

Introduction to Angular 2

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1 Notes

- The book assumes that you are working in a Unix-like environment. If you are on Windows you can use [Cygwin](#) so that you can follow along with the bash terminal commands.
- All the project files for the book are hosted on github: <https://github.com/st32lth/angular2-intro>. You can clone the repository and check out the project files. Throughout the book, you will see references to the project files. Those refer to this repository. For example, `angular2-intro/project-files/hello-angular` refers to the `hello-angular` folder inside the `project-files` folder.
- Make sure you have `git` installed on your machine. That is, make sure you get an output for `git --version`.
- The book assumes that you have a working knowledge of JavaScript and Angular 1.x
- Node is heavily used throughout the book. Make sure that you follow the “Node” chapter to install Node and set permissions correctly.
- All the keyboard shortcuts are mac-based. But if you are using a non-mac machine, you can almost always replace `command` with `ctrl` and you should be good. For example, if you see a shortcut like `command + shift + b`, you can use `ctrl + shift + b` where `ctrl` is obviously the control key.

2 Installing Node

You can use `nvm` to install and manage Node on your machine. Copy the install script and run it:

```
curl -o- https://raw.githubusercontent.com/creationix/nvm/v0.30.1/install.sh | bash
```

After that, make a new terminal window and make sure that it is installed, by running:

```
nvm --help
```

Now you can use `nvm` to install Node `0.12.9` by running:

```
nvm install 0.12.9
```

After that, `nvm` is going to load version `0.12.9` automatically. If it doesn't, you can load it in the current shell, with:

```
nvm use 0.12.9
```

Note that you can load any node version in the current shell with `nvm use 0.x.y` after installing that version.

Also note that if you want to make `0.12.9` the default Node version on your machine, you can do so by running the following:

```
nvm alias default 0.12.9
```

Then you can verify that it is the default version by making a new terminal window and typing `node -v`.

2.1 Permissions

Never use `sudo` to install packages, never do `sudo npm install <package>`. If you get permission errors while installing without `sudo`, you can own the folders instead. So for example, if you get an error like:

```
Error: EACCES, mkdir '/usr/local'
```

you can own the folder with:

```
sudo chown -R `whoami` /usr/local
```

You can own folders until Node doesn't complain.

2.2 Installing live-server

Install a package to verify that node is installed and everything is wired up correctly. We are going to use `live-server` through the book. So let's install that with:

```
npm i -g live-server
```

Then, you should be able to run `live-server` in any folder to serve the content of that folder:

```
mkdir ~/Desktop/sample && cd $_  
live-server .
```

3 Visual Studio Code

Visual Studio Code is a good IDE for developing web apps. In this chapter we will look at installing and configuring VSCode.

3.1 Visual Studio Code Basics

- Install Visual Studio Code from: <https://code.visualstudio.com/>
- You can open new projects by going to the **File > Open** tag, to either open a folder containing your project or a single file
- Some useful keyboard shortcuts are:
 - **command + b**: to close/open the file navigator
 - **command + shift + p**: to open the prompt
- To install extensions open the prompt with **command + shift + p** and type:

```
> install extension
```

- You can change the keyboard shortcuts settings from **Preferences > Keyboard Shortcuts**. Open the settings and then you can add your own shortcuts:

```
// Place your key bindings in this file to overwrite the defaults
[
  {
    "key": "cmd+t",
    "command": "workbench.action.quickOpen"
  },
  {
    "key": "shift+cmd+r",
    "command": "editor.action.format",
    "when": "editorTextFocus"
  }
]
```

3.2 Setting up VSCode for TypeScript

In this section we are going to set up Visual Studio Code for TypeScript. The project files for this chapter are in [angular2-intro/project-files/vscode](#). You can either follow along or check out the folder to see the final result.

3.2.1 Installing TypeScript

Before anything, we need to install the TypeScript compiler. You can install the TypeScript compiler with npm:

```
npm i typescript -g
```

Then to verify that it is installed, run `tsc -v` to see the version of the compiler. You will get an output like this:

```
message TS6029: Version 1.7.5
```

In addition to the compiler, we also need to install the TypeScript Definition manager for DefinitelyTyped (tsd). You can install tsd with:

```
npm i tsd -g
```

Using TSD, you can search and install TypeScript definition files directly from the community driven DefinitelyTyped repository. To verify that tsd is installed, run tsd with the version flag:

```
tsd --version
```

You should get an output like this:

```
>> tsd 0.6.5
```

After tsd and tsc are installed, we can compile a hello world program: make a file called `hello.ts` on your desktop:

```
touch ~/Desktop/hello.ts
```

Then, put some TypeScript code in the file:

```
echo "const adder = (a: number, b: number): number => a + b;" > ~/Desktop/hello.ts
```

Then you can compile the file to JavaScript:

```
tsc ~/Desktop/hello.ts
```

It should output a file in Desktop/hello.js:

```
1 var adder = function (a, b) { return a + b; };
```

Now that your TypeScript compiler setup, we can move on to configuring Visual Studio Code.

3.2.2 Add VSCode Configurations

- First download and install Visual Studio Code from the [VSCode Website](#)
- After installing VSCode, open it and then make a new window: **File > New Window**
- Then, make a folder on your desktop for a new project: `mkdir ~/Desktop/vscode-demo`
- After that, open the folder in VSCode: **File > open** and select the `vscode-demo` folder on your desktop.
- Now we need to make three configuration files:
 1. `tsconfig.json`: configuration for the TypeScript compiler
 2. `tasks.json`: Task configuration for VSCode to watch and compile files
 3. `launch.json`: Configuration for the debugger

The `tsconfig.json` file should be in the root of the project. Let's make the file and put the following in it:

```
1 {  
2   "compilerOptions": {  
3     "experimentalDecorators": true,  
4     "emitDecoratorMetadata": true,
```



```
5     "module": "commonjs",
6     "target": "es5",
7     "sourceMap": true,
8     "outDir": "output",
9     "watch": true
10  }
11 }
```

Now to make the `tasks.json` file. Open the prompt with `command + shift + p` and type:

```
> configure task runner
```

Then put the following in the file and save the file:

```
1 {
2   "version": "0.1.0",
3   "command": "tsc",
4   "showOutput": "silent",
5   "isShellCommand": true,
6   "problemMatcher": "$tsc"
7 }
```

The last thing that we need to set up is the debugger, i.e. the `launch.json` file. Right click on the `.vscode` folder in the file navigator and make a new file called `launch.json` and put in the following:

```
1 {
2   "version": "0.1.0",
3   "configurations": [
4     {
5       "name": "TS Debugger",
6       "type": "node",
7       "program": "main.ts",
8       "stopOnEntry": false,
9       "sourceMaps": true,
```

```
10     "outDir": "output"
11   }
12 ]
13 }
```

After you save the file, you should be able to see the debugger in the debugger dropdown options.

Now, we are ready to make the `main.ts` file in the root of the project:

main.ts

```
1 const sum = (a: number, b: number): number => a + b;
2 const r = sum(1,2);
3 console.log(r);
```

Now you can start the task to watch the files and compile as you work. Open the prompt with `command + shift + p` and type:

```
> run build tasks
```

you can also use the `command + shift + b` keyboard shortcut instead. This will start the debugger and watch the files. After making a change to `main.ts`, you should be able to see the output in the `output` folder.

After the build task is running, we can put a breakpoint anywhere in our TypeScript code. Let's put a breakpoint on line 2 by clicking on the margin. Then start the debugger by going to the debugger tab and clicking the green play icon.

Now you should see that the program will stop at the breakpoint and you should be able to step over or into your program.

To stop the task you can terminate it. Open the prompt and type:

```
> terminate running task
```

You can learn more about running TypeScript with VSCode on MSDN's [blog](#).

3.3 Running VSCode from the Terminal

If you want to run VSCode from the terminal, you can follow the [guide](#) on VSCode's website. Below is the summary of the guide:

MAC

Add the following to your "bash" file:

```
function code () { VSCODE_CWD="$PWD" open -n -b "com.microsoft.VSCode" --args $*; }
```

Linux

```
sudo ln -s /path/to/vscode/Code /usr/local/bin/code
```

Windows

You might need to log off after the installation for the change to the PATH environmental variable to take effect.

3.4 Debugging App from VSCode

The "vscode-chrome-debug" extension allows you to attach VSCode to a running instance of chrome. This makes it very convenient because you can put breakpoints in your TypeScript code and run the debugger to debug your app. Let's get started.

In order to install the [extension](#) open the prompt in VSCode with command + shift + p and type:

```
> install extension
```

hit enter and then type:

```
debugger for chrome
```

Then just click on the result to install the extension. Restart VSCode when you are prompted.

After installing the extension, we need to update or create a `launch.json` file for debugging. You can create one in the `.vscode` folder. After you created the file, put in the following:

```
{
  "version": "0.1.0",
  "configurations": [
    {
      "name": "Launch Chrome Debugger",
      "type": "chrome",
      "request": "launch",
      "url": "http://localhost:8080",
      "sourceMaps": true,
      "webRoot": ".",
      "runtimeExecutable": "/Applications/Google Chrome.app/Contents/MacOS/Google Chrom
      "runtimeArgs": ["--remote-debugging-port=9222", "--incognito"]
    }
  ]
}
```

Notes:

- Depending on your platform you need to change the `runtimeExecutable` path to Chrome's executable path. After configuring the debugger you need to have a server running serving the app. You can change the `url` value accordingly. Also make sure that the `webRoot` path is set to the root of your web server.
- After that it is a good idea to close all the instances of chrome. Then, put a breakpoint in your code and run the debugger. If everything is set up correctly, you should see an instance of chrome running in incognito mode. To trigger the breakpoint, just reload the page and you should be able to see the debugger paused at the breakpoint.
- Also make sure that you have the compiler running so that you can use the JavaScript output and the sourcemaps to use the debugger. See the TypeScript and VSCode set up for more details.

4 TypeScript Crash-course

In this chapter we will quickly go through the most important concepts in TypeScript so that you can have a better understanding of Angular code that you will write. Knowing TypeScript definitely helps to understand Angular, but again it is not a requirement. The project files for this chapter are in [angular2-intro/project-files/typescript](#).

4.1 TypeScript Basics

- TypeScript is a superset of JavaScript with additional features, among which optional types is the most notable. This means that any valid JavaScript code (ES 2015/2016...) is valid TypeScript code. You can basically change the extension of the file to `.ts` and compile it with the TypeScript compiler.
- TypeScript defines 7 primary types:
 - boolean: `var isDone: boolean = false;`
 - number: `var height: number = 6;`
 - string: `var name: string = "bob";`
 - array: `var list: number[] = [1, 2, 3];` also `var list: Array<number> = [1, 2, 3];`
 - enum: `enum Color {Red, Green, Blue};`
 - any: `var notSure: any = 4;`
 - void: `function hello(): void { console.log('hello'); }`

4.2 Interface

- An Interface is defined using the `interface` keyword
- Interfaces are used only during compilation time to check types
- By convention, interface definitions start with an `I`, e.g. : `IPoint`
- Interfaces are used in classical object oriented programming as a design tool
- Interfaces don't contain implementations
- They provide definitions only
- When an object implements an interface, it must adhere to the contract defined by the interface

- An interface defines what properties and methods an object must implement
- If an object implements an interface, it must adhere to the contract. If it doesn't the compiler will let us know.
- Interfaces also define custom types

4.2.1 Basic Interface

Below is an example of an Interface that defines two properties and three methods that implementers should provide implementations for:

```
1 interface IMyInterface {  
2   // some properties  
3   id: number;  
4   name: string;  
5  
6   // some methods  
7   method(): void;  
8   methodWithReturnVal():number;  
9   sum(nums: number[]):number;  
10 }
```

Using the interface above we can create an object that adheres to the interface:

```
1 let myObj: IMyInterface = {  
2   id: 2,  
3   name: 'some name',  
4  
5   method() { console.log('hello'); },  
6   methodWithReturnVal () { return 2; },  
7   sum(numbers) {  
8     return numbers.reduce( (a,b) => { return a + b } );  
9   }  
10 };
```

Notice that we had to provide values to **all** the properties defined by the Interface, and the implementations for **all** the methods defined by the Interface.

And then of course you can use your object methods to perform operations:

```
1 let sum = myObj.sum([1,2,3,4,5]); // -> 15
```

4.2.2 Classes as Interfaces

Because classes define types as well, they can also be used as interfaces. If you have an interface you can extend it with a class for example:

```
1 class Point {
2   x: number;
3   y: number;
4 }
5 interface Point3d extends Point {
6   z: number;
7 }
8 const point3d: Point3d = {x: 1, y: 2, z: 3};
9 console.log(point3d.x); // -> 1
```

First we are defining a class called `Point` that defines two fields. Then we define an interface called `Point3d` that extends the `Point` by adding a third field. An then we create a point of type `point3d` and assign a value to it. We read the value and it outputs 1.

4.3 Classes

- Classes are heavily used in classical object oriented programming
- It defines what an object is and what it can do
- A class is defined using the `class` keyword followed by a name
- By convention, the name of the class start with an uppercase letter
- A class can be used to create multiple objects (instances) of the same class
- An object is created from a class using the `new` keyword
- A class can have a `constructor` which is called when an object is made from the class
- Properties of a class are called instance variables and its functions are called the class methods
- Access modifiers can be used to make them public or private

- The instance variables are attached to the instance itself but not the prototype
- Methods however are attached to the prototype object as opposed to the instance itself
- Classes can inherit functionality from other classes, but you should [favor composition over inheritance](#) or make sure you know [when to use it](#)
- Classes can implement interfaces

Let's make a class definition for a car and incrementally add more things to it. The project files for this section are in [angular2-intro/project-files/typescript/classes/basic-class](#).

4.3.1 Adding an Instance Variable

The Car class definition can be very simple and can define only a single instance variable that all cars can have:

```
1 class Car {  
2   distance: number;  
3 }
```

- Car is the name of the class, which also defines the custom type Car
- distance is a property that tracks the distance that car has traveled
- Distance is of type number and only accepts number type.

Now that we have the definition for a car, we can create a car from the definition:

```
1 let myCar:Car = new Car();  
2 myCar.distance = 0;
```

- myCar:Car means that myCar is of type Car
- new Car() creates an instance from the Car definition.
- myCar.distance = 0 sets the initial value of the distance to 0 for the newly created car

4.3.2 Adding a Method

So far our car doesn't have any definitions for any actions. Let's define a move method that all the cars can have:

```
1 class Car {  
2   distance: number;  
3   move():void {  
4     this.distance += 1;  
5   }  
6 }
```

- `move():void` means that `move` is a method that does not return any value, hence `void`.
- The body of the method is defined in `{ }`
- `this` refers to the instance, therefore `this.distance` points to the `distance` property defined on the car instance.
- Now you can call the `move` method on the car instance to increment the `distance` value by 1:

```
1 myCar.move();  
2 console.log(myCar.distance) // -> 1
```

4.3.3 Using Access Modifiers

If you wanted to tell the compiler that the `distance` variable is private and can only be used by the object itself, you can use the `private` modifier before the name of the property:

```
1 class Car {  
2   private distance: number;  
3   constructor () {  
4     ...  
5   }  
6   ...  
7 }
```

- There are 3 main access modifiers in TypeScript: `private`, `public`, and `protected`:
- `private` modifier means that the property or the method is only defined inside the class only.
- `protected` modifier means that the property or the method is only accessible inside the class and the classes derived from the class.
- `public` is the default modifier which means the property or the method is the accessible everywhere and can be accessed by anyone.

4.3.4 Adding a constructor

A constructor is a special method that gets called when an instance is created from a class. A class may contain at most one constructor declaration. If a class contains no constructor declaration, an automatic constructor is provided.

Let's add a constructor to the `Car` class that initializes the `distance` value to 0. This means that all the cars that are created from this class, will have their `distance` set to 0 automatically:

```
1 class Car {  
2   distance: number;  
3   constructor () {  
4     this.distance = 0;  
5   }  
6   move():void {  
7     this.distance += 1;  
8   }  
9 }
```

- `constructor()` is called automatically when a new car is created
- Parameters are passed to the constructor in the `()`
- The body of the constructor is defined in the `{ }`

Now, let's customize the car's constructor to accept `distance` as a parameter:

```
1 class Car {  
2   private distance: number;  
3   constructor (distance) {  
4     this.distance = distance;  
5   }  
6 }
```

- On line 3 we are passing distance as a parameter. This means that when a new instance is created, a value should be passed in to set the distance of the car.
- On line 4 we are assigning the value of distance to the value that is passed in

This pattern is so common that TypeScript has a shorthand for it:

```
1 class Car {  
2   constructor (private distance) {  
3   }  
4 }
```

Note that the only thing that we had to do was to add `private distance` in the constructor parameter and remove the `this.distance` and `distance: number`. TypeScript will automatically generate that. Below is the JavaScript outputted by TypeScript:

```
1 var Car = (function () {  
2   function Car(distance) {  
3     this.distance = distance;  
4   }  
5   return Car;  
6 })();
```

Now that our car expects a distance we have to always supply a value for the distance when creating a car. You can define default values if you want so that the car is instantiated with a default value for the distance if none is given:

```
1 class Car {  
2   constructor (private distance = 0) {  
3   }  
4   getDistance():number { return this.distance; }  
5 }
```

Now if I forget to pass a value for the distance, it is going to be set to zero by default:

```
1 const mycar = new Car();  
2 console.log(mycar.getDistance()); //-> 0
```

Note that if you pass a value, it will override the default value:

```
1 const mycar = new Car(5);  
2 console.log(mycar.getDistance()); //-> 5
```

4.3.5 Setters and Getters (Accessors)

It is a very common pattern to have setters and getters for properties of a class. TypeScript provides a very simple syntax to achieve that. Let's take our example above and add a setter and getter for the distance property. But before that we are going to rename distance to `_distance` to make it explicit that it is private. It is not required but it is a common pattern to prefix private properties with an underscore.

```
1 class Car {  
2   constructor (private _distance = 0) {}  
3   getDistance():number { return this._distance; }  
4 }
```

In order to create the getter method, we are going to use the `get` keyword and the name for the property followed by `()`:

```
1 class Car {  
2   constructor (private _distance = 0) {}  
3   get distance() { return this._distance; }  
4 }
```

Now we can get the value of `distance`:

```
1 const car2 = new Car(5);
2 console.log(car2.distance) //-> 5
```

Note on line 2 that we didn't call a function. Behind the scenes, TypeScript creates a property for us, that's why it is not a method. Below is the relevant generated JavaScript:

```
1 Object.defineProperty(Car.prototype, "distance", {
2   get: function () { return this._distance; },
3   enumerable: true,
4   configurable: true
5 });
```

JavaScript behind the scenes calls the `get` function for you to get the value, and that's why we simply did `car2.distance` as opposed to `car2.distance()`. For more information about `Object.defineProperty` checkout the [MDN](#) docs.

Similar to the getter, we can define a setter as well:

```
1 class Car {
2   constructor (private _distance = 0) {}
3   get distance() { return this._distance; }
4   set distance(newDistance: number) { this._distance = newDistance; }
5 }
```

Now we can both get and set the `distance` value:

```
1 const coolCar = new Car();
2 console.log(coolCar.distance); // -> 0
3
4 coolCar.distance = 55;
5 console.log(coolCar.distance); // -> 55
```

Note that if we take out the setter, we won't be able to assign a new value to `distance`.

4.3.6 Static Methods and Properties

Static methods and properties belong to the class but not the instances. For example, the `Array.isArray` method is only accessible through the `Array` but not an instance of an array:

```
1 var x = [];  
2 x.isArray // -> undefined  
3 Array.isArray(x) //-> true
```

- On line 2 we are trying to access the `isArray` method, but obviously it is not defined because `isArray` is a static method.
- On line three we are calling the static `isArray` method from `Array` and we can check if `x` is an array.

If you look at the [Array](#) documentation you can see that methods and properties are either defined on the `Array.prototype` or `Array`:

- `Array.prototype.x`: makes `x` available to all the instances of `Array`
- `Array.x`: `x` is static and only available through `Array`.

Now that we have some context, let's see how you can define static methods and properties in TypeScript. Consider the code below:

```
1 class Car {  
2   static controls: {isAuto: boolean } = {  
3     isAuto: true  
4   };  
5   static isAuto():boolean {  
6     return Car.controls.isAuto;  
7   }  
8   constructor (private _distance = 0) {}  
9   get distance() { return this._distance; }  
10 }  
11  
12 console.log(Car.controls); // -> { isAuto: true }  
13 console.log(Car.isAuto()); // -> true
```

- On line 2 we are defining a static property called `controls` using the `static` modifier. Then we specify the form and then assign a value for it.
- On line 5 we are defining a static method called `isAuto` using the `static` modifier. This method simply returns the value of `isAuto` from the static `control` object. Not that we get access to the class using the name of the class as opposed to using `this`. i.e. `return Car.controls.isAuto`

4.3.7 Implementing an Interface

Classes can implement one or multiple interfaces. We can make the `Car` class implement two interfaces:

```
1 interface ICarProps {  
2     distance: number;  
3 }  
4 interface ICarMethods {  
5     move():void;  
6 }
```

Making the `Car` class implement the interfaces:

```
1 class Car implements ICarProps, ICarMethods {  
2     distance: number;  
3     constructor () {  
4         this.distance = 5;  
5     };  
6     move():void {  
7         this.distance += 1;  
8     };  
9 }
```

The above example is silly, but it shows the point that a class can implement one or more interfaces. Now if the class does not provide implementations for any of the interfaces, the compiler will complain. For example, if we leave out the `distance` instance variable, the compiler will print out the following error:

```
error TS2420: Class 'Car' incorrectly implements interface 'ICarProps'.  
Property 'distance' is missing in type 'Car'.
```

4.3.8 Inheritance

In Object-oriented programming, a class can inherit from another class which helps to define shared attributes and methods among objects. Although this pattern is very useful, it should be used cautiously as it can lead to code that is hard to maintain. You can learn more about classical inheritance and prototypical inheritance by watching Eric Elliot's [talk](#) at O'Reilly's Fluent Conference. The project files for this section are in [angular2-intro/project-files/typescript/classes/inheritance](#).

Let's get started by creating a base class called `Vehicle`. This class is going to be the base class for other classes that we create later.

```
1 // Vehicle.ts
2 export class Vehicle {
3     constructor( private _name: string = 'Vehicle',
4                  private _distance: number = 0 ) { }
5     get distance(): number { return this._distance; }
6     set distance(newDistance: number) { this._distance = newDistance; }
7     get name(): string { return this._name; }
8     set name(newName: string) { this._name = newName; }
9     move() { this.distance += 1 }
10    toString() { return this._name; }
11 }
```

There is nothing special in this class. We are just creating a class that has two private properties (name, distance) and we are creating the setters and getters for them. Additionally, we are defining the `toString` method that JavaScript internally calls in “textual contexts”. The constructor is the most notable of all the other methods:

- It sets the `name` property to “Vehicle” for all the instances
- It also sets the `distance` property to 0.

This means that when a class extends the `Vehicle` class, it will have to call the constructor of `Vehicle` using the `super` keyword. Let's do that now by creating two classes called `Car` and `Truck` that inherit from the `Vehicle` class:

`cars.ts`


```
1 import {Vehicle} from './vehicle';
2 export class Car extends Vehicle {
3   constructor(name?: string) {
4     super();
5     this.name = name || 'Car';
6   }
7 }
8 export class Truck extends Vehicle {
9   constructor(name?: string) {
10    super();
11    this.name = name || 'Truck';
12  }
13 }
```

- The Car class and the Truck class both look almost identical. They both inherit from the Vehicle using the extends keyword.
- They both call the Vehicle's constructor in their own constructor method before implementing their own: constructor(name?: string) { super(); }
- They both take an optional name property to set the name of the vehicle. If not name is provided, it will be set to either 'Car' or 'Truck'

Now let's create the main file and run the file:

```
1 import {Car, Truck} from './cars';
2
3 /**
4  * Creating a new car from `Car`
5  */
6 const car = new Car();
7 console.log(car.name);
8 car.distance = 5;
9 car.move();
10 car.move();
11 console.log(car.distance);
12 /**
13  * Creating a new Truck.
```

```
14  */
15  const truck = new Truck();
16  console.log(truck.name);
```

- On line 1 we are importing the Car and the Truck class.
- and then we create a Car and Truck instance and log their names and distance to the console.

Run the build task (command + shift + b) and run the file (F5) and you should see the output:

```
node --debug-brk=7394 --nolazy output/main.js
Debugger listening on port 7394
Car
7
Truck
```

You can play around with the code above and try passing a string when instantiating a Car or a Truck to see the name change.

TODO

- constructor overloading

4.3.9 Class Decorators

There are different types of decorators in TypeScript. In this section we are going to focus on Class Decorators.

TODO

add content

4.4 Modules

- In TypeScript you can use modules to organize your code, avoid polluting the global space, and expose functionalities for others to use.

- Multiple modules can be defined in the same file. However, it makes more sense to keep one module per file
- If you want, you can split a single module across multiple files
- If you decide to split a module across different files, this is how you would do it:
 - Create the module file: `mymodule.ts` and declare your module there:
`module MyModule {}`
 - Create another file: `mymodule.ext1.ts` and on top of the file add:
`/// <reference path="mymodule.ts" />`. Then in the file, you can use the same name of the module and add more stuff to it: `module MyModule { // other stuff... }`
 - Then in your main file, you need two things on top of the file:
`* /// <reference path="mymodule.ts" />`
`* /// <reference path="mymodule.ext1.ts" />`
 - Then, you can use the name of your module to refer to the symbols defined: `MyModule.something`, `MyModule.somethingElse`
- TypeScript has two systems: one used internally and the other used externally
- External modules are used if your app uses CommonJS or AMD modules. Otherwise, you can use TypeScript's internal module system
- Using TypeScript's internal module system, you can:
 - use the `module` keyword to define a module: `module MyModule { ... }`
 - split modules into different files that contribute to a single module
 - use the `/// <reference path="File.ts" />` tag to tell the compiler how files are related to each other when modules are split across files
- Using TypeScript's external module system:
 - you cannot use the `module` keyword. The `module` keyword is used only by the internal module system.
 - instead of the `reference` tag, you can use the `import` keyword to define the relationship between modules
 - you can import symbols using the file name: `import mymodule = require('mymodule')`

The project files for this chapter are in [angular2-intro/project-files/typescript/modules](#).

4.4.1 Simple Module

Let's create a simple module that contains two classes. The first class is a vehicle class and the second is a car class that inherits from the vehicle class. Then we are going to expose the car class to the outside world and import it from another file. The project files for this section are in [angular2-intro/project-files/typescript/modules/basic-module](#).

First, create the `main.ts` file and copy paste the following:

main.ts

```
1 module MyModule {
2   class Vehicle {
3     constructor (public name: string = 'Vehicle', private _distance: number = 0) {}
4     get distance():number { return this._distance; }
5     set distance(newDistance: number) { this._distance = newDistance; }
6     move() { this.distance += 1 }
7   }
8 }
```

- On line 1 we are defining the module called `MyModule`.
- Inside this module we have defined a class called `Vehicle` that has a distance property and a setter and getter.

Now we want to create a class and export it so that it can be imported by others:

main.ts

```
1 module MyModule {
2   class Vehicle {
3     constructor (public name: string = 'Vehicle', private _distance: number = 0) {}
4     get distance():number { return this._distance; }
5     set distance(newDistance: number) { this._distance = newDistance; }
6     move() { this.distance += 1 }
7   }
8   // -> adding the car class
9   export class Car extends Vehicle {
10    constructor (public name: string = 'Car') {
```

```
11     super();
12   }
13 }
14 }
```

- On line 9 we are using the `export` keyword to indicate that the `Car` class is exposed and can be used by others.

Now, let's create a car using the `Car` class defined in the `MyModule` module:

```
1 const mycar = new MyModule.Car('My Car');
2 console.log(mycar.name);
```

Note that we accessed the `Car` class using the `MyModule` symbol: `MyModule.Car`. Now we can split up the module into its own file and import it into the main file. Let's create a file called `MyModule.ts` and move the module definition to that file. Now in our main file we are just going to import the module and use the car class from it.

main.ts

```
1 /// <reference path="MyModule.ts" />
2 const mycar = new MyModule.Car('My Car');
3 console.log(mycar.name);
```

Note that we can create an alias to the `MyModule` using `import AliasName = MyModule`. Now you can reference the module name with `AliasName`:

```
1 /// <reference path="MyModule.ts" />
2 import AliasName = MyModule;
3 const mycar = new AliasName.Car('My Car');
4 console.log(mycar.name);
```

Now if we run this in debug mode, the compiler will complain that it can't find the `MyModule` reference. Because of that we need to make some changes to our config files. First, we are going to add the `out` property in the `tsconfig.json` file. This will tell the compiler to compile all the files into a single file:

```
"out": "output/run.js",
```

So our `tsconfig.json` file will look like this:

```
{
  "compilerOptions": {
    "experimentalDecorators": true,
    "emitDecoratorMetadata": true,
    "module": "commonjs",
    "target": "es5",
    "sourceMap": true,
    "outDir": "output",
    "out": "output/run.js",
    "watch": true
  }
}
```

Now if you run the build, you should see that all the project has been compiled into `output/run.js`. In addition to the `tsconfig.json` file, we are going to update the `launch.json` file and add a new configuration field:

```
{
  "name": "TS All Debugger",
  "type": "node",
  "program": "output/run.js",
  "stopOnEntry": false,
  "sourceMaps": true
}
```

Now we should be able to use the debugger and put breakpoints in our TypeScript files. Select `TS All Debugger` from the debugger dropdown and run the debugger and it should stop if you put a breakpoint in any of your TypeScript files.

NOTE Using the configuration files above we can compile all the TypeScript files into a single JavaScript file. But sometimes that is not what you want. Be aware that using the above configuration you will not get an output for each TypeScript file.

4.4.2 Splitting Internal Modules

Internal modules in TypeScript are open ended. This means that you can define a module with the same name in different files and keep adding to it. This is also known as merging. In this section we are going to demonstrate merging multiple files that contribute to a single module called `Merged`. The project files for this section are in [angular2-intro/project-files/typescript/modules/merged-module](#).

First, we are going to make two files: `A.ts` and `B.ts`. In each file we are going to define the `Merged` module:

```
1 // A.ts
2 module Merged {
3   const name = 'File A'; // not exported
4   export class Door {
5     constructor(private _color = 'white') {}
6     get color() { return this._color; }
7     set color(newColor) { this._color = newColor; }
8   }
9 }
```

and then the `B.ts` file:

```
1 // B.ts
2 module Merged {
3   const name = 'File B'; // not exported
4   export class Car {
5     constructor(public distance = 0) {}
6     move () {this.distance += 1;}
7   }
8 }
```

We just created two files called `A.ts` and `B.ts` and each file we defined the `Merged` module and added a class to each and exported it. Now we are going to make the `main.ts` file and reference these two files:

```
1 // main.ts
2 /// <reference path="./A.ts" />
3 /// <reference path="./B.ts" />
```

And now we can use the classes defined in the Merged module, that is the Car and the Door class:

```
1 /// <reference path="./A.ts" />
2 /// <reference path="./B.ts" />
3 const car: Merged.Car = new Merged.Car();
4 const door: Merged.Door = new Merged.Door();
5 door.color = 'blue';
6 car.move();
7 car.move();
8 console.log(car.distance);
9 console.log(door.color);
```

if you run the build task (command + shift + b) and hit F5 you should see the following output:

```
node --debug-brk=19237 --nolazy output/run.js
Debugger listening on port 19237
2
blue
```

4.4.3 External Modules

In addition to TypeScript's internal module system, you can use external modules as well. In this section we are going to demonstrate how you can use external modules in TypeScript. The project files for this section are in [angular2-intro/project-files/typescript/modules/external-module](#).

Let's say I have a JavaScript Node module defined in CommonJS format in a file called `common.js`:

```
1 // common.js
2 module.exports = function () {
3   this.name = 'CommonJS Module';
4 };
```


In order to import this we need to do two things: first, we need to install Node's Type Definitions. Then we need to require the module. To install Node's Type Definitions run the following the terminal in the root of your project:

```
tsd install node --save
```

Now you should see a folder called `typings` containing the type definitions. Now that we have Node's type definitions, let's add a reference to it on top of `main.ts`:

```
1 // main.ts
2 /// <reference path="./typings/node/node.d.ts" />
```

and then we are going to require the module and log it to the console:

```
1 // main.ts
2 /// <reference path="./typings/node/node.d.ts" />
3 const common = require('./common');
4 console.log(common()); // --> CommonJS Module
```

After running the build task (`command + shift + b`), and running the file (F+5) you should see the following output:

```
node --debug-brk=32221 --nolazy run.js
Debugger listening on port 32221
CommonJS Modules
```

Note the configuration files that we are using:

tsconfig.json

```
{
  "compilerOptions": {
    "experimentalDecorators": true,
    "emitDecoratorMetadata": true,
    "module": "commonjs",
    "target": "es5",
```

```
    "sourceMap": true,  
    "outDir": "output",  
    "out": "run.js",  
    "watch": true  
  }  
}
```

launch.json

```
{  
  "version": "0.1.0",  
  "configurations": [  
    {  
      "name": "TS All Debugger",  
      "type": "node",  
      "program": "./run.js",  
      "stopOnEntry": false,  
      "sourceMaps": true  
    }  
  ]  
}
```

4.5 Decorators

- Decorators can be used to add additional properties and methods to existing objects.
- Decorators are a declarative way to add metadata to code.
- There are four decorators: `ClassDecorator`, `PropertyDecorator`, `MethodDecorator`, `ParameterDecorator`
- TypeScript supports decorators and does not know about Angular's specific annotations.
- Angular provides annotations that are made with decorators behind the scenes

4.5.1 Method Decorators

Goals: - make a method decorator called `log`. - Decorate `someMethod` in a class using `@log`

```
1 class SomeClass {  
2   @log  
3   someMethod(n: number) {  
4     return n * 2;  
5   }  
6 }
```

In the usage, `someMethod` has been decorated with `log` using the `@` symbol. `@log` is decorating `someMethod` because it is placed right before the method.

- Decorator Implementation:

```
1 function log(target: Function, key: string, value: any) {  
2   return {  
3     value: function (...args: any[]) {  
4       var a = args.map(a => JSON.stringify(a)).join();  
5       var result = value.value.apply(this, args);  
6       var r = JSON.stringify(result);  
7       console.log(`Call: ${key}(${a}) => ${r}`);  
8       return result;  
9     }  
10  };  
11 }
```

A method decorators takes a 3 arguments:

- `target`: the method being decorated.
- `key`: the name of the method being decorated.
- `value`: a property descriptor of the given property if it exists on the object, undefined otherwise. The property descriptor is obtained by invoking the `Object.getOwnPropertyDescriptor` function.

TODO

- Add decorator content for each type.

5 Angular Basics

This chapter will walk you through the basics of Angular2. We will start by looking at the basics of components, and then we move onto pipes, events and other concepts. By the end of the chapter you should have a basic understanding of the new concepts in Angular2.

The goal of this chapter is to get your feet wet without scaring you with a lot of details. Don't worry, there will be a lot coming in the later chapters.

5.1 Components

Components are at the heart of Angular. The main idea is that you break down your application into different cohesive components and let the components handle the rest. Every component has a controller defined by a class and a template defined by html. In addition, a component's job is to enable the user experience and delegate everything non-trivial to services.

In this section we are going to write a simple `HelloAngular` component, compile it and run it in the browser. In addition, we will configure VSCode to build the TypeScript files as we go.

Note that there is a lot to talk about components. We are going to dive into components a lot more in later chapters, but for now let's just keep things simple.

5.1.1 Project Files

The project files for this chapter are in [angular2-intro/project-files/angular/basic-component](#)

You can either follow along or just look at the final result. As always, the `node_modules` folder is not included. You would have to install it with `npm i` in the project folder:

```
cd angular2-intro/project-files/angular/basic-component && npm i
```

5.1.2 Getting Started

Make a folder on your desktop called `hello-angular` and navigate to it:

```
mkdir ~/Desktop/hello-angular && cd $_
```

Start npm in this folder with `npm init` and accept all the defaults.

After that, install the dependencies with:

```
npm i angular2 rxjs -S
```

Then install the “devDependencies”:

```
npm i systemjs -D
```

After all the dependencies are installed, start VSCode in this folder with `code .`

Then create a `index.html` file in the root of the project and put in the following:

index.html

```
1 <html>
2 <head>
3   <title>Hello Angular</title>
4
5   <script src="/node_modules/angular2/bundles/angular2-polyfills.js"></script>
6   <script src="/node_modules/systemjs/dist/system.src.js"></script>
7   <script src="/node_modules/rxjs/bundles/Rx.js"></script>
8   <script src="/node_modules/angular2/bundles/angular2.dev.js"></script>
9
10  <!-- add systemjs settings later -->
11
12 </head>
13
14 <body>
15   <!-- add app stuff later -->
16 </body>
17
18 </html>
```

This loads all the necessary scripts that we need to run Angular in the browser.

Note

If you need to support older browsers, you need to include the `es6-shims` before everything else:

```
1 <script src="/node_modules/es6-shim/es6-shim.js"></script>
```

5.1.3 Making the Component

Let's start by making the `main.ts` file in the root of the project. In this file we are going to define the main component called `HelloAngular` and then bootstrap the app with it:

`main.ts`

```
1 import {Component, OnInit } from 'angular2/core';
2 import {bootstrap} from 'angular2/platform/browser';
3
4 @Component({
5   selector: 'app',
6   template: `<h1> hello angular </h1> `
7 });
8
9 class HelloAngular implements OnInit {
10   constructor() { console.log('constructor called'); }
11   ngOnInit() { console.log('component initialized'); }
12 }
13
14 bootstrap(HelloAngular, []);
```

- On line 1 we are importing the component meta data (annotation) and the `OnInit` interface.
- On line 2 we are loading the `bootstrap` method that bootstraps the app given a component.
- On line 4, we are defining a component using the component annotation. The `@component` is technically a class decorator because it precedes the `HelloAngular` class definition.

- On line 5, we are telling angular to look out for the `app` tag. So when Angular looks at the html and comes across the `<app></app>` tag, it is going to load the template (on line 6) and instantiates the class for it (defined on line 9).
- On line 9, we are defining a class called `HelloAngular` that defines the logic of the component. And for fun, we are implementing the `OnInit` interface to log something to the console when the component is ready with its data. We will learn more about the lifecycle hooks later.
- Last but not least, we call the `bootstrap` method with the `HelloAngular` class as the first argument to bootstrap the app with the `HelloAngular` component.

5.1.4 Compiling the Component

Now we need to compile the file to JavaScript. We can do it from the terminal, but let's stick to VSCode. In order to that, we need to make two config files:

1. First is the standard `tsconfig.json` file
2. And the `tasks.json` file for VSCode to do the compiling

Create the `tsconfig.json` file in the root of the project and put in the following:

tsconfig.json

```
1 {
2   "compilerOptions": {
3     "target": "es5",
4     "module": "system",
5     "moduleResolution": "node",
6     "sourceMap": true,
7     "emitDecoratorMetadata": true,
8     "experimentalDecorators": true,
9     "removeComments": false,
10    "noImplicitAny": false,
11    "outDir": "output",
12    "watch": true
```

```
13   },
14   "exclude": [
15     "node_modules"
16   ]
17 }
```

Then create the `tasks.json` in the `.vscode` folder in the root of the project and put in the following:

.vscode/tasks.json

```
1 {
2   "version": "0.1.0",
3   "command": "tsc",
4   "showOutput": "silent",
5   "isShellCommand": true,
6   "problemMatcher": "$tsc"
7 }
```

- Now we can build the TypeScript files as we work. We just need to start the build task with `command + shift + b` or using the prompt. If you want to use the prompt do the following:

- Use `command + shift + p` to open the prompt
- Then, type `> run build task` and hit enter to start the build task.

- After you run the build task, you should see an output file generated with `main.js` and the source maps in it.
- The task is watching the files and compiling as you go. To stop the task, open the prompt and type:

```
> terminate running task
```


5.1.5 Loading the Component

After compiling the component, we need to load it to the `index.html` file with `Systemjs`. Open the `index.html` file and replace `<!-- add systemjs settings later -->` with the following:

```
1 <script>
2   System.config({
3     packages: {
4       output: {
5         format: 'register',
6         defaultExtension: 'js'
7       }
8     }
9   });
10  System.import('output/main')
11    .then(null, console.error.bind(console));
12 </script>
```

Now we can use our component in the body of the html:

```
1 <body>
2   <app>Loading ...</app>
3 </body>
```

It is finally time to serve the app. You can serve the app in the current directory using the `live-server`:

```
live-server .
```

If everything is wired up correctly, you should be able to see the following:

5.2 Metadata

- Angular uses Metadata to decorate classes, methods and properties.
- The most notable Metadata is the `@component` Metadata.

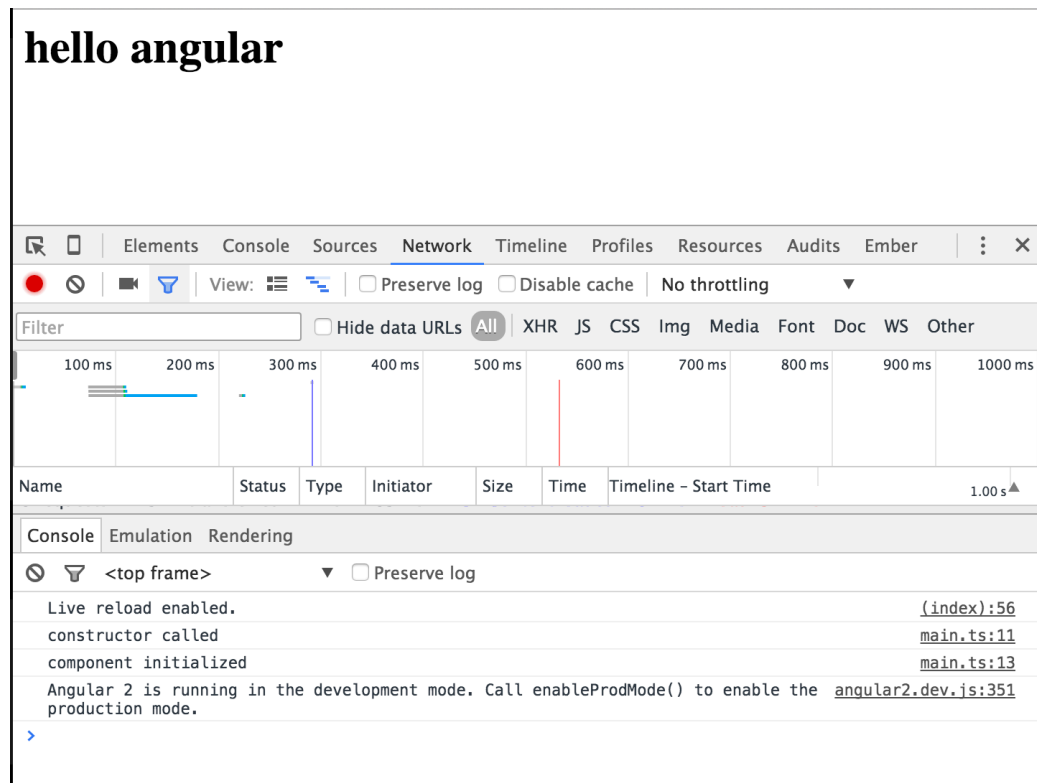


Figure 1: Running a basic component in the browser

Below is a list of Angular's core Metadata classes categorized under directives/components, pipes and di.

Directive/component Meta-data

- **Component**: used to define a component
 - **View**: used to define the template for a component
 - **ViewChild**: used to configure a view query
 - **ViewChildren**: used to configure a view query
- **Directive**: used to define a directive
 - **Attribute** used to grab the value of an attribute on an element hosting a directive
 - **ContentChild**: used to configure a content query
 - **ContentChildren**: used to configure a content query
 - **Input**: used to define the input to a directive/component
 - **Output**: used to define the output events of a directive/component
 - **HostBinding**: used to declare a host property binding
 - **HostListener**: used to declare a host listener

Pipes

- **Pipe**: used to declare reusable pipe function

DI

- **Inject**: parameter metadata that specifies a dependency.
- **Injectable**: a marker metadata that marks a class as available to Injector for creation.
- **Host**: Specifies that an injector should retrieve a dependency from any injector until reaching the closest host.
- **Optional**: parameter metadata that marks a dependency as optional
- **Self**: Specifies that an Injector should retrieve a dependency only from itself.
- **SkipSelf**: Specifies that the dependency resolution should start from the parent injector.
- **Query**: Declares an injectable parameter to be a live list of directives or variable bindings from the content children of a directive.
- **ViewQuery**: Similar to QueryMetadata, but querying the component view, instead of the content children.

5.3 Dependency Injection

Dependency Injection is a coding pattern in which a class receives its dependencies from external sources rather than creating them itself. In order to achieve Dependency Injection we need a Dependency InjectionFramework to handle the dependencies for us. Using a DI framework, you simply ask for a class from the injector instead of worrying about the dependencies inside the class itself.

Angular has a standalone module that handles Dependency Injection. This framework can also be used in non-Angular applications to handle Dependency Injection.

5.4 Services and Providers

- A service is nothing more than a class in Angular 2. It remains nothing more than a class until we register it with the Angular injector.
- When you bootstrap your app, Angular creates an injector on the fly that can inject services and other dependencies throughout the app.
- You can register the service or the dependencies during when bootstrapping the app or when defining a component.
- If you have a class called `MyService`, you can register it with the Injector and then you can inject it everywhere:

```
1 bootstrap(App, [MyService]); // second param is an array of providers
```

- Providers is a way to specify what services are available inside the component in a hierarchical fashion.
- A provider can be a class, a value or a factory.
- Providers create the instances of the things that we ask the injector to inject.
- `[SomeService];` is short for `[provide(SomeService, { useClass: SomeService })]`; where the first param is the token, and the second is the definition object.
- A simple object can be passed to the Injector to create a Value Provider:

```
1 beforeEachProviders(() => {
2   let someService = { getData: () => [] };
3   // using `useValue` instead of `useClass`
4   return [ provide(SomeSvc, {useValue: someService}) ];
5 });
```

- You can also use a factory as a provider.
- You can use a factory function that creates a properly configured Service:

```
1 let myServiceFactory = (dx: DepX, dy: DepY) => {
2   return new MyService(dx, dy.value);
3 }
4
5 // provider definition object.
6 let myServiceDefinition = {
7   useFactory: myServiceFactory,
8   deps: [DepX, DepY]
9 };
10
11 // create provider and bootstrap
12 let myServiceProvider = provide(MyService, myServiceDefinition);
13 bootstrap(AppComponent, [myServiceProvider, DepX, DepY]);
```

- Defining object dependencies is simple. You can make a plain JavaScript object available for injection using a string-based token and the `@Inject` decorator:

```
1 var myObj = {};
2
3 bootstrap(AppComponent, [
4   provide('coolObjToken', {useValue: myObj})
5 ]);
6
7 // and you can inject it to a component
8
9 import {Inject} from 'angular2/core'
10 constructor(dx: DepX, @Inject('coolObjToken') config)
```

5.5 Data Modeling and State

- Angular is flexible and doesn't prescribe a recipe for managing data in your apps
- Since observables are integrated into Angular, you can take advantage of observables to manage data and state
- You can use services to manage streams that emit models
- Components can subscribe to the streams maintained by services and render accordingly.
 - For example, you can have a service for a Todo app that contains a stream of todos and a `ListComponent` can listen for todos and render when a new task is added.
 - You may have another component that listens for the user that has been assigned to a task provided by a service.
- The steps for creating different parts of an app can be summarized in three steps:
 - Defining a Model using a class
 - Defining the service
 - Defining the component

5.6 Observables

- Angular embraces observables using the RxJS library.
- Observables emit events and observers observe observables.
- An observer *subscribes* to events emitted from an observable.
- RxJS has an object called *subject* that can be used both as an observer or an observable. *Subject* can be imported from RxJS very easily:

```
1 import {Subject} from 'rxjs/Subject';
```

- A subscription can be canceled by calling the `unsubscribe` method.

5.7 Angular Router

Angular has a stand-alone module responsible for handling routing.

6 Angular Topics in Depth

Let's deep dive into Angular concepts.

6.1 Components in Depth

- A component declares a reusable building block of an app
- A TypeScript class is used to define a component coupled with the `@component` decorator

6.1.1 Components Options

The `@component` decorator defines the following:

- `selector`: `string` value defining the css selector targeting an html element
- `inputs`: `array of string` values defining the inputs to the component
- `outputs`: `array of string` values defining the output of the component
- `properties`: `array of string` values defining the properties
- `events`: `array of string` values defining the events
- `host?`: `{['string']: 'string'}`,
- `providers`: `array of objects` defining the providers for the component
- `exportAs`: `string` value defining the exported value
- `moduleId`: `string` value defining the module id
- `viewProviders`: `array of objects` defining the providers for the view

- queries: {[key: string]: any},
- changeDetection: ChangeDetectionStrategy object defining the strategy for detecting changes:
 - ChangeDetectionStrategy.Default: sets detector mode to CheckAlways
 - ChangeDetectionStrategy.OnPush: sets detector mode to CheckOnce
 - ChangeDetectionStrategy.Detached: change detector sub tree is not a part of the main tree and should be skipped
 - ChangeDetectionStrategy.CheckAlways: after calling detectChanges the mode of the change detector will remain CheckAlways
 - ChangeDetectionStrategy.Checked: change detector should be skipped until its mode changes to CheckOnce
 - ChangeDetectionStrategy.CheckOnce: after calling detectChanges the mode of the change detector will become Checked
- templateUrl: string value for the url path to the template
- template: string value for the template
- styleUrls: array of string values defining url paths to css files
- styles: array of string values defining css styles:
 - styles: ['.myclass { color: #000;}'],
- directives: array of directives used in the component
- pipes: array of pipes used in the component
- encapsulation: ViewEncapsulation value that defines template and style encapsulation options:
 - ViewEncapsulation.None: means do not provide any style encapsulation
 - ViewEncapsulation.Emulated: No Shadow DOM but style encapsulation emulation using extra attributes on the DOM (default method)
 - ViewEncapsulation.Native: means provide native shadow DOM encapsulation and styles appear in component's template inside the shadow root.