }

}
```

Create one more component with a label element and called “my-label”:

src/my-label/my-label.component.ts

```
import { Component, OnInit, NgModule } from '@angular/core';
import { Extension } from 'plugins-core';

@Extension('my-label', [])
@Component({
    selector: 'my-label',
    template: `<h1>My Label</h1>`
})
export class MyLabelComponent implements OnInit {

    ngOnInit() {
        console.log('My Label Init');
    }

}
```

Both components also produce log messages to the browser console for testing purposes. The only thing that is now left is to export both components in the "main" class.

src/main.ts

```
export { MyLabelComponent } from './my-label/my-label.component';
export { MyButtonComponent } from './my-button/my-button.component';
```

Now run the "build" script to create a redistributable bundle:

```
npm run build
```

Once the compilation completes, the console output should be as follows:

```
src/main.ts => dist/bundle.js...
created dist/bundle.js in 980ms
```

Finally, you should also create a link to this project to test the library without publishing to NPM every time you make changes to the project.

```
npm link
```

We now got the "plugins-core" and "plugins-example" libraries compiled and ready for use with an Angular application as external plugins.

Source code

You can find the source code in the "angular/plugins-example[80]" folder.

Extra libraries and dependencies

Your component library does not restrict you to a particular set of dependencies. You can add many additional libraries to the "rollup" configuration, and plugin components can also have own "providers" sections to get additional services imported.

For example, you can add a FormBuilder integration using the following steps.

First, update the "rollup.config.js" file and add "@angular/forms" to the exclusion list. That prevents entire forms library from getting bundled into your library output.

```
export default {
  ...,

  external: [
      'plugins-core',
      '@angular/core',
      '@angular/forms'
  ]
}
```

Next, import the Forms related types, and update your component decorator to include the "FormBuilder" provider:

src/my-label/my-label.component.ts

```
import { Component, OnInit, NgModule } from '@angular/core';
import { FormBuilder, FormGroup, Validators } from '@angular/forms';
import { Extension } from 'plugins-core';

@Extension('my-label', [])
@Component({
    selector: 'my-label',
    template: `<h1>My Label</h1>`,
    providers: [ FormBuilder ]
})
export class MyLabelComponent implements OnInit {

    ngOnInit() {
```

[80]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/plugins-example

```
        console.log('My Label Init');
    }

}
```

Once you have component configuration set, you can import the FormBuilder and use its APIs from within the plugin component.

src/my-label/my-label.component.ts

```
export class MyLabelComponent implements OnInit {

    form: FormGroup;

    constructor(private fb: FormBuilder) {
        this.form = fb.group({
            name: fb.group({
                first: ['Nancy', Validators.minLength(2)],
                last: 'Drew'
            }),
            email: ''
        });
    }

    ngOnInit() {
        console.log('My Label Init');
        console.log('FB:', this.fb);
        console.log('Form:', this.form);
    }

}
```

Finally, you need updating the “SystemJS” settings of the main application to include extra libraries to use for plugins.

In the example below I am adding “@angular/common”, “@angular/forms” and “@angular/platform-browser” to the list. Those libraries will get available for all the loaded plugins.

src/assets/plugins.config.json

```
{
  ...,

  "system": {
    "baseURL": "/assets/modules",
    "paths": {
      "npm:": "https://unpkg.com/"
    },
    "map": {
      "@angular/core": "npm:@angular/core/bundles/core.umd.js",
      "@angular/common": "npm:@angular/common/bundles/common.umd.js",
      "@angular/forms": "npm:@angular/forms/bundles/forms.umd.js",
      "@angular/platform-browser": "npm:@angular/platform-browser/bundles/platform-b\
rowser.umd.js",
      "rxjs": "npm:rxjs",

      "plugins-core": "/modules/plugins-core/bundle.js",
      "plugins-example": "/modules/plugins-example/bundle.js"
    }
  },
}
```

You might need to import "FormsModule" and "ReactiveFormsModule" also to the root application module.

src/app/app.component.ts

```
import { FormsModule, ReactiveFormsModule } from '@angular/forms';

@NgModule({
  ...,

  imports: [
    BrowserModule,
    HttpModule,
    FormsModule, ReactiveFormsModule
  ],

  ...
})
export class AppModule { }
```

Providing dependencies for your plugins

As I have mentioned earlier, you have full control over what the dynamic module contains. This opens the door to at least two great scenarios for injecting external content into your plugins at run-time.

We have already touched the first one. That is the “imports” section and extra libs you can provide for every plugin you construct. That can be Forms modules, Material modules, you custom or third-party libraries.

Every time we create an instance of the plugin component of the “componentType”, the component templates can use form fields, and material buttons provided with the “MatButtonModule” module.

```
const RuntimeModule = NgModule({
  imports: [
    CommonModule,
    FormsModule,
    ReactiveFormsModule,
    MatButtonModule
  ],
  declarations: [
    componentType
  ]
})(class {})
```

Another way to inject data into the plugin components is by utilising “providers” section. You can create and pre-configure the services prior to exposing them to components and other services that you resolve and create on the fly.

```
const RuntimeModule = NgModule({
  declarations: [
    componentType
  ],
  providers: [
    { provide: Injector, useValue: this.injector },
    { provide: FormBuilder, useValue: this.fb },
    { ... }
  ]
})(class {})
```

That is a powerful feature that allows you having complete control over the dependency resolution process for external components.

Loading plugins into the Application

Switch to the "plugins" application we earlier in this chapter. Use the following commands to link both "plugins-core" and "plugins-example" libraries to emulate installation from NPM:

```
npm link plugins-core
npm link plugins-example
```

Also, you need to install a "systemjs" library. That is a module loader we are going to use to get our plugins into the running application.

```
npm install systemjs
```

SystemJS

Configurable module loader enabling dynamic ES module workflows in browsers and NodeJS. Built with the ES Module Loader project, which is based on principles and APIs from the WhatWG Loader specification, modules in HTML and NodeJS.

For more details please refer to the official project page[81].

As we are using Angular CLI for the application, the "systemjs" library needs to be present within the "scripts" section of the ".angular-cli.json" configuration file.

.angular-cli.json

```
{
  "$schema": "./node_modules/@angular/cli/lib/config/schema.json",
  "project": {
    "name": "plugins"
  },
  "apps": [
    {
      ...,
      "scripts": [
        "../node_modules/systemjs/dist/system.js"
      ],
      ...
    }
  ],
  ...
}
```

[81] https://github.com/systemjs/systemjs/blob/master/README.md

It would be much easier if we also automate plugin bundle copying process. According to our design, all external plugins need to reside in the “modules” folder of the application, either local or running at the server side. As we continuously develop our plugin libraries, it is much easier if Angular CLI automatically copies resulting bundles into appropriate places. We already linked the libraries via the “npm link” command, the only thing that is left is to add extra rules for the “assets” folder:

.angular-cli.json

```
{
  "$schema": "./node_modules/@angular/cli/lib/config/schema.json",
  "project": {
    "name": "plugins"
  },
  "apps": [
    {
      ...,
      "assets": [
        ...,
        {
          "glob": "bundle.js",
          "input": "../node_modules/plugins-core/dist",
          "output": "./modules/plugins-core"
        },
        {
          "glob": "bundle.js",
          "input": "../node_modules/plugins-example/dist",
          "output": "./modules/plugins-example"
        }
      ],
      ...,
      "scripts": [
        "../node_modules/systemjs/dist/system.js"
      ],
      ...
    }
  ],
  ...
}
```

For the next step, we need to provide some basic configuration for SystemJS loader. The best way would be to re-use the same “plugins.config.json” configuration file we have created earlier. In this case, you can manage both the loader and the plugin configuration in the same place, and also without rebuilding the application.

To keep the configuration short, we are going to load all missing dependencies directly from the "UNPKG[82]", a fast CDN for NPM libraries. The "plugins-core" and "plugins-example" point to the local bundle files we copy with the Angular CLI.

src/assets/plugins.config.json

```
{
  "system": {
    "baseURL": "/assets/modules",
    "paths": {
      "npm:": "https://unpkg.com/"
    },
    "map": {
      "@angular/core": "npm:@angular/core/bundles/core.umd.js",
      "rxjs": "npm:rxjs",

      "plugins-core": "/modules/plugins-core/bundle.js",
      "plugins-example": "/modules/plugins-example/bundle.js"
    }
  },
  "sidebar": {
    "components": [
      "app-page2",
      "app-page1"
    ]
  }
}
```

Update the application component imports section with the "SystemJS" type declaration. That allows us using auto-completion and type checking for the SystemJS APIs:

src/app/app.component.ts

```
import {..., AfterViewInit} from '@angular/core';
import { HttpClient } from '@angular/common/http';

import { System } from 'systemjs';
declare var SystemJS: System;
```

As you remember, we can load configuration using HttpClient, and use a TypeScript interface to enable static type checks and IDE support. Let's start with the basic one:

[82]https://unpkg.com/

```
interface PluginsConfig {
  system: any;
}
```

To finish the preparations, add the HttpClient and mark the “ngAfterViewInit” handler as “async”, like in the next example:

src/app/app.component.ts

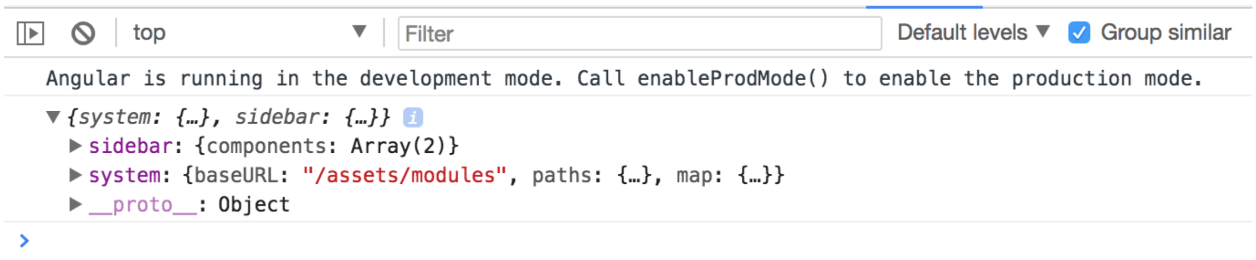
```
@Component({...})
export class AppComponent implements AfterViewInit {
  ...

  constructor(..., private http: HttpClient) {
    ...
  }

  async ngAfterViewInit() {
  }
}
```

Let’s try to load the configuration and log its content to the browser console to ensure the file loads fine:

src/app/app.component.ts

```
@Component({...})
export class AppComponent implements AfterViewInit {
  ...

  constructor(..., private http: HttpClient) {
    ...
  }

  async ngAfterViewInit() {
    const url = '/assets/plugins.config.json';
    const config = <PluginsConfig> await this.http.get(url).toPromise();
    console.log(config);
  }
}
```

Run the application or reload the page. The developer tools console should look similar to the one below:



```
Angular is running in the development mode. Call enableProdMode() to enable the production mode.
▼{system: {…}, sidebar: {…}}
  ▶sidebar: {components: Array(2)}
  ▶system: {baseURL: "/assets/modules", paths: {…}, map: {…}}
  ▶__proto__: Object
```

Loaded configuration

Before we load a plugin, the SystemJS loader needs to get configured. We load and apply settings using the "config" method like in the next example:

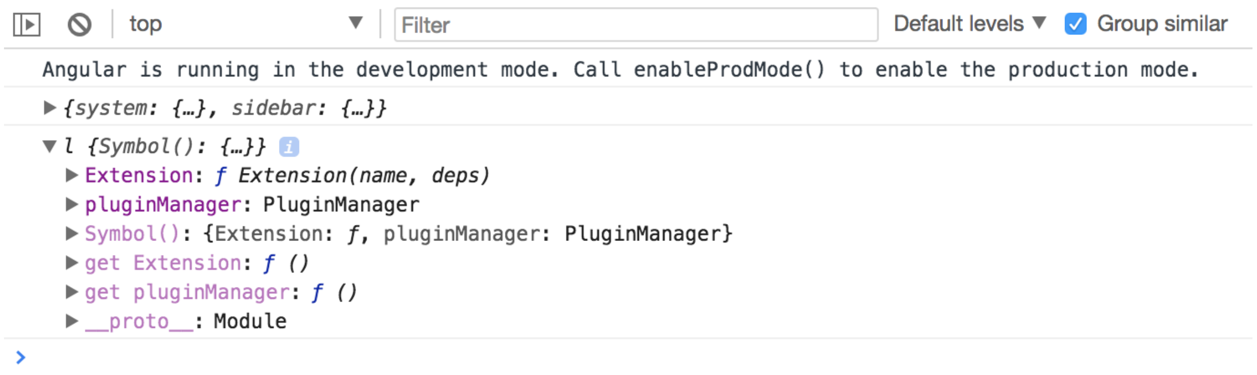
```
SystemJS.config(config.system);
```

You can test the loader by importing the "plugins-core" library:

src/app/app.component.ts

```
export class AppComponent implements AfterViewInit {

  async ngAfterViewInit() {
    const url = '/assets/plugins.config.json';
    const config = <PluginsConfig> await this.http.get(url).toPromise();
    console.log(config);

    SystemJS.config(config.system);

    const core = await SystemJS.import('plugins-core');
    console.log(core);
  }

}
```

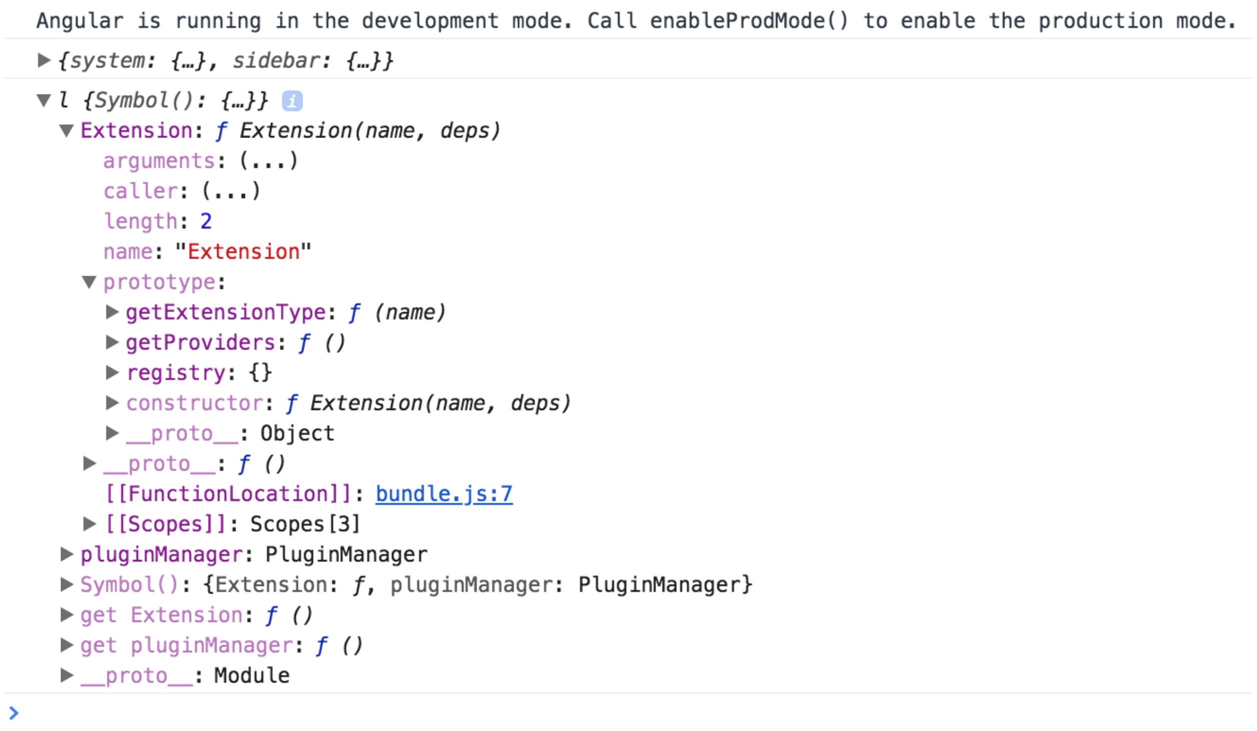
This time the browser console output should contain the "plugins-core" library content:



```
Angular is running in the development mode. Call enableProdMode() to enable the production mode.
▶{system: {…}, sidebar: {…}}
▼l {Symbol(): {…}}
  ▶Extension: ƒ Extension(name, deps)
  ▶pluginManager: PluginManager
  ▶Symbol(): {Extension: ƒ, pluginManager: PluginManager}
  ▶get Extension: ƒ ()
  ▶get pluginManager: ƒ ()
  ▶__proto__: Module
>
```

Loaded core module

Try expanding the "Extension" and "prototype" sections in the console to check the "registry" content. It should be an empty object like this:



```
Angular is running in the development mode. Call enableProdMode() to enable the production mode.
▶{system: {…}, sidebar: {…}}
▼l {Symbol(): {…}}
  ▼Extension: ƒ Extension(name, deps)
     arguments: (...)
     caller: (...)
     length: 2
     name: "Extension"
    ▼prototype:
      ▶getExtensionType: ƒ (name)
      ▶getProviders: ƒ ()
      ▶registry: {}
      ▶constructor: ƒ Extension(name, deps)
      ▶__proto__: Object
    ▶__proto__: ƒ ()
     [[FunctionLocation]]: bundle.js:7
    ▶[[Scopes]]: Scopes[3]
  ▶pluginManager: PluginManager
  ▶Symbol(): {Extension: ƒ, pluginManager: PluginManager}
  ▶get Extension: ƒ ()
  ▶get pluginManager: ƒ ()
  ▶__proto__: Module
>
```

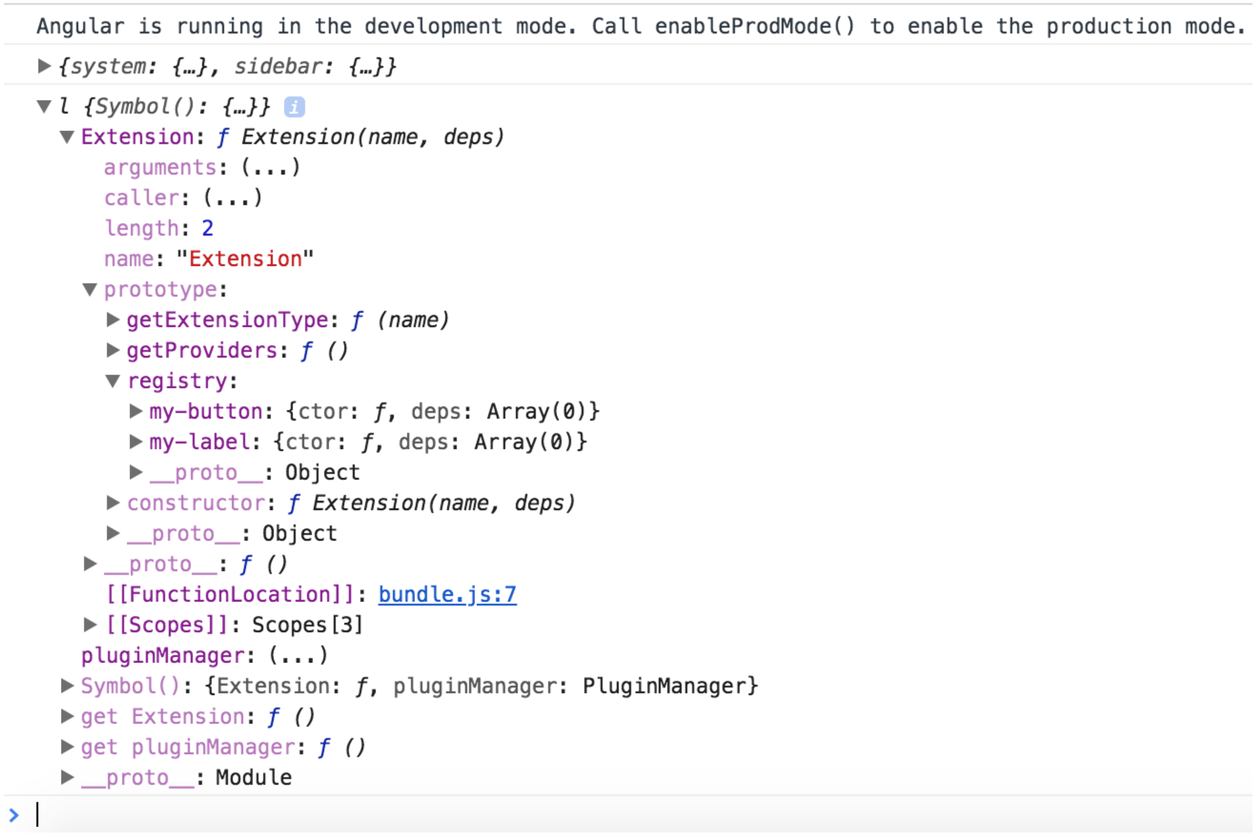
Extension decorator registry

Next, import the "plugins-example" right after the "plugins-core":

src/app/app.component.ts

```
const core = await SystemJS.import('plugins-core');
const pluginExample = await SystemJS.import('plugins-example');
console.log(core);
```

Now, the Extension decorator should contain two entries in the registry. As you can see from the console output they are "my-button" and "my-label":



```
Angular is running in the development mode. Call enableProdMode() to enable the production mode.
▶{system: {…}, sidebar: {…}}
▼l {Symbol(): {…}} i
  ▼Extension: ƒ Extension(name, deps)
     arguments: (...)
     caller: (...)
     length: 2
     name: "Extension"
   ▼prototype:
     ▶getExtensionType: ƒ (name)
     ▶getProviders: ƒ ()
     ▼registry:
       ▶my-button: {ctor: ƒ, deps: Array(0)}
       ▶my-label: {ctor: ƒ, deps: Array(0)}
       ▶__proto__: Object
     ▶constructor: ƒ Extension(name, deps)
     ▶__proto__: Object
   ▶__proto__: ƒ ()
     [[FunctionLocation]]: bundle.js:7
   ▶[[Scopes]]: Scopes[3]
   pluginManager: (...)
  ▶Symbol(): {Extension: ƒ, pluginManager: PluginManager}
  ▶get Extension: ƒ ()
  ▶get pluginManager: ƒ ()
  ▶__proto__: Module
> |
```

Registry with entries

You already know the names of the extensions, because you have defined them in the decorators for each component. Also, you have the corresponding libraries loaded into the application at runtime. It is now possible to use the same technique for dynamic module compilation with the component constructors, fetched using Plugin Manager APIs.

The code below demonstrates the "my-label" plugin compiled and rendered within the "content" element, similar to what we did earlier in this chapter.

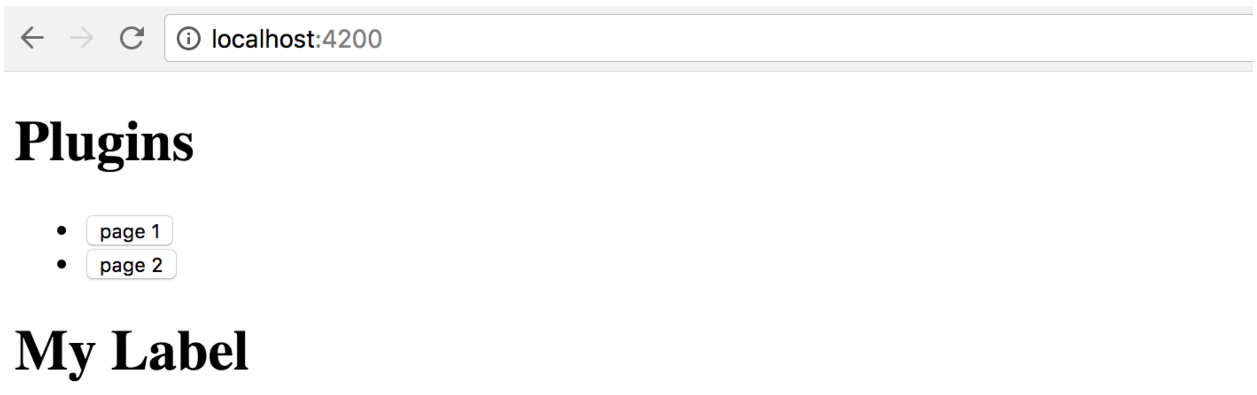
src/app/app.component.ts

```
export class AppComponent implements AfterViewInit {

  async ngAfterViewInit() {
    ...

    SystemJS.config(config.system);

    const core = await SystemJS.import('plugins-core');
    const pluginExample = await SystemJS.import('plugins-example');
    console.log(core);

    const componentType = core.pluginManager.getType('my-label');

    const RuntimeModule = NgModule({
      imports: [
        // extra modules if needed by your plugins
        // for example: FormsModule, HttpClientModule, etc
      ],
      declarations: [componentType]
    })(class {});

    const module = this.compiler.compileModuleAndAllComponentsSync(
      RuntimeModule
    );

    const factory = module.componentFactories.find(
      f => f.componentType === componentType
    );

    this.content.clear();
    this.content.createComponent(factory, 0);
  }

}
```

Dynamic modules and NgModule decorator

Please keep in mind that with the “RuntimeModule” you are creating a real Angular module. Besides “declarations” section you can reuse all other metadata properties exposed by the “NgModule” decorator. For example, you can use “imports” to store a set of extra dependencies for your plugins. Or “providers” where you add new, redefine or configure existing providers.

Switch to the running application and reload the page, if you do not have live reloading enabled. The main page now contains the “My Label” element. That is the content of the plugin we have just dynamically loaded.


localhost:4200

Plugins

- page 1
- page 2

My Label

Live plugin content

Another challenge to address - dependencies for your plugins. In most common scenarios the plugin branch needs to be attached to the running application tree, and have access to all the shared infrastructure. The perfect examples are Authentication layer, Translation services, User Preferences, Application Configuration. Every loaded plugin should not create a new copy, but reuse already configured instances of the services.

You can achieve tight integration of the plugins by using custom Injector instances. It is possible to create the Injector that inherits the main application tree of Injectors, and at the same time contains custom settings that a plugin brings if you need that level of control.

src/app/app.component.ts

```
import { ..., Injector } from '@angular/core';

export class AppComponent implements AfterViewInit {

  constructor(private compiler: Compiler,
              private router: Router,
              private http: HttpClient,
              private injector: Injector) {
    ...
  }

  async ngAfterViewInit() {
    ...

    const pluginInjector = Injector.create([
      ...core.pluginManager.getProviders()
    ], this.injector);

    this.content.clear();
    this.content.createComponent(factory, 0, pluginInjector);
  }

}
```

First of all, we import an instance of the Injector into the component class constructor. That is the same Injector that provides all other dependencies for the given class by the way. It is created for every component and resolves all the required dependencies. If there are no values registered with the component Injector, the Angular goes up the component tree to the parent component and checks its Injector. It repeats the same procedure until it reaches the top of the application tree and its module.

We take the component injector and create a new instance based on it. Moreover, we populate the "providers" section of the current plugin. That allows a plugin to register new or override existing providers if needed, and allows Angular traverse the whole injector tree.

```
const pluginInjector = Injector.create([
  ...core.pluginManager.getProviders()
], this.injector);
```

As soon as you have your custom injector, it becomes trivial to create a new component with the factory, corresponding element position and injector instance:

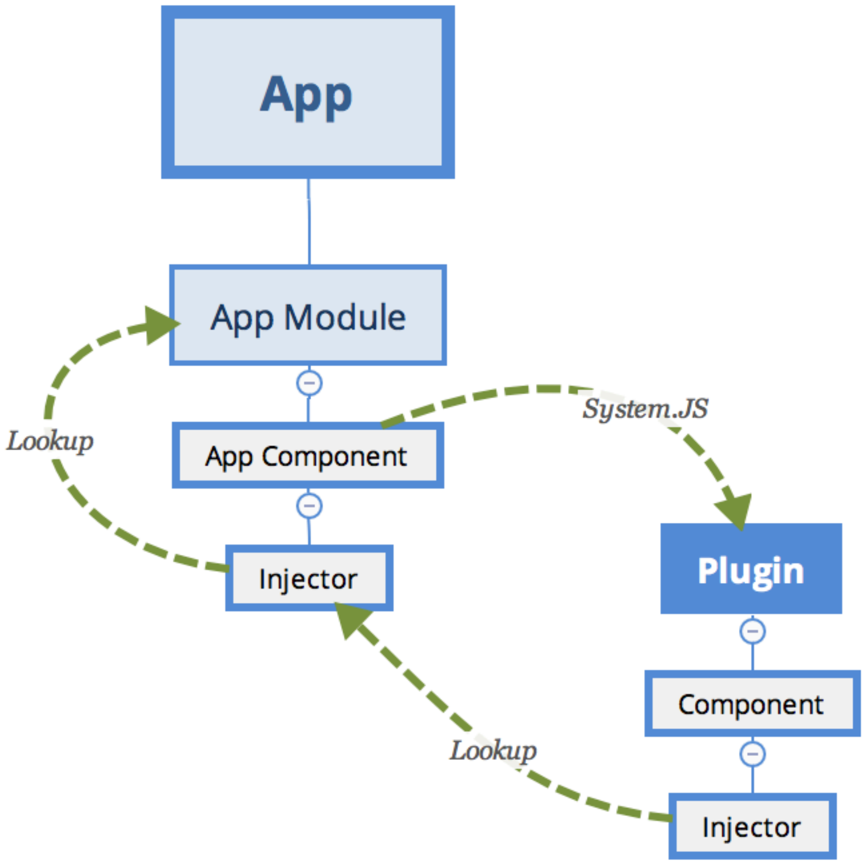
```
this.content.clear();
this.content.createComponent(factory, 0, pluginInjector);
```

Note the usage of the "Extension.prototype.getProviders" that we have created earlier. That method allows us to collect all components marked with the "Extension" decorator, and produce a list of "providers" and their "dependencies", to attach to any custom injector or dynamic module:

plugins-core:/src/extension.js

```
Extension.prototype.getProviders = function () {
    var registry = this.registry;

    return Object.keys(registry).map(function (key) {
        return {
            provide: key,
            useClass: registry[key].ctor,
            deps: registry[key].deps
        };
    });
};
```

Visually the hierarchy of dependencies and injectors should look like the following:



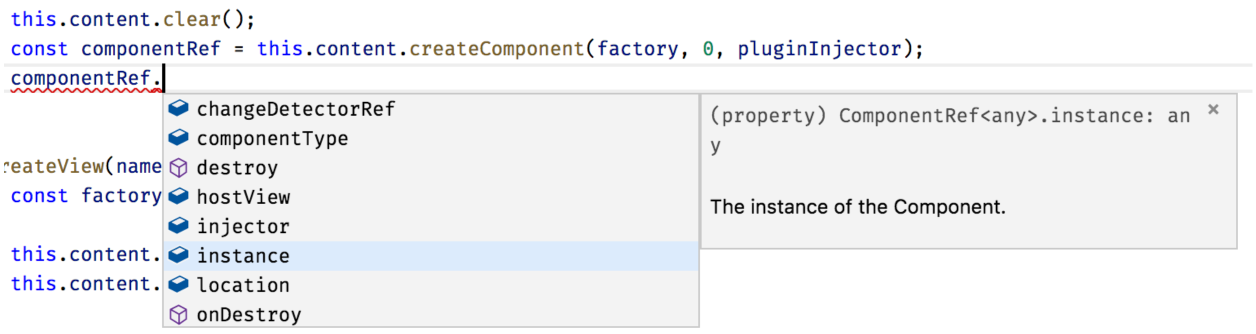
Injectors

Setting plugin properties at runtime

We have already used a few times the “ViewContainerRef.createContent” method to create and inject content.

```
this.content.clear();
this.content.createComponent(factory, 0, pluginInjector);
```

The biggest feature of this method is that it returns the instance of the “ComponentRef” type. That allows you accessing the real instance of the component you have just created, and setting its properties, or calling methods.



```
this.content.clear();
const componentRef = this.content.createComponent(factory, 0, pluginInjector);
componentRef.
```

ComponentRef Members

You can try to check how it works by logging the value of one property the plugin defines, for example a `form`:

```
console.log(componentRef.instance.form);
```

Use this technique to set up dynamic components after theyÂ get created. You can set any properties and call any methods to provide post-constructor setup, or prime your component with extra infrastructure references.

Sometimes it might be easier for you to set the corresponding properties at run time than piping all injectors and dependencies.

As plugins can be of many types unknown at compile time, you can create a set of interfaces to provide a contract for the external developers. For example, you may want all plugin developers to inherit a “PluginComponent” interface with a set of properties your application can rely at run-time.

Dynamic Routes with plugin content

We have been using manual import of the plugins by their names so far. In real life, you are most probably going to make the application fully automatic, based on multiple extension points and configuration settings that are coming either from the file or RESTful service call.

Let’s introduce an application Router extension point similar to the one we have been using before. This time, however, the application is going to load routes from the configuration file. Every route now should be powered by the content exposed by the plugin, and not known to the application at compile time.

There may be many ways to express plugins setup in the configuration. Here’s a simple example for you to get started:

```
{
  "system": {...},
  "sidebar": {...},

  "plugins": {
    "modules": {
      "plugins-core": "/modules/plugins-core/bundle.js" ,
      "plugins-example": "/modules/plugins-example/bundle.js"
    },
    "routes": [
      {
        "name": "Plugin 1 (label)",
        "path": "plugin1",
        "component": {
          "module": "plugins-example",
          "componentType": "my-label"
        }
      },
      {
        "name": "Plugin 2",
        "path": "plugin2 (button)",
        "component": {
          "module": "plugins-example",
          "componentType": "my-button"
        }
      }
    ]
  }
}
```

In our case, we introduce an extra section "plugins" to our existing "plugin.config.json" file. It contains the list of available modules and a couple of routes that we want to create when the application starts. Each route instance consists of the name, route path, and component information: module and alias that we used within Extension decorator.

To enable static checks, let's also extend the "PluginsConfig" interface:

```
interface PluginsConfig {
  system: any;
  plugins: {
    modules: any,
    routes: Array<{
      name: string,
      path: string,
      component: {
        module: string,
        componentType: string
      }
    }>
  };
}
```

Next, edit the “ngAfterViewInit” hook for the main application component class, and add the “loadExternalRoutes” call right after the SystemJS configuration:

src/app/app.component.ts

```
export class AppComponent implements AfterViewInit {
  ...

  async ngAfterViewInit() {
    const url = '/assets/plugins.config.json';
    const config = <PluginsConfig> await this.http.get(url).toPromise();

    SystemJS.config(config.system);
    this.loadExternalRoutes(config);

    ...
  }

}
```

At runtime, we can now quickly get a list of the plugins, their modules and custom routes. Also, you can now get the corresponding component type using its alias and calling “pluginManager.getType” method.

We have already implemented a way to create a dynamic route and display it on the page. The challenging part is that Angular requires the route component to be a “known” type. Due to some architectural reasons, it does not allow us to put an entirely dynamic component type as “route.componentType” value.

You can solve the difficulty with the route components by introducing a statically known to the application component, that has dynamic content. Let's imagine we have a "DynamicPageComponent" component that has an empty template and serves as a wrapper for the dynamic content exported by the external plugin. We already know it is technically feasible, given the dynamic sidebar component we have previously created.

The "loadExternalRoutes" implementation may look like the following one:

src/app/app.component.ts

```
...
import { DynamicPageComponent } from './dynamic-page/dynamic-page.component';

export class AppComponent implements AfterViewInit {
  ...

  private async loadExternalRoutes(config: PluginsConfig) {
    const core = await SystemJS.import('plugins-core');

    for (const route of config.plugins.routes) {
      const module = await SystemJS.import(route.component.module);
      const componentType = core.pluginManager.getType(
        route.component.componentType
      );

      this.createRoute(
        route.name,
        route.path,
        DynamicPageComponent,
        componentType
      );
    }
  }

}
```

Let's now adopt the "createRoute" to match our scenario:

src/app/app.component.ts

```
export class AppComponent implements AfterViewInit {
  ...

  createRoute(text: string,
              path: string,
              componentType: any,
              factoryType?: any) {
    this.router.config.unshift({
      path: path,
      component: componentType,
      data: {
        factory: factoryType
      }
    });

    this.links.push({ text, path });
  }
}
```

As you can see from the example above, we use a known “DynamicPageComponent” for the route, and also provide the required factory from the Extension decorator. The “data” value contains a property bag with arbitrary data that any other component can access, a handy way passing different optional configurations. In our case, the dynamic page component is going to build its content using the factory provided in the property bag.

Next, you can generate the “DynamicPageComponent” by running the next Angular CLI command:

```
ng g component dynamic-page --module=app
```

The component must also be declared as “dynamically created” by putting it to the “entryComponents” section of the top-level module:

src/app/app.module.ts

```
@NgModule({
  ...,
  entryComponents: [
    ...,
    DynamicPageComponent
  ],
  ...
})
export class AppModule { }
```

According to our design, the only thing that we need in the component's template is the container element:

src/app/dynamic-page/dynamic-page.component.html

```
<div #content></div>
```

Similar to the dynamic sidebar, the component class implementation needs to get a reference to the corresponding DOM element, and import injector and compile services, alongside the current route data:

src/app/dynamic-page/dynamic-page.component.ts

```
import {
  Component, OnInit, OnDestroy,
  Injector, ViewChild, ViewContainerRef,
  Compiler, NgModule, ComponentRef
} from '@angular/core';
import { ActivatedRoute } from '@angular/router';

@Component({...})
export class DynamicPageComponent implements OnInit, OnDestroy {

  @ViewChild('content',  { read: ViewContainerRef })
  content: ViewContainerRef;

  component: ComponentRef<any>;

  constructor(
    private route: ActivatedRoute,
    private injector: Injector,
    private compiler: Compiler) {
  }

  ngOnInit() {
  }

  ngOnDestroy() {
  }

}
```

The “ActivatedRoute” represents the current route. We can import it to get access to the underlying details, including the property bag defined earlier, by using “route.snapshot.data” property value.

The code to create and render a dynamic component should already be familiar to you:

src/app/dynamic-page/dynamic-page.component.ts

```
@Component({...})
export class DynamicPageComponent implements OnInit, OnDestroy {
  ...

  ngOnInit() {
    const componentType = this.route.snapshot.data['factory'];

    if (componentType) {
      this.compiler.clearCacheFor(componentType);

      const RuntimeModule = NgModule({
        imports: [/* extra libs */],
        providers: [/* extra providers */],
        declarations: [componentType]
      })(class {});

      const module = this.compiler.compileModuleAndAllComponentsSync(
        RuntimeModule
      );

      const factory = module.componentFactories.find(
        f => f.componentType === componentType
      );

      this.content.clear();
      this.component = this.content.createComponent(
        factory, 0, this.injector
      );
    }
  }

  ngOnDestroy() {
  }

}
```

A critical thing to keep in mind - users might visit the route multiple times, so we need to manage all dynamically created resources and clean them up as soon as possible. That is why we call the following code every time we build a new component:

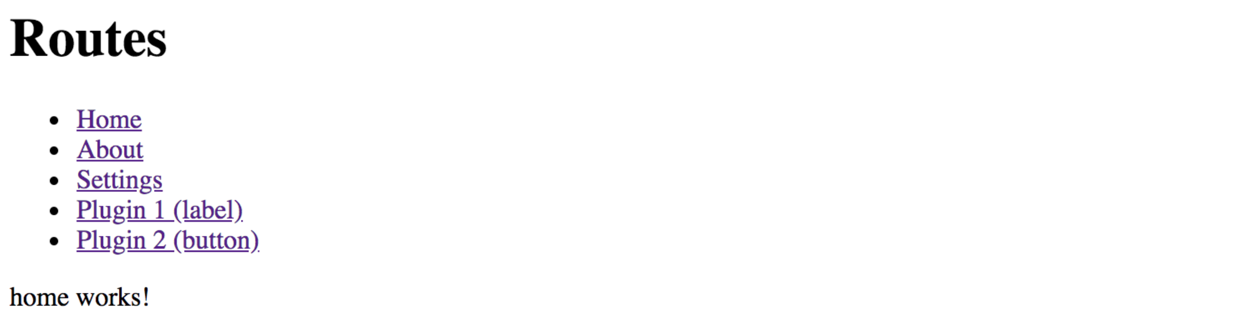
```
this.compiler.clearCacheFor(componentType);
```

As soon as the user leaves the page, the component needs to be released from memory as well:

src/app/dynamic-page/dynamic-page.component.ts

```
@Component({...})
export class DynamicPageComponent implements OnInit, OnDestroy {
  ...

  ngOnDestroy() {
     if (this.component) {
      this.component.destroy();
      this.component = null;
    }
  }

}
```

Now start the application and take a look at the main page. The “Routes” section now contains 5 links - the “Home”, “About” and “Settings” we created earlier, and two more links created with the plugins:



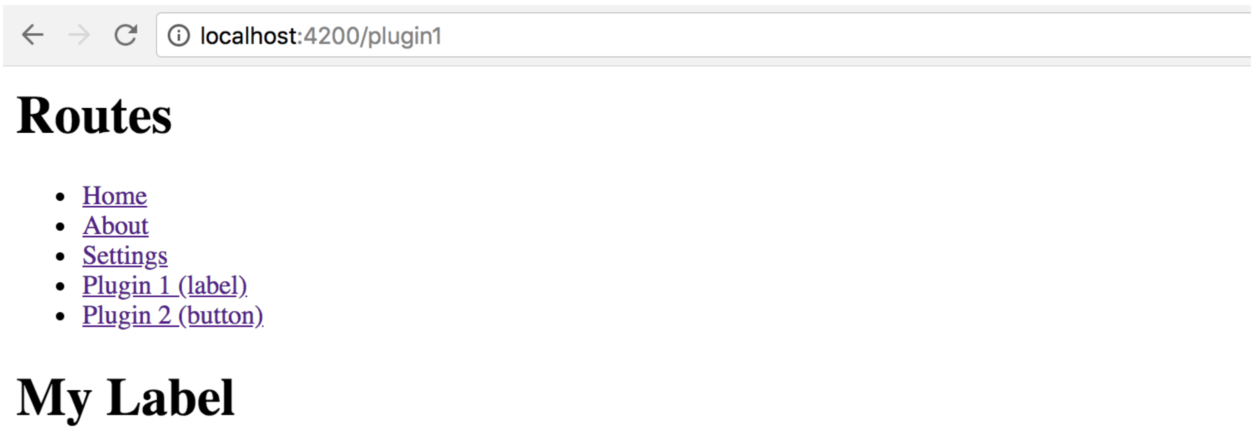
Routes

- Home
- About
- Settings
- Plugin 1 (label)
- Plugin 2 (button)

home works!

Generated routes

Now click the "Plugin 1 (label)" link, and you should see the "My Label" component automatically created underneath. That content is coming from the plugin, and our application has just compiled and created it on demand!



localhost:4200/plugin1

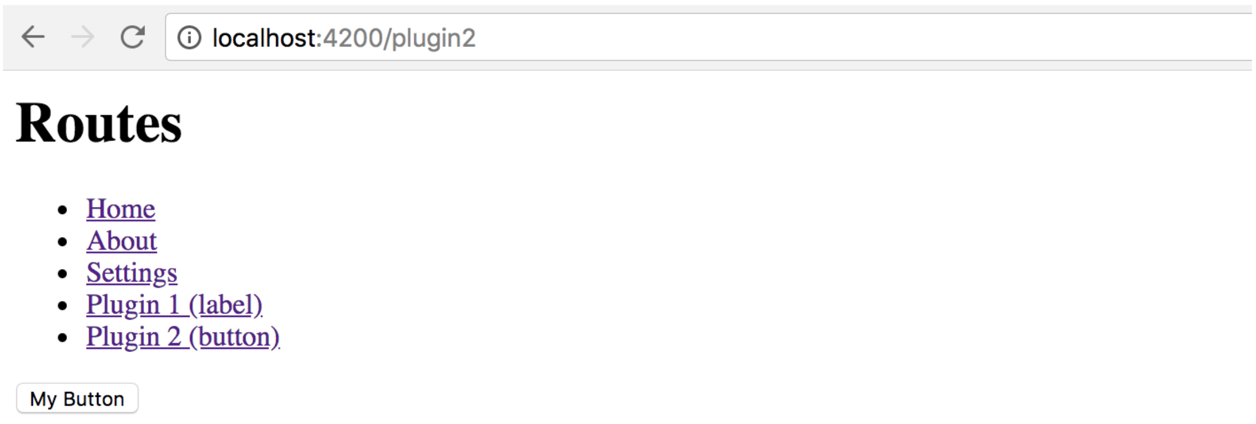
Routes

- Home
- About
- Settings
- Plugin 1 (label)
- Plugin 2 (button)

My Label

Dynamic route with the Label

Next, click the second link to see another component provided by the plugin:



localhost:4200/plugin2

Routes

- Home
- About
- Settings
- Plugin 1 (label)
- Plugin 2 (button)

Dynamic route with the Button

Summary

We have successfully finished the most advanced application setup with fully dynamic external plugins in action. Feel free to enhance your applications with extension points, and plugins that other developers can create and run with your apps.

Source code

You can find the source code in the "angular/plugins[83]" folder.

[83]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/plugins

Reusable Component Libraries

We have already used the Angular CLI to generate applications. For the time being the CLI does not support creating the reusable libraries, so we are going to use "ng-packagr[84]" tool for this purpose.

The "ng-packagr" transpiles your component libraries using the "Angular Package Format[85]". Resulting bundles are ready to be consumed by Angular CLI, Webpack, or SystemJS. For more details on the features, please refer to the project page.

In this chapter, we are going to use Angular CLI to create a new Angular application and two reusable component libraries: a header and a sidebar components. Both libraries can be built and published to NPM separately. Also, the application is going to be linked with the component libraries locally. That allows developing and testing components with the main application.

Creating new application

Let's use Angular CLI to create a new application and call it "ng-framework". You can use that application to test components before building and publishing them to NPM, or redistributing via other resources.

```
ng new ng-framework
```

For convenience purposes, you can change the "start" script to also launch the application in the browser. To do that, open the "package.json" file and append "–open" argument to the "start" command:

```
{
    "scripts": {
        "start": "ng serve --open"
    }
}
```

Next, you need to install the "ng-packagr" library as a development dependency.

```
npm install ng-packagr --save-dev
```

At this point, the project setup is complete, and you are ready to start building reusable component libraries.

[84]https://github.com/dherges/ng-packagr
[85]https://docs.google.com/document/d/1CZC2rcpxffTDfRDs6p1cfbmKNLA6x5O-NtkJglDaBVs/preview

Creating component libraries

Now, we are going to create two separate projects with the "header" and "sidebar" components. That should be more than enough to demonstrate publishing and consuming multiple component libraries.

In the root project folder, run the following commands to create an initial folder structure.

```
mkdir -p modules/header/src
mkdir -p modules/sidebar/src
```

As you can see, the "modules" folder contains all the component projects as subfolders.

Let's start with the "header" component first, and you can then perform similar steps to implement the "sidebar".

First, create a component class and give it a unique selector to avoid clashes at runtime. The value can be anything of your choice, for this guide we are going to use "ngfw-header".

modules/header/src/header.component.ts

```
import { Component, OnInit } from '@angular/core';

@Component({
  selector: 'ngfw-header',
  templateUrl: './header.component.html',
  styleUrls: ['./header.component.css']
})
export class HeaderComponent {}
```

The template is going to be very simple. An "h1" element wrapping the "ng-content" is the minimal implementation we need right now. You can always extend it later with the more sophisticated layout and behaviour.

modules/header/src/header.component.html

```
<h1>
  <ng-content></ng-content>
</h1>
```

Add some CSS to be sure the styles are also loaded from the package when we start using it with the application. In our case, the colour of the header is going to be red.

modules/header/src/header.component.css

```css
h1 {
  color: red;
}
```

Finally, as per Angular architecture, we need to have a module that imports all necessary dependencies and provides declarations and exports. The most important part of our scenario is to put the "HeaderComponent" to the "exports" collection.

modules/header/src/header.module.ts

```ts
import { NgModule } from '@angular/core';
import { CommonModule } from '@angular/common';
import { HeaderComponent } from './header.component';

@NgModule({
  imports: [
    CommonModule
  ],
  declarations: [
    HeaderComponent
  ],
  exports: [
    HeaderComponent
  ]
})
export class HeaderModule { }
```

As the "header" component it planned to be published as a separate library, we need to provide a "package.json" file.

Below is a simple set of details that needs to be in "package.json" for a library before publishing. Note that you can also use NPM scopes to have unique library names associated with your NPM account for instance.

modules/header/package.json

```
{
  "name": "@denysvuika/ng-framework-header",
  "version": "1.0.0",
  "author": "Denys Vuika <denys.vuika@gmail.com>",
  "license": "MIT",
  "private": false,
  "peerDependencies": {
    "@angular/common": "^5.0.0",
    "@angular/core": "^5.0.0"
  }
}
```

modules/header/public_api.ts

```
export * from './src/header.module';
```

Now you can repeat the steps above to implement the second “sidebar” component. The only difference is the name of the project in the “package.json” file.

modules/sidebar/package.json

```
{
  "name": "@denysvuika/ng-framework-sidebar",
  ...
}
```

Also, let’s also change the colour to “green”, just to see we are dealing with two different stylesheets at runtime.

modules/sidebar/src/sidebar.component.css

```
h1 {
  color: green;
}
```

Building the packages

To build the project and produce bundles we need to create a “ng-package.json” file for the “ng-packagr”. The file should live next to the “package.json” in the library root folder.

modules/header/ng-package.json

```
{
  "$schema": "../../node_modules/ng-packagr/ng-package.schema.json",
  "lib": {
    "entryFile": "public_api.ts"
  }
}
```

Note that the same file should be present in both our library root folders. Feel free to copy and paste it, since the file does not contain any project-specific content at this point.

To build a project with “ng-packagr”, we can provide a path to the configuration file. That also allows us to build more than one project from the NPM scripts. You can refer to the example below, with only the change needed for the build, for the sake of simplicity.

package.json

```
{
    "scripts": {
        ...,
        "build:modules": "ng-packagr -p ./modules/header/ng-package.json && ng-packa\
gr -p ./modules/sidebar/ng-package.json"
    }
}
```

Now go to the root folder and execute the following command to build our libraries:

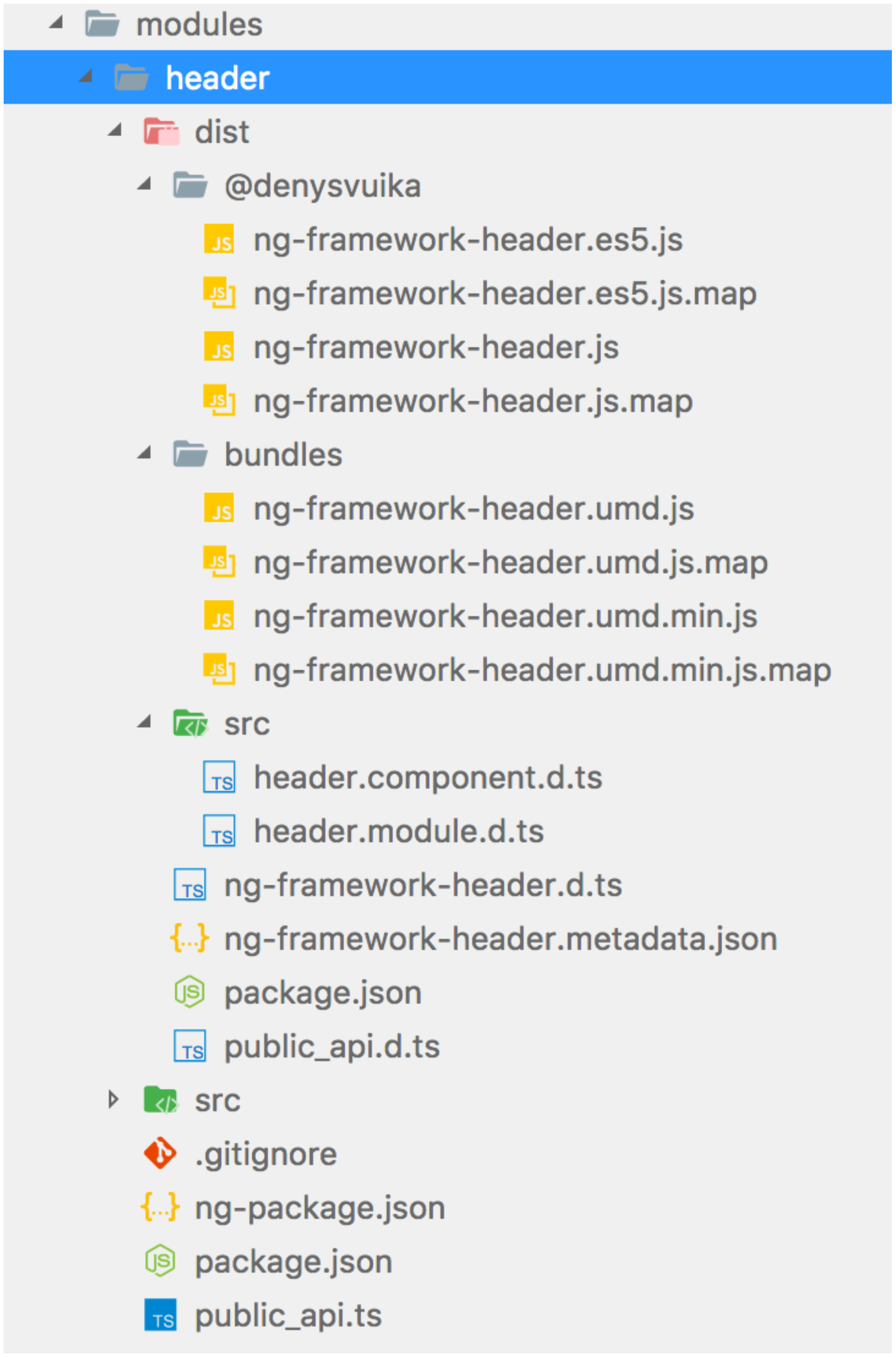
```
npm run build:modules
```

You should see the output similar to the following:

```
$ ng-packagr -p ./modules/header/ng-package.json
Building Angular library
Generating bundle for @denysvuika/ng-framework-header
Cleaning bundle build directory
Processing assets
Running ngc
Compiling to FESM15
Compiling to FESM5
Compiling to UMD
Minifying UMD bundle
Remapping source maps
```

```
Copying staged files
Writing package metadata
Built Angular bundle for @denysvuika/ng-framework-header

Building Angular library
Generating bundle for @denysvuika/ng-framework-sidebar
Cleaning bundle build directory
Processing assets
Running ngc
Compiling to FESM15
Compiling to FESM5
Compiling to UMD
Minifying UMD bundle
Remapping source maps
Copying staged files
Writing package metadata
```

The resulting bundles are in the “dist” folder for every compiled project. Try expanding the one for the “header” component, and you should see the structure similar to that in the screenshot below:



```
modules
  header
    dist
      @denysvuika
        ng-framework-header.es5.js
        ng-framework-header.es5.js.map
        ng-framework-header.js
        ng-framework-header.js.map
      bundles
        ng-framework-header.umd.js
        ng-framework-header.umd.js.map
        ng-framework-header.umd.min.js
        ng-framework-header.umd.min.js.map
      src
        header.component.d.ts
        header.module.d.ts
      ng-framework-header.d.ts
      ng-framework-header.metadata.json
      package.json
      public_api.d.ts
    src
    .gitignore
    ng-package.json
    package.json
    public_api.ts
```

Publishing to NPM

You need to have an NPM account to publish libraries. Once you get it, the process is relatively simple. You need to run the “npm publish” command from within every “dist” folder the “ng-packagr” creates. If you publish the very first version of the library, the “access” attribute needs to be present as well, for example:

```
cd modules/header/dist
npm publish --access public
```

Package scope

You will need to change the scope of your package to be able to publish the project under your account.

Integrating with the application

Developing components can take time, and you also need to test them and get running in some demo application before publishing to NPM. For this case, we need to link the projects as if they got installed from the public source.

First, we modify the root “tsconfig.json” file to map component namespaces to the corresponding “dist” folders. That should also enable code completion support and type checking in your IDE.

tsconfig.json

```
{
    "compileOnSave": false,
    "compilerOptions": {
        ...,

        "baseUrl": ".",
        "paths": {
            "@denysvuika/ng-framework-header": [ "modules/header/dist" ],
            "@denysvuika/ng-framework-sidebar": [ "modules/sidebar/dist" ]
        }
    }
}
```

So now, every time you reference the “@denysvuika/ng-framework-header” namespace, the application is going to fetch the code from the “modules/header/dist” folder instead of the “node_modules” one. Similar behaviour is going to be for the “sidebar” component as well. You can map as many paths as you need.

For the second step, you need to update the “tsconfig.app.json” file and map the namespaces to the corresponding “public_api.ts” files. We define the mappings for both “compilerOptions” and “angularCompilerOptions” as in the next example:

src/tsconfig.app.json

```
{
  "extends": "../tsconfig.json",
  "compilerOptions": {
    "outDir": "../out-tsc/app",
    "baseUrl": "./",
    "module": "es2015",
    "types": [],
    "paths": {
      "@denysvuika/ng-framework-header": [ "../modules/header/public_api.ts" ],
      "@denysvuika/ng-framework-sidebar": [ "../modules/sidebar/public_api.ts" ]
    }
  },
  "exclude": [
    "test.ts",
    "**/*.spec.ts"
  ],
  "angularCompilerOptions": {
    "paths": {
      "@denysvuika/ng-framework-header": [ "../modules/header/public_api.ts" ],
      "@denysvuika/ng-framework-sidebar": [ "../modules/sidebar/public_api.ts" ]
    }
  }
}
```

Finally, let’s use our libraries in the application as if they got installed from the NPM. Import the “HeaderModule” and “SidebarModule” from the corresponding namespaces into the main application module.

src/app/app.module.ts

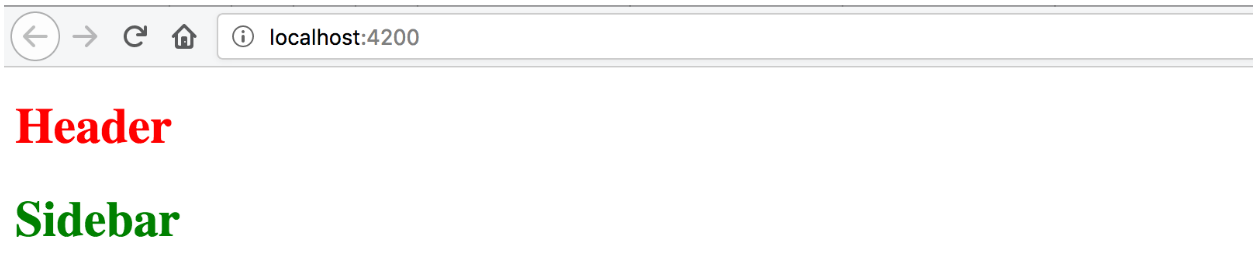
```
import { BrowserModule } from '@angular/platform-browser';
import { NgModule } from '@angular/core';

import { HeaderModule } from '@denysvuika/ng-framework-header';
import { SidebarModule } from '@denysvuika/ng-framework-sidebar';

import { AppComponent } from './app.component';

@NgModule({
  declarations: [
    AppComponent
  ],
  imports: [
    BrowserModule,
    HeaderModule,
    SidebarModule
  ],
  providers: [],
  bootstrap: [AppComponent]
})
export class AppModule { }
```

Replace the content of the main application component template with the next markup:

src/app/app.component.html

```
<ngfw-header>Header</ngfw-header>
<ngfw-sidebar>Sidebar</ngfw-sidebar>
```

Serve the application with "npm start", and you should see the following output:



Header

Sidebar

The configuration is complete. You are now ready to build, test and publish component libraries.

See also

Building an Angular 4 Component Library with the Angular CLI and ng-packagr[86]

Source code

You can find the source code in the “ng-framework[87]” repository. Don’t forget to change the package names and NPM scopes if you intend publishing projects to NPM.

[86]https://medium.com/@ngl817/building-an-angular-4-component-library-with-the-angular-cli-and-ng-packagr-53b2ade0701e
[87]https://gitlab.com/DenysVuika/ng-framework

Using with Docker

In this chapter, we are going to provide Docker support for an Angular application. We are about to create a Docker image that contains the prebuilt code, test it in the container, publish and consume from Docker Hub, and even automate builds and publishing with Travis CI.

As a prerequisite, you need to get a community edition of the Docker for your platform:

- Docker CE for Mac[88]
- Docker CE for Windows[89]

Additional Resources

If you want to get more information on the Docker and how to use it, please refer to the following Udemy course: Docker Mastery: The Complete Toolset From a Docker Captain[90].

If you use Visual Studio Code for development, the “Docker” extension might help you a lot: Docker for VS Code[91]. The Docker extension makes it easy to build and deploy containerized applications from Visual Studio Code.

Preparing new project

Let’s start by using an Angular CLI to create a new project scaffold. We are going to name it “ng-docker”.

```
ng new ng-docker
cd ng-docker
```

Before we continue, please ensure the project builds and runs successfully on your local machine by running the following command:

```
npm start
```

Next, visit the `http://localhost:4200/` to see the default application content that Angular CLI provides you out of the box.

[88]https://store.docker.com/editions/community/docker-ce-desktop-mac
[89]https://store.docker.com/editions/community/docker-ce-desktop-windows
[90]https://www.udemy.com/docker-mastery/
[91]https://marketplace.visualstudio.com/items?itemName=PeterJausovec.vscode-docker

Creating Dockerfile

First of all, you need to build an application to get the “dist” folder with the content ready to redistribute.

```
npm run build
```

In the project root, create a file named “Dockerfile” with the following content:

Dockerfile

```
FROM nginx

COPY nginx.conf /etc/nginx/nginx.conf

WORKDIR /usr/share/nginx/html
COPY dist/ .
```

The image extends the public “nginx[92]” one. Besides, we provide an external configuration to serve our application and copy the contents of the “dist” folder into the image.

The minimal “nginx” configuration can be as following:

nginx.conf

```
worker_processes  1;

events {
    worker_connections  1024;
}

http {
    server {
        listen 80;
        server_name  localhost;

        root   /usr/share/nginx/html;
        index  index.html index.htm;
        include /etc/nginx/mime.types;

        gzip on;
        gzip_min_length 1000;
        gzip_proxied expired no-cache no-store private auth;
```

[92]https://hub.docker.com/_/nginx/

```
        gzip_types text/plain text/css application/json application/javascript appli\
cation/x-javascript text/xml application/xml application/xml+rss text/javascript;

        location / {
            try_files $uri $uri/ /index.html;
        }
    }
}
```

Deployment

There are multiple deployment scenarios documented in the official documentation: "Deployment[93]". Please refer to that article if you want to get more information on available options and best practices.

Now, let's build the image using the next command:

```
docker image build -t ng-docker .
```

Note the dot character at the end of the command as it is essential.

You can also list your local images to ensure the "ng-docker" got created successfully.

```
docker image ls
```

Excluding the images you may already have created or pulled, you should see the at least the following output:

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
ng-docker	latest	98b129bff2fc	24 seconds ago	114MB

Testing in a container

It is now an excellent time to test our image in a container. Use the following command to create a temporary container out of our image, and run the application at port 3000:

```
docker container run -p 3000:80 --rm ng-docker
```

Once you stop the process with "Ctrl+C", the Docker is going to perform a cleanup.

[93]https://angular.io/guide/deployment

Running the container should not take much time. If you now visit the `http://localhost:3000/` in your browser, you should see the Angular CLI application up and running.

Note that the log output gets redirected to your console. You should see the "nginx" output if you switch to the console right now:

```
172.17.0.1 - - [16/Dec/2017:11:41:33 +0000] "GET / HTTP/1.1" 200 611 "-" "Mozilla/5.\
0 (Macintosh; Intel Mac OS X 10.13; rv:57.0) Gecko/20100101 Firefox/57.0"
172.17.0.1 - - [16/Dec/2017:11:41:33 +0000] "GET /inline.bundle.js HTTP/1.1" 200 186\
3 "http://localhost:3000/" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.13; rv:57.0) G\
ecko/20100101 Firefox/57.0"
172.17.0.1 - - [16/Dec/2017:11:41:33 +0000] "GET /polyfills.bundle.js HTTP/1.1" 200 \
50339 "http://localhost:3000/" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.13; rv:57.\
0) Gecko/20100101 Firefox/57.0"
172.17.0.1 - - [16/Dec/2017:11:41:33 +0000] "GET /styles.bundle.js HTTP/1.1" 200 393\
0 "http://localhost:3000/" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.13; rv:57.0) G\
ecko/20100101 Firefox/57.0"
172.17.0.1 - - [16/Dec/2017:11:41:33 +0000] "GET /vendor.bundle.js HTTP/1.1" 200 492\
190 "http://localhost:3000/" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.13; rv:57.0)\
 Gecko/20100101 Firefox/57.0"
172.17.0.1 - - [16/Dec/2017:11:41:33 +0000] "GET /main.bundle.js HTTP/1.1" 200 2526 \
"http://localhost:3000/" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.13; rv:57.0) Gec\
ko/20100101 Firefox/57.0"
```

You can now stop the process and let Docker cleanup the data, or continue experimenting with the application.

Creating docker-compose.yml

For the next step, let's create a simple "docker-compose" file with our Angular application.

```yaml
version: '3.1'

services:
    app:
        image: 'ng-docker'
        build: '.'
        ports:
            - 3000:80
```

Note that we have put the "build" parameter so that Docker builds our local image instead of pulling it from the repository. The Application runs on port 3000 and maps to port 80 inside the container.

You can now run the following command to test the container and docker compose file:

```
docker-compose up
```

The console output should be similar to the following:

```
Creating network "ngdocker_default" with the default driver
Creating ngdocker_app_1 ...
Creating ngdocker_app_1 ... done
Attaching to ngdocker_app_1
```

Once again, visit the `http://localhost:3000` address and ensure the application is up and running.

As soon as you are done testing, press "Ctrl+C" to stop the process, and run the next command if you want to perform a cleanup operation:

```
docker-compose down
```

The Docker cleans only the containers created by our docker-compose file. Add the "–rmi all" parameter if you want to remove the images as well.

```
docker-compose down --rmi all
```

The console output, in this case, should be similar to the example below:

```
Removing ngdocker_app_1 ... done
Removing network ngdocker_default
Removing image ng-docker
```

You now need to publish your image to the docker hub to allow other people use your docker-compose file or build their custom containers with your Angular application image.

Publishing to Docker Hub

In this section, we are going to publish our application image to the public Docker Hub[94]. You can create a new account if you do not yet have one, this takes a couple of minutes.

If you clone a new copy of the project to publish it directly to the Docker Hub, don't forget to install dependencies. In all the cases you should also create a fresh build of the application to be sure the resulting image contains all the latest source code changes.

[94]https://hub.docker.com/

```
npm install
npm run build
```

Let's now build the image and tag it for publishing:

```
docker image build -t account/ng-docker:1.0 .
```

Note that typically you are going to replace the `account` prefix with your account name.

To publish the image run the next command with your account name instead of the "account" prefix:

```
docker push account/ng-docker:1.0
```

In less than a minute your image should be published and available online.

Consuming from Docker Hub

You have successfully published your Angular application image to the Docker Hub, and before testing it out locally, you should remove the one created earlier before publishing.

Please use the following command to remove the existing image:

```
docker image rm account/ng-docker:1.0
```

Now let's create a temporary container and pull the image from the public repository. Replace the "account" prefix with your Docker Hub account name.

```
docker container run -p 3000:80 --rm account/ng-docker:1.0
```

This time you should see Docker downloading and unpacking your image from the internet. Once the setup is over, visit the `http://localhost:3000` and ensure the application is available and running fine.

Automating with Travis

If you use Travis CI[95] for your development and testing, you can set it up to automatically build and deploy images to the Docker Hub.

You can refer to the following ".travis.yml" template as an example:

[95]https://travis-ci.org/

.travis.yml

```
sudo: required

language: node_js
node_js:
  - "8"

cache:
  directories:
    - ./node_modules

services:
  - docker

before_install:
  - "export DISPLAY=:99.0"
  - "sh -e /etc/init.d/xvfb start"

script:
  - npm install
  - npm run build
  - npm run test -- --single-run --no-progress

after_success:
  - docker build -t account/ng-docker .
  - docker login -u "$DOCKER_USERNAME" -p "$DOCKER_PASSWORD"
  - docker push account/ng-docker
```

The configuration file allows to build your Angular application and run unit tests.

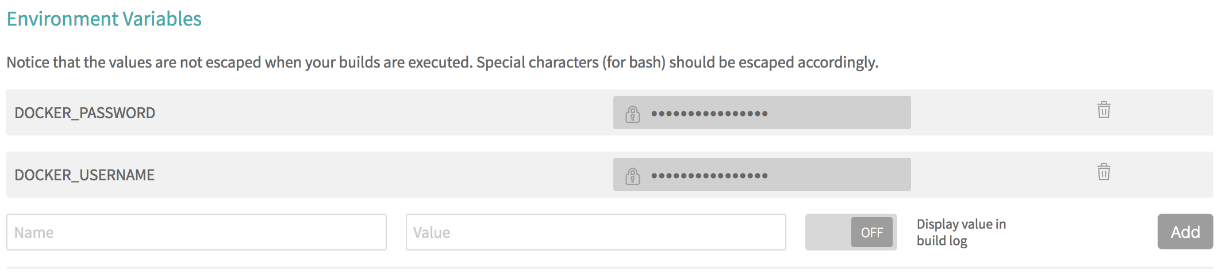
```
script:
  - npm install
  - npm run build
  - npm run test -- --single-run --no-progress
```

As soon as test run is successful, we instruct Travis to build a new Docker image, log in to Docker Hub and push the image to your account.

```
after_success:
  - docker build -t account/ng-docker .
  - docker login -u "$DOCKER_USERNAME" -p "$DOCKER_PASSWORD"
  - docker push account/ng-docker
```

Note that we store credentials as encrypted environment variables, and refer to as `$DOCKER_USERNAME` and `$DOCKER_PASSWORD`.

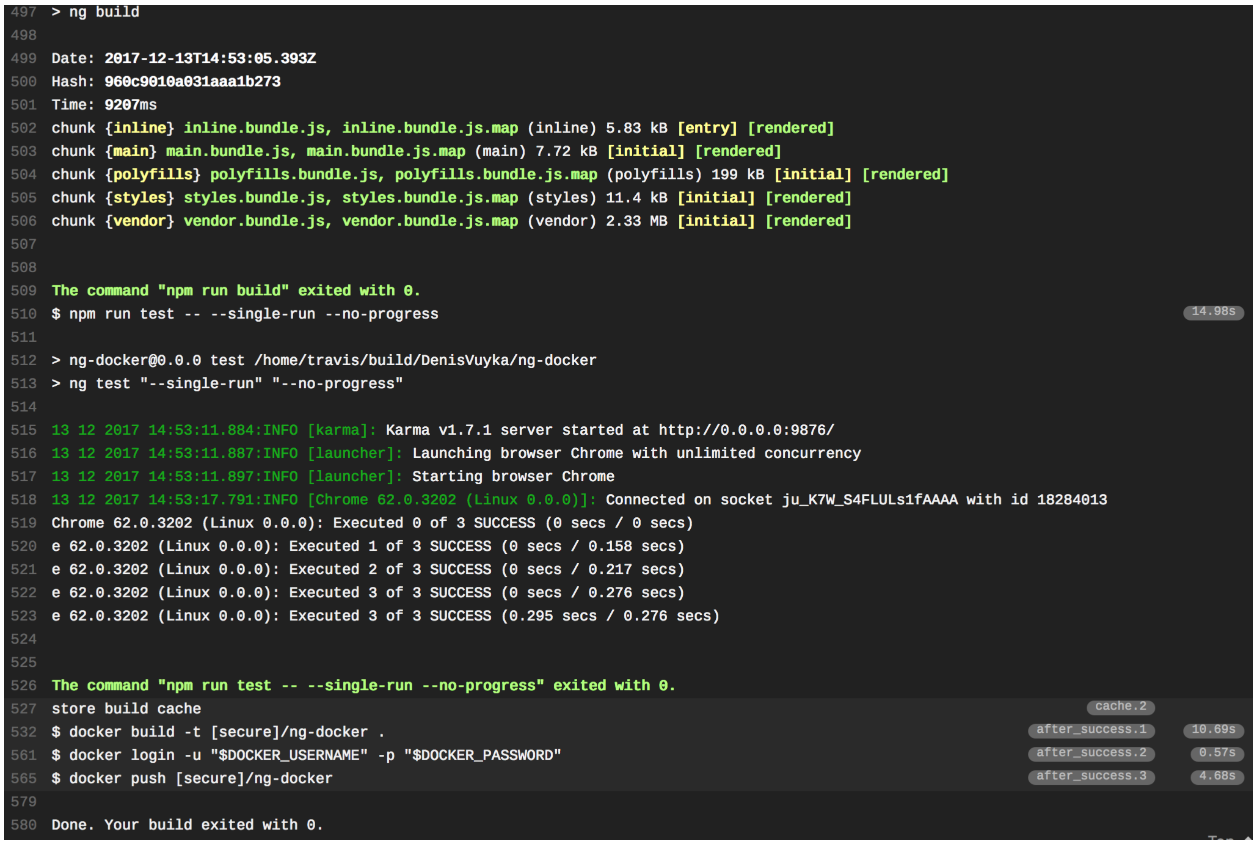
Also, you can either hardcode the correct "account" prefix or use the "$DOCKER_USERNAME" value there as well.


Environment Variables

Notice that the values are not escaped when your builds are executed. Special characters (for bash) should be escaped accordingly.

DOCKER_PASSWORD	••••••••••••••••
DOCKER_USERNAME	••••••••••••••••

Now, if you push the code and switch to the Travis output, you are going to see something like the following:



```
> ng build

Date: 2017-12-13T14:53:05.393Z
Hash: 960c9010a031aaa1b273
Time: 9207ms
chunk {inline} inline.bundle.js, inline.bundle.js.map (inline) 5.83 kB [entry] [rendered]
chunk {main} main.bundle.js, main.bundle.js.map (main) 7.72 kB [initial] [rendered]
chunk {polyfills} polyfills.bundle.js, polyfills.bundle.js.map (polyfills) 199 kB [initial] [rendered]
chunk {styles} styles.bundle.js, styles.bundle.js.map (styles) 11.4 kB [initial] [rendered]
chunk {vendor} vendor.bundle.js, vendor.bundle.js.map (vendor) 2.33 MB [initial] [rendered]


The command "npm run build" exited with 0.
$ npm run test -- --single-run --no-progress                                                14.98s

> ng-docker@0.0.0 test /home/travis/build/DenisVuyka/ng-docker
> ng test "--single-run" "--no-progress"

13 12 2017 14:53:11.884:INFO [karma]: Karma v1.7.1 server started at http://0.0.0.0:9876/
13 12 2017 14:53:11.887:INFO [launcher]: Launching browser Chrome with unlimited concurrency
13 12 2017 14:53:11.897:INFO [launcher]: Starting browser Chrome
13 12 2017 14:53:17.791:INFO [Chrome 62.0.3202 (Linux 0.0.0)]: Connected on socket ju_K7W_S4FLULs1fAAAA with id 18284013
Chrome 62.0.3202 (Linux 0.0.0): Executed 0 of 3 SUCCESS (0 secs / 0 secs)
e 62.0.3202 (Linux 0.0.0): Executed 1 of 3 SUCCESS (0 secs / 0.158 secs)
e 62.0.3202 (Linux 0.0.0): Executed 2 of 3 SUCCESS (0 secs / 0.217 secs)
e 62.0.3202 (Linux 0.0.0): Executed 3 of 3 SUCCESS (0 secs / 0.276 secs)
e 62.0.3202 (Linux 0.0.0): Executed 3 of 3 SUCCESS (0.295 secs / 0.276 secs)


The command "npm run test -- --single-run --no-progress" exited with 0.
store build cache                                                              cache.2
$ docker build -t [secure]/ng-docker .                                 after_success.1    10.69s
$ docker login -u "$DOCKER_USERNAME" -p "$DOCKER_PASSWORD"             after_success.2     0.57s
$ docker push [secure]/ng-docker                                       after_success.3     4.68s

Done. Your build exited with 0.
```

See also

Using Docker in Builds[96]

Source code

You can find the source code in the "angular/ng-docker[97]" folder.

[96]https://docs.travis-ci.com/user/docker/
[97]https://github.com/DenysVuika/developing-with-angular/tree/master/angular/ng-docker

Webpack

Webpack is the most popular module bundler for modern JavaScript applications. It takes modules with dependencies and generates static assets representing those modules.

In this chapter, we are going to learn how to integrate Typescript with webpack.

Initial project structure

First, let's create a basic project structure using `npm` and `node.js`. The application is going to be called `webpack-example`.

Source code

You can find the source code in the "webpack/webpack-example[98]" folder.

```
mkdir webpack-example
cd webpack-example
npm init -y
```

Initial set of dependencies:

```
npm install --save-dev webpack
npm install --save-dev typescript
npm install --save-dev ts-loader
npm install --save-dev @types/node
```

Typescript configuration

Create a new `tsconfig.json` file with the following content:

[98]https://github.com/DenysVuika/developing-with-angular/tree/master/webpack/webpack-example

```
{
    "compilerOptions": {
        "target": "es5",
        "module": "commonjs",
        "moduleResolution": "node",
        "sourceMap": true,
        "emitDecoratorMetadata": true,
        "experimentalDecorators": true,
        "lib": [ "es2015", "dom" ],
        "noImplicitAny": false,
        "suppressImplicitAnyIndexErrors": true,
        "outDir": "./dist/",
        "allowJs": true
    },
    "exclude": [
        "node_modules",
        "dist"
    ]
}
```

It is a typical Typescript configuration with additional support for experimental decorators required by Angular, and source map generation to allow debugging Typescript code in browser developer tools.

Basic webpack setup

Let's start with creating a `webpack.config.js` file in the project root folder:

```
module.exports = {
    entry: './src/main.ts',
    output: {
        path: './dist',
        filename: 'bundle.js'
    },
    module: {
        rules: [
            {
                test: /\.ts$/,
                loader: 'ts-loader',
                exclude: /node_modules/,
            }
        ]
    },
    resolve: {
        extensions: [".ts", ".js"]
    }
};
```

We are keeping all source files in the `src` folder. The main `entry` is going to be `./src/main.ts` file. Based on configuration webpack is going to create a bundle called `bundle.js` and store it in the `dist` folder. If you delete `dist` folder (in the future you might be doing that before each production build), it gets automatically recreated during the next bundle compilation.

Also, we define a `ts-loader` webpack loader to work with all TypeScript files in our project. Your project may contain many 3rd party libraries stored in the `node_modules` folder, so we exclude it processing.

Finally, `resolve.extensions` config is set to `.ts` and `.js`. That means webpack is going to resolve class imports by appending given extensions.

For example:

```
import { TextWidget } from 'widgets';
```

Webpack should start probing the following files to get the content for import:

```
widgets.ts
widgets.js
```

Enabling source maps

First, you need installing `source-map-loader` library:

```
npm install --save-dev source-map-loader
```

We have already configured `sourceMap: true` property in the `tsconfig.json` during previous steps. Now update the configuration file with the following rules:

```
...
rules: [
    {
        enforce: 'pre',
        test: /\.js$/,
        loader: "source-map-loader"
    },
    {
        enforce: 'pre',
        test: /\.ts$/,
        use: "source-map-loader"
    }
    ...
]
...
```

Based on settings above webpack is instructed to run `source-map-loader` for `.js` and `.ts` files before any other loaders through the `enforce: 'pre'`.

Finally, we enable source mapping by setting the `devtool` property value:

```
devtool: 'inline-source-map'
```

Simple Angular application

Let's build a minimal Angular application to bundle.

Open your `package.json` file and put the following Angular libraries to the `dependencies` section:

```
{
    "dependencies": {
        "@angular/common": "2.4.7",
        "@angular/compiler": "2.4.7",
        "@angular/compiler-cli": "2.4.7",
        "@angular/core": "2.4.7",
        "@angular/forms": "2.4.7",
        "@angular/http": "2.4.7",
        "@angular/material": "2.0.0-beta.1",
        "@angular/platform-browser": "2.4.7",
        "@angular/platform-browser-dynamic": "2.4.7",
        "@angular/router": "3.4.7",
        "core-js": "2.4.1",
        "reflect-metadata": "0.1.9",
        "rxjs": "5.1.0",
        "zone.js": "0.7.6"
    }
}
```

Above is a common set of Angular libraries used for web applications. Save the file and run `npm install` to download and install all dependencies.

src/main.ts

```
import 'core-js/es6';
import 'core-js/es7/reflect';
require('zone.js/dist/zone');

import { platformBrowserDynamic } from '@angular/platform-browser-dynamic';
import { enableProdMode } from '@angular/core';
import { AppModule } from './app/app.module';

const platform = platformBrowserDynamic();
platform.bootstrapModule(AppModule);
```

src/app/app.component.ts

```
import { Component } from '@angular/core';

@Component({
    selector: 'my-app',
    template: `
        <h1>Hello from an Angular app.</h1>
    `
})
export class AppComponent { }
```

src/app/app.module.ts

```
import { NgModule } from '@angular/core';
import { BrowserModule } from '@angular/platform-browser';

import { AppComponent } from './app.component';

@NgModule({
    imports: [ BrowserModule ],
    declarations: [ AppComponent ],
    bootstrap: [ AppComponent ]
})
export class AppModule { }
```

Generating index page

There's a very useful webpack plugin `html-webpack-plugin` that allows generating HTML pages hosting webpack bundles. Webpack supports hash generation for output file names that change with every compilation, so automatic page generation becomes handy. The plugin takes care of scripts files and puts them in proper places in the resulting document.

```
npm install --save-dev html-webpack-plugin
```

You can create either default HTML template or provide your custom one. In our case, we are going to provide a custom template containing Angular application component.

src/index.html

```html
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <title>Webpack 2</title>
    <base href="/">
</head>
<body>
    <my-app>Loading AppComponent content here ...</my-app>
</body>
</html>
```

You can get more details here: html-webpack-plugin[99].

In order to integrate the plugin add the following settings to `webpack.config.js`:

[99] https://www.npmjs.com/package/html-webpack-plugin

webpack.config.js

```
const HtmlWebpackPlugin = require('html-webpack-plugin');

module.exports = {

    plugins: [

        new HtmlWebpackPlugin({
            template: 'src/index.html'
        })

    ]

}
```

Development server

Once the page is ready, you need some development server to test it. It is suggested to use `webpack-dev-server` that besides serving capabilities also supports watching for file changes and livereload.

Install it with the following command:

```
npm install --save-dev webpack-dev-server
```

Edit `webpack.config.js` file to add the following settings:

webpack.config.js

```
const path = require('path');

module.exports = {
    ...

    devServer: {
        contentBase: path.join(__dirname, "dist"),
        host: '0.0.0.0',
        port: 3000,
        historyApiFallback: true,
        compress: true
        // inline: true
    }
};
```

Above is basic configuration section for `webpack-dev-server`.

- `contentBase` tells server where static content reside, in our case it is `dist` subdirectory;
- `host` and `port` properties are set to **0.0.0.0:3000**, you can use either `http://localhost:3000` or `http://0.0.0.0:3000` to browse your site once the server is up and running. You can also access the website from the local network in case you are using multiple computers or virtual machines.
- by setting `historyApiFallback` to `true` you enable **single page application** mode support, the server responds with `index.html` content for all 404 responses;
- `compress` enables **gzip compression** for all content served, significantly improves the load time of your web application;

For a full list of available options, please refer to the official documentation[100].

Start command with NPM

The final step is creating a `start` script to automate compilation and startup. Open the `package.json` file and add the following line inside `scripts` section:

```
{
    "scripts": {
        "start": "webpack-dev-server"
    }
}
```

Now you are ready to compile and run the application:

```
npm start
```

Webpack bundles all scripts and serves resulting application at `http://localhost:3000`. You should see the following text when browsing the main page at given address:

```
Hello from an Angular app.
```

The `webpack-dev-server` remains running and watching for changes. It also enables `live reload` feature for browsers by default. Every time you change and save your source code, the application is getting recompiled in the background, and the browser should reload automatically.

To test live reload open `src/app/app.component.ts` and edit `template` without stopping the server:

[100]https://webpack.js.org/configuration/dev-server/

src/app/app.component.ts

```
import { Component } from '@angular/core';

@Component({
    selector: 'my-app',
    template: `
        <h1>Hello from Angular app and Webpack.</h1>
    `
})
export class AppComponent { }
```

After several seconds your browser page should reload and render updated HTML content:

```
Hello from Angular app and Webpack.
```

Another remarkable feature is a fast `in-memory` compilation. Webpack does not create files on the disk when running in development mode.

Fixing Angular warnings

You may see one or multiple warnings related to Angular during compilation, something like shown below:

```
WARNING in ./~/@angular/core/src/linker/system_js_ng_module_factory_loader.js
71:15-36 Critical dependency: the request of a dependency is an expression
```

It is a known issue and should be addressed in the future. Meanwhile, there is a workaround for this involving `ContextReplacementPlugin` plugin.

Add the following plugin to the `plugins` collection in your `webpack.config.js` file:

webpack.config.js

```
const webpack = require("webpack");

module.exports = {

    plugins: [

        // Workaround for angular/angular#11580
        new webpack.ContextReplacementPlugin(
            // The (\\|\/) piece accounts for path separators in *nix and Windows
            /angular(\\|\/)core(\\|\/)(esm(\\|\/)src|src)(\\|\/)linker/,
            path.join(__dirname, 'src'), // location of your src
            {} // a map of your routes
        )

    ]

};
```

Once dev server is restarted the warnings should go away.

Testing source maps

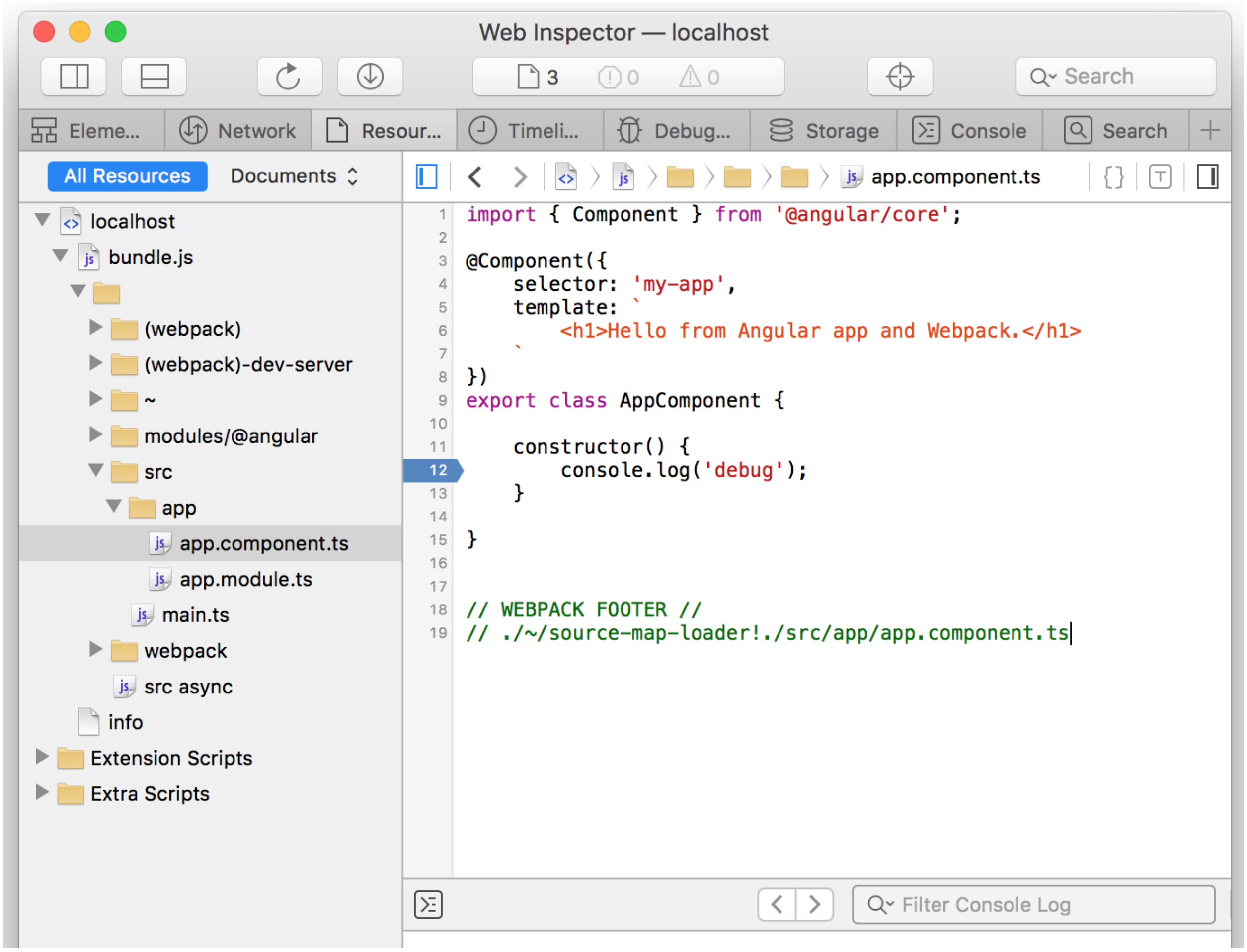
You have configured `source-map-loader` earlier. Let's ensure it is working with webpack and you can indeed debug TypeScript code.

Add some additional code to `app.component.ts` to be able setting breakpoints:

app.component.ts

```
@Component(...)
export class AppComponent {

    constructor() {
        console.log('debug');
    }

}
```

Now launch your browser developer tools and detect `app.component.ts`:



```
import { Component } from '@angular/core';

@Component({
    selector: 'my-app',
    template: `
        <h1>Hello from Angular app and Webpack.</h1>
    `
})
export class AppComponent {

    constructor() {
        console.log('debug');
    }

}


// WEBPACK FOOTER //
// ./~/source-map-loader!./src/app/app.component.ts
```

Try putting a breakpoint at `console.log('debug')` line and reloading the page.

Note that you are running plain JavaScript, but thanks to source map generation provided by TypeScript and `source-map-loader` webpack loader it becomes possible working with and debugging TypeScript code.

Advanced webpack setup

As per Angular Style Guide[101], you might be following the *one-thing-per-file* rule and storing code, tests, templates and styles in separate files.

For example:

[101]https://angular.io/docs/ts/latest/guide/style-guide.html#!#application-structure-and-angular-modules

```
app.component.ts
app.component.html
app.component.css
app.component.spec.ts
```

While Angular provides ways referencing external content it does not do any runtime importing or path resolution, it relies on module loaders and bundlers instead.

External Html templates

Angular's `Component` decorator supports both inline and external templates. We have been using inline templates earlier:

```
@Component({
    selector: 'my-app',
    template: '<h1>Simple inline template</h1>'
})
export class AppComponent {}
```

Most of the popular code editors already support mixed content and provide syntax highlighting and auto-completion. However, while it might be convenient to keep small HTML template close to the code, once the HTML grows it becomes harder to maintain it. Also, it is recommended splitting component implementation into different files for better maintainability.

To use an external template you replace `template` property with the `templateUrl` one pointing to the `html` file:

```
@Component({
    selector: 'my-app',
    templateUrl: './path/to/template.html'
})
export class AppComponent {}
```

There's a special `angular2-template-loader` loader for webpack that inlines all HTML templates and CSS styles in Angular components.

Install it with the following command:

```
npm install --save-dev angular2-template-loader
```

Now it can be associated with the TypeScript files in your project. Replace previously defined `.ts` rule in the `webpack.config.js` file with the following one:

webpack.config.js

```
module.exports = {
    module: {
        rules: [
            {
                test: /\.ts$/,
                use: [
                    'ts-loader',
                    'angular2-template-loader'
                ],
                exclude: /node_modules/
            }
        ]
    }
}
```

Loaders are invoked from left to right, or as in our case from bottom to top. That means TypeScript passes every TypeScript file to `angular2-template-loader` at first. Then `ts-loader` receives processed TypeScript files with inlined HTML templates and transpile them to JavaScript.

You also need adding `html-loader` webpack loader that enables reading HTML files:

```
npm install --save-dev html-loader
```

Update `webpack.config.js` configuration file associate all project `.html` files with the `html-loader`:

webpack.config.js

```
module.exports = {
    module: {
        rules: [
            {
                test: /\.html$/,
                loader: 'html-loader'
            }
        ]
    }
}
```

You can now extract and place HTML template of the component into a separate file:

src/app/app.component.html

```
<h1>Hello from Angular app and Webpack.</h1>
<small>(external template)</small>
```

src/app/app.component.ts

```
import { Component } from '@angular/core';

@Component({
    selector: 'my-app',
    templateUrl: './app.component.html'
})
export class AppComponent {}
```

As you can see besides `template` property Angular also provides `templateUrl` for the `Component` decorator.

Now if you run the project with `npm start` script you should see the following content on the main page:

```
Hello from Angular app and Webpack.
(external template)
```

External CSS styles

Angular supports both inline and external styles within `Component` decorator. You can provide multiple styles per component using `styleUrls` property taking an array of values:

src/app/app.component.ts

```
@Component({
    selector: 'my-app',
    templateUrl: './app.component.html',
    styleUrls: ['./app.component.css']
})
export class AppComponent {}
```

Create a new `app.component.css` style next to the `html` and `ts` files with the following content:

src/app/app.component.css

```css
.main-title {
    color: blueviolet;
}
```

Assign newly introduced `main-title` class to the first element of the `app.component.html` file:

src/app/app.component.html

```html
<h1 class="main-title">Hello from Angular app and Webpack.</h1>
<small>(external template)</small>
```

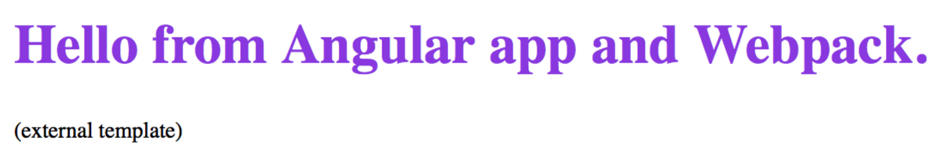
The `angular2-template-loader` is capable of loading `.html` and `.css` files. It is working best with the `raw-loader` that lets you importing files as strings to inline them into compiled Angular code.

```
npm install --save-dev raw-loader
```

For current scenario we need to use `raw-loader` only with our Angular components and their styles, all other CSS files should not be affected. That is why the rule is restricting loader only to content coming from `src/app` folder (and all subfolders):

```javascript
const path = require('path');

module.exports = {
    module: {
        rules: [
            {
                test: /\.css$/,
                include: path.join(__dirname, 'src/app'),
                loader: 'raw-loader'
            }
        ]
    }
};
```

Now if you rebuild and start the application with `npm start` command you should see the styles applied:



Hello from Angular app and Webpack.

(external template)

Loading images

The easiest way to provide support for image loading with webpack is to use `file-loader` loader. Install it for your project with the following command:

```
npm install --save-dev file-loader
```

Here's the rule to be added to your `webpack.config.js` file. The rule is addressing the most common set of extensions for images, icons and web fonts.

webpack.config.js

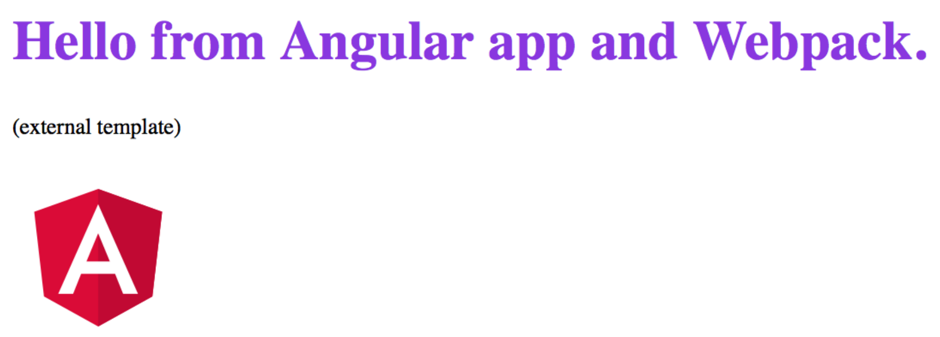
```
module.exports = {
    module: {
        rules: [
            {
                test: /\.(png|jpe?g|gif|svg|woff|woff2|ttf|eot|ico)$/,
                loader: 'file-loader?name=assets/[name].[hash].[ext]'
            }
        ]
    }
};
```

Let's put an `angular.svg` image to `src/resources` folder and update `app.component.html` like following:

src/app/app.component.html

```
<h1 class="main-title">Hello from Angular app and Webpack.</h1>
<small>(external template)</small>
<p>
    <img src="../resources/angular.svg" width="100" height="100">
</p>
```

Once the application is rebuilt and restarted you should see an image displayed on the page:


Hello from Angular app and Webpack.

(external template)

TSLint

TSLint checks your TypeScript code for readability, maintainability, and functionality errors. You can use it as a standalone utility or part of your webpack pipeline using special loaders and plugins.

Global installation

```
npm install tslint typescript -g
```

You may want to install TSLint globally to be able using its CLI commands from any place like for instance generating new configuration files for a project. Also, many development environments expect global installation to enable live checking and style error reporting for TypeScript code.

Local installation

```
npm install tslint --save-dev typescript
```

It is recommended to install TSLint as a local project library not to depend on specific global version. That also helps to reduce the number of prerequisites needed to setup and compile your project as developers need to run only `npm install` to get all dependencies downloaded and installed.

Configuring rules

Install TSLint globally and locally like shown above and let's start by creating a minimal configuration file for the project by generating it with the CLI:

```
tslint --init
```

You should get a new file `tslint.json` in the current folder that contains a default set of rules. To ensure it is working fine just run a quick code style check from the command line:

```
tslint -c tslint.json './src/**/*.ts'
```

The command above runs TSLint with the newly created `tslint.json` as a configuration file, and instructs linter to check all `.ts` files starting with the `src` folder (including all subfolders).

You should get several errors from the linter related to quote mark usage:

```
src/app/app.component.spec.ts[1, 30]: ' should be "
src/app/app.component.spec.ts[3, 50]: ' should be "
src/app/app.component.spec.ts[4, 20]: ' should be "
src/app/app.component.spec.ts[5, 30]: ' should be "
src/app/app.component.spec.ts[7, 10]: ' should be "
src/app/app.component.spec.ts[22, 48]: ' should be "
src/app/app.component.spec.ts[25, 8]: ' should be "
src/app/app.component.spec.ts[27, 8]: ' should be "
src/app/app.component.spec.ts[31, 13]: ' should be "
src/app/app.component.ts[1, 27]: ' should be "
src/app/app.component.ts[4, 15]: ' should be "
src/app/app.component.ts[5, 18]: ' should be "
src/app/app.component.ts[6, 17]: ' should be "
src/app/app.component.ts[11, 21]: ' should be "
src/app/app.module.ts[1, 26]: ' should be "
src/app/app.module.ts[2, 31]: ' should be "
src/app/app.module.ts[4, 30]: ' should be "
src/main.ts[1, 8]: ' should be "
src/main.ts[2, 8]: ' should be "
src/main.ts[3, 9]: ' should be "
src/main.ts[5, 40]: ' should be "
src/main.ts[6, 32]: ' should be "
src/main.ts[7, 27]: ' should be "
```

That is because we have been using single quote marks across the code examples. Now when you know that the linter works, you can decide whether to correct the code and switch to "double quotes", or change the rule to use single quotation marks instead.

Let's change the rule. Open `tslint.json` and find the following section:

tslint.json

```
{
    "rules": {
        "quotemark": [
            true,
            "double"
        ]
    }
}
```

Change the setting `double` to `single`, save the file and run code check again:

```
tslint -c tslint.json './src/**/*.ts'
```

This time linter should exit without any errors or warnings.

Integrating with Webpack

```
npm install --save-dev tslint-loader
```

```
module.exports = {
    module: {
        rules: [
            {
                enforce: 'pre',
                test: /\.ts$/,
                loader: 'tslint-loader',
                exclude: /node_modules/
            }
        ]
    }
}
```

The rule executes before other rules (`enforce: 'pre'`) and runs for all `.ts` files in your project folder and all its subfolders excluding `node_modules` one. You are going to see warnings every time TSLint finds an issue with the TypeScript code, including hot reloading when you change the code.

Unit testing

We are going to use `Karma` with Webpack for unit testing. The benefit of such configuration is that Webpack transpiles TypeScript into JavaScript in memory and redirects output to Karma test runner on the fly. No files get created on disk during the process.

Open the `package.json` file and append the new entry to the `scripts` section like shown below:

package.json

```
{
    "scripts": {
        ...
        "test": "karma start"
    },
}
```

The script we added allows running unit tests with the command `npm test`.

You also need appending the following entries to the `devDependencies` section:

package.json

```
{
    "devDependencies": {
        ...
        "@types/jasmine": "2.5.41",
        "jasmine-core": "2.5.2",
        "karma": "1.4.1",
        "karma-chrome-launcher": "2.0.0",
        "karma-jasmine": "1.1.0",
        "karma-mocha-reporter": "2.2.2",
        "karma-webpack": "2.0.2",
        "null-loader": "0.1.1",
        "rimraf": "2.5.4"
    }
}
```

Save the file and run `npm install` to download and install new libraries.

Next, you need to create a `karma-test-shim.js` file in your project root folder.

karma-test-shim.js

```
Error.stackTraceLimit = Infinity;

require('core-js/es6');
require('core-js/es7/reflect');

require('zone.js/dist/zone');
require('zone.js/dist/long-stack-trace-zone');
require('zone.js/dist/proxy');
require('zone.js/dist/sync-test');
require('zone.js/dist/jasmine-patch');
require('zone.js/dist/async-test');
require('zone.js/dist/fake-async-test');

var appContext = require.context('./src', true, /\.spec\.ts/);

appContext.keys().forEach(appContext);

var testing = require('@angular/core/testing');
var browser = require('@angular/platform-browser-dynamic/testing');

testing.TestBed.initTestEnvironment(
    browser.BrowserDynamicTestingModule,
    browser.platformBrowserDynamicTesting()
);
```

This file preloads `core-js` and `zone.js` libraries and provides basic configuration for the Angular testing framework. Only files ending with `.spec.ts` load into the application context.

Finally we need a `karma.conf.js` file to setup Webpack with Karma:

karma.conf.js

```
var webpackConfig = require('./webpack.test');

module.exports = function (config) {
    var _config = {
        basePath: '',

        frameworks: ['jasmine'],

        files: [
            { pattern: './karma-test-shim.js', watched: false }
        ],

        preprocessors: {
            './karma-test-shim.js': ['webpack']
        },

        webpack: webpackConfig,

        webpackMiddleware: {
            stats: 'errors-only'
        },

        webpackServer: {
            noInfo: true
        },

        reporters: ['mocha'],
        port: 9876,
        colors: true,
        logLevel: config.LOG_INFO,
        autoWatch: false,
        browsers: ['Chrome'],
        singleRun: true
    };

    config.set(_config);
};
```

At this point, Webpack is using `PhantomJS` headless browser and loads `karma-test-shim.js` that references the rest of the content. Let's create a couple of unit tests to see the entire flow in action:

src/app/app.component.spec.ts

```
import { AppComponent } from './app.component';

import { async, ComponentFixture, TestBed } from '@angular/core/testing';
import { By } from '@angular/platform-browser';
import { DebugElement } from '@angular/core';

describe('AppComponent', function () {
    let de: DebugElement;
    let comp: AppComponent;
    let fixture: ComponentFixture<AppComponent>;

    beforeEach(async(() => {
        TestBed.configureTestingModule({
            declarations: [AppComponent]
        })
        .compileComponents();
    }));

    beforeEach(() => {
        fixture = TestBed.createComponent(AppComponent);
        comp = fixture.componentInstance;
        de = fixture.debugElement.query(By.css('h1'));
    });

    it('should create the component', () => expect(comp).toBeDefined());

    it('should have expected <h1> text', () => {
        fixture.detectChanges();
        const h1 = de.nativeElement;
        expect(h1.innerText).toMatch(/angular/i,
            '<h1>Hello from Angular app and Webpack."');
    });
});
```

To run unit tests execute this command:

```
npm test
```

You should 2 unit tests compiled and run successfully:

```
AppComponent
    ▯ should create the component
    ▯ should have expected <h1> text
```

Code coverage

Having support for code coverage reports is often critical when running unit tests, especially when dealing with JavaScript and TypeScript.

It is important to remember that code and unit tests get transpiled from TypeScript to JavaScript before execution. We are going to use webpack to perform the following:

1. transpile code and unit tests written in TypeScript into JavaScript
2. run unit tests with `Jasmine` framework and generate report code coverage report
3. remap code coverage report from JavaScript back to TypeScript
4. generate and serve HTML version of the coverage report

Let's start with adding additional development dependencies to the `package.json` file:

package.json

```
{
    "devDependencies": {
        ...
        "karma-coverage": "1.1.1",
        "karma-remap-istanbul": "0.6.0",
        "karma-sourcemap-loader": "0.3.7",
        "sourcemap-istanbul-instrumenter-loader": "0.2.0",
        "rimraf": "2.5.4",
        "wsrv": "0.1.6"
    }
}
```

Save the file and run `npm install` to download and install newly added dependencies.

That adds libraries required to enable support for re-mapping of code coverage. Also, we are adding `rimraf` library to be able cleaning previously generated reports when running unit tests, and a lightweight web server `wsrv` to see the final report in the browser.

The webpack setup remains pretty much the same we have created in previous chapters. We only need appending a rule to instrument JavaScript files with Istanbul for subsequent code coverage reporting. The rule executes as the last one (via `enforce: 'post'` setting) after all other rules invoked.

webpack.test.js

```
module.exports = {
    module: {
        ...
        rules: [
            ...
            {
                test: /src\/.+\.ts$/,
                exclude: /(node_modules|\.spec\.ts$)/,
                loader: 'sourcemap-istanbul-instrumenter-loader?force-sourcemap=true\
',
                enforce: 'post'
            }
        ]
    }
}
```

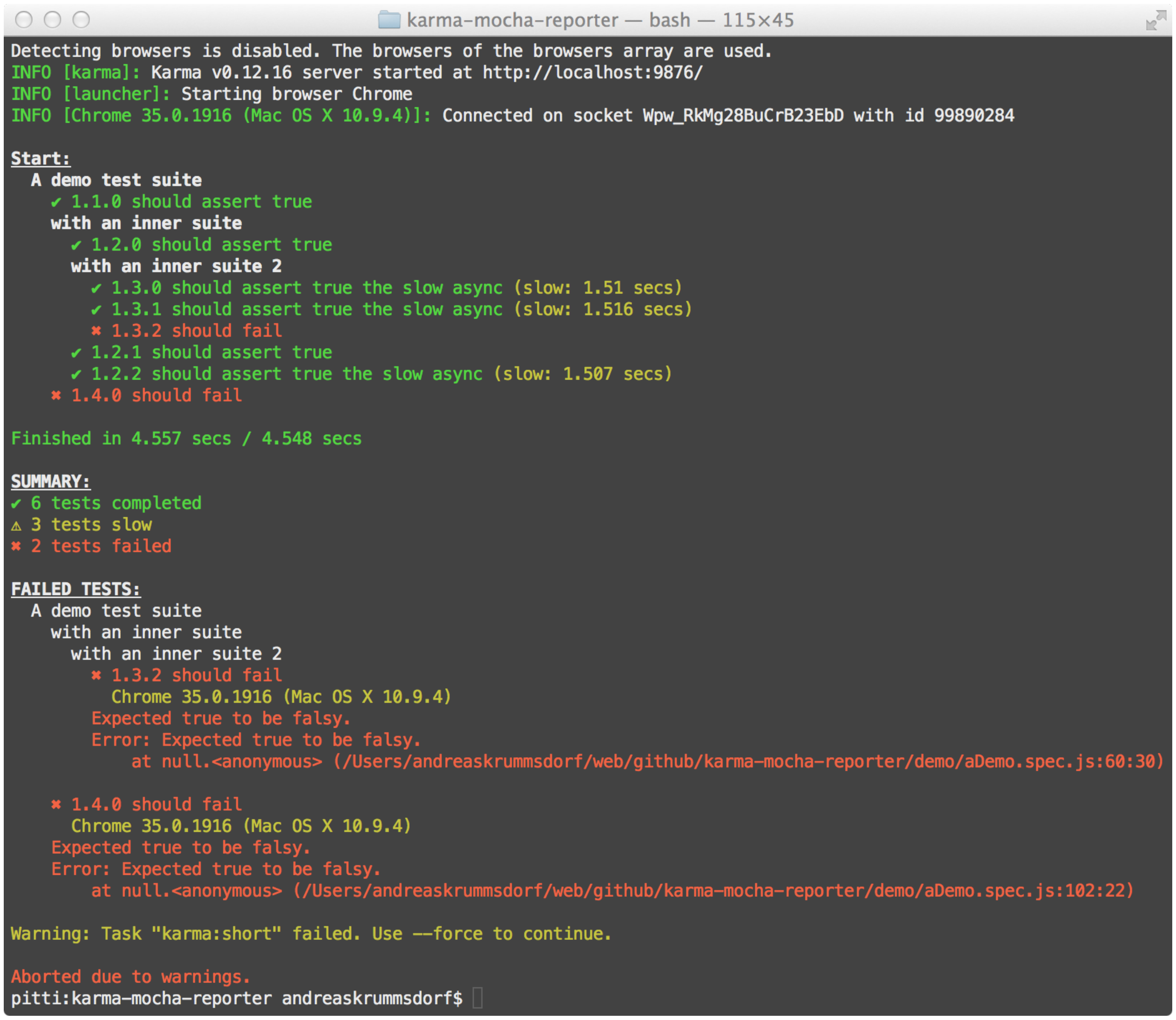
Next, you need extending `preprocessors` and `reporters` sections, as well as adding `remapIstanbulReporter` settings:

karma.conf.js

```
{
    ...

    preprocessors: {
        './karma-test-shim.js': [
            'webpack',
            'sourcemap'
        ]
    },

    reporters: [
        'mocha',
        'karma-remap-istanbul'
    ],

    remapIstanbulReporter: {
        reports: {
            'html': './coverage',
            'lcovonly': './coverage/lcov.info'
        }
    }

    ...
}
```

We are going to use `sourcemap` preprocessor together with a `webpack` one for all unit tests in the project. There going to be two test reporters: `mocha` and `karma-remap-istanbul`.

mocha: Karma reporter with mocha style logging should give you excellent human-readable console output:



```
Detecting browsers is disabled. The browsers of the browsers array are used.
INFO [karma]: Karma v0.12.16 server started at http://localhost:9876/
INFO [launcher]: Starting browser Chrome
INFO [Chrome 35.0.1916 (Mac OS X 10.9.4)]: Connected on socket Wpw_RkMg28BuCrB23EbD with id 99890284

Start:
  A demo test suite
    ✔ 1.1.0 should assert true
    with an inner suite
      ✔ 1.2.0 should assert true
      with an inner suite 2
        ✔ 1.3.0 should assert true the slow async (slow: 1.51 secs)
        ✔ 1.3.1 should assert true the slow async (slow: 1.516 secs)
        ✖ 1.3.2 should fail
      ✔ 1.2.1 should assert true
      ✔ 1.2.2 should assert true the slow async (slow: 1.507 secs)
    ✖ 1.4.0 should fail

Finished in 4.557 secs / 4.548 secs

SUMMARY:
✔ 6 tests completed
⚠ 3 tests slow
✖ 2 tests failed

FAILED TESTS:
  A demo test suite
    with an inner suite
      with an inner suite 2
        ✖ 1.3.2 should fail
          Chrome 35.0.1916 (Mac OS X 10.9.4)
        Expected true to be falsy.
        Error: Expected true to be falsy.
            at null.<anonymous> (/Users/andreaskrummsdorf/web/github/karma-mocha-reporter/demo/aDemo.spec.js:60:30)

    ✖ 1.4.0 should fail
      Chrome 35.0.1916 (Mac OS X 10.9.4)
    Expected true to be falsy.
    Error: Expected true to be falsy.
        at null.<anonymous> (/Users/andreaskrummsdorf/web/github/karma-mocha-reporter/demo/aDemo.spec.js:102:22)

Warning: Task "karma:short" failed. Use --force to continue.

Aborted due to warnings.
pitti:karma-mocha-reporter andreaskrummsdorf$
```

The `karma-remap-istanbul` wraps `remap-istanbul` library as a Karma reporter, used to generate re-mapped back to TypeScript coverage reports. As a result, we are getting an HTML version of the report stored in the `coverage` subfolder.

Now we need to extend our NPM scripts in `package.json` file:

package.json

```
{
    "scripts": {
        ...
        "test": "rimraf coverage && karma start",
        "coverage": "wsrv coverage -o"
    },
}
```

Upon every test run the `karma` and `webpack` are automatically generating code coverage report, remapping it to TypeScript and storing within the `coverage` folder. To avoid any potential problems with the subsequent runs we are going to remove previous report folder with the `rimraf` utility we have installed earlier.

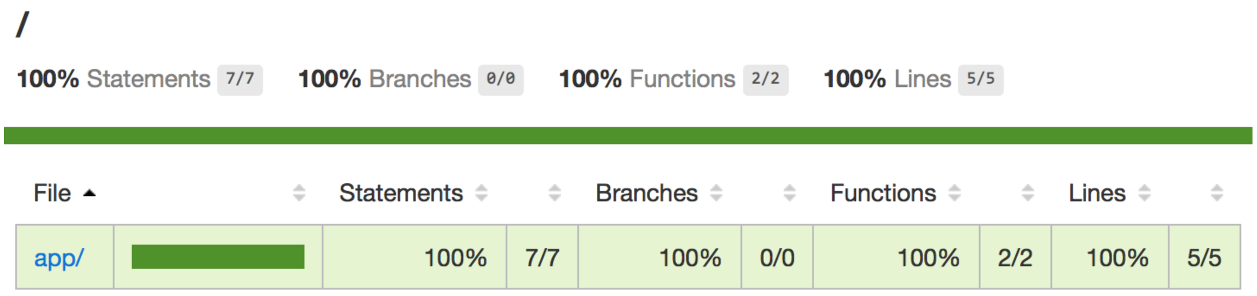
You can now run tests with the following command:

```
npm test
```

Finally, we need a separate command to serve HTML report:

```
npm run coverage
```

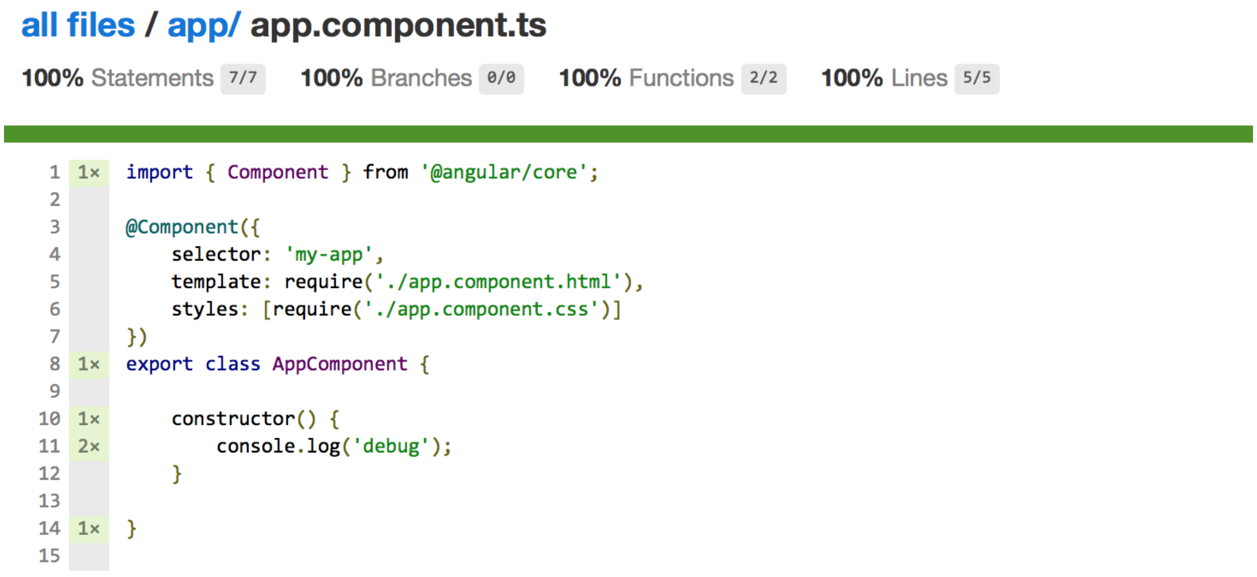
Once executed this command automatically launches your default browser pointing to the coverage report. It is possible to browse all instrumented files and see details for TypeScript content:



/

100% Statements 7/7   **100%** Branches 0/0   **100%** Functions 2/2   **100%** Lines 5/5

File		Statements		Branches		Functions		Lines	
app/	🟩	100%	7/7	100%	0/0	100%	2/2	100%	5/5


all files / app/ app.component.ts

100% Statements 7/7 100% Branches 0/0 100% Functions 2/2 100% Lines 5/5

```
1x  import { Component } from '@angular/core';

    @Component({
        selector: 'my-app',
        template: require('./app.component.html'),
        styles: [require('./app.component.css')]
    })
1x  export class AppComponent {

1x      constructor() {
2x          console.log('debug');
        }

1x  }

```

Source code

You can find the source code in the "webpack/webpack-example[102]" folder.

Code splitting

Code splitting is one of the most important and popular features of webpack. It allows you to prepare web applications for production and greatly optimises them by splitting into separate bundles. Smaller bundles improve application load time as bundle files get cached by the browsers or loaded on demand.

As a starting point, we are going to use the webpack project created in previous chapters. Alternatively, you can take the source code from the "webpack/webpack-example[103]" folder

Multiple configurations

For real-life scenarios it is strongly recommended splitting webpack configuration into at least 3 main blocks:

- development settings (`webpack.dev.js`)
- production build settings (`webpack.prod.js`)
- unit testing settings (`webpack.test.js`)

[102] https://github.com/DenysVuika/developing-with-angular/tree/master/webpack/webpack-example
[103] https://github.com/DenysVuika/developing-with-angular/tree/master/webpack/webpack-example

All configuration files may contain same setting blocks, so you should use a shared `webpack.common.js` file to avoid code duplication.

Let's start by installing a `webpack-merge` library that helps to merge multiple webpack configuration files:

```
npm install --save-dev webpack-merge
```

Now we can create `webpack.common.js` file hosting shared settings. You can take most of the content already created for the `webpack.config.js` file in previous chapters. The basic structure of the file can look like the following:

webpack.common.js

```
const webpack = require("webpack");
const path = require('path');
const HtmlWebpackPlugin = require('html-webpack-plugin');

module.exports = {
    entry: './src/main.ts',
    output: {
        path: path.join(__dirname, 'dist'),
        filename: 'bundle.js'
    },
    resolve: {
        extensions: [".ts", ".js"]
    },
    module: {
        rules: [
            ...
        ]
    },

    plugins: [
        ...
    ]
};
```

Regardless of the configuration mode (development, production, custom) webpack should be taking `./src/main.ts` file as the main entry point, and saving the resulting bundle as `./dist/bundle.js` file.

Development mode

Note that we do not set `devtool` and `devServer` configuration in the `webpack.common.js` file because these settings are mode-specific. Running development server makes sense only for `development` mode, and style of source mapping to enhance the debugging process (`devtool`) usually differs across configurations. Let's create `webpack.dev.js` to hold these values.

webpack.dev.js

```
const webpack = require('webpack');
const webpackMerge = require('webpack-merge');
const path = require('path');
const commonConfig = require('./webpack.common.js');

module.exports = webpackMerge(commonConfig, {
    devtool: 'source-map',
    devServer: {
        contentBase: path.join(__dirname, "dist"),
        host: '0.0.0.0',
        port: 3000,
        historyApiFallback: true,
        compress: true
    }
});
```

You can now replace the content of the `webpack.config.js` with the next code:

webpack.config.js

```
module.exports = require('./webpack.dev.js');
```

All the tooling that defaults to `webpack.config.js` is automatically going to use development config.

To test our current setup just use `start` command:

```
npm start
```

You should be able to see running web application at `http://localhost:3000`.

Production mode

Now let's create a separate configuration file for production builds. There are many optimisations that you can add to module settings, but we need webpack to perform at least the following additional actions:

- make resulting bundle file as small as possible by minimising JavaScript
- enable production mode for Angular (requires a special function call at runtime)

Create `webpack.prod.js` file and put the following content:

webpack.prod.js

```
const webpack = require('webpack');
const webpackMerge = require('webpack-merge');
const path = require('path');
const commonConfig = require('./webpack.common.js');
const ENV = process.env.NODE_ENV = process.env.ENV = 'production';

module.exports = webpackMerge(commonConfig, {
    devtool: 'source-map',

    plugins: [
        new webpack.NoEmitOnErrorsPlugin(),
        new webpack.optimize.UglifyJsPlugin({
            mangle: {
                keep_fnames: true
            },
            compress: {
                warnings: false
            },
            output: {
                comments: false
            },
            sourceMap: true
        }),
        new webpack.DefinePlugin({
            'process.env': {
                'ENV': JSON.stringify(ENV)
            }
        }),
        new webpack.LoaderOptionsPlugin({
            htmlLoader: {
                minimize: false // workaround for ng2
            }
        })
    ]
});
```

Creating a bundle can take some time especially when running different optimisations. There may be multiple loaders and plugins invoked in the bundling process, and an error raised by one usually means broken bundle files. To save time, we are going to use `NoEmitOnErrorsPlugin` webpack plugin that stops the build if there is an error.

The `UglifyJsPlugin` plugin is used to minify JavaScript we get by transpiling TypeScript. We also instruct plugin to remove all comments from the code to make resulting bundle much smaller.

The `DefinePlugin` plugin allows using environment variables in your application code. We use it to declare `process.env` object that can later be accessed from `main.ts` TypeScript file to determine whether the `enableProdMode` function should be called.

```
import { platformBrowserDynamic } from '@angular/platform-browser-dynamic';
import { enableProdMode } from '@angular/core';
import { AppModule } from './app/app.module';

if (process.env.ENV === 'production') {
  enableProdMode();
}

const platform = platformBrowserDynamic();
platform.bootstrapModule(AppModule);
```

Finally a `LoaderOptionsPlugin` plugin is used to set or override options of various plugins. In our case, the minification of HTML is switched off as a workaround for Angular component templates.

Now edit `package.json` file to add a script for triggering production builds:

package.json

```
{
    "scripts": {
        ...
        "build": "rimraf dist && webpack --config webpack.prod.js --progress --bail"
    }
}
```

Note that `rimraf` utility is used to delete the `dist` folder before each build. In this case, we can be sure there are no files left from previous runs.

Run the following command to create production build:

```
npm run build
```

As a result, you get compiled and bundled application that can be served by any web server of your choice. To test it locally we can use `wsrv` tool and the following script in `package.json`:

package.json

```
{
    "scripts": {
        ...
        "serve:prod": "wsrv dist --spa --open"
    }
}
```

Use the next command to serve your production build and run it with the default browser automatically:

```
npm run serve:prod
```

CSS splitting

Webpack allows you to bundle multiple CSS files into a separate bundle that can be loaded and cached by browsers. With the help of additional plugins and loaders you can use `import` keyword for `.css` files similar to how JavaScript or TypeScript modules are imported:

```
import './main.css';
```

You need to install three additional libraries to be able importing and bundling CSS with webpack:

```
npm install --save-dev extract-text-webpack-plugin
npm install --save-dev style-loader
npm install --save-dev css-loader
```

Based on previous chapters webpack configuration for the project should already have `angular2-template-loader` that inlines all html templates (`templateUrl`) and styles (`styleUrls`) for Angular components.

We are going to use `extract-text-webpack-plugin` plugin to get the rest of the CSS files and put them into a separate bundle.

webpack.common.js

```
const ExtractTextPlugin = require('extract-text-webpack-plugin');

module.exports = {
    ...
    module: {
        rules: [
            ...
            {
                test: /\.css$/,
                exclude: path.join(__dirname, 'src/app'),
                loader: ExtractTextPlugin.extract({
                    fallback: 'style-loader',
                    use: 'css-loader?sourceMap'
                })
            }
        ]
    }
};
```

Note that `src/app` folder is excluded as it needs to be processed by `angular2-template-loader`.

As a next step, you need updating `development` and `production` webpack settings to generate resulting CSS bundle.

webpack.dev.js

```
const ExtractTextPlugin = require("extract-text-webpack-plugin");

module.exports = webpackMerge(commonConfig, {
    ...
    plugins: [
        new ExtractTextPlugin('[name].css')
    ]
});
```

For development mode the `webpack-dev-server` automatically reloads browser page with the latest bundle files. That means we do not need maintaining browser cache and generating hash suffixes for bundles.

The resulting file has a regular format, just a name with an extension, something like `main.css`.

webpack.prod.js

```
const ExtractTextPlugin = require("extract-text-webpack-plugin");

module.exports = webpackMerge(commonConfig, {
    ...
    plugins: [
        new ExtractTextPlugin('[name].[hash].css'),
    ]
});
```

For production mode, the CSS file gets a hash suffix based on its content. This allows controlling browser cache on the client side. Browsers should cache all bundles on the first application load so that the subsequent loads are much faster. If content of the bundle changes (one of the bundled CSS files changes for instance), its corresponding hash code updates as well. Updated file be downloaded and cached like a previous one.

The resulting file will be named like `main.0f40125588b03ddb8b86.css`.

Now create a simple `main.css` file to test configuration above:

src/main.css

```
/* Main theme */

.title {
    color: black;
}
```

As it was mentioned earlier, you can import CSS files similar to how modules are imported. Open `main.ts` file and put the import of the newly created `main.css` inside:

src/main.ts

```
...
import './main.css';

const platform = platformBrowserDynamic();
platform.bootstrapModule(AppModule);
```

It is important to note that besides importing styles by relative paths you can also bundle content from external libraries installed to `node_modules`. For example getting the `deeppurple-amber.css` theme style from the `@angular/material` library looks like following:

```
import '@angular/material/core/theming/prebuilt/deeppurple-amber.css';
```

Now run the production build with the `npm` command:

```
npm run build
```

Once the build is finished you should get two additional files in the `dist` folder similar to the following:

```
main.0f40125588b03ddb8b86.css
main.0f40125588b03ddb8b86.css.map
```

Webpack not only builds all your additional CSS files into a single bundle, but it also changes the resulting `index.html` page to include the bundle:

dist/index.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <title>Webpack 2</title>
    <base href="/">
    <link href="main.0f40125588b03ddb8b86.css" rel="stylesheet">
</head>
<body>
    <my-app>Loading AppComponent content here ...</my-app>
    <script type="text/javascript" src="bundle.js"></script>
</body>
</html>
```

Vendor code splitting

You are not going to change third party libraries frequently unlike your application code. So it should be more efficient putting vendor code into a separate bundle to allow browser caching if for a longer time. The same applies to various browser polyfills that get updated even less often.

Traditionally web application gets split into three main bundles:

- polyfills bundle
- vendors bundle
- application bundle

Let’s start with the minimal setup as per Angular documentation.

src/polyfills.ts

```
import 'core-js/es6';
import 'core-js/es7/reflect';
require('zone.js/dist/zone');

if (process.env.ENV === 'production') {
  // Production
} else {
  // Development and test
  Error['stackTraceLimit'] = Infinity;
  require('zone.js/dist/long-stack-trace-zone');
}
```

All libraries for the polyfills are resolved via `node_modules` folder.

For the polyfills bundle, we set `core-js` and `zone.js`. If the application is running in development mode, we also enable long stack traces for `zone.js` library. That provides more details on exceptions happened within Angular components.

Based on the application features and target browsers you may need adding more polyfills to this file.

src/vendor.ts

```
// Angular
import '@angular/platform-browser';
import '@angular/platform-browser-dynamic';
import '@angular/core';
import '@angular/common';
import '@angular/http';
import '@angular/router';

// RxJS
import 'rxjs';

// Other vendors for example jQuery, Lodash or Bootstrap
// You can import js, ts, css, sass, ...
```

Vendors file contains a bare minimum for a typical Angular-based application. You are going to put here all additional third party libraries being used. All libraries for the `vendors.ts` file are resolved via `node_modules` folder.

Finally the `main.ts` file should look like following:

src/main.ts

```
import { platformBrowserDynamic } from '@angular/platform-browser-dynamic';
import { enableProdMode } from '@angular/core';
import { AppModule } from './app/app.module';

import './main.css';

if (process.env.ENV === 'production') {
  enableProdMode();
}

const platform = platformBrowserDynamic();
platform.bootstrapModule(AppModule);
```

Now let's tell webpack we have `polyfills.ts`, `vendors.ts` and `main.ts` bundles. You need to change `webpack.common.js` like shown below:

webpack.common.js

Before:

```
module.exports = {
    entry: './src/main.ts',
    ...
}
```

After:

```
module.exports = {
    entry: {
        'polyfills': './src/polyfills.ts',
        'vendor': './src/vendor.ts',
        'app': './src/main.ts'
    },
    plugins: [
        ...
        new webpack.optimize.CommonsChunkPlugin({
            name: ['app', 'vendor', 'polyfills']
        })
    ]
    ...
}
```

We instruct webpack to use three entries instead of a single one and use `CommonsChunkPlugin` to improve result greatly.

> The CommonsChunkPlugin is an opt-in feature that creates a separate file (known as a chunk), consisting of common modules shared between multiple entry points. By separating common modules from bundles, the resulting chunked file can be loaded once initially, and stored in cache for later use. This results in pagespeed optimisations as the browser can quickly serve the shared code from cache, rather than being forced to load a larger bundle whenever a new page is visited.

You can read more details in the official CommonsChunkPlugin[104] documentation.

For the last step, we are going to tune output settings for `development` and `production` configuration files.

webpack.dev.js

```
module.exports = {
    ...
    output: {
        path: path.join(__dirname, 'dist'),
        filename: '[name].js',
        chunkFilename: '[id].chunk.js'
    }
}
```

webpack.prod.js

```
module.exports = webpackMerge(commonConfig, {

    output: {
        path: path.join(__dirname, 'dist'),
        publicPath: '/',
        filename: '[name].[hash].js',
        chunkFilename: '[id].[hash].chunk.js'
    },
    ...

});
```

At this point, the minimal configuration should be complete. To see code splitting in action just run the production build with the `build` npm command

[104] https://webpack.js.org/plugins/commons-chunk-plugin/

```
npm run build
```

Now if you inspect the `dist` folder you should see the structure similar to the following one:

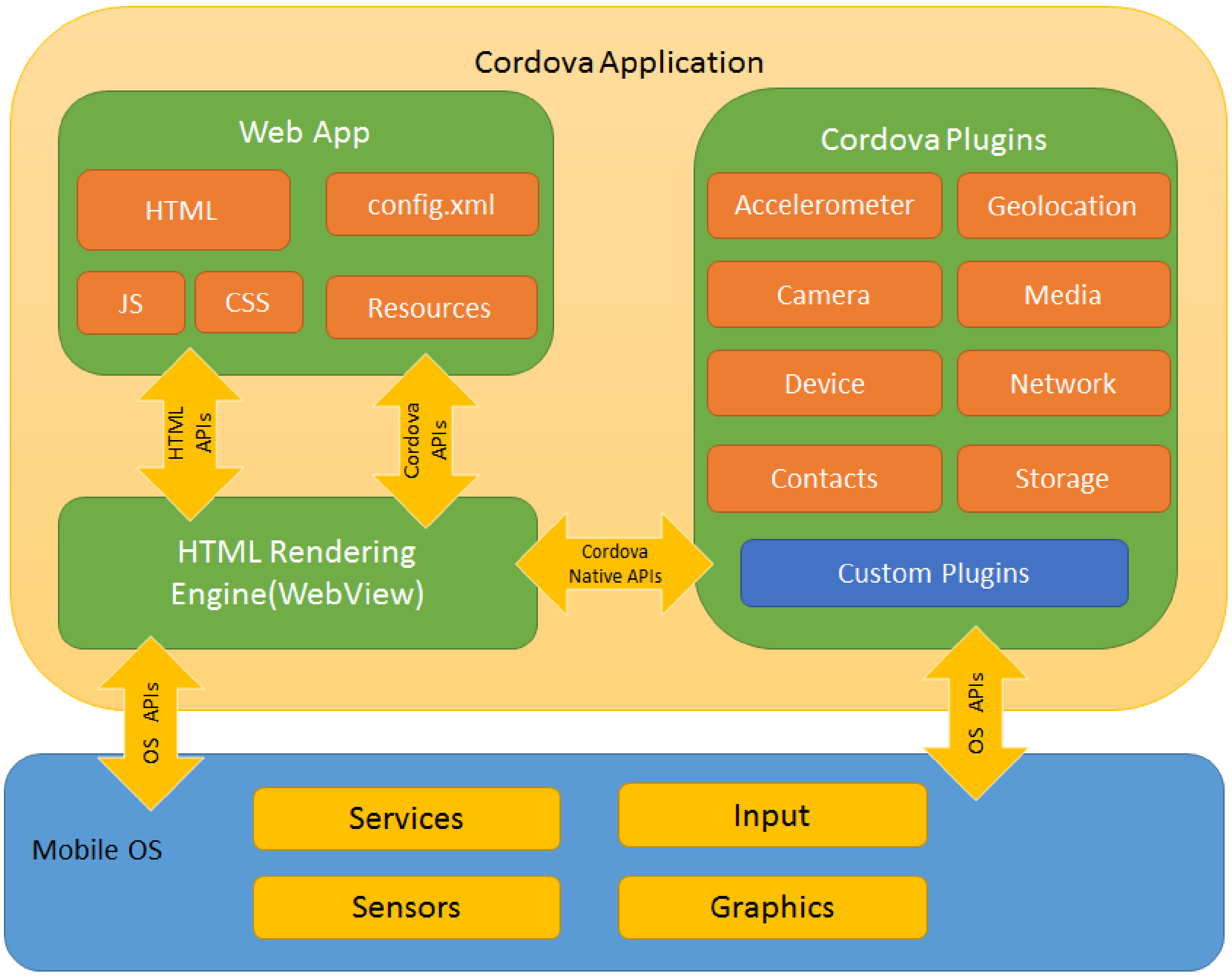
Size	Name
102	**app.e9ba0634398c31b37d5a.css**
295	app.e9ba0634398c31b37d5a.css.map
1923	**app.e9ba0634398c31b37d5a.js**
8716	app.e9ba0634398c31b37d5a.js.map
572	index.html
104047	**polyfills.e9ba0634398c31b37d5a.js**
792348	polyfills.e9ba0634398c31b37d5a.js.map
1048488	**vendor.e9ba0634398c31b37d5a.js**
7962491	vendor.e9ba0634398c31b37d5a.js.map

As you can see the `app` bundle is now very small (± 2kB) and containing only your application-specific code. Next comes the `polyfills` bundle (± 104kB) that contains cross-browser support. Finally the `vendor` bundle (± 1MB) having Angular framework and all third party libraries used by your web application combined together.

All files have hash codes in the names, so browsers are able caching them and downloading new versions only when the content of the files (and so the hash code) changes.

Building a Mobile App with Cordova and Angular

Apache Cordova is an open-source mobile development framework. It allows you to use standard web technologies - HTML5, CSS3, and JavaScript for cross-platform development.



You can get an excellent overview and technical details on the official "Overview[105]" page.

The Apache Cordova framework allows you to write the same code to address at least the following platforms:

- Android

[105]https://cordova.apache.org/docs/en/latest/guide/overview/index.html

- Blackberry 10
- iOS
- macOS (OS X)
- Ubuntu
- Windows
- WP8

In this chapter, we are going to setup Apache Cordova with the Angular framework and see a simple iOS application powered by the Angular in action.

Installing command-line tools

Before we start, you need to install the command-line tools for the Cordova development:

```
npm install -g cordova
```

We are going to need the Angular CLI tools, so ensure you also have it installed globally:

```
npm install -g @angular/cli
```

Angular CLI

You can get more information in the corresponding Angular CLI chapter.

Generating a new Cordova App

In the command-line prompt, navigate to a directory where you want to create your new Cordova application and run the following commands:

```
cordova create myCordovaApp
cd myCordovaApp/
```

With the commands above we get a new Cordova application called "myCordovaApp" in the current directory and switch to the application directory after that.

By default, Cordova creates just an application scaffold to use with different platforms of your choice. You need to add each platform manually depending on the requirements.

In this chapter, we are going to focus on two platforms: Browser and iOS.

Adding the Browser platform

The “Browser” platform provides you with all the essentials needed to test your code in the browser. You are probably going to use it frequently during the development process and before testing with emulators and real devices.

With the Cordova CLI, you add various platforms using the following format:

```
cordova platform add <platform>
```

You can add the support for the Browser platform by executing the following Cordova CLI command:

```
cordova platform add browser
```

To run the newly created application with the given platform, we are going to use the following command format:

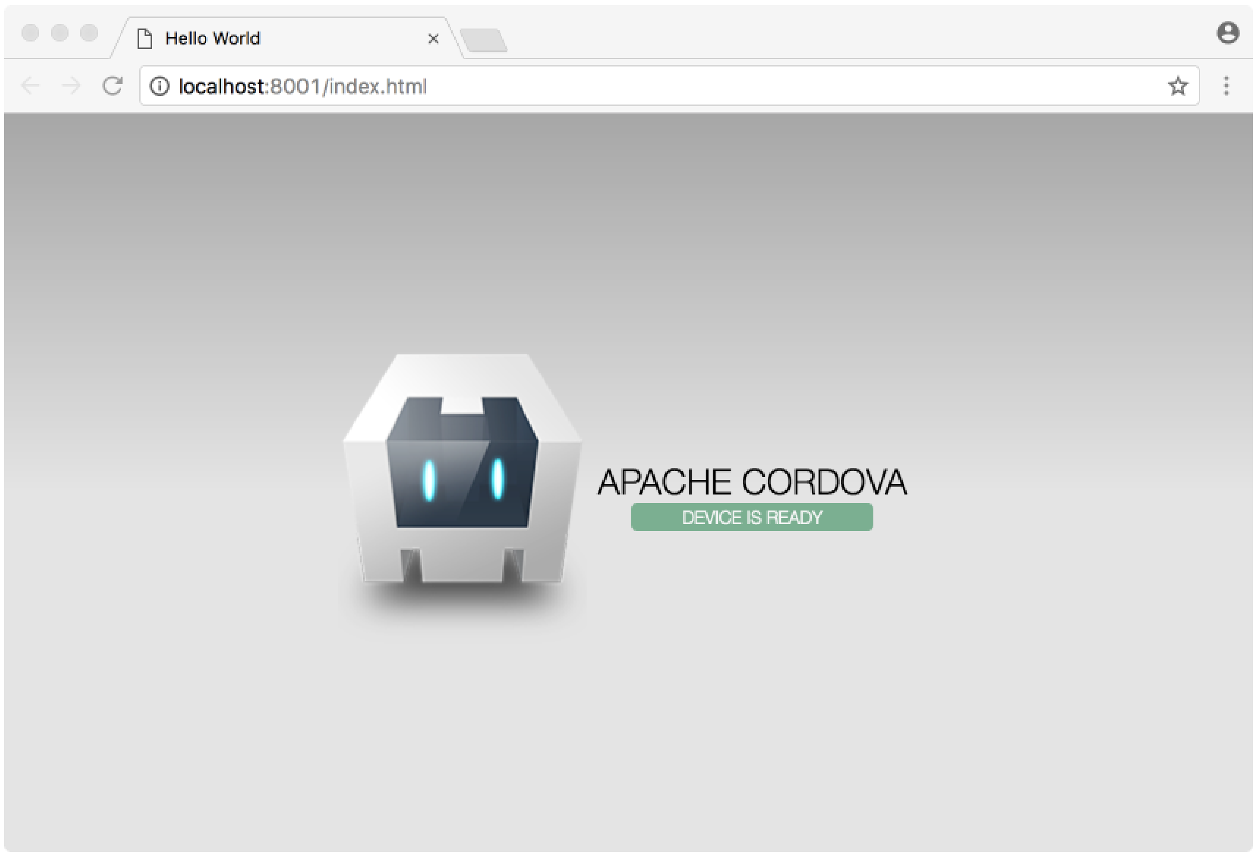
```
cordova run <platform> [params]
```

As with adding a new one, you need to specify the platform name and optionally some parameters if particular platform plugin supports that.

Let’s see that in action by running the Browser platform we have added earlier.

```
cordova run browser
```

With the command above, the Cordova CLI builds the project and launches it within a separate instance of the browser upon completion:



Adding the iOS platform

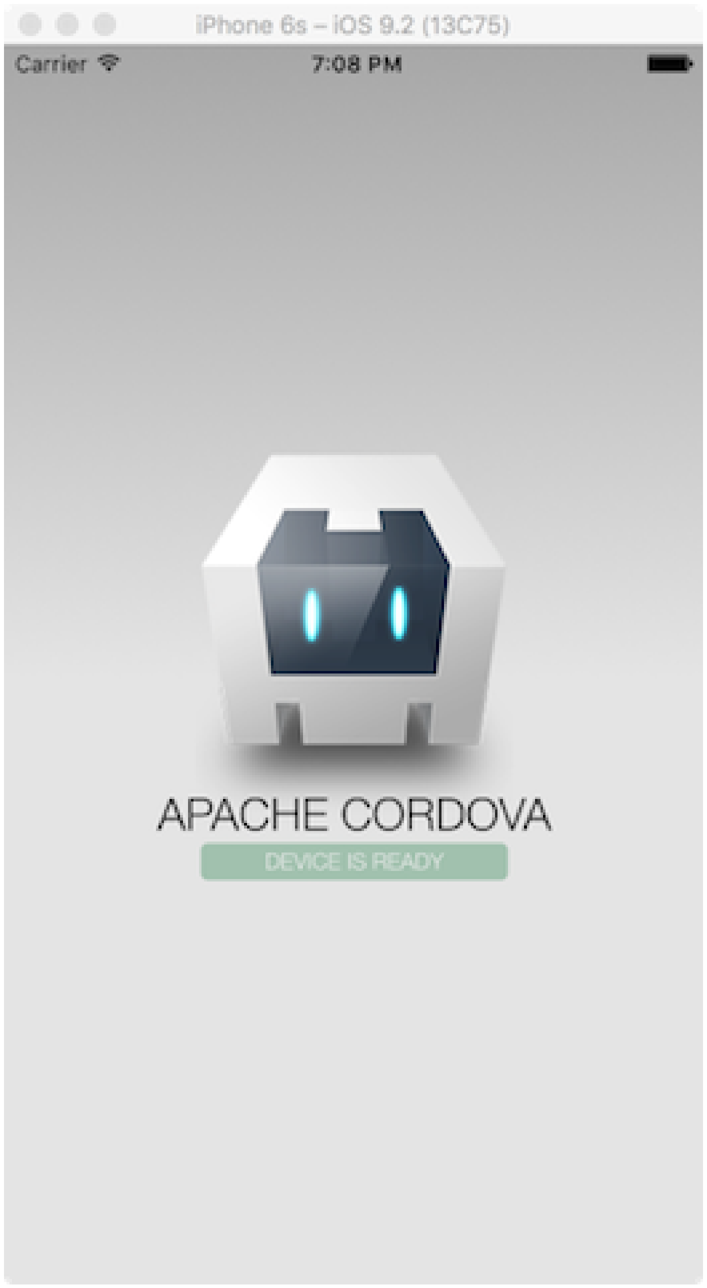
Now let's get the iOS platform support to be able to deploy our final application either to an iOS emulator or a real device.

```
cordova platform add ios
```

The Cordova CLI can now build your app for iOS platform alongside the Browser one. We can utilise the same "cordova run" command to launch the app in the iOS simulator. We just need to provide the target, for example, let's try the "iPhone 6s" emulator with our newly generated app:

```
cordova run ios --target='iPhone-6s'
```

It may take some time to compile the application for iOS for the first time. Once the compilation completes, you should get the iPhone emulator up and running with your app.



Generating a new Angular App

We have now a basic Cordova application working with two different platforms. It is now time to start configuring the Angular support, let's use the Angular CLI utility to generate a new application scaffold in the "webapp" directory in the project root folder.

```
ng new webapp -dir webapp
```

Next, edit the "index.html" file created in the "webapp/src" folder, and replace with the following content:

webapp/src/index.html

```
<!DOCTYPE html>
<html>
    <head>
        <meta http-equiv="Content-Security-Policy" content="default-src 'self' data:\
 gap: https://ssl.gstatic.com 'unsafe-eval'; style-src 'self' 'unsafe-inline'; media\
-src *; img-src 'self' data: content:;">
        <meta name="format-detection" content="telephone=no">
        <meta name="msapplication-tap-highlight" content="no">
        <meta name="viewport" content="user-scalable=no, initial-scale=1, maximum-sc\
ale=1, minimum-scale=1, width=device-width">
        <link rel="icon" type="image/x-icon" href="favicon.ico">
        <meta charset="utf-8">
        <title>Hello World</title>
        <base href=".">
    </head>
    <body>
        <script type="text/javascript" src="cordova.js"></script>
        <app-root></app-root>
    </body>
</html>
```

The file above is a hybrid made of the default Cordova "index.html" combined with the default Angular CLI one.

We also need to update the ".angular-cli.json" file and set the default output directory to point to the "www" folder used by Cordova when preparing the code for various platforms.

webapp/.angular-cli.json

```
{
  "apps": {
    "outDir": "../www"
  }
}
```

Build scripts

At this point, our project consists of the code produced and maintained by two different command-line tools. We are going to use Angular CLI utilities when working with the Angular part of the project, and Cordova CLI when preparing the code for devices or emulators.

The easiest way to improve the development experience is to create a set of NPM commands addressing all the common scenarios. Edit the root “package.json” file and put the following content in the “scripts” section:

```
{
  "scripts": {
    "build": "(cd webapp && ng build --prod) && cordova build",
    "start": "(cd webapp && ng build --prod) && cordova run browser",
    "ios": "cordova run ios --target='iPhone-6s'",
    "serve": "cordova serve 3000"
  }
}
```

The “build” script, executed with the “npm run build” command, is going to build our Angular application in production mode, and then use Cordova tools to compile the entire project for all the configured platforms.

You are going to use the “start” script to build your Angular application and run it with the Browser platform. You can use “npm run start” or shorthand version “npm start” for that.

The third common script we have in the “package.json” is the “ios” one, called with the “npm run ios” command and is used to invoke iOS emulator targeting the iPhone 6s. Please note that this script by default does not rebuild everything, and gets typically invoked after “npm run build” command.

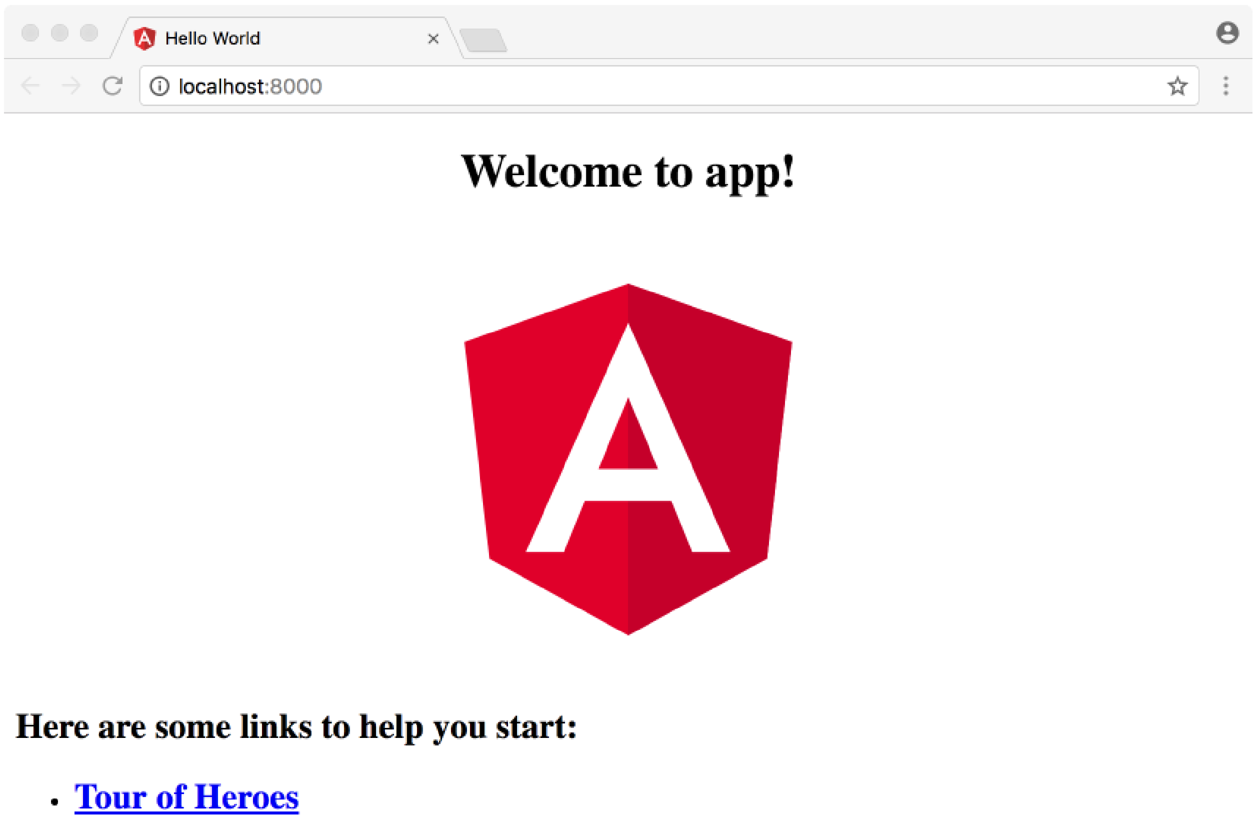
Finally, the “serve” command may help you quickly serving the web part in the browser to see the latest state of your code when your focus is the functionality rather than the platform.

Running Angular in the Browser

With the “scripts” section we created earlier, it becomes quite easy to run the entire project with the Browser platform. Just use “npm start” in the project root directory:

```
npm start
```

Once Angular application compiles and Cordova runs it in the separate browser instance, you should see the default Angular CLI project template on your screen.



Welcome to app!

Here are some links to help you start:

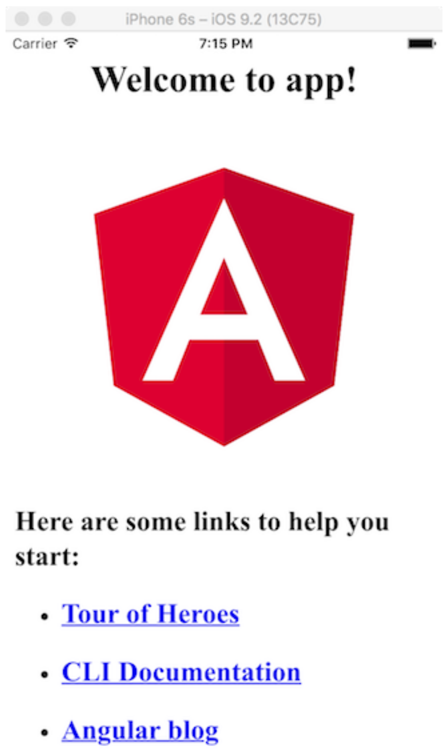
- Tour of Heroes

Running Angular in the iOS emulator

Next, you can check that the same Angular app works with the iOS emulator without issues. That is where we use the "ios" command from the "scripts" section:

```
npm run ios
```

You should see the emulator window that contains a content similar to that on the picture below:



Welcome to app!

Here are some links to help you start:

- Tour of Heroes
- CLI Documentation
- Angular blog

Routing support

Routing is one of the major features when it comes to Mobile apps created with HTML5, so to finalise our initial project setup we should also ensure, for instance, that the Angular Router works inside the iOS simulator as expected.

Let's use Angular CLI to generate a couple of extra components to use with the router outlet:

```
cd webapp
ng g component page1
ng g component page2
```

Now update the main application module file "app.module.ts" with the routing settings:

```
import { RouterModule } from '@angular/router';

@NgModule({
  ...,
  imports: [
    ...,
    RouterModule.forRoot([
      {
        path: 'page1',
        component: Page1Component
      },
      {
        path: 'page2',
        component: Page2Component
      }
    ])
  ],
  ...
})
export class AppModule { }
```

Finally, we need to update the main application component template "app.component.html" with the following simple Router setup appended to the end of the file:

```
<ul>
    <li>
        <a routerLink="/page1">Page 1</a>
    </li>
    <li>
        <a routerLink="/page2">Page 2</a>
    </li>
</ul>

<router-outlet></router-outlet>
```

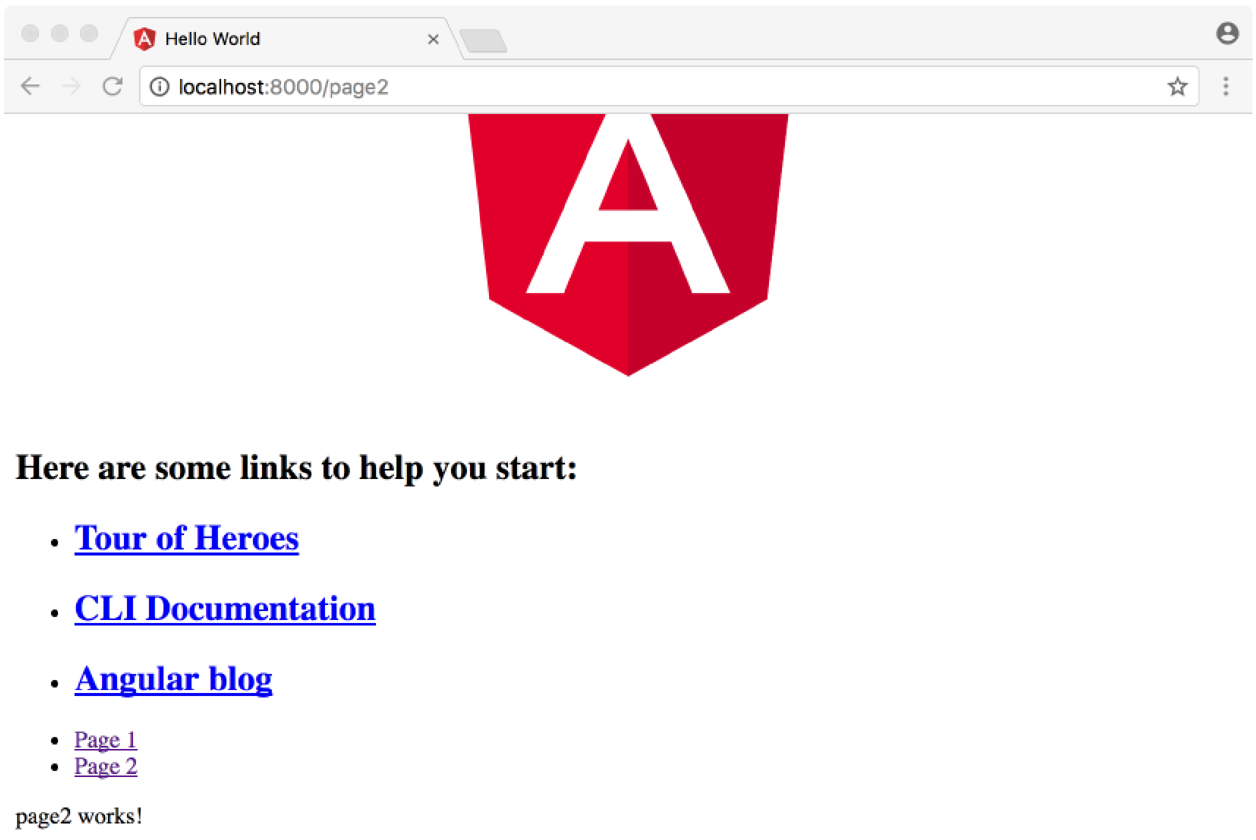
Now let's run the "build" script to compile everything:

```
npm run build
```

First of all, we can test the code with the Browser platform to see if everything works as expected, and fix the code errors if any. As you can imagine debugging and fixing bugs in the browser developer tools is much easier than using an emulator and remote debugging.

```
npm start
```

Once application runs in the browser, scroll to the bottom of the page where "Page 1" and "Page 2" links are rendered, and try clicking them. The content under the links section should change to reflect current page content. By default, for "Page 2" it is going to be something like "page2 works!".



Here are some links to help you start:

- Tour of Heroes
- CLI Documentation
- Angular blog

- Page 1
- Page 2

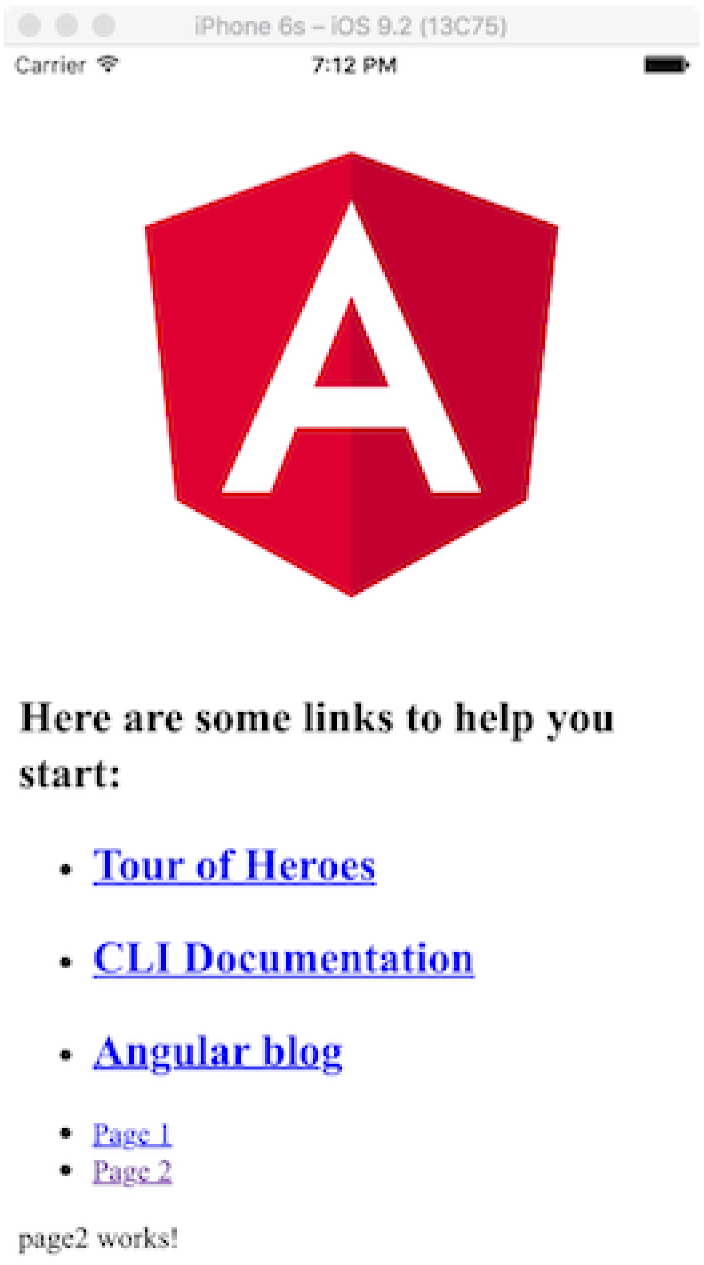
page2 works!

Routing in the iOS emulator

For the final step let's now run the same application in the iOS emulator and ensure the routing behaviour is the same as in the desktop browser:

```
npm run ios
```

Scroll to the bottom of the page and test both routes as we did previously with the Browser platform plugin. You should see the same "page2 works!" message when tapping the "Page 2" link, and "page1 works!" for the first link.



Here are some links to help you start:

- Tour of Heroes
- CLI Documentation
- Angular blog

- Page 1
- Page 2

page2 works!

Summary

Congratulations, you now have a working configuration that allows you to compile and run Angular applications with Apache Cordova, and address various platforms and devices at the same time.

Don't forget to check out the latest Apache Cordova documentation[106] to get more details on the framework and scenarios related to cross-platform application development with HTML5.

[106]https://cordova.apache.org/docs/en/latest/

Changelog

This chapter contains a list of notable changes introduced to the book with each version.

Revision 16 (2018-10-23)

- Upgrade all examples to Angular 7 and Angular CLI 7
- Update chapters to use Angular 7 examples
- Setup Travis CI and unit testing for all example projects
- Setup Prettier and provide better code formatting for example projects
- Minor text polishing and link fixes

Revision 15 (2018-06-03)

- Updated: ngOnDestroy
- New Listening for View and Content changes

Revision 14 (2018-04-08)

- Updated Plugins chapter with more details
- Updated Angular CLI chapter with more details on Modules
- Updated Directives chapter with ng-container directive
- Updated Internationalisation (i18n) chapter with a reference to "@ngstack/translate[107]"

Revision 13 (2018-02-12)

- Plugins

Revision 12 (2017-12-17)

- Using with Docker

[107]https://www.npmjs.com/package/@ngstack/translate

Revision 11 (2017-12-03)

- Reusable component libraries

Revision 10 (2017-11-12)

- Components
  - Component Lifecycle

Revision 9 (2017-10-15)

- Components
  - Providers
  - Host
  - Queries

Revision 8 (2017-09-17)

- Global Application Configuration
- Internationalisation (i18n)

Revision 7 (2017-09-14)

- Events

Revision 6 (2017-08-24)

- Building a Mobile Application with Cordova and Angular

Revision 5 (2017-08-13)

- Dependency Injection

Revision 4 (2017-07-22)

- ES6: Destructuring assignment

Revision 3 (2017-07-09)

- NG: Advanced Angular, Dynamic Content

Revision 2 (2017-07-02)

- NG: Components Chapter (part 1, basic components)
- Updated Introduction with a link to the project board

Revision 1 (2017-06-09)

Initial version of the book published to public.