

Become a
NINJA
with



ANGULAR

ninja  *squad*

Become a ninja with Angular (free
sample)

Ninja Squad

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Chapter 1. Free sample

What you're going to read is a free sample of [our Angular ebook](#): the starting part of the full book, which explains its purpose and contents, gives an overview of ECMAScript 6, TypeScript, and Web Components, describes Angular philosophy, and finally lets you write your first application.

This sample extract does not require any preliminary knowledge.

Chapter 2. Introduction

So you want to be a ninja, huh? Well, you're in good hands!

But we have a long road, you and me, with lots of things to learn :).

We're living exciting times in Web development. There is a new Angular. A complete rewrite of the good old AngularJS. Why a complete rewrite? Was AngularJS 1.x not enough?

I like the old AngularJS very much. In our small company, we have built several projects with it, contributed code to the core framework, trained hundreds of developers (yes, really), and even written a book about it (in French, but that still counts).

AngularJS is incredibly productive once you have mastered it. Despite all of this, it doesn't prevent us from seeing its weaknesses. AngularJS is not perfect, with some very difficult concepts to grasp, and traps hard to avoid.

Most of all, the Web has changed since AngularJS was conceived. JavaScript has changed. New frameworks have emerged, with great ideas, or better implementation. We are not the kind of developers to tell you that you should use this tool instead of that one. We just happen to know some tools very well, and know what fits the project. AngularJS was one of those tools, allowing us to build well-tested web applications, and to build them fast. We also tried to bend it where it didn't fit. Don't blame us, it happens to the best of us.

Will Angular be the tool we will use without hesitation in our future projects? It's hard to say right now, because the framework is really young and the ecosystem only just blooming.

But Angular has a lot of interesting points, and a vision that few other frameworks have. It has been designed for the Web of tomorrow, with ECMAScript 6, Web Components and Mobile in mind. When it was first announced, I was, like many, sad at first that the 2.0 version would not be a simple update (I'm sorry if you're just learning about it).

But I was also eager to see what solution the talented Google team would come up with.

So I started to write this ebook, pretty much after the first commits, reading the design docs, watching the conference videos, reviewing every commit since the beginning. When I wrote my first ebook, about AngularJS 1.x, it was already a stable and known beast. This one is very different, it started when Angular was not even clear in the minds of its designers. Because I knew I would learn a lot, not only about Angular but also about the concepts that would shape the future of Web development, some of which have nothing to do with Angular. And I did. I had to dig a lot about some of these concepts, and I hope that you will enjoy the journey of learning about them, and how they relate to Angular, as much as I did.

The ambition of this ebook is to evolve with Angular. If it turns out that Angular is the great framework we hope, you will receive updates with the best practices and some new features as they emerge (and with fewer typos, because, despite our countless reviews, there are probably some left...). And I would love to hear back from you - if some chapters aren't clear enough, if you spot a mistake or if you have a better way for some parts.

I'm fairly confident about the code samples, though, as they are all in a real project, with several

hundred unit tests. It was the only way to write an ebook with a newborn framework, and to be able to catch all the problems that inevitably arose with each release.

Even if you are not convinced by Angular in the end, I'm pretty sure you will have learnt a thing or two along your read.

If you have bought the "Pro package" (thank you!), you'll build a small application piece by piece along the book. This application is called **PonyRacer**, and it is a website where you can bet on pony races. You can even test the application [here](#)! Go on, I'll wait for you.

Fun, isn't it?

But it's not just a fun application, it's a complete one. You'll have to write components, forms, tests, use the router, call an HTTP API (that we have already built) and even do Web Sockets. It has all the pieces you'll need for writing a real app. Each exercise will come with a skeleton, a set of instructions and a few tests. Once you have all the tests in success, you have completed the exercise!

The first 6 exercises of the Pro Pack are free. The other ones are only accessible if you buy our online training. At the end of every chapter, we will link to the exercises of the Pro Pack that are related to the features explained in the chapter, mark the free ones with the following label: 🐾, and mark the other ones with the following label: 🦄.

If you did not buy the "Pro package" (but really you should), don't worry: you'll learn everything that's needed. But you will not build this awesome application with beautiful ponies in pixel art. Your loss :)!

You will quickly see that, beyond Angular itself, we have tried to explain the core concepts the framework uses. The first chapters don't even talk about Angular: they are what I call the "Concept Chapters", here to help you level up with the new and exciting things happening in our field.

Then we will slowly build our knowledge of the framework, with components, templates, pipes, forms, http, routing, tests...

And finally we will learn about the advanced topics. But that's another story.

Enough with the introduction, let's start with one of the things that will definitely change the way we code: ECMAScript 6.



The ebook is using Angular version 9.0.6 for the examples.

Angular and versioning

This book used to be named "Become a Ninja with Angular 2". Because, originally, Google named its framework Angular 2. But in October 2016, they reviewed their [versioning and release policy](#).



We'll have a major release every six months, according to the plan. And now the framework should be called just "Angular".

Don't worry, these releases are not a complete rewrite with no backward compatibility like Angular 2 was to AngularJS 1.x.

As this ebook will be updated (for free) with all these following major releases, it is now named "Become a Ninja with Angular" (without any number).

Chapter 3. A gentle introduction to ECMAScript 2015+

If you're reading this, we can be pretty sure you have heard of JavaScript. What we call JS is one implementation of a standard specification, called ECMAScript. The spec version you know the most about is the version 5, that has been used these last years.

But, in 2015, a new version of the spec has been released, called ECMAScript 2015, ES2015, or sometimes ES6, as it was the sixth version of the specification. And since then, we had a yearly release of the specification (ES2016, ES2017, etc.), with a few new features every year. From now on, I'll mainly say ES2015, as it is the most popular way to reference it, or ES2015+ to reference ES2015, ES2016, ES2017, etc. It adds A LOT of things to JavaScript, like classes, constants, arrow functions, generators... It has so much stuff that we can't go through all of it, as it would take the whole book. But Angular has been designed to take advantage of the brand new version of JavaScript. And, even if you can still use your old JavaScript, things will be more awesome if you use ES2015+. So we're going to spend some time in this chapter to get a grip on what ES2015+ is, and what will be useful to us when building an Angular app.

That means we're going to leave a lot of stuff aside, and we won't be exhaustive on the rest, but it will be a great starting point. If you already know ES2015+, you can skip these pages. And if you don't, you will learn some pretty amazing things that will be useful to you even if you end up not using Angular in the future!

3.1. Transpilers

The sixth version of the specification reached its final state in 2015. So it's now supported by modern browsers, but there are still browsers in the wild that don't support it yet, or only support it partially. And of course, now that we have a new specification every year (ES2016, ES2017, etc.), some browsers will always be late. You might be thinking: what's the point of all this, if I need to be careful on what I can use? And you'd be right, because there aren't that many apps that can afford to ignore older browsers. But, since virtually every JS developer who has tried ES2015+ wants to write ES2015+ apps, the community has found a solution: a transpiler.

A transpiler takes ES2015+ source code and generates ES5 code that can run in every browser. It even generates the source map files, which allows to debug directly the ES2015+ source code from the browser. Back in 2015, there were two main alternatives to transpile ES2015+ code:

- [Traceur](#), a Google project, historically the first one but now unmaintained.
- [Babeljs](#), a project started by a young developer, Sebastian McKenzie (17 years old at the time, yeah, that hurts me too), with a lot of diverse contributions.

The source code of Angular itself was at first transpiled with Traceur, before switching to TypeScript. TypeScript is an open source language developed by Microsoft. It's a typed superset of JavaScript that compiles to plain JavaScript, but we'll dive into it very soon.

Let's be honest: Babel has waaaaay more steam than Traceur nowadays, so I would advise you to use it. It is now the de-facto standard in this area.

So if you want to play with ES2015+, or set it up in one of your projects, take a look at these transpilers, and add a build step to your process. It will take your ES2015+ source files and generate the equivalent ES5 code. It works very well but, of course, some of the new features are quite hard or impossible to transform in ES5, as they just did not exist. However, the current state is largely good enough for us to use without worrying, so let's have a look at all these shiny new things we can do in JavaScript!

3.2. let

If you have been writing JS for some time, you know that the `var` declaration is tricky. In pretty much any other languages, a variable is declared where the declaration is done. But in JS, there is a concept, called "hoisting", which actually declares a variable at the top of the function, even if you declared it later.

So declaring a variable like `name` in the `if` block:

```
function getPonyFullName(pony) {  
  if (pony.isChampion) {  
    var name = 'Champion ' + pony.name;  
    return name;  
  }  
  return pony.name;  
}
```

is equivalent to declaring it at the top of the function:

```
function getPonyFullName(pony) {  
  var name;  
  if (pony.isChampion) {  
    name = 'Champion ' + pony.name;  
    return name;  
  }  
  // name is still accessible here  
  return pony.name;  
}
```

ES2015 introduces a new keyword for variable declaration, `let`, behaving much more like what you would expect:

```
function getPonyFullName(pony) {
  if (pony.isChampion) {
    let name = 'Champion ' + pony.name;
    return name;
  }
  // name is not accessible here
  return pony.name;
}
```

The variable `name` is now restricted to its block. `let` has been introduced to replace `var` in the long run, so you can pretty much drop the good old `var` keyword and start using `let` instead. The cool thing is, it should be painless to use `let`, and if you can't, you have probably spotted something wrong with your code!

3.3. Constants

Since we are on the topic of new keywords and variables, there is another one that can be of interest. ES2015 introduces `const` to declare... constants! When you declare a variable with `const`, it has to be initialized and you can't assign another value later.

```
const poniesInRace = 6;
```

```
poniesInRace = 7; // SyntaxError
```

As for variables declared with `let`, constants are not hoisted and are only declared at the block level.

One small thing might surprise you: you can initialize a constant with an object and later modify the object content.

```
const PONY = {};
PONY.color = 'blue'; // works
```

But you can't assign another object:

```
const PONY = {};
```

```
PONY = {color: 'blue'}; // SyntaxError
```

Same thing with arrays:

```
const PONIES = [];  
PONIES.push({ color: 'blue' }); // works
```

```
PONIES = []; // SyntaxError
```

3.4. Shorthands in object creation

Not a new keyword, but it can also catch your attention when reading ES2015 code. There is now a shortcut for creating objects, when the object property you want to create has the same name as the variable used as the value.

Example:

```
function createPony() {  
  const name = 'Rainbow Dash';  
  const color = 'blue';  
  return { name: name, color: color };  
}
```

can be simplified to:

```
function createPony() {  
  const name = 'Rainbow Dash';  
  const color = 'blue';  
  return { name, color };  
}
```

Similarly, when you want to define a method in the object:

```
function createPony() {  
  return {  
    run: () => {  
      console.log('Run!');  
    }  
  };  
}
```

you can simplify it to:

```
function createPony() {  
  return {  
    run() {  
      console.log('Run!');  
    }  
  };  
}
```

3.5. Destructuring assignment

This new feature can also catch your attention when reading ES2015 code. There is now a shortcut for assigning variables from objects or arrays.

In ES5:

```
var httpOptions = { timeout: 2000, isCache: true };  
// later  
var httpTimeout = httpOptions.timeout;  
var httpCache = httpOptions.isCache;
```

Now, in ES2015, you can do:

```
const httpOptions = { timeout: 2000, isCache: true };  
// later  
const { timeout: httpTimeout, isCache: httpCache } = httpOptions;
```

And you will have the same result. It can be a little disturbing, as the key is the property to look for into the object and the value is the variable to assign. But it works great! Even better: if the variable you want to assign has the same name as the property, you can simply write:

```
const httpOptions = { timeout: 2000, isCache: true };  
// later  
const { timeout, isCache } = httpOptions;  
// you now have a variable named 'timeout'  
// and one named 'isCache' with correct values
```

The cool thing is that it also works with nested objects:

```
const httpOptions = { timeout: 2000, cache: { age: 2 } };  
// later  
const {  
  cache: { age }  
} = httpOptions;  
// you now have a variable named 'age' with value 2
```

And the same is possible with arrays:

```
const timeouts = [1000, 2000, 3000];
// later
const [shortTimeout, mediumTimeout] = timeouts;
// you now have a variable named 'shortTimeout' with value 1000
// and a variable named 'mediumTimeout' with value 2000
```

Of course it also works for arrays in arrays, or arrays in objects, etc.

One interesting use of this can be for multiple return values. Imagine a function `randomPonyInRace` that returns a pony and its position in a race.

```
function randomPonyInRace() {
  const pony = { name: 'Rainbow Dash' };
  const position = 2;
  // ...
  return { pony, position };
}

const { position, pony } = randomPonyInRace();
```

The new destructuring feature is assigning the position returned by the method to the position variable, and the pony to the pony variable! And if you don't care about the position, you can write:

```
function randomPonyInRace() {
  const pony = { name: 'Rainbow Dash' };
  const position = 2;
  // ...
  return { pony, position };
}

const { pony } = randomPonyInRace();
```

And you will only have the pony!

3.6. Default parameters and values

One of the characteristics of JavaScript is that it allows developers to call a function with any number of arguments:

- if you pass more arguments than the number of the parameters, the extra arguments are ignored (well, you can still use them with the special `arguments` variable, to be accurate).
- if you pass fewer arguments than the number of the parameters, the missing parameter will be set to `undefined`.

The last case is the one that is the most relevant to us. Usually, we pass fewer arguments when the parameters are optional, like in the following example:

```
function getPonies(size, page) {  
  size = size || 10;  
  page = page || 1;  
  // ...  
  server.get(size, page);  
}
```

The optional parameters usually have a default value. The OR operator will return the right operand if the left one is *undefined*, as will be the case if the parameter was not provided (to be completely accurate, if it is *falsy*, i.e. *0*, *false*, *""*, etc.). Using this trick, the function *getPonies* can then be called:

```
getPonies(20, 2);  
getPonies(); // same as getPonies(10, 1);  
getPonies(15); // same as getPonies(15, 1);
```

This worked alright, but it was not really obvious that the parameters were optional ones with default values, without reading the function body. ES2015 introduces a more precise way to have default parameters, directly in the function definition:

```
function getPonies(size = 10, page = 1) {  
  // ...  
  server.get(size, page);  
}
```

Now it is perfectly clear that the *size* parameter will be *10* and the *page* parameter will be *1* if not provided.



There is a small difference though, as now *0* or *""* are valid values and will not be replaced by the default one, as *size = size || 10* would have done. It will be more like *size = size === undefined ? 10: size;*

The default value can also be a function call:

```
function getPonies(size = defaultSize(), page = 1) {  
  // the defaultSize method will be called if size is not provided  
  // ...  
  server.get(size, page);  
}
```

or even other variables, either global variables, or other parameters of the function:

```
function getPonies(size = defaultSize(), page = size - 1) {
  // if page is not provided, it will be set to the value
  // of the size parameter minus one.
  // ...
  server.get(size, page);
}
```

This mechanism for parameters can also be applied to values, for example when using a destructuring assignment:

```
const { timeout = 1000 } = httpOptions;
// you now have a variable named 'timeout',
// with the value of 'httpOptions.timeout' if it exists
// or 1000 if not
```

3.7. Rest operator

ES2015 introduces a new syntax to define variable parameters in functions. As said in the previous part, you could always pass extra arguments to a function and get them with the special `arguments` variable. So you could have done something like that:

```
function addPonies(ponies) {
  for (var i = 0; i < arguments.length; i++) {
    poniesInRace.push(arguments[i]);
  }
}

addPonies('Rainbow Dash', 'Pinkie Pie');
```

But I think we can agree that it's neither pretty nor obvious: since the `ponies` parameter is never used, how do we know that we can pass several ponies?

ES2015 gives us a way better syntax, using the rest operator `...`:

```
function addPonies(...ponies) {
  for (let pony of ponies) {
    poniesInRace.push(pony);
  }
}
```

`ponies` is now a true array on which we can iterate. The `for ... of` loop used for iteration is also a new feature in ES2015. It allows to be sure to iterate over the collection values, and not also on its properties as `for ... in` would do. Don't you think our code is prettier and more obvious now?

The rest operator can also work when destructuring data:


```
const [winner, ...losers] = poniesInRace;
// assuming 'poniesInRace' is an array containing several ponies
// 'winner' will have the first pony,
// and 'losers' will be an array of the other ones
```

The rest operator is not to be confused with the spread operator which, I'll give you that, looks awfully similar! But the spread operator is the opposite: it takes an array and spreads it in variable arguments. The only examples I have in mind are functions like `min` or `max`, that receive variable arguments, and that you might want to call on an array:

```
const ponyPrices = [12, 3, 4];
const minPrice = Math.min(...ponyPrices);
```

3.8. Classes

One of the most emblematic new features, and one that we will vastly use when writing an Angular app: ES2015 introduces classes to JavaScript! You can now easily use classes and inheritance in JavaScript. You always could, using prototypal inheritance, but that was not an easy task, especially for beginners.

Now it's very easy, take a look:

```
class Pony {
  constructor(color) {
    this.color = color;
  }

  toString() {
    return `${this.color} pony`;
    // see that? It is another cool feature of ES2015, called template literals
    // we'll talk about these quickly!
  }
}
const bluePony = new Pony('blue');
console.log(bluePony.toString()); // blue pony
```

Class declarations, unlike function declarations, are not hoisted, so you need to declare a class before using it. You may have noticed the special function `constructor`. It is the function being called when we create a new pony, with the `new` operator. Here it needs a color, and we create a new Pony instance with the color set to "blue". A class can also have methods, callable on an instance, as the method `toString()` here.

It can also have static attributes and methods:

```
class Pony {
  static defaultSpeed() {
    return 10;
  }
}
```

Static methods can be called only on the class directly:

```
const speed = Pony.defaultSpeed();
```

A class can have getters and setters, if you want to hook on these operations:

```
class Pony {
  get color() {
    console.log('get color');
    return this._color;
  }

  set color(newColor) {
    console.log(`set color ${newColor}`);
    this._color = newColor;
  }
}

const pony = new Pony();
pony.color = 'red';
// 'set color red'
console.log(pony.color);
// 'get color'
// 'red'
```

And, of course, if you have classes, you also have inheritance out of the box in ES2015.

```
class Animal {
  speed() {
    return 10;
  }
}

class Pony extends Animal {}

const pony = new Pony();
console.log(pony.speed()); // 10, as Pony inherits the parent method
```

Animal is called the base class, and Pony the derived class. As you can see, the derived class has the methods of the base class. It can also override them:

```

class Animal {
  speed() {
    return 10;
  }
}
class Pony extends Animal {
  speed() {
    return super.speed() + 10;
  }
}
const pony = new Pony();
console.log(pony.speed()); // 20, as Pony overrides the parent method

```

As you can see, the keyword `super` allows calling the method of the base class, with `super.speed()` for example.

The `super` keyword can also be used in constructors, to call the base class constructor:

```

class Animal {
  constructor(speed) {
    this.speed = speed;
  }
}
class Pony extends Animal {
  constructor(speed, color) {
    super(speed);
    this.color = color;
  }
}
const pony = new Pony(20, 'blue');
console.log(pony.speed); // 20

```

3.9. Promises

Promises are not so new, and you might know them or use them already, as they were a big part of AngularJS 1.x. But since you will use them a lot in Angular, and even if you're just using JS, I think it's important to make a stop.

Promises aim to simplify asynchronous programming. Our JS code is full of async stuff, like AJAX requests, and usually we use callbacks to handle the result and the error. But it can get messy, with callbacks inside callbacks, and it makes the code hard to read and to maintain. Promises are much nicer than callbacks, as they flatten the code, and thus make it easier to understand. Let's consider a simple use case, where we need to fetch a user, then their rights, then update a menu when we have these.

With callbacks:

```
getUser(login, function(user) {  
  getRights(user, function(rights) {  
    updateMenu(rights);  
  });  
});
```

Now, let's compare it with promises:

```
getUser(login)  
  .then(function(user) {  
    return getRights(user);  
  })  
  .then(function(rights) {  
    updateMenu(rights);  
  })
```

I like this version, because it executes as you read it: I want to fetch a user, then get their rights, then update the menu.

As you can see, a promise is a 'thenable' object, which simply means it has a `then` method. This method takes two arguments: one success callback and one reject callback. The promise has three states:

- pending: while the promise is not done, for example, our server call is not completed yet.
- fulfilled: when the promise is completed with success, for example, the server call returns an OK HTTP status.
- rejected: when the promise has failed, for example, the server returns a 404 status.

When the promise is fulfilled, then the success callback is called, with the result as an argument. If the promise is rejected, then the reject callback is called, with a rejected value or an error as the argument.

So, how do you create a promise? Pretty simple, there is a new class called `Promise`, whose constructor expects a function with two parameters, `resolve` and `reject`.

```
const getUser = function(login) {  
  return new Promise(function(resolve, reject) {  
    // async stuff, like fetching users from server, returning a response  
    if (response.status === 200) {  
      resolve(response.data);  
    } else {  
      reject('No user');  
    }  
  });  
};
```

Once you have created the promise, you can register callbacks, using the **then** method. This method can receive two parameters, the two callbacks you want to call in case of success or in case of failure. Here we only pass a success callback, ignoring the potential error:

```
getUser(login)
  .then(function(user) {
    console.log(user);
  })
```

Once the promise is resolved, the success callback (here simply logging the user on the console) will be called.

The cool part is that it flattens the code. For example, if your resolve callback is also returning a promise, you can write:

```
getUser(login)
  .then(function(user) {
    return getRights(user) // getRights is returning a promise
      .then(function(rights) {
        return updateMenu(rights);
      });
  })
```

but more beautifully:

```
getUser(login)
  .then(function(user) {
    return getRights(user); // getRights is returning a promise
  })
  .then(function(rights) {
    return updateMenu(rights);
  })
```

Another interesting thing is the error handling, as you can use one handler per promise, or one for all the chain.

One per promise:

```

getUser(login)
  .then(
    function(user) {
      return getRights(user);
    },
    function(error) {
      console.log(error); // will be called if getUser fails
      return Promise.reject(error);
    }
  )
  .then(
    function(rights) {
      return updateMenu(rights);
    },
    function(error) {
      console.log(error); // will be called if getRights fails
      return Promise.reject(error);
    }
  )
)

```

One for the chain:

```

getUser(login)
  .then(function(user) {
    return getRights(user);
  })
  .then(function(rights) {
    return updateMenu(rights);
  })
  .catch(function(error) {
    console.log(error); // will be called if getUser or getRights fails
  })

```

You should seriously look into Promises, because they are going to be the new way to write APIs, and every library will use them. Even the standard ones: the new [Fetch API](#) does for example.

3.10. Arrow functions

One thing I like a lot in ES2015 is the new arrow function syntax, using the 'fat arrow' operator (\Rightarrow). It is SO useful for callbacks and anonymous functions!

Let's take our previous example with promises:

```
getUser(login)
  .then(function(user) {
    return getRights(user); // getRights is returning a promise
  })
  .then(function(rights) {
    return updateMenu(rights);
  })
```

can be written with arrow functions like this:

```
getUser(login)
  .then(user => getRights(user))
  .then(rights => updateMenu(rights))
```

How cool is it? THAT cool!

Note that the return is also implicit if there is no block: no need to write `user => return getRights(user)`. But if we did have a block, we would need the explicit return:

```
getUser(login)
  .then(user => {
    console.log(user);
    return getRights(user);
  })
  .then(rights => updateMenu(rights))
```

And it has a special trick, a great power over normal functions: the `this` stays lexically bounded, which means that these functions don't have a new `this` as other functions do. Let's take an example, where you are iterating over an array with the `map` function to find the max.

In ES5:

```

var maxFinder = {
  max: 0,
  find: function(numbers) {
    // let's iterate
    numbers.forEach(function(element) {
      // if the element is greater, set it as the max
      if (element > this.max) {
        this.max = element;
      }
    });
  }
};

maxFinder.find([2, 3, 4]);
// log the result
console.log(maxFinder.max);

```

You would expect this to work, but it doesn't. If you have a good eye, you may have noticed that the `forEach` in the `find` function uses `this`, but the `this` is not bound to an object. So `this.max` is not the `max` of the `maxFinder` object... Of course you can fix it easily, using an alias:

```

var maxFinder = {
  max: 0,
  find: function(numbers) {
    var self = this;
    numbers.forEach(function(element) {
      if (element > self.max) {
        self.max = element;
      }
    });
  }
};

maxFinder.find([2, 3, 4]);
// log the result
console.log(maxFinder.max);

```

or binding the `this`:


```

var maxFinder = {
  max: 0,
  find: function(numbers) {
    numbers.forEach(
      function(element) {
        if (element > this.max) {
          this.max = element;
        }
      }.bind(this)
    );
  }
};

maxFinder.find([2, 3, 4]);
// log the result
console.log(maxFinder.max);

```

or even passing it as a second parameter of the `forEach` function (as it was designed for):

```

var maxFinder = {
  max: 0,
  find: function(numbers) {
    numbers.forEach(function(element) {
      if (element > this.max) {
        this.max = element;
      }
    }, this);
  }
};

maxFinder.find([2, 3, 4]);
// log the result
console.log(maxFinder.max);

```

But there is now an even more elegant solution with the arrow function syntax:

```
const maxFinder = {
  max: 0,
  find: function(numbers) {
    numbers.forEach(element => {
      if (element > this.max) {
        this.max = element;
      }
    });
  }
};
```

```
maxFinder.find([2, 3, 4]);
// log the result
console.log(maxFinder.max);
```

That makes the arrow functions the perfect candidates for anonymous functions in callbacks!

3.11. Async/await

We were talking about promises earlier, and it's worth knowing another keyword was introduced to handle them more synchronously: **await**.

This is not a feature introduced in ECMAScript 2015 but in ECMAScript 2017, and to use **await**, your function must be marked as **async**. When you use the **await** keyword in front of a Promise, you pause the execution of your **async** function, wait for the Promise to resolve, and then resume the execution of the **async** function. The returned value will be the resolved value.

So we can write our previous example using **async/await** like this:

```
async function getUserRightsAndUpdateMenu() {
  // getUser is a promise
  const user = await getUser(login);
  // getRights is a promise
  const rights = await getRights(user);
  updateMenu(rights);
}
await getUserRightsAndUpdateMenu();
```

And your code now looks like it is synchronous! Another cool feature of **async/await** is that you can use a simple **try/catch** to handle errors:

```

async function getUserRightsAndUpdateMenu() {
  try {
    // getUser is a promise
    const user = await getUser(login);
    // getRights is a promise
    const rights = await getRights(user);
    updateMenu(rights);
  } catch (e) {
    // will be called if getUser, getRights or updateMenu fails
    console.log(e);
  }
}
await getUserRightsAndUpdateMenu();

```

Note that `async/await` is still asynchronous, although it looks like synchronous. The function execution is paused and resumed, but just like with callbacks, this doesn't block the thread: other JavaScript events can be handled while the execution is paused.

3.12. Sets and Maps

This is a short one: you now have proper collections in ES2015. Yay \o/! We used to have dictionaries filling the role of a map, but we can now use the class `Map`:

```

const cedric = { id: 1, name: 'Cedric' };
const users = new Map();
users.set(cedric.id, cedric); // adds a user
console.log(users.has(cedric.id)); // true
console.log(users.size); // 1
users.delete(cedric.id); // removes the user

```

We also have a class `Set`:

```

const cedric = { id: 1, name: 'Cedric' };
const users = new Set();
users.add(cedric); // adds a user
console.log(users.has(cedric)); // true
console.log(users.size); // 1
users.delete(cedric); // removes the user

```

You can iterate over a collection, with the new syntax `for ... of`:

```

for (let user of users) {
  console.log(user.name);
}

```

You'll see that the `for ... of` syntax is the one the Angular team chose to iterate over a collection in a template.

3.13. Template literals

Composing strings has always been painful in JavaScript, as we usually have to use concatenation:

```
const fullname = 'Miss ' + firstname + ' ' + lastname;
```

Template literals are a new small feature, where you have to use backticks (``) instead of quotes or simple quotes, and you have a basic templating system, with multiline support:

```
const fullname = `Miss ${firstname} ${lastname}`;
```

The multiline support is especially great when you are writing HTML strings, as we will do for our Angular components:

```
const template = `

<h1>Hello</h1>
</div>`;


```

One last feature is the ability to tag them. You can define a function, and apply it to a template string. Here `askQuestion` adds an interrogation point at the end of the string:

```
const askQuestion = strings => strings + '?';
const template = askQuestion`Hello there`;
```

So what's the difference with a simple function? The tag function in fact receives several arguments:

- an array of the static parts of the string
- the values resulting of the evaluation of the expressions

For example if we have a template string containing expressions:

```
const person1 = 'Cedric';
const person2 = 'Agnes';
const template = `Hello ${person1}! Where is ${person2}?`;
```

then the tag function will receive the various static and dynamic parts. Here we have a tag function to uppercase the names of the protagonists:

```
const uppercaseNames = (strings, ...values) => {
  // `strings` is an array with the static parts ['Hello ', '! How are you', '?']
  // `values` is an array with the evaluated expressions ['Cedric', 'Agnes']
  const names = values.map(name => name.toUpperCase());
  // `names` now has ['CEDRIC', 'AGNES']
  // let's merge the `strings` and `names` arrays
  return strings.map((string, i) => `${string}${names[i] ? names[i] : ''}`).join('');
};
const result = uppercaseNames`Hello ${person1}! Where is ${person2}?`;
// returns 'Hello CEDRIC! Where is AGNES?'
```

Let's now talk about one of the big changes introduced: modules.

3.14. Modules

A standard way to organize functions in namespaces and to dynamically load code in JS has always been lacking. Node.js has been one of the leaders in this, with a thriving ecosystem of modules using the CommonJS convention. On the browser side, there is also the [AMD](#) (Asynchronous Module Definition) API, used by [RequireJS](#). But none of these were a real standard, thus leading to endless discussions on what's best.

ES2015 aims to create a syntax using the best from both worlds, without caring about the actual implementation. The [Ecma TC39 committee](#) (which is responsible for evolving ES2015 and authoring the specification of the language) wanted to have a nice and easy syntax (that's arguably CommonJS's strong suit), but to support asynchronous loading (like AMD), and a few goodies like the possibility to statically analyze the code by tools and support cyclic dependencies nicely. The new syntax handles how you export and import things to and from modules.

This module thing is really important in Angular, as pretty much everything is defined in modules, that you have to import when you want to use them. Let's say I want to expose a function to bet on a specific pony in a race and a function to start the race.

In `racesservice.js`:

```
export function bet(race, pony) {
  // ...
}
export function start(race) {
  // ...
}
```

As you can see, this is fairly easy: the new keyword `export` does a straightforward job and exports the two functions.

Now, let's say one of our application components needs to call these functions.

In another file:

```
import { bet, start } from './races.service';
```

```
// later  
bet(race, pony1);  
start(race);
```

That's what is called a *named export*. Here we are importing the two functions, and we have to specify the filename containing these functions - here 'races.service'. Of course, you can import only one method if you need, you can even give it an alias:

```
import { start as startRace } from './races.service';
```

```
// later  
startRace(race);
```

And if you want to use all the exported symbols (functions, constants, classes etc.) from the module, you can use a wildcard '*'.

As you would do with other languages, use the wildcard with care, only when you really want all the functions, or most of them. As this will be analyzed by our IDEs, we will see auto-import soon and that will free us from the bother to import the right things.

With a wildcard, you have to use an alias, and I kind of like it, because it makes the rest of the code clearer:

```
import * as racesService from './races.service';
```

```
// later  
racesService.bet(race, pony1);  
racesService.start(race);
```

If your module exposes only one function or value or class, you don't have to use named export, and you can leverage the default keyword. It works great for classes for example:

```
// pony.js  
export default class Pony {}  
// races.service.js  
import Pony from './pony';
```

Notice the lack of curly braces to import a default. You can import it with the alias you want, but to be consistent, it's better to call the import with the module name (except if you have multiple modules with the same name of course, then you can choose an alias that allows to distinguish

them). And of course, you can mix default export with named ones, but obviously with only one default per module.

In Angular, you're going to use a lot of these imports in your app. Each component and service will be a class, generally isolated in their own file and exported, and then imported when needed in other components.

3.15. Conclusion

That ends our gentle introduction to ES2015+. We skipped some other parts, but if you're comfortable with this chapter, you will have no problem writing your apps in ES2015+. If you want to have a deeper understanding of this, I highly recommend [Exploring JS](#) by [Axel Rauschmayer](#) or [Understanding ES6](#) from [Nicholas C. Zakas](#)... Both ebooks can be read online for free, but don't forget to buy it to support their authors, they have done a great work! Actually I've re-read [Speaking JS](#), Axel's previous book, and I again learned a few things, so if you want to refresh your JS skills, I definitely recommend it!

Chapter 4. Going further than ES2015+

4.1. Dynamic, static and optional types

You may have heard that Angular apps can be written in TypeScript. And you may be wondering what TypeScript is, or what it brings to the table.

JavaScript is dynamically typed. That means you can do things like:

```
let pony = 'Rainbow Dash';  
pony = 2;
```

And it works. That's great for all sort of things, as you can pass pretty much any object to a function and it works, as long as the object has the properties the function needs:

```
const pony = { name: 'Rainbow Dash', color: 'blue' };  
const horse = { speed: 40, color: 'black' };  
const printColor = animal => console.log(animal.color);  
// works as long as the object has a `color` property
```

This dynamic nature allows wonderful things but it is also a pain for a few others compared to more statically-typed languages. The most obvious might be when you call an unknown function in JS from another API, you pretty much have to read the doc (or, worse, the function code) to know what the parameter should look like. Take a look at our previous example: the method `printColor` needs a parameter with a `color` property. That can be hard to guess, and of course it is much worse in day-to-day work, where we use various libraries and services developed by fellow developers. One of Ninja Squad's co-founders is often complaining about the lack of types in JS, and finds it regrettable he can't be as productive and write as good code as he would in a more statically-typed environment. And he is not entirely wrong, even if he is sometimes ranting for the sake of it too! Without type information, IDEs have no real clue if you're doing something wrong, and tools can't help you find bugs in your code. Of course, we have tests in our apps, and Angular has always been keen on making testing easy, but it's nearly impossible to have a perfect test coverage.

That leads to the maintainability topic. JS code can become hard to maintain, despite tests and documentation. Refactoring a huge JS app is no easy task, compared to what could be done in other statically-typed languages. Maintainability is a very important topic, and types help humans and tools to avoid mistakes when writing and maintaining code. Google has always been keen to push new solutions in that direction: it's easy to understand as they have some of the biggest web apps of the world, with GMail, Google apps, Maps... So they have tried several approaches to front-end maintainability: GWT, Google Closure, Dart... All trying to help writing big webapps.

For Angular, the Google team wanted to help us writing better JS, by adding some type information to our code. It's not a very new concept in JS, it was even the subject of the ECMAScript 4 specification, which was later abandoned. At first they announced AtScript, as a superset of ES2015+ with annotations (types annotations and another kind I'll discuss later). They also announced the support of TypeScript, the Microsoft language, with additional type annotations.

And then, a few months later, the TypeScript team announced that they had worked closely with the Google team, and the new version of the language (1.5) would have all the shiny new things AtScript had. And the Google team announced that AtScript was officially dropped, and that TypeScript was the new top-notch way to write Angular apps!

4.2. Enters TypeScript

I think this was a smart move for several reasons. For one, no one really wants to learn another language extension. And TypeScript was already there, with an active community and ecosystem. I never really used it before Angular, but I heard good things on it, from various people. TypeScript is a Microsoft project. But it's not the Microsoft you have in mind, from the Ballmer and Gates years. It's the Microsoft of the Nadella era, the one opening to its community, and, well, open-source. Google knows this, and it's far better for them to contribute to an existing project, rather than to have to bear the burden to maintain their own. And the TypeScript framework will gain a huge popularity boost: win-win, as your manager would say.

But the main reason to bet on TypeScript is the type system it offers. It's an optional type system that helps without getting in the way. In fact, after coding some time with it, you'll probably want to code every application with it. I do like what they have done, and we will have a look at what TypeScript offers in the next section. At the end, you'll have enough understanding to read any Angular code, and you'll be able to choose whether you want to use it or not, in your apps.

You may be wondering: why use typed code in Angular apps? Let's take an example. Angular 1 and 2 have been built around a powerful concept named "dependency injection". You might already be familiar with it, as it is a common design pattern used in several frameworks for different languages and, as I said, already used in AngularJS 1.x.

4.3. A practical example with DI

To sum up what dependency injection is, think about a component of the app, let's say `RaceList`, needing to access the races list that the service `RaceService` can give. You would write `RaceList` like this:

```
class RaceList {
  constructor() {
    this.raceService = new RaceService();
    // let's say that list() returns a promise
    this.raceService
      .list()
      // we store the races returned into a member of `RaceList`
      .then(races => (this.races = races));
    // arrow functions, FTW!
  }
}
```

But it has several flaws. One of them is the testability: it is now very hard to replace the `raceService` by a fake (mock) one, to test our component.

If we use the Dependency Injection (DI) pattern, we delegate the creation of the `RaceService` to the framework, and we simply ask for an instance. The framework is now in charge of the creation of the dependency, and, well, injects it:

```
class RaceList {
  constructor(raceService) {
    this.raceService = raceService;
    this.raceService.list().then(races => (this.races = races));
  }
}
```

Now, when we test this class, we can easily pass a fake service to the constructor:

```
// in a test
const fakeService = {
  list: () => {
    // returns a fake promise
  }
};
const raceList = new RaceList(fakeService);
// now we are sure that the race list
// is the one we want for the test
```

But how does the framework know what to inject in the constructor? Good question! AngularJS 1.x relied on the parameter's names, but it had a severe limitation, because minification of your code would have changed the param name... You could use the array syntax to fix this, or add a metadata to the class:

```
RaceList.$inject = ['RaceService'];
```

We had to add some metadata for the framework to understand what classes needed to be injected with. And that's exactly what type annotations give: a metadata giving the framework a hint it needs to do the right injection. In Angular, using TypeScript, we can write our `RaceList` component like:

```
class RaceList {
  raceService: RaceService;
  races: Array<string>;

  constructor(raceService: RaceService) {
    // the interesting part is `: RaceService`
    this.raceService = raceService;
    this.raceService.list().then(races => (this.races = races));
  }
}
```

Now the injection can be done!

That's why we're going to spend some time learning TypeScript (TS). Angular is clearly built to leverage this language, so we will have the easiest time writing our apps using it. And the Angular team really hopes to submit the type system to the standard committee, so maybe one day we'll have types in JS, and all this will be usual.

Let's dive in!

Chapter 5. Diving into TypeScript

TypeScript has been around since 2012. It's a superset of JavaScript, adding a few things to ES5. The most important one is the type system, giving TypeScript its name. From version 1.5, released in 2015, the library is trying to be a superset of ES2015+, including all the shiny features we saw in the previous chapter, and a few new things as well, like decorators. Writing TypeScript feels very much like writing JavaScript. By convention, TypeScript files are named with a `.ts` extension, and they will need to be compiled to standard JavaScript, usually at build time, using the TypeScript compiler. The generated code is very readable.

```
npm install -g typescript
tsc test.ts
```

But let's start with the beginning.



5.1. Types as in TypeScript

The general syntax to add type info in TypeScript is rather straightforward:

```
let variable: type;
```

The types are easy to remember:

```
const ponyNumber: number = 0;
const ponyName: string = 'Rainbow Dash';
```

In such cases, the types are optional because the TS compiler can guess them (it's called "type inference") from the values.

The type can also be coming from your app, as with the following class `Pony`:

```
const pony: Pony = new Pony();
```

TypeScript also supports what some languages call "generics", for example for an array:

```
const ponies: Array<Pony> = [new Pony()];
```

The array can only contain ponies, and the generic notation, using `<>`, indicates this. You may be wondering what the point of doing this is. Adding types information will help the compiler catch possible mistakes:

```
ponies.push('hello'); // error TS2345
// Argument of type 'string' is not assignable to parameter of type 'Pony'.
```

So, if you need a variable to have multiple types, does it mean you're screwed? No, because TS has a special type, called `any`.

```
let changing: any = 2;
changing = true; // no problem
```

It's really useful when you don't know the type of a value, either because it's from a dynamic content or from a library you're using.

If your variable can only be of type `number` or `boolean`, you can use a union type:

```
let changing: number | boolean = 2;
changing = true; // no problem
```

5.2. Enums

TypeScript also offers `enum`. For example, a race in our app can be either `ready`, `started` or `done`.

```
enum RaceStatus {
  Ready,
  Started,
  Done
}
```

```
const race = new Race();
race.status = RaceStatus.Ready;
```

The enum is in fact a numeric value, starting at 0. You can set the value you want, though:

```
enum Medal {  
  Gold = 1,  
  Silver,  
  Bronze  
}
```

Since TypeScript 2.4, you can even specify a string value:

```
enum Position {  
  First = 'First',  
  Second = 'Second',  
  Other = 'Other'  
}
```

To be honest though, we don't use enums a lot in our projects: we use union types. They are simpler and cover roughly the same use-cases:

```
let color: 'blue' | 'red' | 'green';  
// we can only give one of these values to `color`  
color = 'blue';
```

TypeScript even allows to create your own types, so you could do something like:

```
type Color = 'blue' | 'red' | 'green';  
const ponyColor: Color = 'blue';
```

5.3. Return types

You can also set the return type of a function:

```
function startRace(race: Race): Race {  
  race.status = RaceStatus.Started;  
  return race;  
}
```

If the function returns nothing, you can show it using `void`:

```
function startRace(race: Race): void {  
  race.status = RaceStatus.Started;  
}
```

5.4. Interfaces

That's a good first step. But as I said earlier, JavaScript is great for its dynamic nature. A function will work if it receives an object with the correct property:

```
function addPointsToScore(player, points) {  
  player.score += points;  
}
```

This function can be applied to any object with a `score` property. How do you translate this in TypeScript? It's easy: you define an interface, like the "shape" of the object.

```
function addPointsToScore(player: { score: number }, points: number): void {  
  player.score += points;  
}
```

It means that the parameter must have a property called `score` of the type `number`. You can name these interfaces, of course:

```
interface HasScore {  
  score: number;  
}
```

```
function addPointsToScore(player: HasScore, points: number): void {  
  player.score += points;  
}
```

You'll see that we often use interfaces throughout the book to represent our entities. We use interfaces for our models in our other projects as well. We usually append a `Model` suffix to make it clear. It's then very easy to create a new entity:

```
interface PonyModel {  
  name: string;  
  speed: number;  
}  
const pony: PonyModel = { name: 'Light Shoe', speed: 56 };
```

5.5. Optional arguments

Another treat of JavaScript is that arguments are optional. You can omit them, and they will become `undefined`. But if you define a function with typed parameter in TypeScript, the compiler will shout at you if you forget them:

```
addPointsToScore(player); // error TS2346
// Supplied parameters do not match any signature of call target.
```

To show that a parameter is optional in a function (or a property in an interface), you can add `?` after the parameter. Here, the `points` parameter could be optional:

```
function addPointsToScore(player: HasScore, points?: number): void {
  points = points || 0;
  player.score += points;
}
```

5.6. Functions as property

You may also be interested in describing a parameter that must have a specific function instead of a property:

```
function startRunning(pony) {
  pony.run(10);
}
```

The interface definition will be:

```
interface CanRun {
  run(meters: number): void;
}
```

```
function startRunning(pony: CanRun): void {
  pony.run(10);
}

const ponyOne = {
  run: meters => logger.log(`pony runs ${meters}m`)
};
startRunning(ponyOne);
```

5.7. Classes

A class can implement an interface. For us, the `Pony` class should be able to run, so we can write:


```
class Pony implements CanRun {
  run(meters) {
    logger.log(`pony runs ${meters}m`);
  }
}
```

The compiler will force us to implement a `run` method in the class. If we implement it badly, by expecting a `string` instead of a `number` for example, the compiler will yell:

```
class IllegalPony implements CanRun {
  run(meters: string) {
    console.log(`pony runs ${meters}m`);
  }
}
// error TS2420: Class 'IllegalPony' incorrectly implements interface 'CanRun'.
// Types of property 'run' are incompatible.
```

You can also implement several interfaces if you want:

```
class HungryPony implements CanRun, CanEat {
  run(meters) {
    logger.log(`pony runs ${meters}m`);
  }

  eat() {
    logger.log(`pony eats`);
  }
}
```

And an interface can extend one or several others:

```
interface Animal extends CanRun, CanEat {}

class Pony implements Animal {
  // ...
}
```

When you're defining a class in TypeScript, you can have properties and methods in your class. You may realize that properties in classes are not a standard ES2015+ feature, it is only possible in TypeScript.

```
class SpeedyPony {
  speed = 10;

  run() {
    logger.log(`pony runs at ${this.speed}m/s`);
  }
}
```

Everything is public by default, but you can use the `private` keyword to hide a property or a method. If you add `private` or `public` to a constructor parameter, it is a shortcut to create and initialize a private or public member:

```
class NamedPony {
  constructor(public name: string, private speed: number) {}

  run() {
    logger.log(`pony runs at ${this.speed}m/s`);
  }
}
```

```
const pony = new NamedPony('Rainbow Dash', 10);
// defines a public property name with 'Rainbow Dash'
// and a private one speed with 10
```

Which is the same as the more verbose:

```
class NamedPonyWithoutShortcut {
  public name: string;
  private speed: number;

  constructor(name: string, speed: number) {
    this.name = name;
    this.speed = speed;
  }

  run() {
    logger.log(`pony runs at ${this.speed}m/s`);
  }
}
```

These shortcuts are really useful and we'll rely on them a lot in Angular!

5.8. Working with other libraries

When working with external libraries written in JS, you may think we are doomed because we

don't know what types of parameter the function in that library will expect. That's one of the cool things with the TypeScript community: its members have defined interfaces for the types and functions exposed by the popular JavaScript libraries!

The files containing these interfaces have a special `.d.ts` extension. They contain a list of the library's public functions. A good place to look for these files is [DefinitelyTyped](#). For example, if you want to use TS in your AngularJS 1.x apps, you can download the proper file from the repo directly with NPM:

```
npm install --save-dev @types/angular
```

or download it manually. Then include the file at the top of your code, and enjoy the compilation checks:

```
/// <reference path="angular.d.ts" />
angular.module(10, []); // the module name should be a string
// so when I compile, I get:
// Argument of type 'number' is not assignable to parameter of type 'string'.
```

`/// <reference path="angular.d.ts" />` is a special comment recognized by TS, telling the compiler to look for the interface `angular.d.ts`. Now, if you misuse an AngularJS method, the compiler will complain, and you can fix it on the spot, without having to manually run your app!

Even cooler, since TypeScript 1.6, the compiler will auto-discover the type definitions of an NPM library if they are packaged with the library itself. More and more projects are adopting this approach, and so is Angular. So you don't even have to worry about including the interfaces in your Angular project: the TS compiler will figure it out by itself if you are using NPM to manage your dependencies!

5.9. Decorators

This feature was added in TypeScript 1.5, notably to help supporting Angular. Indeed, as we will shortly see, Angular components can be described using decorators. You may not have heard about decorators, as not every language has them. A decorator is a way to do some meta-programming. They are fairly similar to annotations which are mainly used in Java, C# and Python, and maybe other languages I don't know. Depending on the language, you add an annotation to a method, an attribute, or a class. Generally, annotations are not really used by the language itself, but mainly by frameworks and libraries.

Decorators are really powerful: they can modify their target (method, classes, etc.), and for example alter the parameters of the call, tamper with the result, call other methods when the target is called or add metadata for a framework (which is what Angular decorators do). Until now, it was not something possible in JavaScript. But the language is evolving and there is now an official proposal for `decorators`, which may be standardized one day in the future (possibly in ES7/ES2016). Note that the TypeScript implementation goes slightly further than the proposed standard.

In Angular, we will use the decorators provided by the framework. Their role is fairly basic: they

add some metadata to our classes, attributes or parameters to say things like "this class is a component", "this is an optional dependency", "this is a custom property", etc. It's not required to use them, as you can add the metadata manually (if you want to stick to ES5 for example), but the code will definitely be more elegant using decorators, as provided by TypeScript.

In TypeScript, decorators start with an `@`, and can be applied to a class, a class property, a function or a function parameter. They can't be applied to a constructor, but can be applied to its parameters.

To have a better grasp on this, let's try to build a simple decorator, `@Log()`, that will log something every time a method is called.

It will be used like this:

```
class RaceService {
  @Log()
  getRaces() {
    // call API
  }

  @Log()
  getRace(raceId) {
    // call API
  }
}
```

To define it, we have to write a method returning a function like this:

```
const Log = () => {
  return (target: any, name: string, descriptor: any) => {
    logger.log(`call to ${name}`);
    return descriptor;
  };
};
```

Depending on what you want to apply your decorator to, the function will not have exactly the same arguments. Here we have a method decorator that takes 3 parameters:

- `target`: the method targeted by our decorator
- `name`: the name of the targeted method
- `descriptor`: a descriptor of the targeted method (is the method enumerable, writable, etc.)

Here we simply log the method name, but you could do pretty much whatever you want: interfere with the parameters, the result, calling another function, etc.

So, in our simple example, every time the `getRace()` or `getRaces()` methods are called, we'll see a trace in the browser logs:

```
raceService.getRaces();  
// logs: call to getRaces  
raceService.getRace(1);  
// logs: call to getRace
```

As a user, let's look at what a decorator in Angular looks like:

```
@Component({ selector: 'ns-home', template: 'home' })  
class HomeComponent {  
  constructor(@Optional() hello: HelloService) {  
    logger.log(hello);  
  }  
}
```

The `@Component` decorator is added to the class `Home`. When Angular loads our app, it will find the class `Home` and will understand that it is a component, based on the metadata the decorator will add. Cool, huh? As you can see, a decorator can also receive parameters, here a configuration object.

I just wanted to introduce the raw concept of decorators; we'll look into every decorator available in Angular all along the book.

So my advice would be to give TypeScript a try! All my examples from here will be in TypeScript, as Angular and all the tooling around are really designed for it.

Chapter 6. Advanced TypeScript

If you're just starting to learn TypeScript, you can safely skip this chapter for now and come back later. This chapter is here to showcase some more advanced usages of TypeScript. They'll only make sense if you already have some familiarity with the language

6.1. readonly

You can use the `readonly` keyword to mark the property of a class or interface as... read only! That way, the compiler will refuse to compile any code trying to assign a new value to the property:

```
interface Config {
  readonly timeout: number;
}

const config: Config = { timeout: 2000 };
// `config.timeout` is now readonly and can't be reassigned
```

6.2. keyof

The `keyof` keyword can be used to get a type representing the union of the names of the properties of another type. For example, you have a `PonyModel` interface:

```
interface PonyModel {
  name: string;
  color: string;
  speed: number;
}
```

You want to build a function that returns the value of a property. You could implement a naive version:

```
function getProperty(obj: any, key: string): any {
  return obj[key];
}

const pony: PonyModel = {
  name: 'Rainbow Dash',
  color: 'blue',
  speed: 45
};

const nameValue = getProperty(pony, 'name');
```

Two problems here:

- you can give any value to the `key` parameter, even keys that don't exist on `PonyModel`.
- the return type being `any`, you are losing a lot of type information.

This is where `keyof` can shine. `keyof` allows to list all the keys of a type:

```
type PonyModelKey = keyof PonyModel;
// this is the same as `'name'|'speed'|'color'`
let property: PonyModelKey = 'name'; // works
property = 'speed'; // works
// key = 'other' would not compile
```

So we can use this type to make `getProperty` safer, by declaring that:

- the first parameter is of type `T`
- the second parameter is of type `K`, which is a key of `T`

```
function getProperty<T, K extends keyof T>(obj: T, key: K) {
  return obj[key];
}

const pony: PonyModel = {
  name: 'Rainbow Dash',
  color: 'blue',
  speed: 45
};
// TypeScript infers that `nameValue` is of type `string`!
const nameValue = getProperty(pony, 'name');
```

We killed two birds with one stone here:

- `key` can now only be an existing property of `PonyModel`
- the return value will be inferred by TypeScript (which is pretty awesome!)

Now let's see how we can leverage `keyof` to do even more.

6.3. Mapped type

Let's say you want to create a type that has exactly the same properties as `PonyModel`, but you want every property to be optional. You can of course define it manually:

```
interface PartialPonyModel {
  name?: string;
  color?: string;
  speed?: number;
}

const pony: PartialPonyModel = {
  name: 'Rainbow Dash'
};
```

But you can do something more generic with a mapped type:

```
type Partial<T> = {
  [P in keyof T]?: T[P];
};

const pony: Partial<PonyModel> = {
  name: 'Rainbow Dash'
};
```

The **Partial** type is a transformation that applies the **?** modifier to every property of a type! In fact, you don't have to define the type **Partial** yourself, because since version 2.1, it's part of the language itself, and it's declared exactly like in the above example.

TypeScript offers other mapped types out of the box.

6.3.1. Readonly

Readonly makes all the properties of an object **readonly**:

```
const pony: Readonly<PonyModel> = {
  name: 'Rainbow Dash',
  color: 'blue',
  speed: 45
};
// all properties are `readonly`
```

6.3.2. Pick

Pick helps you build a type with only some of the original properties:


```
const pony: Pick<PonyModel, 'name' | 'color'> = {
  name: 'Rainbow Dash',
  color: 'blue'
};
// `pony` can't have a `speed` property
```

6.3.3. Record

Record helps you build a type with the same properties as another type, but with a different type:

```
interface FormValue {
  value: string;
  valid: boolean;
}

const pony: Record<keyof PonyModel, FormValue> = {
  name: { value: 'Rainbow Dash', valid: true },
  color: { value: 'blue', valid: true },
  speed: { value: '45', valid: true }
};
```

There are [even more than that](#), but these are the most useful.

6.4. Union types and type guards

Union types are really handy. Let's say your application has authenticated users and anonymous users, and sometimes you need to do a different action depending on that. You can model this as:

```

interface User {
  type: 'authenticated' | 'anonymous';
  name: string;
  // other fields
}

interface AuthenticatedUser extends User {
  type: 'authenticated';
  loggedInSince: number;
}

interface AnonymousUser extends User {
  type: 'anonymous';
  visitingSince: number;
}

function onWebsiteSince(user: User): number {
  if (user.type === 'authenticated') {
    // this is a LoggedUser
    return (user as AuthenticatedUser).loggedInSince;
  } else if (user.type === 'anonymous') {
    // this is an AnonymousUser
    return (user as AnonymousUser).visitingSince;
  }
  // TS doesn't know every possibility was covered
  // so we have to return something here
  return 0;
}

```

I don't know about you, but I don't like these `as` ... explicit casts. Maybe we can do better?

One possibility is to use a type guard, a special function whose sole purpose is to help the TypeScript compiler.

```

function isAuthenticated(user: User): user is AuthenticatedUser {
    return user.type === 'authenticated';
}

function isAnonymous(user: User): user is AnonymousUser {
    return user.type === 'anonymous';
}

function onWebsiteSince(user: User): number {
    if (isAuthenticated(user)) {
        // this is inferred as a LoggedUser
        return user.loggedSince;
    } else if (isAnonymous(user)) {
        // this is inferred as an AnonymousUser
        return user.visitingSince;
    }
    // TS still doesn't know every possibility was covered
    // so we have to return something here
    return 0;
}

```

This is better! But we still need to return a default value, even if we covered all the possibilities.

We can slightly improve the situation if we drop the type guards and use a union type instead.

```

interface BaseUser {
  name: string;
  // other fields
}

interface AuthenticatedUser extends BaseUser {
  type: 'authenticated';
  loggedSince: number;
}

interface AnonymousUser extends BaseUser {
  type: 'anonymous';
  visitingSince: number;
}

type User = AuthenticatedUser | AnonymousUser;

function onWebsiteSince(user: User): number {
  if (user.type === 'authenticated') {
    // this is inferred as a LoggedUser
    return user.loggedSince;
  } else {
    // this is narrowed as an AnonymousUser
    // without even testing the type!
    return user.visitingSince;
  }
  // no need to return a default value
  // as TS knows that we covered every possibility!
}

```

This is even better, as TypeScript automatically narrows the type in the `else` branch.

Sometimes you know that the model will grow in the future, and that more cases will need to be handled. For example if you introduce an `AdminUser`. In that case, you can use a `switch`. A `switch` statement will break if one of the cases is not handled. So introducing our `AdminUser`, or another type of user later, would automatically add compilation errors in every place you need to handle it!

```

interface AdminUser extends BaseUser {
  type: 'admin';
  adminSince: number;
}

type User = AuthenticatedUser | AnonymousUser | AdminUser;

function onWebsiteSince(user: User): number {
  switch (user.type) {
    case 'authenticated':
      return user.loggedSince;
    case 'anonymous':
      return user.visitingSince;
    case 'admin':
      // without this case, we could not even compile the code
      // as TS would complain that all possible paths are not returning a value
      return user.adminSince;
  }
}

```

I hope these patterns will help you. Now let's focus on Web Components.

Chapter 7. The wonderful land of Web Components

Before going further, I'd like to make a brief stop to talk about Web Components. You don't have to know about Web Components to write Angular code. But I think it's a good thing to have an overview of what they are, because some choices in Angular have been made to facilitate the integration with Web Components, or to make the components we will build similar to Web Components. Feel free to skip this part if you have no interest in this topic; however, I do believe you'll learn a thing or two that will be useful for the rest of the road.

7.1. A brave new world

Components are an old fantasy in development. Something you can grab off the shelves and drop into your app, something that would work right away and bring a needed functionality to your users.

My friends, this time has come.

Well, maybe. At least, there is the start of something.

That's not completely new. We have had components in web development for quite some time, but they usually require some kind of dependency, like jQuery, Dojo, Prototype, AngularJS, etc. Not necessarily libraries you wanted to add to your app.

Web Components attempt to solve this problem: let's have reusable and encapsulated components.



They rely on a set of emerging standards that browsers don't perfectly support yet. But, still, it's an interesting topic, even if there's a chance that we'll have to wait a few years to use them fully, or even that the concept never takes off.

This emerging standard is defined in 3 specifications:

- Custom elements
- Shadow DOM
- Template

Note that the samples are most likely to work in a recent Chrome or Firefox browser.

7.2. Custom elements

Custom elements are a new standard allowing developers to create their own DOM elements, making something like `<ns-pony></ns-pony>` a perfectly valid HTML element. The specification defines how to declare such elements, how to make them extend existing elements, how to define your API, etc.

Declaring a custom element is done with a simple `document.registerElement('ns-pony')`:

```
// new element
var PonyComponent = document.registerElement('ns-pony');
// insert in current body
document.body.appendChild(new PonyComponent());
```

Note that the name must contain a dash, so that the browser knows it is a custom element. Of course, your custom element can have properties and methods, and it also has lifecycle callbacks, to be able to execute code when the component is inserted or removed, or when one of its attributes changes. It can also have a template of its own. Maybe the `ns-pony` displays an image of the pony or just its name:

```
// let's extend HTMLElement
var PonyComponentProto = Object.create(HTMLElement.prototype);
// and add some template using a lifecycle
PonyComponentProto.createdCallback = function() {
  this.innerHTML = '<h1>General Soda</h1>';
};

// new element
var PonyComponent = document.registerElement('ns-pony', {prototype:
PonyComponentProto});
// insert in current body
document.body.appendChild(new PonyComponent());
```

If you try to look at the DOM, you'll see `<ns-pony><h1>General Soda</h1></ns-pony>`. But that means the CSS and JavaScript logic of your app can have undesired effects on your component. So, usually, the template is hidden and encapsulated in something called Shadow DOM, and you'll only see `<ns-pony></ns-pony>` if you inspect the DOM, despite the fact that the browser displays the pony's name.

7.3. Shadow DOM

With a mysterious name like this, you expect something with great powers. And surely it is. The Shadow DOM is a way to encapsulate the DOM of our component. This encapsulation means that the stylesheet and JavaScript logic of your app will not apply on the component and ruin it inadvertently. It gives us the perfect tool to hide the internals of a component, and be sure that nothing leaks from the component to the app, or vice-versa.

Going back to our previous example:

```

var PonyComponentProto = Object.create(HTMLElement.prototype);

// add some template in the Shadow DOM
PonyComponentProto.createdCallback = function() {
  var shadow = this.createShadowRoot();
  shadow.innerHTML = '<h1>General Soda</h1>';
};

var PonyComponent = document.registerElement('ns-pony', {prototype:
PonyComponentProto});
document.body.appendChild(new PonyComponent());

```

If you try to inspect it now you should see:

```

<ns-pony>
  #shadow-root (open)
    <h1>General Soda</h1>
</ns-pony>

```

Now, even if you try to add some style to the `h1` elements, the visual aspect of the component won't change at all: that's because the Shadow DOM acts like a barrier.

Until now, we just used a string as a template of our web component. But that's usually not the way you do that. Instead, the best practice is to use the `<template>` element.

7.4. Template

A template specified in a `<template>` element is not displayed in your browser. Its main goal is to be cloned in an element at some point. What you declare inside will be inert: scripts don't run, images don't load, etc. Its content can't be queried by the rest of the page using usual method like `getElementById()` and it can be safely placed anywhere in your page.

To use a template, it needs to be cloned:

```

<template id="pony-tpl">
  <style>
    h1 { color: orange; }
  </style>
  <h1>General Soda</h1>
</template>

```



```

var PonyComponentProto = Object.create(HTMLElement.prototype);

// add some template using the template tag
PonyComponentProto.createdCallback = function() {
  var template = document.querySelector('#pony-tpl');
  var clone = document.importNode(template.content, true);
  this.createShadowRoot().appendChild(clone);
};

var PonyComponent = document.registerElement('ns-pony', {prototype:
PonyComponentProto});
document.body.appendChild(new PonyComponent());

```

7.5. Frameworks on top of Web Components

All these things put together make the Web Components. I'm far from being an expert on this topic, and there are all sorts of twisted traps on this road.

As Web Components are not fully supported by every browser, there is a polyfill you can include in your app to make sure it will work. The polyfill is called [web-component.js](#), and it's worth noting that it is a joint effort from Google, Mozilla and Microsoft among others.

On top of this polyfill, a few libraries have seen the light. All aim to facilitate working with Web Components, and often come with some ready-to-use Web Components.

Among the most notable initiatives, you find:

- [Polymer](#), the first attempt from Google
- [LitElement](#), a more recent project from the Polymer team ;
- [X-tag](#) from Mozilla and Microsoft
- [Stencil](#).

I won't go into the details, but you can easily use an already existing component. Let's say you want a Google Map in your app:

```

<!-- Polyfill Web Components support for older browsers -->
<script src="webcomponents.js"></script>

<!-- Import element -->
<script src="google-map.js"></script>

<!-- Use element -->
<body>
  <google-map latitude="45.780" longitude="4.842"></google-map>
</body>

```

There are a LOT of components out there. You can have an overview on <https://www.webcomponents.org/>.

Polymer (and the others) also helps you build your own components:

```
<dom-module id="ns-pony">
  <template>
    <h1>[[name]]</h1>
  </template>
  <script>
    Polymer({
      is: 'ns-pony',
      properties: {
        name: String
      }
    });
  </script>
</dom-module>
```

and use them:

```
<!-- Use element -->
<body>
  <ns-pony name="General Soda"></ns-pony>
</body>
```

You can do a lot of cool things with Polymer and the other similar frameworks, like two-way data binding, default values for attributes, emit custom events, react on attribute changes, repeat elements if we give a collection to a component, etc.

That's obviously far too short a chapter to tell you everything there is to say on Web Components, but you'll see that some of the concepts are going to pop out along your read. And you'll definitely see that the Google team designed Angular to make it easy to use Web Components along our Angular components. It is even possible to export our own Angular components as Web Components, with the help of [Angular Elements](#).

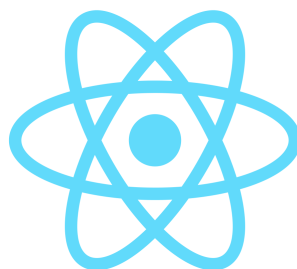
Chapter 8. Grasping Angular's philosophy

To write an Angular application, you have to grasp a few things on the framework's philosophy.



First and foremost, Angular is component-oriented. You will write tiny components and, together, they will constitute a whole application. A component is a group of HTML elements in a template, dedicated to a particular task. For this, you will usually also need to have some logic linked to that template, to populate data, and react to events for example. For the veterans of AngularJS 1.x, it's a bit like a 'template/controller' duo, or a directive.

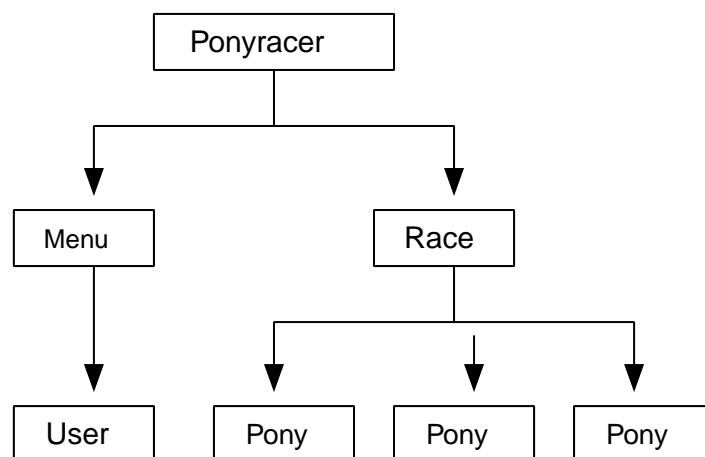
This component orientation is something that is becoming widely shared across front-end frameworks: [React](#), the cool kid from Facebook, has been doing it that way from the beginning; [Ember](#) and [AngularJS](#) have their way of doing something similar; and others like [Svelte](#) or [Vue.js](#) are betting on building small components too.





Angular is not alone in this, but it is among the first (it might actually be the first?) to really care about the integration of Web Components (the standard ones). But let's forget about this for now, as it is a more advanced topic.

Your components will be arranged in a hierarchical way, like the DOM is. A root component will have child components, each of them will also have children, etc. If you want to display a pony race (who wouldn't?), you'll have something like an app (**Ponyracer**), displaying a menu (**Menu**) with the logged in user (**User**) and a child view (**Race**), displaying, of course, the ponies (**Pony**) in the races:



Writing components will be your everyday work, so let's see what it looks like. The Angular team wanted to harness another goodness of today's web development: ES2015+. So you can write your components in ES5 (but that's not very cool) or in ES2015+ (way cooler!). But that was not enough for them, they wanted to use a feature that is not a standard (yet): decorators. So they worked closely with the transpiler teams (Traceur and Babel) and the TypeScript team at Microsoft, to

enable us to use decorators in our Angular apps. A few decorators are available, allowing to easily declare a component for example. I hope you already know all of that, as I just spent two chapters on these things!

For example, if we simplify, the Race component could look like this:

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

@Component({
  selector: 'ns-race',
  templateUrl: './race.component.html'
})
export class RaceComponent {
  race: any;

  constructor(racesService: RacesService) {
    racesService.get().then(race => (this.race = race));
  }
}
```

And the template looks like this:

```
<div>
  <h2>{{ race.name }}</h2>
  <div>{{ race.status }}</div>
  <div *ngFor="let pony of race.ponies">
    <ns-pony [pony]="pony"></ns-pony>
  </div>
</div>
```

If you already know AngularJS 1.x, the template should look familiar, with the same expression in curly braces `{{ }}`, that will be evaluated and replaced by the according value. Some things have changed though: no more `ng-repeat` for example. I don't want to go too deep for now, merely just give you a feel of what the code looks like.

A component is a very isolated piece of your app. Your app is a component like the others.

You will group components in one or several coherent entities, called modules (Angular Modules, not ES2015 Modules).

You can also take available modules from the community and just put them in your app, and be able to enjoy their features.

Such modules can offer UI components, or drag and drop capability, or validation for your forms, or whatever you can think of.

In the next chapters, we are going to explore how to get started, how to build a small component, your first module and the templating syntax.

There is another concept that is at the core, and that is Dependency injection (often called by its little name, DI). It is a very powerful pattern, and you will quickly get used to it after reading the dedicated chapter. It is especially useful to test your application, and I love doing tests, watching the progress bar go all green in my IDE. It makes me feel I'm doing a good job. So there will be an entire chapter on testing everything: your components, your services, your UI...

Angular still has the magic feeling it had in v1, where changes were automatically detected by the framework and applied to the model and the views. But it is done in a very different way than it was then: the change detection now uses a concept called **zones**. We will look into this, of course.

Angular is also a complete framework which provides a lot of help for performing common tasks in web development. Writing forms, calling an HTTP backend, routing, interacting with other libraries, animations, you name it: you're covered.

Well, that's a lot of things to learn! We should start with the beginning: bootstrap an app and write our first component.

Chapter 9. From zero to something

Let's start by creating our first Angular app and our first component, with a minimum of tooling.

9.1. Node.js and NPM

Pretty much all the modern JavaScript tools are built for Node.js and NPM these days. You'll have to install Node.js and NPM on your system. The best way to do that depends on your operating system - you can find more information on the [official website](#). Make sure you have a recent enough version of Node.js (by executing `node --version`).

9.2. Angular CLI

You *could* setup everything by yourself, starting with a TypeScript project, then install every dependency needed, etc.

But in a real project, you'll probably have to set up several other things too, like:

- some tests to check if we're not breaking things
- maybe a linter to check your code
- maybe a CSS preprocessor
- a build tool, to orchestrate the various tasks (compile, test, package, etc.)

But it's a bit cumbersome to setup everything yourself, especially when there are sooooo many tools to learn first.

These past few years, a lot of small project generators have seen the light, pretty much all using the great [Yeoman](#). It used to be the case for AngularJS 1.x, and there were a few attempts for Angular from the community.

But this time, the Google team has been working on this issue, and they have come up with something: **Angular CLI**.



Angular CLI is a command line utility to easily quick start a project, already configured with Webpack as a build tool (the popular kid these years), tests, packaging, etc.

The idea is not new, and is in fact borrowed from another popular framework: EmberJS and its

popularly acclaimed `ember-cli`.

The tool is under continuous development, with a dedicated Google team working on it and making it better and better. It is now the recommended and *de facto* standard way of creating and building Angular apps. So let's give it a try, and discover the ton of cool stuff packed in it!



If you want, you can follow our online exercise [Getting Started](#) 🙌! It's free and part of our Pro Pack, where you'll learn how to build a complete application step by step. The first exercise is about getting everything up and running with Angular CLI, and goes further than what we see in the chapter.

First let's install Angular CLI, and generate a new application with the `ng new` command. If you want to use exactly the same CLI version than we are (9.0.6), you can use `npm install -g @angular/cli@9.0.6` instead.

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

```
ng new ponyracer --prefix ns --defaults
```

This will create a project skeleton in a new directory called `ponyracer`. From this directory, you can start your app with:

```
ng serve
```

This will start a small HTTP server locally, with a hot reload configuration. It means that every time you modify and save a file, the server will rebuild the app, and the browser will reload it immediately.

Tada! You have your first application up and running! 🎉

9.3. Application structure

Let's dive for a few seconds into the generated code.

Open the project in your preferred IDE. You can use pretty much anything you want, but you should activate the TypeScript support for maximum comfort. Pick your favorite: Webstorm, Visual Studio Code, Atom... All of them have great support for TypeScript.



If your IDE supports it, code completion should work as the Angular dependencies have their own `d.ts` files in the `node_modules` directory, and TypeScript is able to detect them. You can even navigate to the type definitions if you want to. TypeScript will bring its type-checking to the table, so you'll see what mistakes you make as you type. As we are using source maps, you can see the TS code directly from your browser, and even debug your app by setting breakpoints in the TypeScript code.

You should see a bunch of configuration files in the root directory: welcome to Modern JavaScript!

The first one you may recognize is the `package.json` file: that's where the dependencies of the application are defined. You can have a look inside, it should now contain the following dependencies:

- the different `@angular` packages.
- `rxjs`, a really cool library for reactive programming. We have a dedicated chapter on this topic and about `RxJS` in particular.
- `zone.js`, doing the heavy lifting for detecting the changes (we'll dive into this later also).
- some dependencies for developing the application, like the CLI, TypeScript, some test libraries, some typings...

TypeScript itself has a configuration file `tsconfig.json` (and another one in `src` called `tsconfig.app.json`), which stores the compilation options. As we saw in the previous chapters, we are using TypeScript with decorators (hence the two options about decorators), and we want our code to transpile to ECMAScript 5, allowing it to run in every browser. The `sourceMap` option allows generating source maps, i.e. files that contain a mapping between the generated ES5 code and the original TypeScript code. Those source maps are used by the browser to let you debug the ES5 code it executes by stepping through the original TypeScript code that you have written.

TypeScript projects often also use TSLint, a linter used to check your code against the best practices. TSLint has its own options, stored in `tslint.json`, where you add/remove some of its rules.

Angular CLI itself has a configuration file `angular.json` if you want to override some of its defaults.

The last one, `karma.conf.js` is used to configure the testing tool (more about that when we'll talk about testing).



The ebook is using Angular version `9.0.6` for the examples. Angular CLI will probably install the most recent version, which might not be exactly the same. If you want to use the same version as we are, replace the version in the `package.json` by `9.0.6` for each Angular package. That might save you a few headaches! Or, even better, follow our free online exercise [Getting Started](#) 🐾 which is always up-to-date and battle-tested!

Now that we have been over the configuration, let's see the application code.

9.4. Our first component

As we saw in the previous section, a component is a combination of a view (the template) and some logic (our TS class). The CLI has already created one for us: `src/app/app.component.ts`. Let's check it out:

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

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

Our application itself is a simple component. To tell Angular that it is a component, we use the `@Component` decorator. And to be able to use this decorator, we have to import it as you can see at the top of the file.

When you write new components, don't forget to import the `Component` decorator. You may forget to do so at the beginning, but it won't last, as the compiler will yell at you! ;)

You'll see that most of the things we need are in the `@angular/core` module, but that's not always the case. For example, when dealing with HTTP, we'll use imports from `@angular/http`; or, if we use the router, we'll import from `@angular/router`, etc.

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

@Component({
})
export class AppComponent {
  title = 'ponyracer';
}
```

The `@Component` decorator is expecting a configuration object. We'll see later in details what you can configure here, but for now only one property is expected: the `selector` one. It will tell Angular what to look for in our HTML pages. Every time Angular finds an element in our HTML which matches the selector of the component, it will create an instance of the component, and replace the content of the element by the template of the component.

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

@Component({
  selector: 'ns-root',
})
export class AppComponent {
  title = 'ponyracer';
}
```

So, here, every time our HTML will contain an element like `<ns-root></ns-root>`, Angular will instantiate a new instance of our `AppComponent` class.



There is a clear naming convention established, and applied by Angular CLI. Component classes end with `Component`, and they are defined in a file ending with `.component.ts`. Angular also recommends using a prefix in component selectors, to avoid name clashes with external components. For example, since our company is named **Ninja Squad**, we chose to use the prefix `ns`. Our pony component selector is thus named `ns-pony`. You can configure Angular CLI so that it prepends this prefix to every generated component.

A component must also have a template. We can have an inline template or externalize it in another file, like the CLI does:

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

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

The corresponding HTML is defined in `app.component.html`, with a bunch of static elements, except the first `h1`:

```
<span>{{ title }} app is running!</span>
```

9.5. Our first Angular Module

Like we briefly said in the previous chapter, we are going to group our components and other pieces we'll see later in coherent entities: Angular Modules.

An Angular Module is different from the ES2015 Modules we crossed earlier: here we are talking about **application** modules.

Your application will always have at least one module, the **root module**. Maybe, later, when your application grows, you'll add other modules, by feature. For example, you could add a module dedicated to the Admin part of your application, containing all the components and the logic for this part. But we'll come back to this later. We'll also see that third party libraries and Angular itself expose modules, that we can use in our app.

Of course, the CLI has generated a module too, called `app.module.ts`.

The class is decorated with `@NgModule`.

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

@NgModule({
})
export class AppModule { }
```

Like the `@Component` decorator, it takes a configuration object.

As we are building an app for the browser, the root module imports `BrowserModule`. This is not the only target possible for Angular, you could choose to render the app on the server for example, and therefore import another module. `BrowserModule` contains all kinds of useful stuff we will use later. A module can choose to *export* components, directives and pipes. When you import a module, you will make all the directives, components and pipes exported by the imported module usable in your module. Our root module won't be imported in another module, so we don't have *exports*, but we will have several *imports* in the end.

The terminology is not beginner friendly here. We were talking about ES2015+ and TS modules in the first chapters, which define imports and exports. And now we are talking about Angular modules, which also have imports and exports... I'm not a fan of having the same terms for different things, so let me explain a little bit more.

You can see an ES2015+ or TS import purely as a language feature, like an import statement in Java: it allows using the imported classes/functions in your source code. It also declares a dependency for the bundler or module loader (Webpack or SystemJS, for example), which knows that if `a.ts` is loaded, then `b.ts` must also be loaded since `a` imports `b`. You have to use imports and exports with ES2015+ and TypeScript, whether or not you're using Angular or any other framework.

On the other hand, importing an Angular module (for example `BrowserModule`) in your own Angular module (`AppModule`), has a functional meaning. It tells Angular: all the components, directives and pipes that are exported by `BrowserModule` should be made available to my Angular components/templates. It has no special meaning for the TypeScript compiler.

Back to `NgModule`: in its configuration object, we must declare the components that belong to our root module, with the *declarations* field. You can see it contains the previous component we talked about: `AppComponent`.

```
import { BrowserModule } from '@angular/platform-browser';
import { NgModule } from '@angular/core';

import { AppComponent } from './app.component';

@NgModule({
  declarations: [
    AppComponent
  ],
  imports: [
    BrowserModule
  ],
})
export class AppModule { }
```

Since this is the root module, we need to tell Angular which component is the root component, i.e. the component that will be started when we bootstrap the app. That's what the **bootstrap** field of the configuration object is for:

```
import { BrowserModule } from '@angular/platform-browser';
import { NgModule } from '@angular/core';

import { AppComponent } from './app.component';

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

Module ready, let's bootstrap the app!

9.6. Bootstrapping the app

Finally, we need to start our app, using the **bootstrapModule** method. This method is exposed on an object returned by a method called **platformBrowserDynamic**. You have to import it too, from **@angular/platform-browser-dynamic**. Now, that's a strange module! Why is it not **@angular/core**? Good question: it's because you might want to run your app somewhere else than in a browser, as Angular supports server-side rendering or running in a Web Worker for example. And in these cases, the bootstrap logic would be a bit different. But we'll see this later, as we are just focusing on the browser right now.

Angular CLI will by default generate a separate file containing this bootstrap logic: `main.ts`:

```
import { enableProdMode } from '@angular/core';
import { platformBrowserDynamic } from '@angular/platform-browser-dynamic';

import { AppModule } from './app/app.module';
import { environment } from './environments/environment';

if (environment.production) {
  enableProdMode();
}

platformBrowserDynamic().bootstrapModule(AppModule)
  .catch(err => console.error(err));
```

Yay! But wait a second. We need an HTML file to serve to our users, right?

The CLI created an `index.html` file for us, which is the single page of our application. You might wonder how it could possibly work, since it doesn't contain any `script` element.

When you run `ng serve`, the CLI calls the TypeScript compiler. The compiler outputs JavaScript files. The CLI then bundles them and adds the necessary `script` elements to the `index.html` file (using [Webpack](#) behind the scenes).

Hopefully, you now have a better understanding of the various parts of this first Angular application. It's not really a dynamic app yet, and we could have done the same in one second in a static HTML page, I'll give you that. So let's jump to the next sections, and learn all about dependency injection and templating.

Chapter 10. End of the free sample

That's it! I hope that you enjoy this reading. If you want more of it (and you should), go buy it on the [ebook website](#)! :)

Appendix A: Changelog

Here are all the major changes since the first version. It should help you to see what changed since your last read!

By buying this ebook, you'll get all the following updates for free. Go to <https://books.ninja-squad.com/claim> to obtain the latest version of this ebook.

Current versions:

- Angular: 9.0.6
- Angular CLI: 9.0.6

A.1. v9.0.0 - 2020-02-07

Global

- Bump to ng 9.0.0 (2020-02-07)
- Bump to ng 9.0.0-next.5 (2020-02-06)

A gentle introduction to ECMAScript 2015+

- Add a section about tagged template strings. (2019-08-02)

Diving into TypeScript

- Showcase interface usage for modeling entities (2019-08-10)
- Improve the enum section with examples of how to use union types (2019-08-10)

Advanced TypeScript

- Introduce a new chapter about advanced TypeScript patterns, like keyof, mapped types, type guards, and other things! (2019-08-10)

From zero to something

- Bump to cli 9.0.1 (2020-02-07)
- Bump to cli 9.0.0-next.3 (2020-02-06)
- Bump to cli 8.3.2 (2019-08-30)
- Bump to cli 8.3.0 (2019-08-22)

Testing your app

- Use TestBed.inject instead of the deprecated TestBed.get in ng 9.0.0 (2020-02-06)

Internationalization

- Explains how to configure the default currency code (2020-02-07)

- Introduce `@angular/localize` usage in ng 9.0.0 (2020-02-07)

Going to production

- Mention the multiple configurations support introduced in CLI v9.0 (2020-02-07)
- Explain the `fullTemplateTypeCheck` and `strictTemplates` options (2020-02-07)

A.2. v8.2.0 - 2019-08-01

Global

- Bump to ng 8.2.0 (2019-08-01)

From zero to something

- Bump to cli 8.2.0 (2019-08-01)

Testing your app

- Use a more strictly typed `createSpyObj` syntax. (2019-07-31)

A.3. v8.1.0 - 2019-07-02

Global

- Bump to ng 8.1.0 (2019-07-02)

The Wonderful world of Web Components

- Mention more recent alternatives to Polymer, remove the dead HTML import spec and mention Angular Elements (2019-06-01)

From zero to something

- Bump to cli 8.1.0 (2019-07-02)

A.4. v8.0.0 - 2019-05-29

Global

- Bump to ng 8.0.0 (2019-05-29)

A gentle introduction to ECMAScript 2015+

- How to use `async/await` with promises (2019-05-19)

From zero to something

- Bump to cli 8.0.0 (2019-05-29)
- Bump cli to 7.3.0 (2019-02-28)

Testing your app

- Showcase the awesome `ngx-speculoos` library for cleaner unit tests (2019-05-20)

Forms

- Showcase the awesome `ngx-valdemort` library for better validation error messages (2019-05-19)

Router

- Use `import` for lazy-loading routes as introduced by ng `8.0.0` (2019-05-20)

Angular compiler

- Update the AoT explanation and generated code for Angular 8.0.0 (Ivy) (2019-05-20)

Advanced components and directives

- Add and explain the `static` flag for `ViewChild` and `ContentChild` introduced by Angular `8.0.0` (2019-05-27)

Going to production

- Differential loading using `browserslist` as introduced by the cli `8.0.0`. (2019-05-20)

A.5. v7.2.0 - 2019-01-09

Global

- Bump to ng `7.2.0` (2019-01-07)
- Bump to ng `7.2.0-rc.0` (2019-01-03)
- Bump to ng `7.2.0-beta.2` (2018-12-14)

From zero to something

- Bump to cli `7.2.0` (2019-01-09)
- Bump to cli `7.2.0-rc.0` (2019-01-07)
- Bump to cli `7.2.0-beta.2` (2019-01-07)

A.6. v7.1.0 - 2018-11-27

Global

- Bump to ng `7.1.0` (2018-11-22)
- Bump to ng `7.1.0-rc.0` (2018-11-20)
- Bump to ng `7.0.2` (2018-11-05)

From zero to something

- Bump to cli **7.1.0** (2018-11-27)
- Bump to cli **7.0.4** (2018-11-05)

Router

- Use **UrLTree** in **CanActivate** guard, as introduced by 7.1 (2018-11-22)

A.7. v7.0.0 - 2018-10-25

Global

- Bump to ng **7.0.0** (2018-10-18)
- Bump to ng **7.0.0-rc.1** (2018-10-18)
- Bump to ng **7.0.0-rc.0** (2018-10-18)
- Bump to ng **7.0.0-beta.6** (2018-10-18)
- Bump to ng **7.0.0-beta.4** (2018-10-18)
- Bump to ng **7.0.0-beta.0** (2018-10-18)

From zero to something

- Bump to cli **7.0.2** (2018-10-24)
- Bump to cli **7.0.1** (2018-10-18)
- Bump to cli **6.2.1** (2018-09-07)
- Bump to cli **6.2.0-rc.0** (2018-09-07)

Performances

- Adds a performances chapter! (2018-08-30)

Going to production

- Adds a new chapter about Going to production! (2018-10-25)

A.8. v6.1.0 - 2018-07-26

Global

- Bump to ng **6.1.0** (2018-07-26)
- Bump to ng **6.1.0-rc.0** (2018-07-26)
- Bump to ng **6.1.0-beta.1** (2018-07-26)
- Bump to ng **6.0.7** (2018-07-06)

From zero to something

- Bump to cli **6.1.0** (2018-07-26)

- Bump to cli **6.0.8** (2018-07-06)
- Bump cli to **6.0.7** (2018-05-30)

Pipes

- Add the **keyvalue** pipe introduced in Angular 6.1 (2018-07-26)
- Show usage of formatting functions available since Angular 6.0 (2018-06-15)

Styling components and encapsulation

- New **ShadowDom** encapsulation option with Shadow DOM v1 support (the old and soon deprecated **Native** option uses Shadow DOM v0) (2018-07-26)

Send and receive data with Http

- HTTP tests now use **verify** every time (2018-07-06)

Router

- Adds the **Scroll** event and **scrollPositionRestoration** option introduced in 6.1 (2018-07-26)

Advanced observables

- Use **shareReplay** instead of **publishReplay** and **refCount** (2018-07-20)

Internationalization

- Update for CLI 6.0 and use a dedicated configuration (2018-05-09)

A.9. v6.0.0 - 2018-05-04

Global

- Bump to ng **6.0.0** (2018-05-04)
- Bump to ng **6.0.0-rc.4** (2018-04-13)
- Bump to ng **6.0.0-rc0** (2018-04-05)
- Bump to ng **6.0.0-beta.7** (2018-04-05)
- Bump to ng **6.0.0-beta.6** (2018-04-05)
- Bump to ng **6.0.0-beta.1** (2018-04-05)

The Wonderful world of Web Components

- Replace customelements.io by webcomponents.org (2018-01-19)

From zero to something

- Bump to cli **6.0.0** (2018-05-04)
- The chapter now uses Angular CLI from the start! (2018-03-19)

Dependency Injection

- Use `providedIn` to register services, as recommended for Angular 6.0 (2018-04-15)
- Updates the dependency injection via token section with a better example (2018-03-19)

Reactive Programming

- We now use the pipeable operators introduced in RxJS 5.5 (2018-01-28)

Services

- Use `providedIn` to register the service, as recommended for Angular 6.0 (2018-04-15)

Testing your app

- Simplify service unit tests now that they use `providedIn` from ng 6.0 (2018-04-15)

Advanced components and directives

- Angular 6.0+ allows to type `ElementRef<T>` (2018-04-05)

Advanced observables

- We now use the imports introduced in RxJS 6.0 (`import { Observable, of } from 'rxjs'`) (2018-04-05)
- We now use the pipeable operators introduced with RxJS 5.5 (2018-01-28)

A.10. v5.2.0 - 2018-01-10

Global

- Bump to ng `5.2.0` (2018-01-10)
- Bump to ng `5.1.0` (2017-12-07)

Building components and directives

- Better lifecycle explanation (2017-12-13)

Forms

- Reintroduce the `min` and `max` validators from version 4.2.0, even if they are not available as directives. (2017-12-13)

Send and receive data with Http

- Remove remaining mentions to the deprecated `HttpModule` and `Http` (2017-12-08)

A.11. v5.0.0 - 2017-11-02

Global

- Bump to ng 5.0.0 (2017-11-02)
- Bump to ng 5.0.0-rc.5 (2017-11-02)
- Bump to ng 5.0.0-rc.3 (2017-11-02)
- Bump to ng 5.0.0-rc.2 (2017-11-02)
- Bump to ng 5.0.0-rc.0 (2017-11-02)
- Bump to ng 5.0.0-beta.6 (2017-11-02)
- Bump to ng 5.0.0-beta.5 (2017-11-02)
- Bump to ng 5.0.0-beta.4 (2017-11-02)
- Bump to ng 5.0.0-beta.1 (2017-11-02)
- Bump to ng 4.4.1 (2017-09-16)

Pipes

- Use the new i18n pipes introduced in ng 5.0.0 (2017-11-02)

Forms

- Add a section on the `updateOn: 'blur'` option for controls and groups introduced in 5.0 (2017-11-02)
- Remove the section about combining template-based and code-based approaches (2017-09-01)

Send and receive data with Http

- Use object literals for headers and params for the new http client, introduced in 5.0.0 (2017-11-02)

Router

- Adds ng 5.0 `ChildActivationStart/ChildActivationEnd` to the router events (2017-11-02)

Internationalization

- Remove deprecated i18n comment with ng 5.0.0 (2017-11-02)
- Show how to load the locale data as required in ng 5.0.0 and uses the new i18n pipes (2017-11-02)
- Placeholders now displays the interpolation in translation files to help translators (2017-11-02)

A.12. v4.3.0 - 2017-07-16

Global

- Bump to ng 4.3.0 (2017-07-16)
- Bump to ng 4.2.3 (2017-06-17)

Forms

- Remove min/max validators mention, as they have been removed temporarily in ng 4.2.3 (2017-06-17)

Send and receive data with Http

- Updates the chapter to use the new `HttpClientModule` introduced in ng 4.3.0. (2017-07-16)

Router

- List the new router events introduced in 4.3.0 (2017-07-16)

Advanced components and directives

- Add a section about `HostBinding` (2017-06-29)
- Add a section about `HostListener` (2017-06-29)
- New chapter on advanced components, with `ViewChild`, `ContentChild` and `ng-content`! (2017-06-29)

A.13. v4.2.0 - 2017-06-09

Global

- Bump to ng `4.2.0` (2017-06-09)
- Bump to ng `4.1.0` (2017-04-28)

Forms

- Introduce the `min` and `max` validators from version 4.2.0 (2017-06-09)

Router

- New chapter on advanced router usage: protected routes with guards, nested routes, resolvers and lazy-loading! (2017-04-28)

Angular compiler

- Adds a chapter about the Angular compiler and the differences between JiT and AoT. (2017-05-02)

A.14. v4.0.0 - 2017-03-24

Global

- 🚧 Bump to stable release `4.0.0` 🚧 (2017-03-24)
- Bump to `4.0.0-rc.6` (2017-03-23)
- Bump to `4.0.0-rc.5` (2017-03-23)
- Bump to `4.0.0-rc.4` (2017-03-23)
- Bump to `4.0.0-rc.3` (2017-03-23)

- Bump to `4.0.0-rc.1` (2017-03-23)
- Bump to `4.0.0-beta.8` (2017-03-23)
- Bump to ng `4.0.0-beta.7` and TS 2.1+ is now required (2017-03-23)
- Bump to `4.0.0-beta.5` (2017-03-23)
- Bump to `4.0.0-beta.0` (2017-03-23)
- Each chapter now has a link to the corresponding exercise of our [Pro Pack](#) Chapters are slightly re-ordered to match the exercises order. (2017-03-22)

The templating syntax

- Use `as`, introduced in 4.0.0, instead of `let` for variables in templates (2017-03-23)
- The `template` tag is now deprecated in favor of `ng-template` in 4.0 (2017-03-23)
- Introduces the `else` syntax from version 4.0.0 (2017-03-23)

Dependency Injection

- Fix the Babel 6 config for dependency injection without TypeScript (2017-02-17)

Pipes

- Introduce the `as` syntax to store a `NgIf` or `NgFor` result, which can be useful with some pipes like `slice` or `async`. (2017-03-23)
- Adds `titlecase` pipe introduced in 4.0.0 (2017-03-23)

Services

- New `Meta` service in 4.0.0 to get/set meta tags (2017-03-23)

Testing your app

- `overrideTemplate` has been added in 4.0.0 (2017-03-23)

Forms

- Introduce the `email` validator from version 4.0.0 (2017-03-23)

Send and receive data with Http

- Use `params` instead of the deprecated `search` in 4.0.0 (2017-03-23)

Router

- Use `paramMap` introduced in 4.0 instead of `params` (2017-03-23)

Advanced observables

- Shows the `as` syntax introduced in 4.0.0 as an alternative for the multiple `async` pipe subscriptions problem (2017-03-23)

Internationalization

- Add a new chapter on internationalization (i18n) (2017-03-23)

A.15. v2.4.4 - 2017-01-25

Global

- Bump to **2.4.4** (2017-01-25)
- The big rename: "Angular 2" is now known as "Angular" (2017-01-13)
- Bump to **2.4.0** (2016-12-21)

Forms

- Fix the **NgModel** explanation (2017-01-09)
- **Validators.compose()** is no longer necessary, we can apply several validators by just passing an array. (2016-12-01)

A.16. v2.2.0 - 2016-11-18

Global

- Bump to **2.2.0** (2016-11-18)
- Bump to **2.1.0** (2016-10-17)
- Remove typings and use **npm install @types/...** (2016-10-17)
- Use **const** instead of **let** and TypeScript type inference whenever possible (2016-10-01)
- Bump to **2.0.1** (2016-09-24)

Testing your app

- Use **TestBed.get** instead of **inject** in tests (2016-09-30)

Forms

- Add an async validator example (2016-11-18)
- Remove the useless (2.2+) **.control** in templates like **username.control.hasError('required')**. (2016-11-18)

Router

- **routerLinkActive** can be exported (2.2+). (2016-11-18)
- We don't need to unsubscribe from the router params in the **ngOnDestroy** method. (2016-10-07)

Advanced observables

- New chapter on Advanced Observables! (2016-11-03)

A.17. v2.0.0 - 2016-09-15

Global

- 🚧 Bump to stable release **2.0.0** 🚧 (2016-09-15)
- Bump to **rc.7** (2016-09-14)
- Bump to **rc.6** (2016-09-05)

From zero to something

- Update the SystemJS config for **rc.6** and bump the RxJS version (2016-09-05)

Pipes

- Remove the section about the replace pipe, removed in rc.6 (2016-09-05)

A.18. v2.0.0-rc.5 - 2016-08-25

Global

- Bump to **rc.5** (2016-08-23)
- Bump to **rc.4** (2016-07-08)
- Bump to **rc.3** (2016-06-28)
- Bump to **rc.2** (2016-06-16)
- Bump to **rc.1** (2016-06-08)
- Code examples now follow the official style guide (2016-06-08)

From zero to something

- Small introduction to NgModule when you start your app from scratch (2016-08-12)

The templating syntax

- Replace the deprecated **ngSwitchWhen** with **ngSwitchCase** (2016-06-16)

Dependency Injection

- Introduce modules and their role in DI. Changed the example to use a custom service instead of Http. (2016-08-15)
- Remove deprecated **provide()** method and use **{provide: ...}** instead (2016-06-09)

Pipes

- Date pipe is now fixed in **rc.2**, no more problem with Intl API (2016-06-16)

Styling components and encapsulation

- New chapter on styling components and the different encapsulation strategies! (2016-06-08)

Services

- Add the service to the module's providers (2016-08-21)

Testing your app

- Tests now use the TestBed API instead of the deprecated TestComponentBuilder one. (2016-08-15)
- Angular 2 does not provide Jasmine wrappers and custom matchers for unit tests in **rc.4** anymore (2016-07-08)

Forms

- Forms now use the new form API (FormsModule and ReactiveFormsModule). (2016-08-22)
- Warn about forms module being rewritten (and deprecated) (2016-06-16)

Send and receive data with Http

- Add the HttpClientModule import (2016-08-21)
- **http.post()** now autodetects the body type, removing the need of using **JSON.stringify** and setting the **ContentType** (2016-06-16)

Router

- Introduce RouterModule (2016-08-21)
- Update the router to the API v3! (2016-07-08)
- Warn about router module being rewritten (and deprecated) (2016-06-16)

Changelog

- Mention free updates and web page for obtaining latest version (2016-07-25)

A.19. v2.0.0-rc.0 - 2016-05-06

Global

- Bump to **rc.0**. All packages have changed! (2016-05-03)
- Bump to **beta.17** (2016-05-03)
- Bump to **beta.15** (2016-04-16)
- Bump to **beta.14** (2016-04-11)
- Bump to **beta.11** (2016-03-19)
- Bump to **beta.9** (2016-03-11)
- Bump to **beta.8** (2016-03-10)
- Bump to **beta.7** (2016-03-04)
- Display the Angular 2 version used in the intro and in the chapter "Zero to something". (2016-03-

04)

- Bump to **beta.6** (**beta.4** and **beta.5** were broken) (2016-03-04)
- Bump to **beta.3** (2016-03-04)
- Bump to **beta.2** (2016-03-04)

Diving into TypeScript

- Use **typings** instead of **tsd**. (2016-03-04)

The templating syntax

- ***ngFor** now uses **let** instead of **to declare a variable** ***ngFor="let pony of ponies"** **[small]**(2016-05-03)#
- ***ngFor** now also exports a **first** variable (2016-04-16)

Dependency Injection

- Better explanation of hierarchical injectors (2016-03-04)

Pipes

- A **replace** pipe has been introduced (2016-04-16)

Reactive Programming

- Observables are not scheduled for ES7 anymore (2016-03-04)

Building components and directives

- Explain how to remove the compilation warning when using **@Input** and a setter at the same time (2016-03-04)
- Add an explanation on **isFirstChange** for **ngOnChanges** (2016-03-04)

Testing your app

- **injectAsync** is now deprecated and replaced by **async** (2016-05-03)
- Add an example on how to test an event emitter (2016-03-04)

Forms

- A pattern validator has been introduced to make sure that the input matches a regexp (2016-04-16)
- Add a mnemonic tip to remember the **[]** syntax: the banana box! (2016-03-04)
- Examples use **module.id** to have a relative **templateUrl** (2016-03-04)
- Fix error **ng-no-form** → **ngNoForm** (2016-03-04)
- Fix errors (**ngModel**) → (**ngModelChange**), **is-old-enough** → **isOldEnough** (2016-03-04)

Send and receive data with Http

- Use `JSON.stringify` before sending data with a POST (2016-03-04)
- Add a mention to `JSONP_PROVIDERS` (2016-03-04)

Router

- Introduce the new router (previous one is deprecated), and how to use parameters in URLs! (2016-05-06)
- `RouterOutlet` inserts the template of the component just after itself and not inside itself (2016-03-04)

Zones and the Angular magic

- New chapter! Let's talk about how Angular 2 works under the hood! First part is about how AngularJS 1.x used to work, and then we'll see how Angular 2 differs, and uses a new concept called zones. (2016-05-03)

A.20. v2.0.0-alpha.47 - 2016-01-15

Global

- First public release of the ebook! (2016-01-15)