CHAPTER 11

Creating an Angular Project

In this chapter, I explain the process of starting a new Angular project and creating an application in detail. The result is a simple Angular application that, admittedly, does little. However, by the end of the chapter, you will understand how the parts of a project fit together and have a foundation on which to apply the more advanced features that are described in the chapters that follow. Table 11-1 summarizes the chapter.

Table 11-1. *Chapter Summary*

Problem	Solution	Listing
Start Angular development	Use the `ng new` command to create a project and use the `ng serve` command to start the development tools	1, 2
Check the project source code for common errors and formatting issues	Use the `ng lint` command	3–5
Create a simple Angular application	Create a data model and a root component, which can then be used to update the root module	6–15

Creating a New Angular Project

The `angular-cli` package you installed in Chapter 2 contains all the functionality required to create a new Angular project that contains some placeholder content to jump-start development and a set of tightly integrated tools that are used to build, test, and prepare Angular applications for deployment.

To create a new Angular project, open a command prompt, navigate to a convenient location, and run the following command:

```
ng new example
```

The `ng new` command creates new projects, and the argument is the project name, which is `example` in this case. The `ng new` command has a set of arguments that shape the project that is created, and the most useful are described in Table 11-2.

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Table 11-2. Useful ng new Options

Argument	Description
`--directory`	This option is used to specify the name of the directory for the project. It defaults to the project name.
`--dry-run`	This option is used to simulate the project creation process without actually performing it.
`--inline-style`	This option specifies that the project will be configured with styles that are defined in the component and not in a separate CSS file.
`--inline-template`	This option specifies that the project will be configured with templates that are defined in the component and not in a separate HTML file.
`--prefix`	This option applies a prefix to all of the component selectors, as described in the "Understanding How an Angular Application Works" section.
`--routing`	This option is used to create a routing module in the project. I explain how the routing feature works in detail in Chapters 25 and 26.
`--skip-git`	Using this option prevents a Git repository from being created in the project.
`--skip-commit`	Using this option prevents the initial commit to the Git repository that is added to the project by default.
`--skip-install`	This option prevents the initial `npm install` operation that downloads and installs the NPM packages required by Angular applications and the project's development tools.
`--skip-tests`	This option prevents the addition of the initial configuration for testing tools.
`--verbose`	This option enables additional messages during the project initialization process.

■ **Tip** Don't worry if the purpose of these options doesn't make sense at the moment. You will understand all of these options by the time you have finished this book, and running the `ng new` command without any arguments provides a good starting point for most projects.

The project initialization process performed by the `ng new` command can take some time to complete because there are a large number of packages required by the project, both to run the Angular application and for the development and testing tools that I describe in this chapter.

■ **Tip** You can download the example project for this chapter—and for all the other chapters in this book—from `https://github.com/Apress/pro-angular-6`.

Understanding the Project Structure

Use your preferred code editor to open the `example` folder, and you will see the files and folder structure shown in Figure 11-1. The figure shows the way that Visual Studio presents the project, and other editors may present the project contents in a different way.

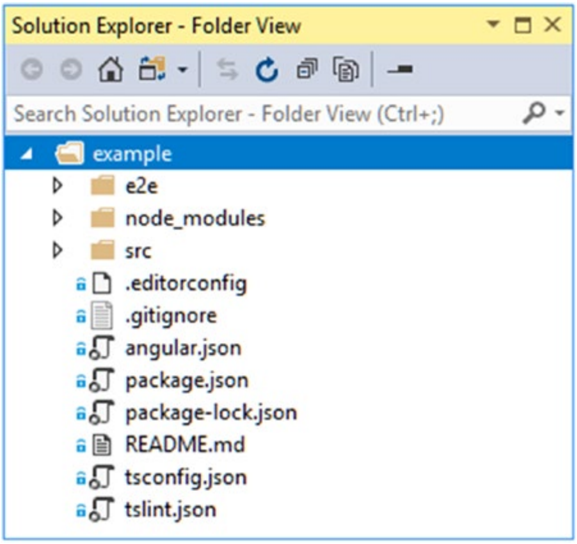


Figure 11-1. *The structure of a new Angular project*

Table 11-3 describes the files and folders that are added to a new project by the `ng new` command and that provide the starting point for most Angular development.

Table 11-3. *The Files and Folders in a New Angular Project*

Name	Description
`e2e`	This folder contains the files for end-to-end testing, which is set up to use the Protractor package. I don't describe end-to-end testing in this book because it requires additional infrastructure, but you can learn more at `www.protractortest.org`.
`node_modules`	This folder contains the NPM packages that are required for the application and for the Angular development tools, as described in the "Understanding the Packages Folder" section.
`src`	This folder contains the application's source code, resources, and configuration files, as described in the "Understanding the Source Code Folder" section.
`.editorconfig`	This file contains settings that configure text editors. Not all editors respond to this file, but it may override the preferences you have defined. You can learn more about the editor settings that can be set in this file at `http://editorconfig.org`.
`.gitignore`	This file contains a list of files and folders that are excluded from version control when using Git.
`angular.json`	This file contains the configuration for the Angular development tools.
`package.json`	This file contains details of the NPM packages required by the application and the development tools and defines the commands that run the development tools, as described in the "Understanding the Packages Folder" section.

(*continued*)

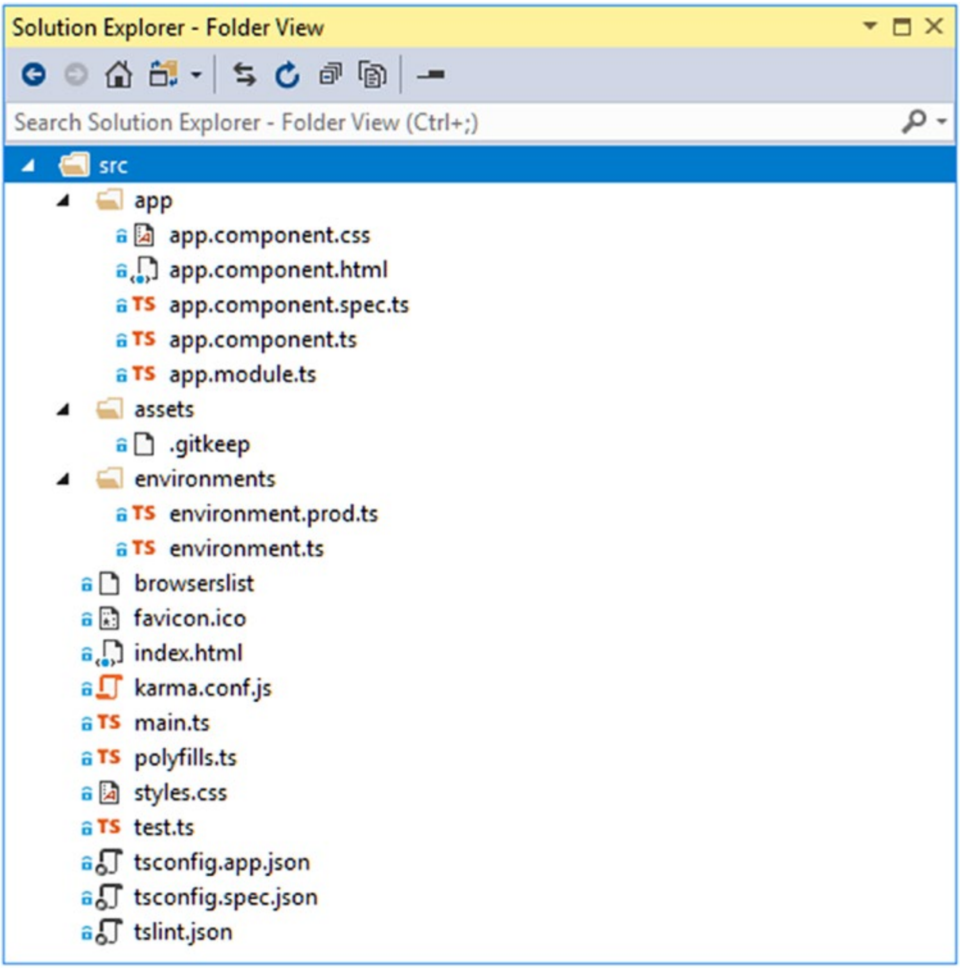
Table 11-3. (*continued*)

Name	Description
`package-lock.json`	This file contains version information for all the packages that are installed in the `node_modules` folder, as described in the "Understanding the Packages Folder" section.
`README.md`	This is a readme file that contains the list of commands for the development tools, which are described in the "Using the Development Tools" section.
`tsconfig.json`	This file contains the configuration settings for the TypeScript compiler.
`tstlint.json`	This file contains the settings for the TypeScript linter, as described in the "Using the Linter" section.

You won't always need all these files in every project, and you can remove the ones you don't require. I tend to remove the `README.md`, `.editorconfig`, and `.gitignore` files, for example, because I am already familiar with the tool commands, I prefer not to override my editor settings, and I don't use Git for version control, tending to create my projects with the `--skip-git` option described in Table 11-2.

Understanding the Source Code Folder

The `src` folder contains the application's files, including the source code and static assets, such as images. This folder is the focus of most development activity, and Figure 11-2 shows the contents of the `src` folder created using the `ng new` command.


Solution Explorer - Folder View
Search Solution Explorer - Folder View (Ctrl+;)

```
src
  app
    app.component.css
    app.component.html
    app.component.spec.ts
    app.component.ts
    app.module.ts
  assets
    .gitkeep
  environments
    environment.prod.ts
    environment.ts
  browserslist
  favicon.ico
  index.html
  karma.conf.js
  main.ts
  polyfills.ts
  styles.css
  test.ts
  tsconfig.app.json
  tsconfig.spec.json
  tslint.json
```

Figure 11-2. *The contents of the src folder*

The app folder is where you will add the custom code and content for your application, and its structure becomes more complex as you add features. The other files support the development process, as described in Table 11-4.

Table 11-4. The Files and Folders in the src Folder

Name	Description
app	This folder contains an application's source code and content. The contents of this folder are the topic of the "Understanding How an Angular Application Works" section and other chapters in this part of the book.
assets	This folder is used for the static resources required by the application, such as images.
environments	This folder contains configuration files that define settings for different environments. By default, the only configuration setting is the production flag, which is set to true when the application is built for deployment, as explained in the "Understanding the Application Bootstrap" section.
browserlist	This file is used to support the CSS processing packages that are used by the development tools.
favicon.ico	This file contains an icon that browsers will display in the tab for the application. The default image is the Angular logo.
index.html	This is the HTML file that is sent to the browser during development, as explained in the "Understanding the HTML Document" section.
karma.conf.js	This file contains the configuration for the Karma testing tool, which I describe in Chapter 29.
main.ts	This file contains the TypeScript statements that start the application when they are executed, as described in the "Understanding the Application Bootstrap" section.
polyfills.ts	This file is used to include polyfills in the project to provide support for features that are not available natively in some browsers, especially Internet Explorer.
styles.css	This file is used to define CSS styles that are applied throughout the application.
tests.ts	This is the configuration file for the Karma test package, which I describe in Chapter 29.
tsconfig.app.json	This is the configuration file for the TypeScript compiler that is used during development.
tsconfig.spec.json	This is the configuration file for the TypeScript compiler that is used during testing.

Understanding the Packages Folder

The world of JavaScript application development depends on a rich ecosystem of packages, some of which contain the Angular framework that will be sent to the browser through to small packages that are used behind the scenes during development. A lot of packages are required for an Angular project: the example project created at the start of this chapter, for example, requires almost 900 packages.

Many of these packages are just a few lines of code, but there is a complex hierarchy of dependencies between them that is too large to manage manually, so a package manager is used. The package manager is given an initial list of packages required for the project. Each of these packages is then inspected for its dependencies, and the process continues until the complete set of packages has been created. All of the required packages are downloaded and installed in the node_modules folder.

The initial set of packages is defined in the package.json file using the dependencies and devDependencies properties. The dependencies property is used to list the packages that the application will require to run. Here are the dependencies packages from the package.json file in the example application, although you may see different version numbers in your project):

```
...
"dependencies": {
    "@angular/animations": "^6.0.3",
    "@angular/common": "^6.0.3",
    "@angular/compiler": "^6.0.3",
    "@angular/core": "^6.0.3",
    "@angular/forms": "^6.0.3",
    "@angular/http": "^6.0.3",
    "@angular/platform-browser": "^6.0.3",
    "@angular/platform-browser-dynamic": "^6.0.3",
    "@angular/router": "^6.0.3",
    "core-js": "^2.5.4",
    "rxjs": "^6.0.0",
    "zone.js": "^0.8.26"
},
...
```

Most of the packages provide Angular functionality, with a handful of supporting packages that are used behind the scenes. For each package, the package.json file includes details of the version numbers that are acceptable, using the format described in Table 11-5.

Table 11-5. *The Package Version Numbering System*

Format	Description
6.0.3	Expressing a version number directly will accept only the package with the exact matching version number, e.g., 6.0.3.
*	Using an asterisk accepts any version of the package to be installed.
>6.0.3 >=6.0.3	Prefixing a version number with > or >= accepts any version of the package that is greater than or greater than or equal to a given version.
<6.0.3 <=6.0.3	Prefixing a version number with < or <= accepts any version of the package that is less than or less than or equal to a given version.
~6.0.3	Prefixing a version number with a tilde (the ~ character) accepts versions to be installed even if the patch level number (the last of the three version numbers) doesn't match. For example, specifying ~6.0.3 will accept version 6.0.4 or 6.0.5 (which would contain patches to version 6.0.3) but not version 6.1.0 (which would be a new minor release).
^6.0.3	Prefixing a version number with a caret (the ^ character) will accept versions even if the minor release number (the second of the three version numbers) or the patch number doesn't match. For example, specifying ^6.0.3 will allow versions 6.1.0, and 6.2.0, for example, but not version 7.0.0.

The version numbers specified in the dependencies section of the package.json file will accept minor updates and patches. Version flexibility is more important when it comes to the devDependencies section of the file, which contains a list of the packages that are required for development but which will not be part of the finished application. There are 19 packages listed in devDependencies section of the package.json file in the example application, each of which has its own range of acceptable versions.

```
...
"devDependencies": {
    "@angular/compiler-cli": "^6.0.3",
    "@angular-devkit/build-angular": "~0.6.8",
    "typescript": "~2.7.2",
    "@angular/cli": "~6.0.8",
    "@angular/language-service": "^6.0.3",
    "@types/jasmine": "~2.8.6",
    "@types/jasminewd2": "~2.0.3",
    "@types/node": "~8.9.4",
    "codelyzer": "~4.2.1",
    "jasmine-core": "~2.99.1",
    "jasmine-spec-reporter": "~4.2.1",
    "karma": "~1.7.1",
    "karma-chrome-launcher": "~2.2.0",
    "karma-coverage-istanbul-reporter": "~2.0.0",
    "karma-jasmine": "~1.1.1",
    "karma-jasmine-html-reporter": "^0.2.2",
    "protractor": "~5.3.0",
    "ts-node": "~5.0.1",
    "tslint": "~5.9.1"
}
...
```

Once again, you may see different details, but the key point is that the management of dependencies between packages is too complex to do manually and is delegated to a package manager. The most widely used package manager is NPM, which is installed alongside Node.js and was part of the preparations for this book in Chapter 2.

All the packages required for development are automatically downloaded and installed into the node_modules folder when you create a project, but Table 11-6 lists some commands that you may find useful during development. All of these commands should be run inside the project folder, which is the one that contains the package.json file.

Table 11-6. *Useful NPM Commands*

Command	Description
npm install	This command performs a local install of the packages specified in the package.json file.
npm install package@version	This command performs a local install of a specific version of a package and updates the package.json file to add the package to the dependencies section.

(*continued*)

Table 11-6. *(continued)*

Command	Description
`npm install package@version --save-dev`	This command performs a local install of a specific version of a package and updates the `package.json` file to add the package to the `devDependencies` section.
`npm install --global package@version`	This command will perform a global install of a specific version of a package.
`npm list`	This command will list all of the local packages and their dependencies.
`npm run <script name>`	This command will execute one of the scripts defined in the `package.json` file, as described next.

UNDERSTANDING GLOBAL AND LOCAL PACKAGES

NPM can install packages so they are specific to a single project (known as a *local install*) or so they can be accessed from anywhere (known as a *global install*). Few packages require global installs, but one exception is the `@angular/cli` package installed in Chapter 2 as part of the preparations for this book. The `@angular-cli` package requires a global install because it is used to create new projects. The individual packages required for the project are installed locally, into the `node_modules` folder.

The last command described in Table 11-6 is an oddity, but package managers have traditionally included support for running commands that are defined in the `scripts` section of the `package.json` file. In an Angular project, this feature is used to provide access to the tools that are used during development and that prepare the application for deployment. Here is the `scripts` section of the `package.json` file in the example project:

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

Table 11-7 summarizes these commands, and I demonstrate their use in later sections of this chapter or in later chapters in this part of the book.

Table 11-7. The Commands in the Scripts Section of the package.json File

Name	Description
`ng`	This command runs the `ng` command, which provides access to the Angular development tools.
`start`	This command starts the development tools, as described in the next section, and is equivalent to the `ng serve` command.
`build`	This command performs the production build process, as demonstrated in Chapter 10, and is equivalent to running the `ng build` command with the `--prod` argument.
`test`	This command starts the unit testing tools, which are described in Chapter 29, and is equivalent to the `ng test` command.
`lint`	This command starts the TypeScript linter, as described in the "Using the Linter" section, and is equivalent to the `ng list` command.
`e2e`	This command starts the end-to-end testing tools and is equivalent to the `ng e2e` command.

The commands in Table 11-7 are run by using `npm run` followed by the name of the command that you require, and this must be done in the folder that contains the `package.json` file. So, if you want to run the `lint` command in the example project, you would navigate to the `example` folder and type `npm run lint`. You can also get the same result by using the command `ng lint`.

USING YARN FOR PACKAGE MANAGEMENT

Yarn is a recent alternative to NPM. Yarn was introduced as a response to limitations in NPM, but some of the features that differentiated Yarn have since made their way into NPM, such as a file that keeps track of the exact version of all packages that are installed by the `npm install` command, which avoids inconsistencies when different developers work on the same project. NPM has since added many of the features that were unique to Yarn, and the choice of package manager is one of personal preference.

For Angular development, either package manager can be used, and I chose NPM because it is installed alongside Node.js. You can download Yarn from `yarnpkg.com`, and you can configure the `angular-cli` package to use Yarn by running this command:

```
ng set --global packageManager=yarn
```

Once you have configured Yarn as your package manager, it will be used to download and install the packages required by new projects created with the `ng new` command.

Using the Development Tools

Projects created using the `ng new` command include a complete set of development tools that monitor the application's files and build the project when a change is detected. You don't have to use these tools for Angular development, but they result in a pleasant development experience that suits most developers. Run the commands shown in Listing 11-1 to navigate to the `example` folder and start the development tools.

Listing 11-1. Starting the Development Tools

```
cd example
ng serve
```

The key package for Angular development is called *webpack*, and it is installed automatically by `ng new` when the project is created. Webpack is a module bundler, which means that it packages JavaScript modules for use in a browser. That's a bland description for an important function, and it is one of the key tools that you will rely on while developing an Angular application, albeit one that you won't deal with directly since it is managed for you by the Angular development tools.

When you run the commands in Listing 11-1, you will see a series of messages as webpack prepares the bundles required to run the example application. Webpack starts with the code in the `main.ts` file and loads all of the modules for which there are `import` statements to create a set of dependencies. This process is repeated for each of the modules that `main.ts` depends on, and webpack keeps working its way through the application until it has a complete set of dependencies for the entire application, which is then combined into a file known as a *bundle*.

During the bundling process, webpack reports on its process as it works its way through the modules and finds the ones that it needs to include in its bundle, like this:

```
...
10% building modules 4/7 modules 3 active
...
```

The bundling process can take a moment, but it only needs to be performed when you start the development tools. At the end of the process, you will see a summary of the bundles that have been created, like this:

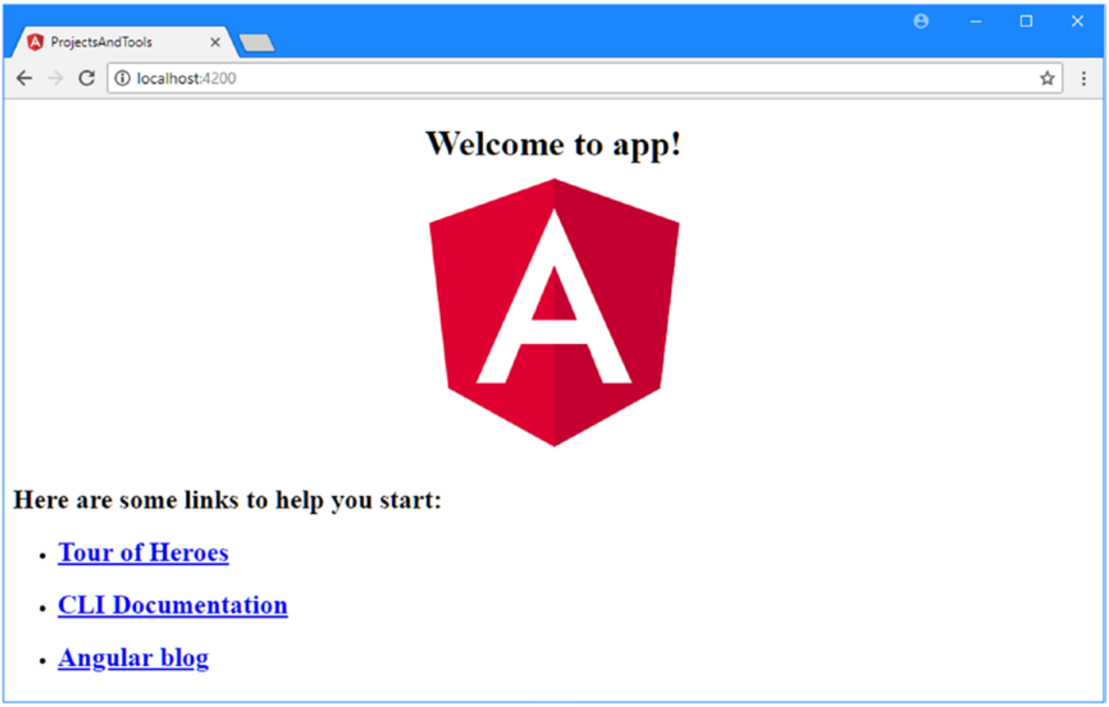
```
...
** Angular Live Development Server is listening on localhost:4200, open your browser on
http://localhost:4200/ **

Date: 2018-07-05T07:53:12.614Z
Hash: e8e3505bb172de5054c9
Time: 6559ms
chunk {main} main.js, main.js.map (main) 10.8 kB [initial] [rendered]
chunk {polyfills} polyfills.js, polyfills.js.map (polyfills) 227 kB [initial] [rendered]
chunk {runtime} runtime.js, runtime.js.map (runtime) 5.22 kB [entry] [rendered]
chunk {styles} styles.js, styles.js.map (styles) 15.7 kB [initial] [rendered]
chunk {vendor} vendor.js, vendor.js.map (vendor) 3.07 MB [initial] [rendered]
wdm: Compiled successfully.
...
```

Understanding the Development HTTP Server

To simplify the development process, the project incorporates the `webpack-dev-server` package, which is an HTTP server that is tightly integrated with webpack. The summary that reports the completion of the initial bundling process also tells you that the development HTTP server is ready and tells you the port on which it is listening for requests.

```
...
** NG Live Development Server is listening on localhost:4200, open your browser on http://
localhost:4200/ **

...
```

The default port for the development HTTP server is 4200, and once you see this message, you can open a new browser window and request `http://localhost:4200`, which will produce the response shown in Figure 11-3.



Welcome to app!

Here are some links to help you start:

- Tour of Heroes
- CLI Documentation
- Angular blog

Figure 11-3. Running the example application

Understanding Hot Model Replacement

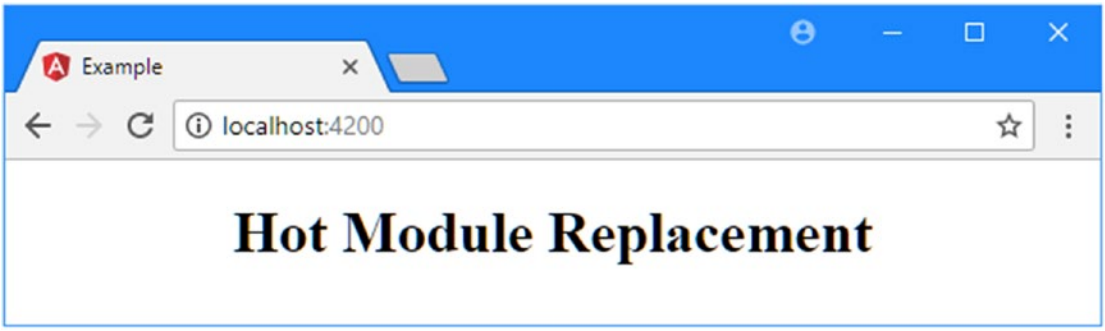
The bundles that webpack creates include support for a feature called *hot module replacement* (HMR). When you make a change to the application's source or content files, the altered file is compiled, put into a bundle by webpack, and sent to the browser. In most cases, only a small change is sent to the browser, and the application is updated on the fly.

As a demonstration, I replaced the contents of the `app.component.html` file in the `src/app` folder with the elements shown in Listing 11-2.

Listing 11-2. Replacing the Contents of the app.component.html File in the src/app Folder

```
<div style="text-align:center">
  <h1>Hot Module Replacement</h1>
</div>
```

As soon as the file is saved, the change is detected, and webpack creates a replacement module. The HMR feature includes code that is sent to the browser in the original bundle to open a persistent connection to the development HTTP server and listen for updates. When the new module is available, it is sent to the browser, and the application is automatically updated, as shown in Figure 11-4.



Hot Module Replacement

Figure 11-4. *Using the hot module replacement feature*

■ **Tip** The hot module replacement feature tries to preserve the state of the application where possible, but doesn't always get it right, in which case reloading the browser will refresh the application.

Using the Linter

A linter is a tool that inspects source code to ensure that it conforms to a set of coding conventions and rules. Projects created with the `ng new` command include a TypeScript linter called TSLint, and the rules it supports are described at `https://github.com/palantir/tslint`, covering everything from common errors that are likely to cause unexpected results through to issues of style.

You can enable and disable linting rules in the `tslint.json` file, and many of the rules have configuration options that fine-tune the problems they detect. To demonstrate how the linter works, I made two changes to a TypeScript file, as shown in Listing 11-3.

Listing 11-3. Making Changes in the app.component.ts File in the src/app Folder

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

debugger;

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

I added a debugger statement and removed the semicolon from the end of the statement that sets the value for the title property in the AppComponent class. Both these changes contravene the default TSLint rules, and you can see the result by opening a new command prompt, navigating to the example project folder, and running the linter using the command shown in Listing 11-4.

Listing 11-4. Running the TypeScript Linter

```
ng lint
```

The linter inspects the TypeScript files in the project and reports any problems that it encounters. The changes in Listing 11-4 result in the following messages:

```
...
ERROR: /example/src/app/app.component.ts[3, 1]: Use of debugger statements is forbidden
ERROR: /example/src/app/app.component.ts[11, 16]: Missing semicolon

Lint errors found in the listed files.
...
```

Linting isn't integrated into the regular build process and can be performed only manually. The most common use for linting is to check for potential problems before committing changes to a version control system, although some project teams make broader use of the linting facility by integrating it into other processes.

You may find that there are individual statements that cause the linter to report an error but that you are not able to change. Rather than disable the rule entirely, you can add a comment to the code that tells the linter to ignore the next line, like this:

```
...
// tslint:disable-next-line
...
```

If you have a file that is full of problems but you cannot make changes—often because there are constraints applied from some other part of the application—then you can disable linting for the entire file by adding this comment at the top of the page:

```
...
/* tslint:disable */
...
```

These comments allow you to ignore code that doesn't conform to the rules but that cannot be changed, while still linting the rest of the project.

To address the linter warnings, I commented out the debugger statement and restored the semicolon in the app.component.ts file, as shown in Listing 11-5.

Listing 11-5. Addressing Linting Warnings in the app.component.ts File in the src/app Folder

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

// debugger;

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

THE JOY AND MISERY OF LINTING

Linters can be a powerful tool for good, especially in a development team with mixed levels of skill and experience. Linters can detect common problems and subtle errors that lead to unexpected behavior or long-term maintenance issues. A good example is the difference between the JavaScript `==` and `===` operators, where a linter can warn when the wrong type of comparison has been performed. I like this kind of linting, and I like to run my code through the linting process after I have completed a major application feature or before I commit my code into version control.

But linters can also be a tool of division and strife. In addition to detecting coding errors, linters can also be used to enforce rules about indentation, brace placement, the use of semicolons and spaces, and dozens of other style issues. Most developers have style preferences—I certainly do: I like four spaces for indentation, and I like opening braces to be on the same line and the expression they relate to. I know that some programmers have different preferences, just as I know those people are plain wrong and will one day see the light and start formatting their code correctly.

Linters allow people with strong views about formatting to enforce them on others, generally under the banner of being "opinionated," which can tend toward "obnoxious." The logic is that developers waste time arguing about different coding styles and everyone is better off being forced to write in the same way, which is typically the way preferred by the person with the strong views and ignores the fact that developers will just argue about something else because arguing is fun.

I especially dislike linting of formatting, which I see as divisive and unnecessary. I often help readers when they can't get book examples working (my e-mail address is `adam@adam-freeman.com` if you need help), and I see all sorts of coding style every week. But rather than forcing readers to code my way, I just get my code editor to reformat the code to the format that I prefer, which is a feature that every capable editor provides.

My advice is to use linting sparingly and focus on the issues that will cause real problems. Leave formatting decisions to the individuals and rely on code editor reformatting when you need to read code written by a team member who has different preferences.

Understanding How an Angular Application Works

Angular can seem like magic when you first start using it, and it is easy to become wary of making changes to the project files for fear of breaking something. Although there are a lot of files in an Angular application, they all have a specific purpose, and they work together to do something that far from magic: display HTML content to the user. In this section, I explain how the example Angular application works and how each part works toward the end result.

Understanding the HTML Document

The HTML document that is sent to the browser by the development HTTP server is the first part of the process. When the browser requests the default URL, such as `http://localhost:4200`, the development server responds with the contents of the `index.html` file in the `src` folder, which contains the following elements:

```
<!doctype html>
<html lang="en">
<head>
  <meta charset="utf-8">
  <title>Example</title>
  <base href="/">
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <link rel="icon" type="image/x-icon" href="favicon.ico">
</head>
<body>
  <app-root></app-root>
</body>
</html>
```

①
index.html

The body contains only an `app-root` element, whose purpose will become clear shortly. As it processes the HTML document, the development HTTP server populates the body with script elements that tell the browser to load the bundle files created during the build process, like this:

```
<!doctype html>
<html lang="en">
<head>
  <meta charset="utf-8">
  <title>Example</title>
  <base href="/">

  <meta name="viewport" content="width=device-width, initial-scale=1">
  <link rel="icon" type="image/x-icon" href="favicon.ico">
</head>
<body>
  <app-root></app-root>
  <script type="text/javascript" src="runtime.js"></script>
  <script type="text/javascript" src="polyfills.js"></script>
  <script type="text/javascript" src="styles.js"></script>
  <script type="text/javascript" src="vendor.js"></script>
  <script type="text/javascript" src="main.js"></script></body>
</html>
```

Understanding the Application Bootstrap

Browsers execute JavaScript files in the order in which their `script` elements appear, starting with the `runtime.js` file, which contains the Angular framework code. For most projects, the interesting file is `main.js`, which contains the custom application code. This is the file that contains the code defined in the `main.ts` file, which starts the application and relies on the code contained in the other JavaScript files. Here are the statements added to the `main.ts` file by the `ng new` command when it creates a project:

```
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.log(err));
```

Deprecated

The `import` statements declare dependencies on other JavaScript modules, providing access to Angular features (the dependencies on `@angular` modules) and the custom code in the application (the `AppModule` dependency). The final import is for environment settings, which are used to create different configuration settings for development, test, and production platforms, such as this code:

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

Angular has a production mode that disables some useful checks that are performed during development and that are described in later chapters. Enabling production mode means provides a performance increase and means that the results of the checks are not reported in the browser's JavaScript console where they can be seen by the user. Production mode is enabled by calling the `enableProdMode` function, which is imported from the `@angular/core` module.

To work out whether production mode should be enabled, a check is performed to see whether `environment.production` is `true`. This check corresponds to the contents of the `envirionment.prod.ts` file in the `src/envirionments` folder, which sets this value and is applied when the application is built in preparation for deployment. The result is that production mode will be enabled if the application has been built for production but disabled the rest of the time.

The remaining statement in the `main.ts` file is responsible for starting the application.

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

The `platformBrowserDynamic` function initializes the Angular platform for use in a web browser and is imported from the `@angular/platform-browser-dynamic` module. Angular has been designed to run in a range of different environments, and calling the `platformBrowserDynamic` function is the first step in starting an application in a browser. The next step is to call the bootstrapModule method, which accepts the Angular root module for the application, which is AppModule by default and which is imported from the app.module.ts file in the src/app folder and described in the next section. The bootstrapModule method provides Angular with the entry point into the application and represents the bridge between the functionality provided by the @angular modules and the custom code and content in the project. The final part of this statement uses the catch keyword to handle any bootstrapping errors by writing them to the browser's JavaScript console.

■ **Tip** Notice that the argument to the bootstrapModule method is the name of the class and not a new instance of that class. Put another way, you call bootstrapModule(AppModule) and not bootstrapModule (new AppModule()) or bootstrapModule("AppModule").

Understanding the Root Angular Module

The term *module* does double duty in an Angular application and refers to both a JavaScript module and an Angular module. JavaScript modules are used to track dependencies in the application and ensure that the browser receives only the code it requires. Angular modules are used to configure a part of the Angular application.

Every application has a *root* Angular module, which is responsible for describing the application to Angular. The root module is called AppModule, and it is defined in the app.module.ts file in the src/app folder; it contains the following code:

```
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 { }
```

← Code Komponente

The AppModule class doesn't define any members, but it provides Angular with essential information through the configuration properties of its @NgModule decorator. I describe the different properties that are used to configure an Angular module in later chapters, but the one that is of interest now is the bootstrap property, which tells Angular that it should load a component called AppComponent as part of the application startup process. Components are the main building block in Angular applications, and the content provided by the component called AppComponent will be displayed to the user.

Understanding the Angular Component

The component called AppComponent, which is selected by the root Angular module, is defined in the app.component.ts file in the src/app folder. Here are the contents of the app.component.ts file, which I edited earlier in the chapter to demonstrate linting:

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

//debugger;

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

← Replaces HTML Element

← HTML Content

← CSS Styles

The properties for the @Component decorator configure its behavior. The selector property tells Angular that this component will be used to replace an HTML element called app-root. The templateUrl and styleUrls properties tell Angular that the HTML content that the component wants to present to the user can be found in a file called app.component.html and that the CSS styles to apply to the HTML content are defined in a file called app.component.css (although the CSS file is empty in new projects).

Here is the content of the app.component.html file, which I edited earlier in the chapter to demonstrate hot module reloading:

```
<div style="text-align:center">
  <h1>
    Hot Module Replacement
  </h1>
</div>
```

This file contains regular HTML elements, but, as you will learn, Angular features are applied by using custom HTML elements or by adding attributes to regular HTML elements.

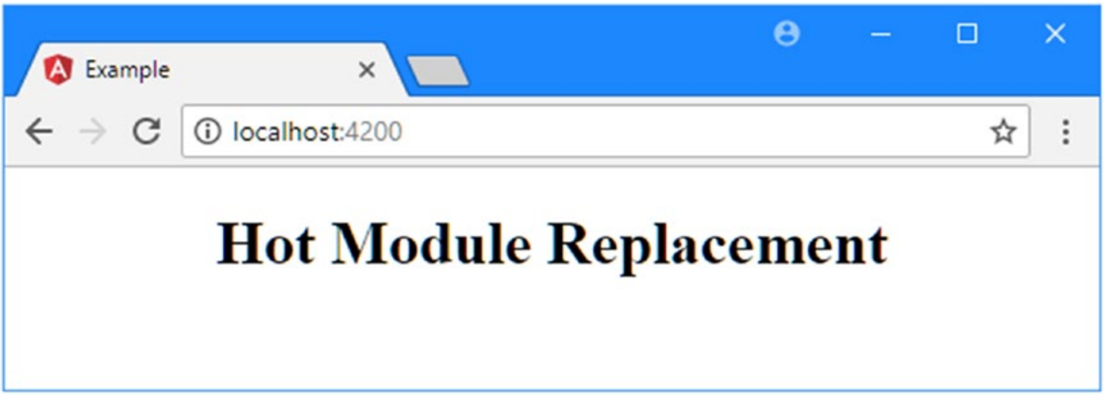
Understanding Content Display

Index.html Element → → HTML
→ CSS

When the application starts, Angular processes the index.html file, locates the element that matches the root component's selector property, and replaces it with the contents of the files specified by the root component's templateUrl and styleUrls properties. This is done using the Domain Object Model (DOM) API provided by the browser for JavaScript applications, and the changes can be seen only by right-clicking in the browser window and selecting Inspect from the pop-up menu, producing the following result:

```
<html lang="en"><head>
    <meta charset="utf-8">
    <title>Example</title>
    <base href="/">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="icon" type="image/x-icon" href="favicon.ico">
    <style type="text/css">
      /* You can add global styles to this file, and also import other style files */
    </style>
    <style></style>
  </head>
  <body>
    <app-root _nghost-c0="" ng-version="6.0.7">
        <div _ngcontent-c0="" style="text-align:center">
            <h1 _ngcontent-c0="">Hot Module Replacement</h1>
        </div>
    </app-root>
    <script type="text/javascript" src="runtime.js"></script>
    <script type="text/javascript" src="polyfills.js"></script>
    <script type="text/javascript" src="styles.js"></script>
    <script type="text/javascript" src="vendor.js"></script>
    <script type="text/javascript" src="main.js"></script>
</body></html>
```

The app-root element contains the div and h1 elements from the component's template, and the attributes are added by Angular during the initialization process. The style elements represent the contents of the styles.css file in the app folder and the app.component.css file in the src/app folder. (The CSS files do not contain any styles when the project is created, which is why the style elements do not contain any styles.) The result of the bootstrap process is the component's content is presented to the user, as shown in Figure 11-5.



Hot Module Replacement

Figure 11-5. *Displaying a component's content*

Starting Development in an Angular Project

You have seen how the initial building blocks of an Angular application fit together and how the bootstrap process results in content being displayed to the user. In this section, I add a simple data model to the project, which is the typical starting point for most developers, and replace placeholder content created by the ng new command with a new component and HTML template.

Adding the Bootstrap CSS Framework

I use the Bootstrap CSS framework throughout this book because it lets me easily style HTML elements by assigning them to classes. Run the command shown in Listing 11-6 in the `example` folder to download the Bootstrap package and add it to the project.

Listing 11-6. Installing the Bootstrap Package

```
npm install bootstrap@4.1.1
```

In Listing 11-7, I have added the path to the file that contains the Bootstrap CSS styles to the `angular.json` file, which is used to configure the development tools.

Listing 11-7. Configuring a CSS File in the angular.json File in the example Folder

```
...
"styles": [
    "styles.css",
    "node_modules/bootstrap/dist/css/bootstrap.min.css"
],
...
```

This tells the Angular development tools to include the Bootstrap CSS styles in the content that is sent to the browser.

■ **Tip** There are two `style` sections in the `angular.json` file. The Bootstrap CSS file should be added to the one closest to the top of the file.

The development tools must be restarted to reflect the configuration change. Use Ctrl+C to terminate any existing Angular processes and run the command shown in Listing 11-8 in the `example` folder.

Listing 11-8. Starting the Development Tools

```
ng serve
```

Creating the Data Model

Of all the building blocks in an application, the data model is the one for which Angular is the least prescriptive. Elsewhere in the application, Angular requires specific decorators to be applied or parts of the API to be used, but the only requirement for the model is that it provides access to the data that the application requires; the details of how this is done and what that data looks like is left to the developer.

This can feel a little odd, and it can be difficult to know how to begin, but, at its heart, the model can be broken into three different parts.

- A class that describes the data in the model
- A data source that loads and saves data, typically to a server
- A repository that allows the data in the model to be manipulated

Model

In the following sections, I create a simple model, which provides the functionality that I need to describe Angular features in the chapters that follow.

Creating the Descriptive Model Class

Descriptive classes, as the name suggests, describe the data in the application. In a real project, there will usually be a lot of classes to fully describe the data that the application operates on. To get started for this chapter, I am going to create a single, simple class and add a file called `product.model.ts` to the `src/app` folder with the code shown in Listing 11-9.

Listing 11-9. The Contents of the product.model.ts File in the src/app Folder

```
export class Product {

    constructor(public id?: number,
        public name?: string,
        public category?: string,
        public price?: number) { }
}
```

Class

The `Product` class defines properties for a product identifier, the name of the product, its category, and the price. The properties are defined as optional constructor arguments, which is a useful approach if you are creating objects using an HTML form, which I demonstrate in Chapter 14.

Creating the Data Source

The data source provides the application with the data. The most common type of data source uses HTTP to request data from a web service, which I describe in Chapter 24. For this chapter, I need something simpler that I can reset to a known state each time the application is started to ensure that you get the expected results from the examples. I added a file called `datasource.model.ts` to the `src/app` folder with the code shown in Listing 11-10.

Listing 11-10. The Contents of the datasource.model.ts File in the src/app Folder

```
import { Product } from "./product.model";

export class SimpleDataSource {
    private data: Product[];

    constructor() {
        this.data = new Array<Product>(
            new Product(1, "Kayak", "Watersports", 275),
            new Product(2, "Lifejacket", "Watersports", 48.95),
            new Product(3, "Soccer Ball", "Soccer", 19.50),
            new Product(4, "Corner Flags", "Soccer", 34.95),
            new Product(5, "Thinking Cap", "Chess", 16));
    }

    getData(): Product[] {
        return this.data;
    }
}
```

Mock

The data in this class is hardwired, which means that any changes that are made in the application will be lost when the browser is reloaded. This is far from useful in a real application, but it is ideal for book examples.

Creating the Model Repository

The final step to complete the simple model is to define a repository that will provide access to the data from the data source and allow it to be manipulated in the application. I added a file called `repository.model.ts` in the `src/app` folder and used it to defined the class shown in Listing 11-11.

Listing 11-11. The Contents of the repository.model.ts File in the src/app Folder

```
import { Product } from "./product.model";
import { SimpleDataSource } from "./datasource.model";

export class Model {
    private dataSource: SimpleDataSource;
    private products: Product[];
    private locator = (p: Product, id: number) => p.id == id;

    constructor() {
        this.dataSource = new SimpleDataSource();
        this.products = new Array<Product>();
        this.dataSource.getData().forEach(p => this.products.push(p));
    }

    getProducts(): Product[] {
        return this.products;
    }

    getProduct(id: number): Product {
        return this.products.find(p => this.locator(p, id));
    }

    saveProduct(product: Product) {
        if (product.id == 0 || product.id == null) {
            product.id = this.generateID();
            this.products.push(product);
        } else {
            let index = this.products
                .findIndex(p => this.locator(p, product.id));
            this.products.splice(index, 1, product);
        }
    }

    deleteProduct(id: number) {
        let index = this.products.findIndex(p => this.locator(p, id));
        if (index > -1) {
            this.products.splice(index, 1);
        }
    }
    private generateID(): number {
        let candidate = 100;
        while (this.getProduct(candidate) != null) {
            candidate++;
        }
        return candidate;
    }
}
```

The Model class defines a constructor that gets the initial data from the data source class and provides access to it through a set of methods. These methods are typical of those defined by a repository and are described in Table 11-8.

Table 11-8. *The Types of Web Forms Code Nuggets*

Name	Description
getProducts	This method returns an array containing all the Product objects in the model.
getProduct	This method returns a single Product object based on its ID.
saveProduct	This method updates an existing Product object or adds a new one to the model.
deleteProduct	This method removes a Product object from the model based on its ID.

The implementation of the repository may seem odd because the data objects are stored in a standard JavaScript array, but the methods defined by the Model class present the data as though it were a collection of Product objects indexed by the id property. There are two main considerations when writing a repository for model data. The first is that it should present the data that will be displayed as efficiently as possible. For the example application, this means presenting all the data in the model in a form that can be iterated, such as an array. This is important because the iteration can happen often, as I explain in Chapter 16. The other operations of the Model class are inefficient, but they will be used less often.

The second consideration is being able to present unchanged data for Angular to work with. I explain why this is important in Chapter 13, but in terms of implementing the repository, it means that the getProducts method should return the same object when it is called multiple times, unless one of the other methods or another part of the application has made a change to the data that the getProducts method provides. If a method returns a different object each time it is returned, even if they are different arrays containing the same objects, then Angular will report an error. Taking both of these points into account means that the best way to implement the repository is to store the data in an array and accept the inefficiencies.

Creating a Component and Template

Templates contain the HTML content that a component wants to present to the user. Templates can range from a single HTML element through to a complex block of content.

To create a template, I added a file called template.html to the src/app folder and added the HTML elements shown in Listing 11-12.

Listing 11-12. The Contents of the template.html File in the src/app Folder

```
<div class="bg-info text-white m-2 p-2">
    There are {{model.getProducts().length}} products in the model
</div>
```

Most of this template is standard HTML, but the part between the double brace characters (the {{ and }} in the div element) is an example of a data binding. When the template is displayed, Angular will process its content, discover the binding, and evaluate the expression that it contains to produce the content that will be displayed by the data binding.

The logic and data required to support the template are provided by its component, which is a TypeScript class to which the @Component decorator has been applied. To provide a component for the template in Listing 11-12, I added a file called component.ts to the src/app folder and defined the class shown in Listing 11-13.

Listing 11-13. The Contents of the component.ts File in the src/app Folder

```
import { Component } from "@angular/core";
import { Model } from "./repository.model";

@Component({
    selector: "app",
    templateUrl: "template.html"
})
export class ProductComponent {
    model: Model = new Model();
}
```

Html Element

Template

Daten und Logik für Binding

The @Component decorator configures the component. The selector property specifies the HTML element that the directive will be applied to, which is app. The templateUrl property in the @Component directive specifies the content that will be used as the contents of the app element, and, for this example, this property specifies the template.html file.

The component class, which is ProductComponent for this example, is responsible for providing the template with the data and logic that is needed for its bindings. The ProductComponent class defines a single property, called model, which provides access to a Model object.

The app element I used for the component's selector isn't the same element that the ng new command uses when it creates a project and that is expected in the index.html file. In Listing 11-14, I have modified the index.html file to introduce an app element to match the component's selector from Listing 11-13.

Listing 11-14. Changing the Custom Element in the index.html File in the app Folder

```
<!doctype html>
<html lang="en">
<head>
  <meta charset="utf-8">
  <title>Example</title>
  <base href="/">

  <meta name="viewport" content="width=device-width, initial-scale=1">
  <link rel="icon" type="image/x-icon" href="favicon.ico">
</head>
<body>
  <app></app>
</body>
</html>
```

This isn't something you need to do in a real project, but it further demonstrates that Angular applications fit together in simple and predictable ways and that you can change any part that you need to or want to.

Configuring the Root Angular Module

The component that I created in the previous section won't be part of the application until I register it with the root Angular module. In Listing 11-15, I have used the `import` keyword to import the component and used the `@NgModule` configuration properties to register the component.

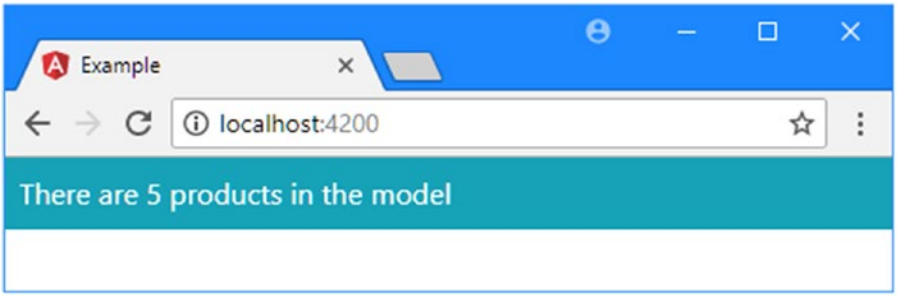
Listing 11-15. Registering a Component in the app.module.ts File in the app/src Folder

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

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

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

← Features

← Code
Template

I used the name `ProductComponent` in the `import` statement, and I added this name to the `declarations` array, which configures the set of components and other features in the application. I also changed the value of the `bootstrap` property so that the new component is the one that is used when the application starts. When the change to the `app.module.ts` file is saved, the new configuration will take effect, and you will see the content shown in Figure 11-6.



There are 5 products in the model

Figure 11-6. *The effect of a new component and template*

The standard Angular bootstrap sequence is performed, but the custom component and template that I created in the previous section are used, rather than the ones set up when the project was created.

Summary

In this chapter, I created an Angular project and used it to introduce the tools that it contains and explained how a simple Angular application works. In the next chapter, I start digging into the detail, starting with data bindings.