Course 2324

Building Web Applications With Angular

by

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Introduction and Overview

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Course Objectives

- Create well-structured Angular applications
- Develop Components using TypeScript, Templates, and Decorators
- Modularize applications with Feature Modules and the Component Router
- Add interactivity with event handlers and bindings
- Capture and validate input with template-driven and reactive forms
- Consume REST services using Observables

REST = Representational State Transfer

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Course Contents

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Chapter 2	Creating Components
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Chapter 5	Component Interaction
Chapter 6	Routes, Modules, and Pipes
Chapter 7	Forms
Chapter 8	Managing Asynchronous Behavior
Chapter 9	Extending Angular With Directives and Animation
Chapter 10	Publishing your Application
Chapter 11	Course Summary
	Next Steps
Appendix A	Migrating From Angular JS 1

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Course Structure

- **General**
  - Course materials presented in an interactive lecture format
  - Course designed in a step-by-step, logical approach
- **Do Now exercises**
  - Short exercises in Course Notes

  - Immediately practice a technique or process discussed during the lecture
- **Hands-On Exercises**
  - Practice key concepts or techniques learned
- **Hints**
  - Are provided within the Exercise Manual
  - Are collapsed in the AdaptaLearn version
- **The following fonts have special meaning in the Course Notes**
  - Text in *Arial italic* introduces an important concept or term
  - `Consolas` is used to indicate JavaScript/TypeScript language keywords or examples

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Exercise Structure

- **Exercises are intended to challenge you**
  - Early exercises require you to create all of the code
  - Later exercises provide a framework
    - Within which you will complete the most significant parts of the code
- **Exercise solutions**
  - Provided for all exercises
  - Located in `C:\course2324\Solutions`
    - Feel free to peek if you get stuck
- **All exercises, solutions, and course examples are available online**
  - Can be downloaded from your My Learning Tree account

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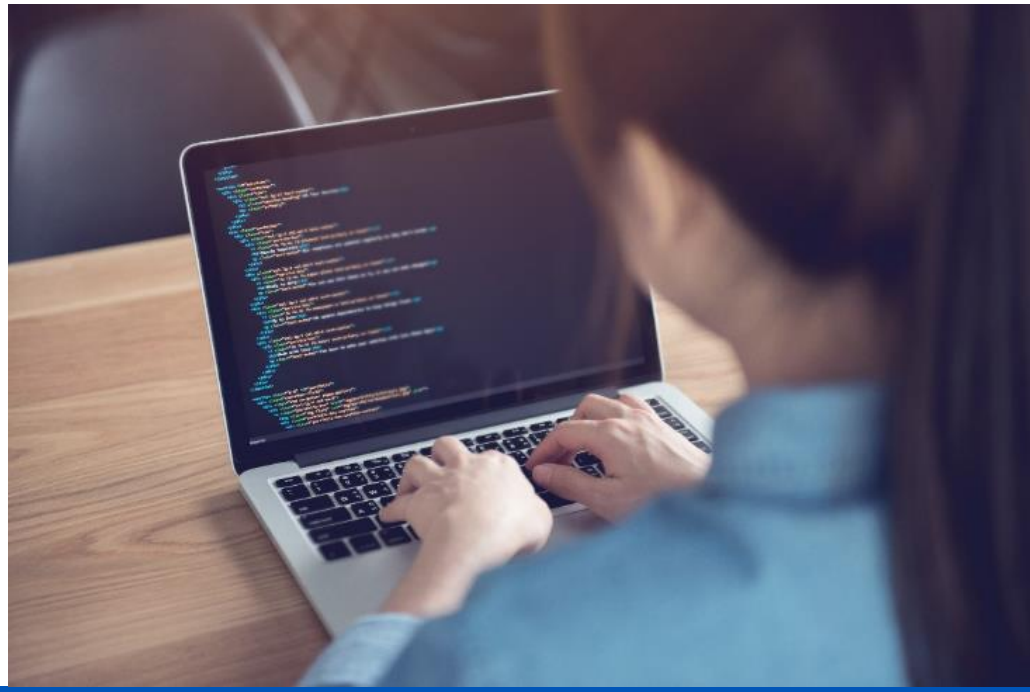
Expected Background

- **Experience with JavaScript or TypeScript is required**
  - To the level of Learning Tree Course 2319—JavaScript Essentials for the Full Stack Developer Using ECMAScript
- **Knowledge of HTML and CSS is beneficial**



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Our Classroom Environment

- **Each machine runs**
  - Windows 10
  - WebStorm
  - Visual Studio Code
  - Notepad++
  - Chrome
  - Mozilla Firefox
  - Apache Tomcat
  - Node JS
  - Angular-cli

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Chapter 1

Introducing Angular

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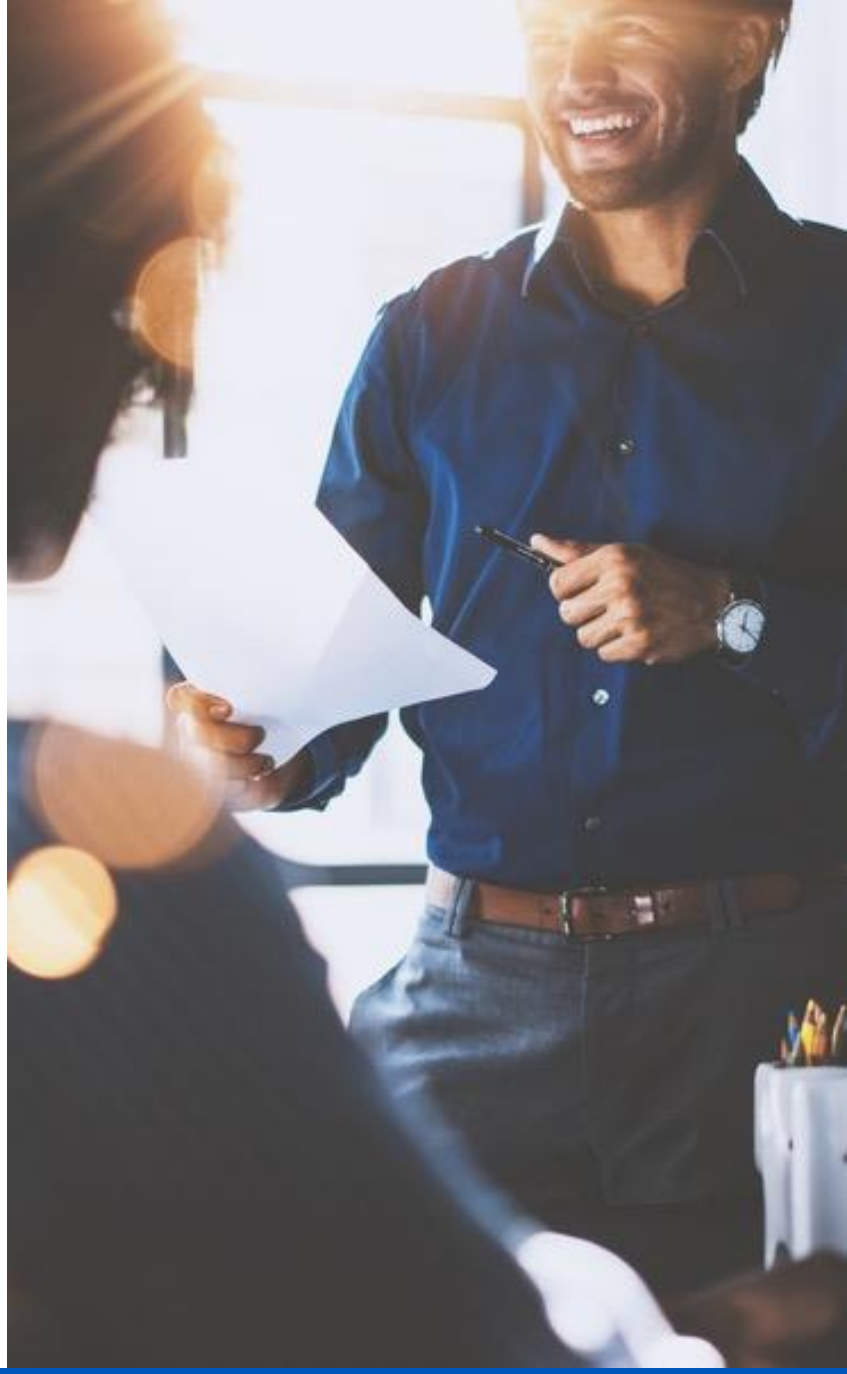
Objectives

- Learn how Angular eases the development of modern GUI applications
- Learn how to configure an Angular environment
- Learn how to navigate the architecture of Angular
- Learn essential TypeScript programming skills



GUI = graphical user interface

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Benefits of Angular

- Architectural Overview
- Configuring an Environment
- Components of an Angular Application
- TypeScript Primer

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In the Beginning

- **Early web applications were simple**
  - Server delivered an HTML page to the browser
    - Containing a form if input was required
  - Browser displays the page
    - User submits the form
  - Server sends another page for the browser
- **Simple to develop**
- **The user interface experience was poor**

HTML = hypertext markup language

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Request Processing: Traditional vs. Ajax

- **Traditional web browser—web server interaction:**

- **Ajax interaction:**

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Modern Web Applications

- **Modern web applications provide an excellent user experience**
- **Combine three key technologies sometimes known as Ajax**
  - JavaScript
    - The `XMLHttpRequest` (XHR) object
  - REST web services
  - CSS
- **Provide an excellent user experience**
- **Results in larger applications**
  - More difficult to develop, test, and maintain

Ajax = Asynchronous JavaScript and XML
CSS = Cascading Style Sheets

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Angular—Yet Another Framework?

- **Cross-platform development framework for**
  - Modern web applications
  - Native mobile applications
- **Component-based declarative programming model**
  - Developer defines appearance and behavior
  - Framework maps components onto the HTML DOM
    - Decouples user interface from direct DOM manipulation
  - Simplifies development and testing
- **Dependency injection**
  - Developer specifies component relationships
  - Angular wires them together
- **Easy integration with REST APIs**
- **Modular design**
  - Reduced load times
  - Expandable

API= application programming interface
DOM = document object model

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Angular—What's in a Name?

- **Angular**
  - Originally known as Angular 2
  - Is a redevelopment of Angular JS
    - AKA Angular 1
  - Same basic objectives
  - Radically different engineering solution
- **Migration is supported**
  - Options
    - Migrate entire Angular JS application to Angular
    - Use Angular Components in an Angular JS application
    - Use Angular JS directives in an Angular application

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Angular Versions

- **Initial version of what is now called Angular was 2.0.0**
- **Angular uses Semantic Versioning**
  - Changes to the last digit indicate a bug fix
  - Changes to the middle digit indicate a new feature
  - Changes to the first digit indicate a major change
    - Which may not be backward compatible

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1.1: Investigating the Case Study Application

Do Now

- **From the Desktop, run the Course Command Prompt**
  - On Windows, Angular CLI runs much more quickly as administrator
- **At the command prompt, type `cd FlySharpSolution` and press `<Enter>`**
- **Type `ng serve`**
- **Wait until you see the message "`webpack: Compiled successfully`"**
- **Start Chrome and open the URL `http://localhost:4200/`**
- **You should see the case study application running**
- **Click each of the tabs in the application**
- **Click the "Buy" button on the Buy Flights page**

URL = uniform resource locator

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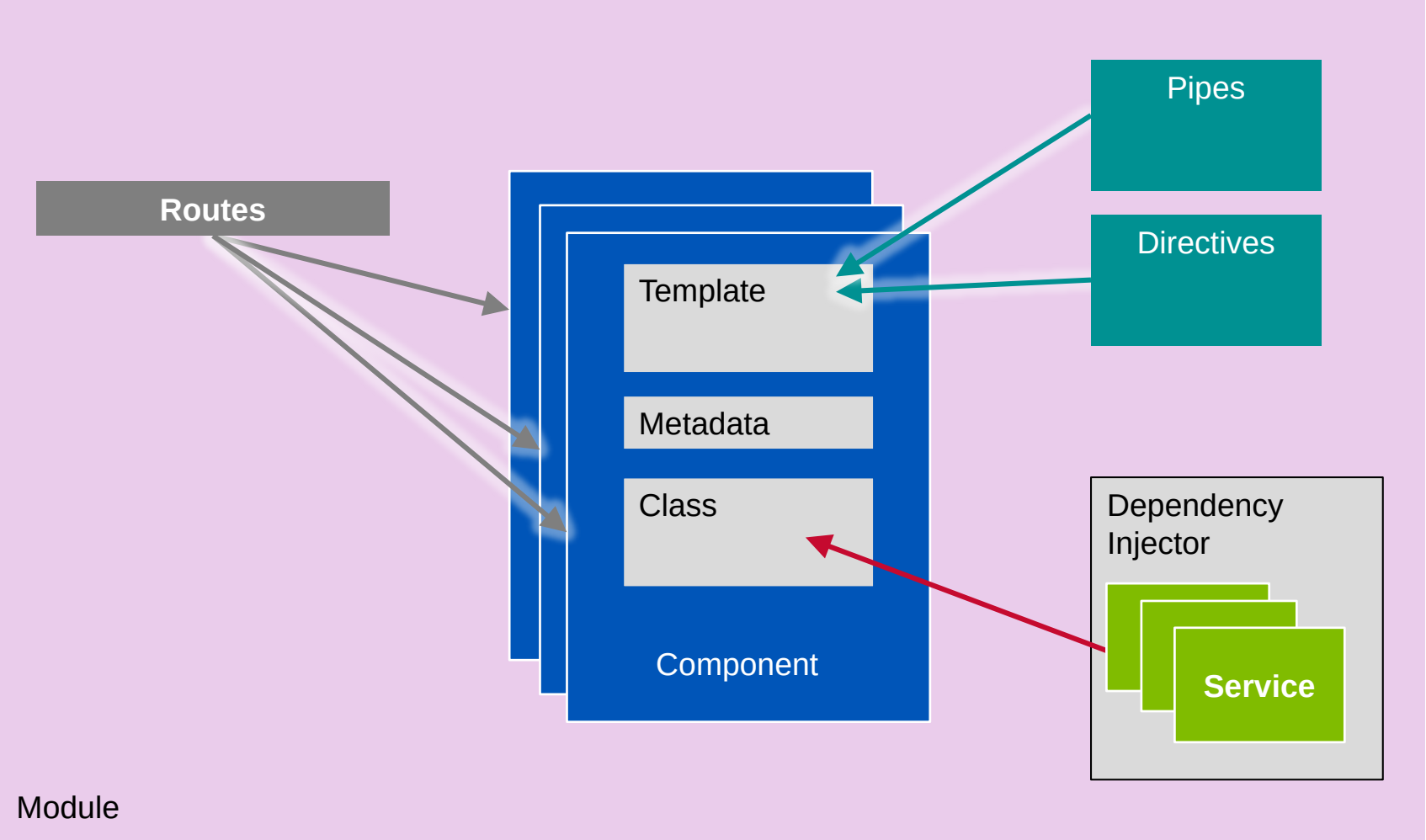
Architecture Diagram



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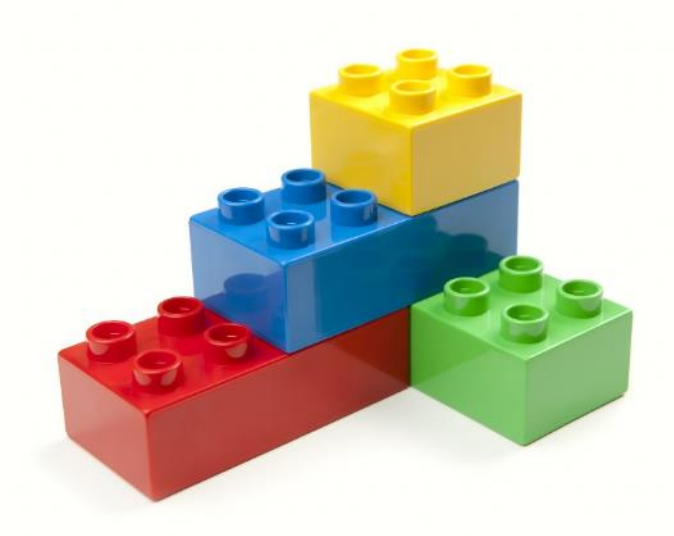
Angular Building Blocks

- **Component**
  - Primary building blocks of visual interface
  - A template for the view with supporting code
- **Directive**
  - Allows Angular code to manipulate the DOM
- **Pipe**
  - Data transformation
- **Service**
  - Encapsulation of application logic
  - A mechanism to share functionality across multiple Components
- **Modules**
  - A collection of the previous items
- **Route**
  - A URL path/Component ID combination
    - Used to control navigation/flow through an application



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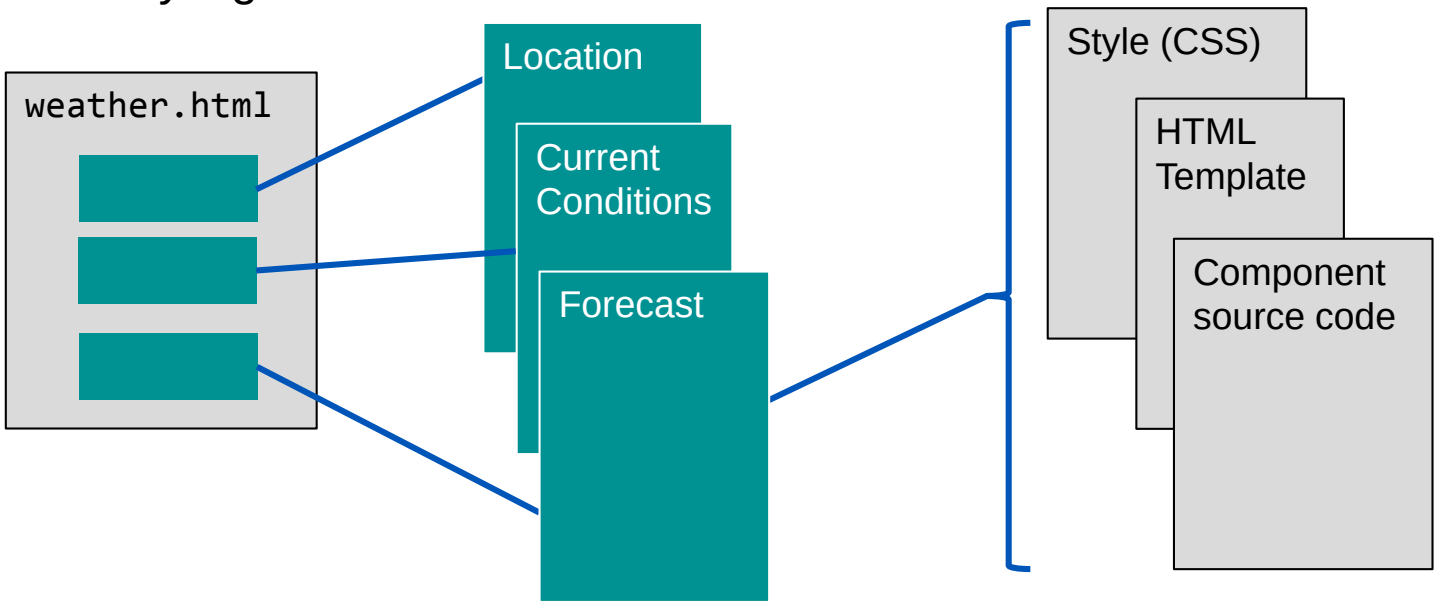
Component-Based Architecture

- **User interfaces are built from one or more Components**
- **Each Component consists of**
  - Code—written or *transpiled* into JavaScript
  - HTML—visual structure of the Component
  - CSS—styling



***Transpiling.** *The process of converting the source code from one programming language into the source code for another*

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Data-Bound Components

- **The visual representation of a Component is defined by its template**
- **Templates look like regular HTML with additional Angular syntax**
  - Angular expressions and directives
- **Expressions define data bindings**
  - Bindings populate the template from the model at runtime
- **Data binding is also used with forms**
  - To populate the model with user data

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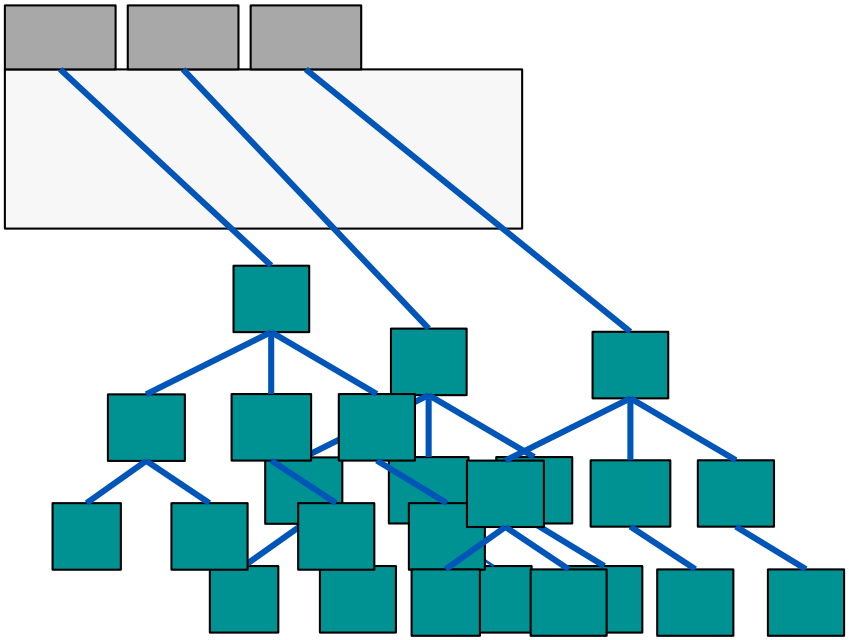
Component Routing

- **A mechanism to define user paths (routes) through the application**
  - Supports back-button navigation
- **Creates logical divisions within an application**
  - Reduces load time and application complexity
  - Breaks the application into multiple component hierarchies
    - Loaded on demand
- **For example, a tabbed application**



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Programming Language for Angular

- **Angular code is written in TypeScript**
- **But browsers do not execute TypeScript!**
  - They execute JavaScript
- **JavaScript is more accurately known as ECMAScript**
  - Versions
    - ES5—released 2009
    - ES6, aka ECMAScript 2015—released 2015
- **Angular 8 generates code for both ES5 and ES6+**
  - ES5 for legacy browsers
  - ES6+ offers native support for many TypeScript features
    - Smaller, more efficient code
- **TypeScript primer coming soon**

Remember: Transpiling is the process of converting the source code from one programming language into the source code for another

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ECMAScript: European Computer Manufactures Association Script

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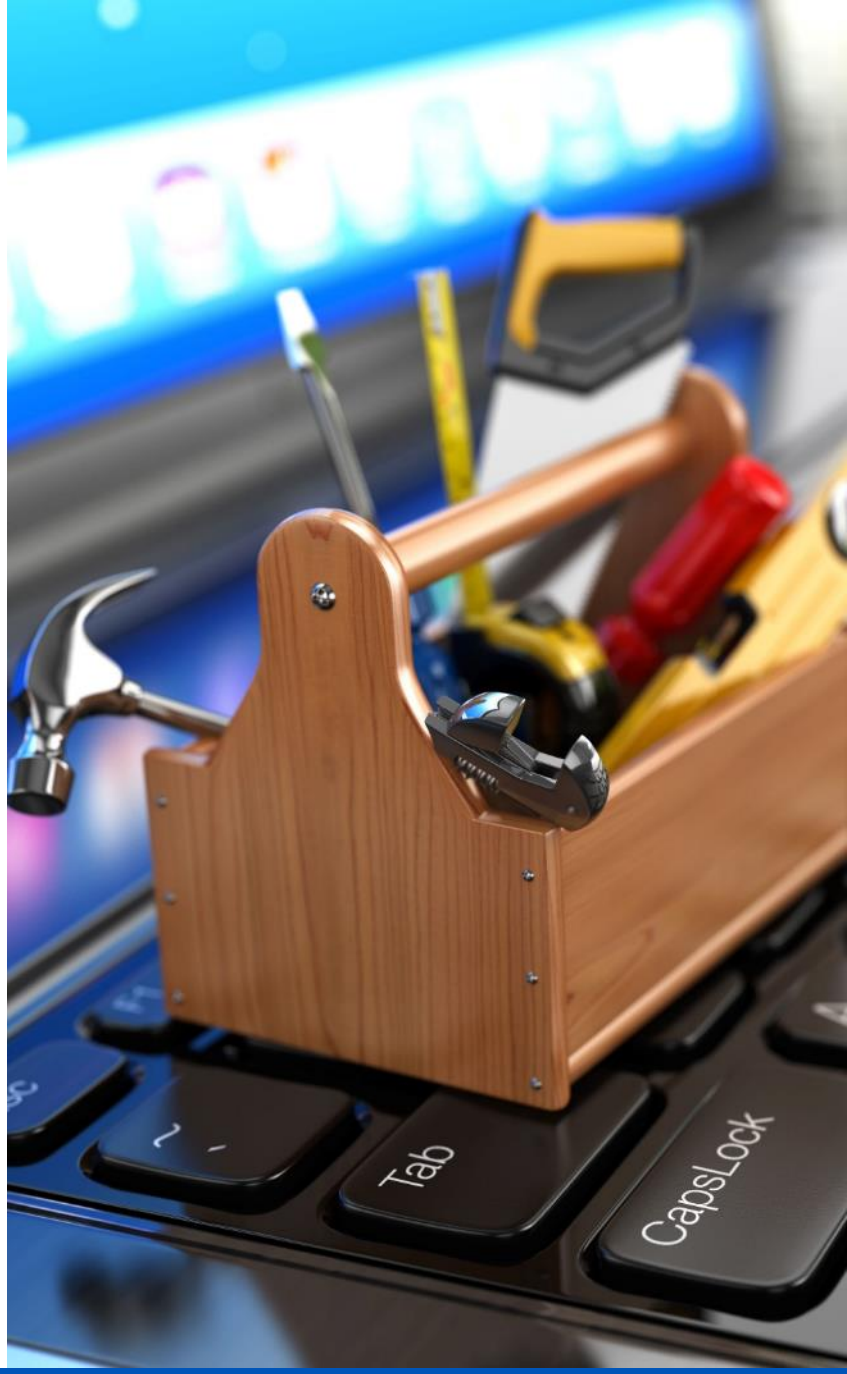
Angular Development Environment

- **Tools to build an Angular application**
- **An editor**
  - WebStorm, Visual Studio Code, Eclipse
- **Angular CLI**
  - Angular command line interface
  - Supports all development activity except editing
- **Angular CLI is a `Node.js` module**



HTTPD = Apache's Web server
IIS = Internet Information Services

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Introducing `Node.js`

- **`Node.js` is a JavaScript runtime**
  - Based on the Chrome V8 JavaScript engine
  - Lightweight, efficient environment for running JavaScript code
    - Can be used to create and run applications written in JavaScript
    - Outside of a browser
  - Vast number of prebuilt modules available
  - Managed via `npm`
    - The `Node.js` default package manager

- **`Node.js` is required to develop Angular applications**
  - Angular applications should be built and tested using the Angular CLI `Node.js` module
  - Once built, the Angular application can be deployed without requiring `Node.js`
  - Can be deployed into virtually any web server

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Angular CLI

- **Angular CLI provides a set of utilities to simplify Angular development**
  - Angular CLI is run using the `ng` command
    - Create a new project `ng new`
    - Create a new Component `ng generate`
    - Build and execute `ng serve`
    - Run tests `ng test`
    - Create a production build `ng build --prod`
- **Prerequisites**
  - `Node.js`—version 10+
  - NPM
    - Installed as part of `Node.js`

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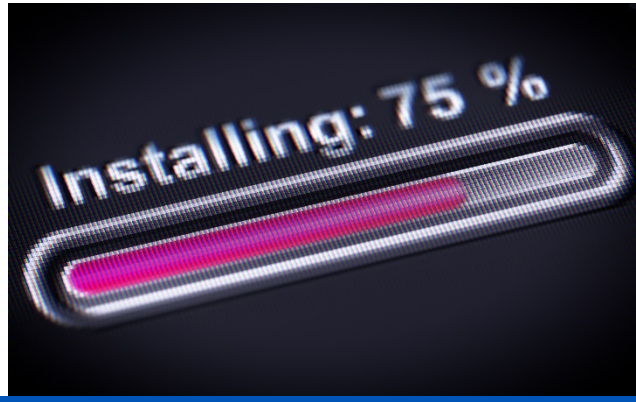
Installing Angular CLI

- **Install prerequisites**
  1. Download and install `Node.js` from https://nodejs.org/en/
     - Installers for Windows and OS/X
     - RPM and Debian packages available for Linux installations
- **Use `npm` to install Angular CLI**

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

- **Your workstation has already been configured**
- **`@angular/cli` has a huge number of options**
  - Run `ng help` to see them



RPM = RPM Package Manager

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Creating an Angular Application

- **Creating a new Angular application is easy with the Angular CLI**
  - Type the command:

```
ng new <App_Name>
```

  - This creates a new project
    - Within a new folder named `<App_Name>`
  - And configures the structure of the project with all required artifacts except the Node.js modules
  - There are many additional options
    - You will use `--routing` to add a routing module to the project

- **Creating a project this way is easy and reliable**
  - Installing the `Node.js` modules can be slow!
    - Dependent on your network connection

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AdaptaLearn™ Enabled

- **Electronic, interactive exercise manual**
- **Offers an enhanced learning experience**
  - Some courses provide folded steps that adapt to your skill level
  - Code is easily copied from the manual
  - After class, the manual can be accessed remotely for continued reference and practice
- **Printed and downloaded copies show all detail levels (hints and answers are unfolded)**

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Using AdaptaLearn™

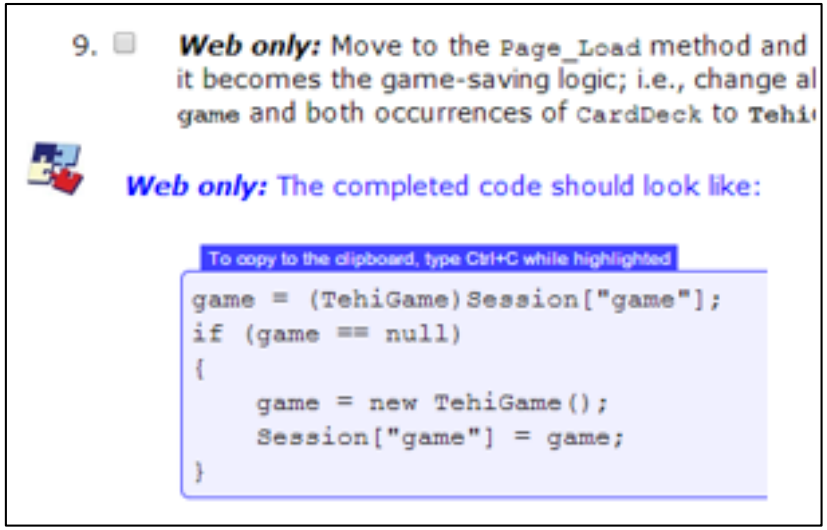
Do Now

1. **Launch AdaptaLearn by double-clicking its icon on the desktop**
   - Move the AdaptaLearn window to the side of your screen or shrink it to leave room for a work area for your development tools

2. **Select an exercise from the exercise menu**
   - Zoom in and out of the AdaptaLearn window
   - Toggle between the AdaptaLearn window and your other windows

3. **Look for a folded area introduced with blue text (not available in all courses)**
   - Click the text to see how folds work

4. **Try to copy and paste text from the manual**
   - Some courses have code boxes that make it easy to copy areas of text while highlighted (as shown)



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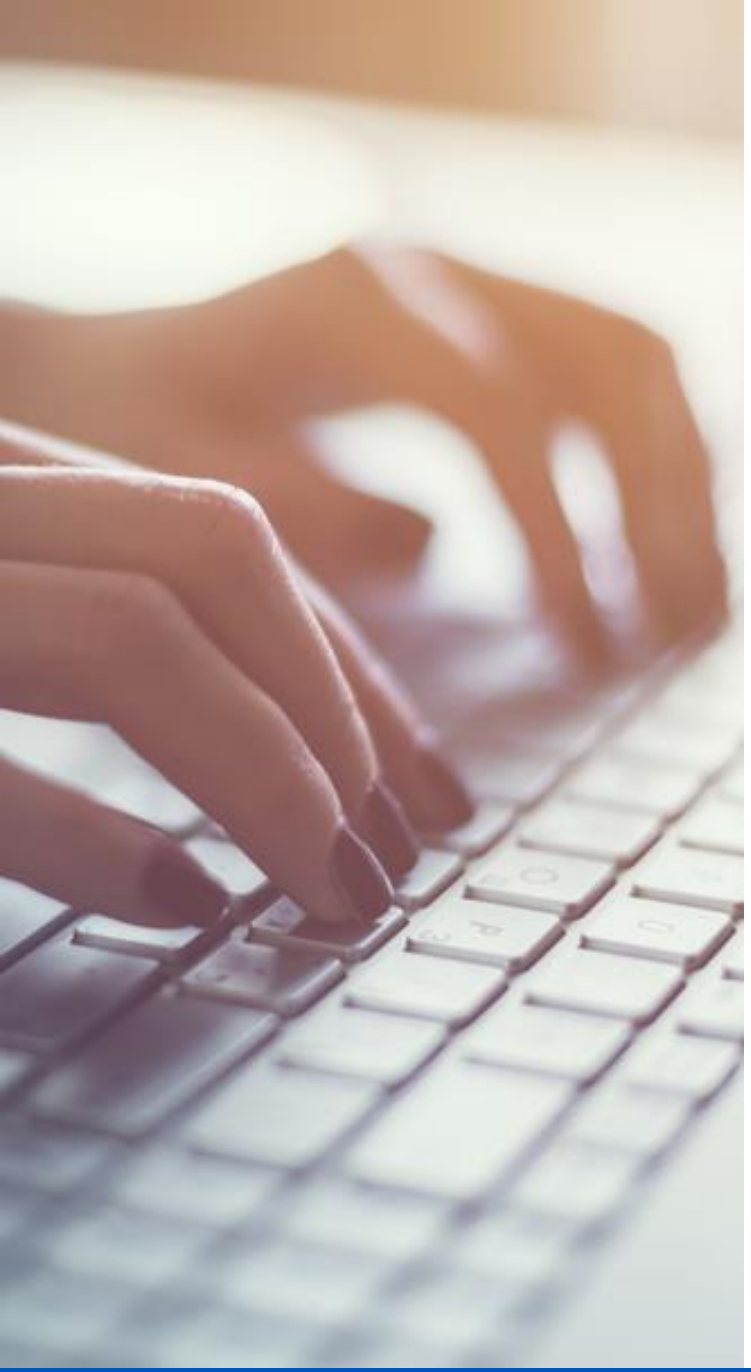

1.2: Creating an Angular Application

Do Now

- In your Exercise Manual, please refer to Do Now 1.2: Creating an Angular Application

IMPORTANT: you must complete this exercise before attempting any others

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The Application Component

- **Angular CLI creates an initial Component**
  - In the app directory
- **The Component is named `AppComponent`**
  - In a set of files `app.component.*`
- **Four files created as standard***
  - `.css`—CSS styling (empty placeholder)
  - `.html`—HTML template
  - `.spec.ts`—unit test code (TypeScript)
  - `.ts`—the Component source code and metadata
- **Convention is that all visual Components' names should end with `Component`**

*Our app directory has an additional file `app-routing.module.ts`. This was created as a consequence of using the `--routing` flag.

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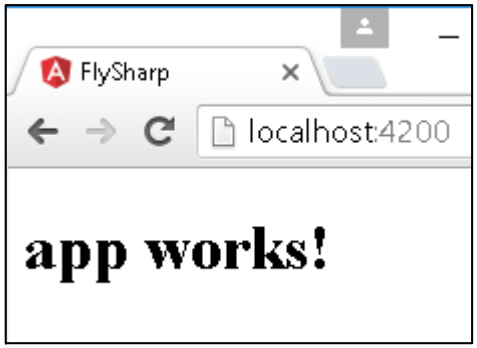
The HTML Template

- **Template file uses HTML 5 plus Angular binding syntax to define visual appearance of Components**

app.component.html

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

Binding to `title` property



Note: this is a greatly simplified version of the default `app.component.html` page

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The Component TypeScript File

- **The code that defines the `Component`**

app.component.ts

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

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

Metadata describing the component

Location of template

This is all the executable code!

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Bootstrapping the Component

- **One problem**
  - The Component won't run!
  - It does not actually contain executable code
- **The solution**
  - Bootstrap Angular and load the Component
  - Angular converts the Component definition into executable code

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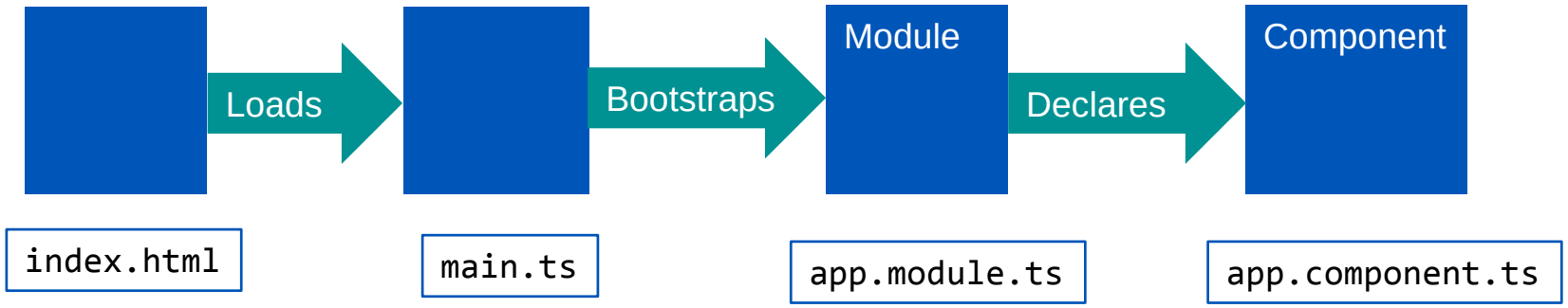
Bootstrap Process

- **Browser loads `index.html`**
  - Includes an HTML tag identifying where to display the Component
  - Loads the transpiled version of `main.ts` (`main.js`)
    - As part of a bundle of JavaScript
- **`main.ts` bootstraps the application module (`AppModule`)**

```
platformBrowserDynamic().bootstrapModule(AppModule);
```

- **`AppModule` makes `AppComponent` available**
  - The main application Component
  - Loaded into the location specified in `index.html`



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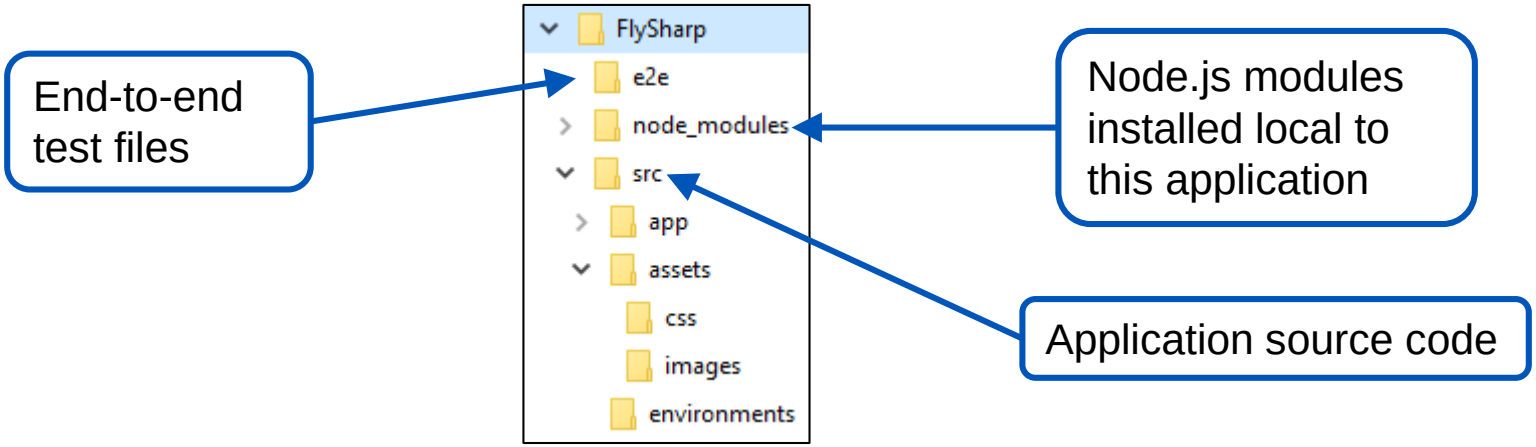
Directory Structure

- **Angular CLI creates a standard directory structure**
  - As created in the previous Do Now exercise



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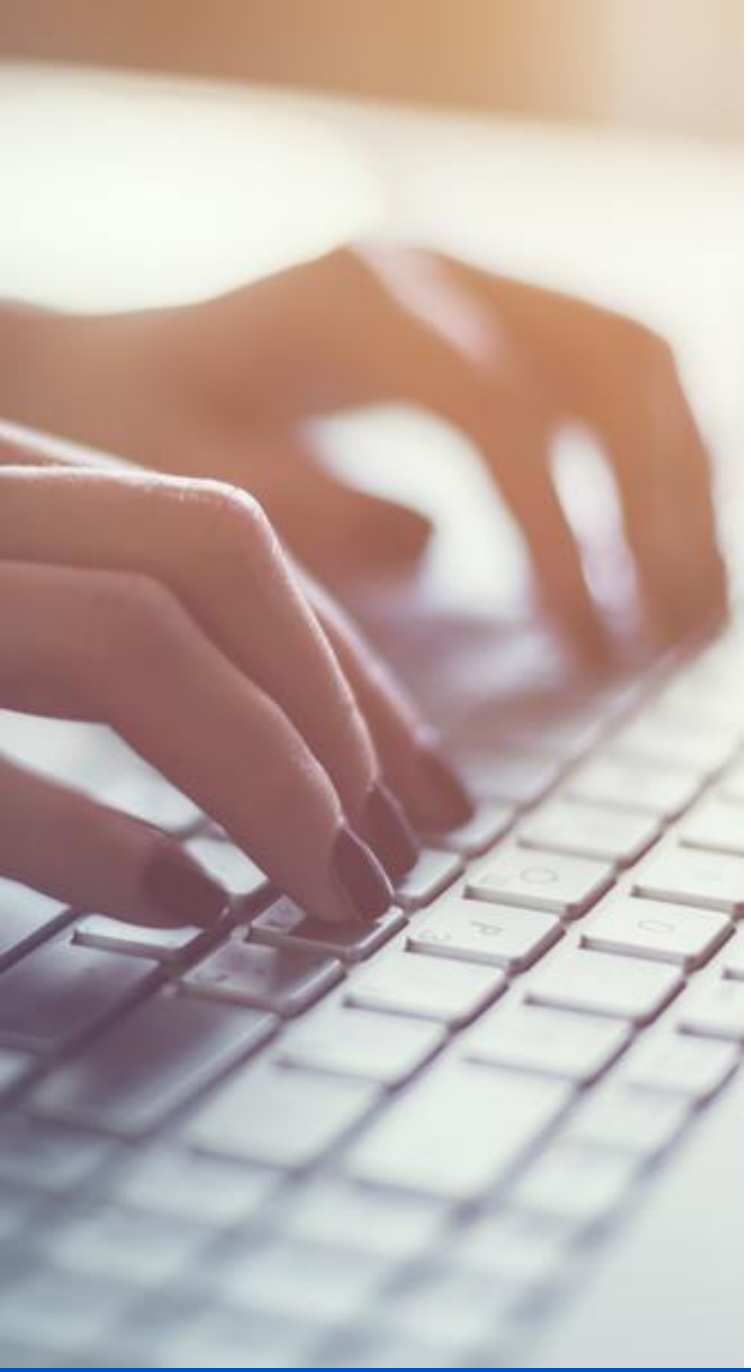

Development Environment Configuration

Reference

- **Multiple configuration files created in the project**
  - `angular.json`—overall configuration for Angular CLI
  - `karma-conf.js`—configuration for the Karma test runner
  - `package.json`—npm configuration
  - `E2e/protractor.conf`—configuration for the Protractor E2E test runner
  - `tsconfig.json, tsconfig.app.json`—configures the typescript compiler
  - `tslint.json`—configures the lint source code checking tool

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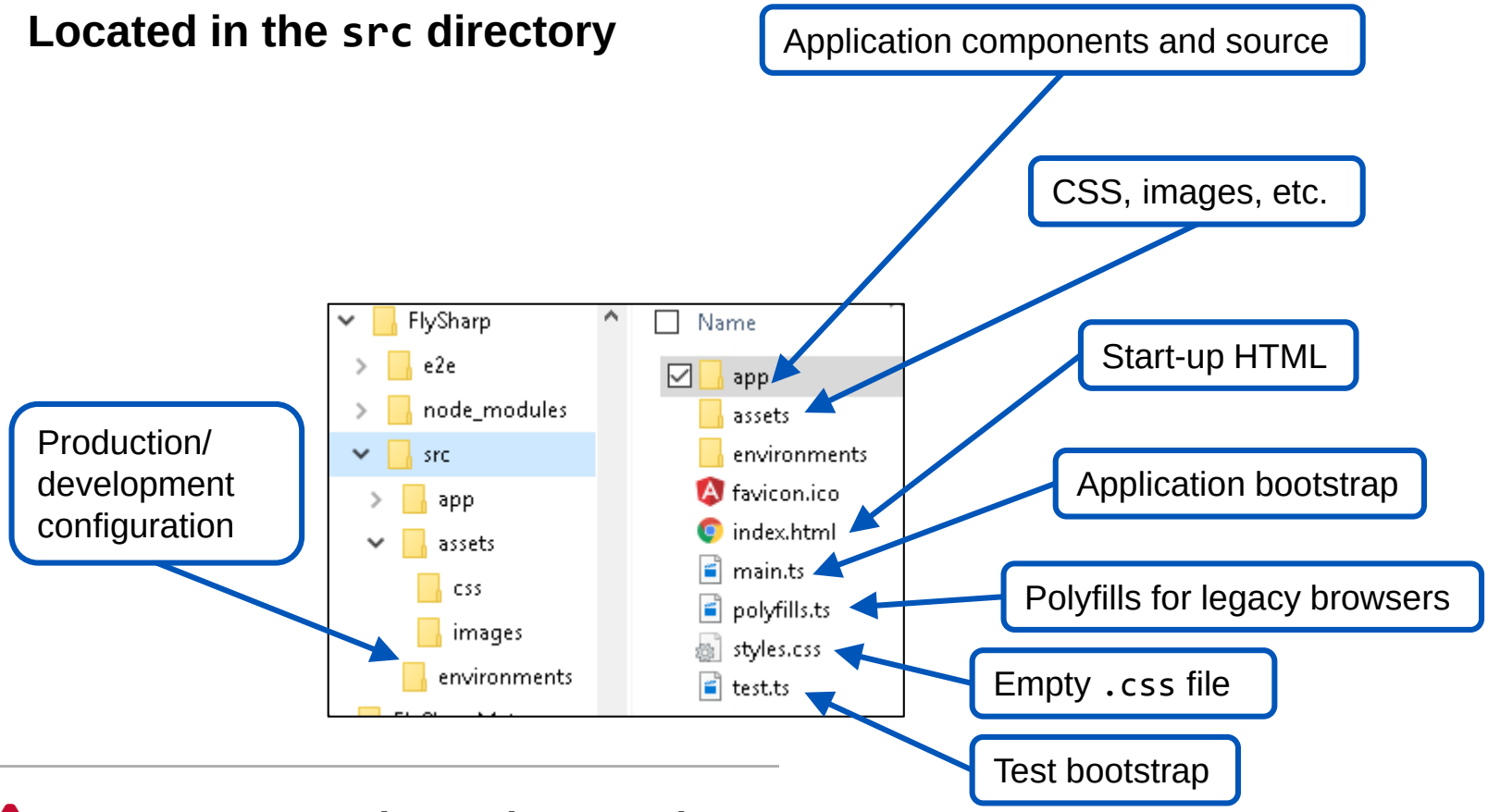
Application Source Structure

- **Located in the `src` directory**



IMPORTANT: when using Angular CLI, all additional web assets (css, images, etc.) must be placed in the assets folder (or sub-folder)

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Choice of Editors

- **The instructions for the exercises specify WebStorm as the editor**
- **Feel free to use an alternative editor**
  - You will need to figure out any extra steps
    - Your instructor will help, but may not know the specifics of your chosen editor
- **The course load has Visual Studio Code and Visual Studio Community Edition installed**
  - Popular alternatives to WebStorm
  - Feel free to install your preferred editor
    - As long as you do not violate any license agreements!

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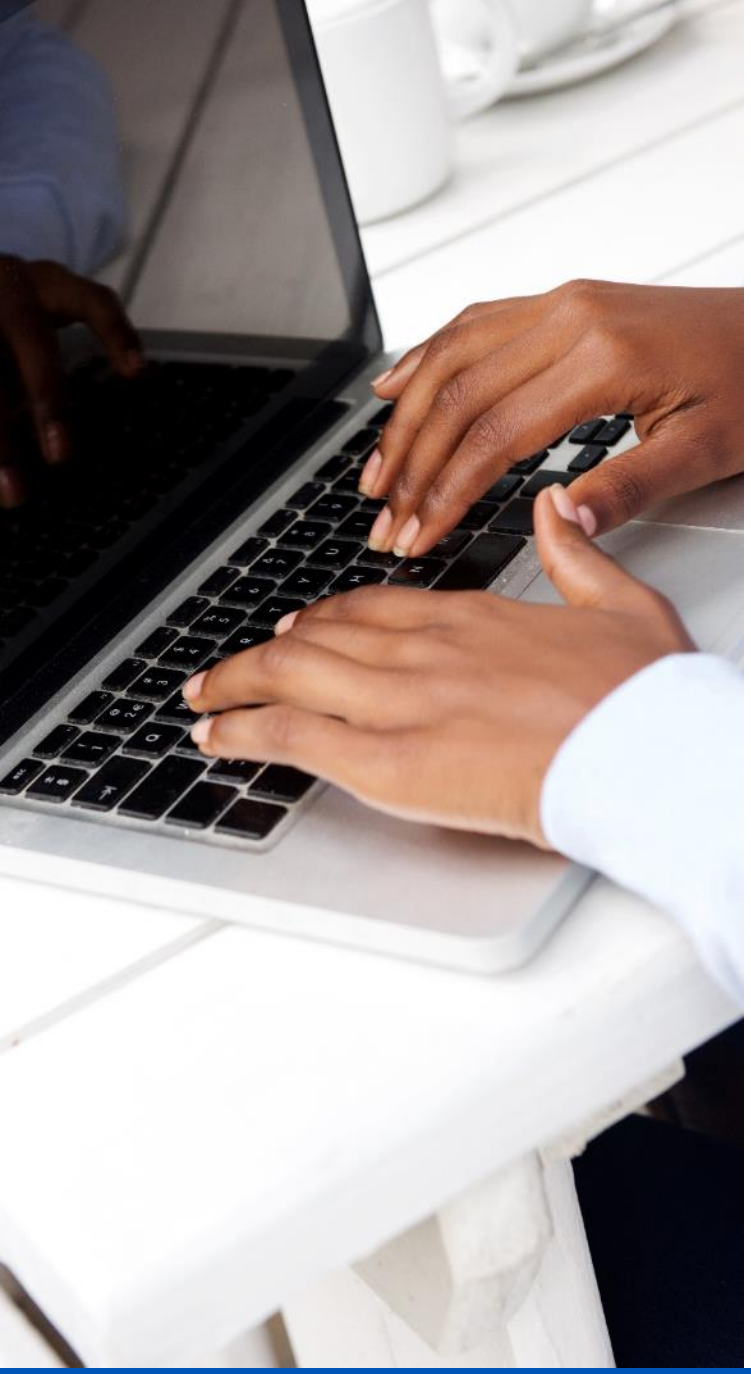

Hands-On Exercise 1.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 1.1: Developing an Angular Application

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TypeScript Primer

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TypeScript Is a Superset of JavaScript

- **If you know JavaScript, then you know the core of TypeScript**
  - Just change the file extension to `.ts`
- **TypeScript is transpiled to JavaScript**
  - Transpilation is part of the development process
  - Browsers are served JavaScript, not TypeScript

```
> tsc file.ts
```

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A Simple TypeScript Example

- **TypeScript transpiles to JavaScript**
  - Can transpile to ES5 or ES6

starthere.ts

```
function getInfo(){
  return "TypeScript is really just JavaScript with a few
  bits added";
}

document.body.innerHTML = getInfo();
```

starthere.js

```
function getInfo(){
  return "TypeScript is really just JavaScript with a few
  bits added";
}
document.body.innerHTML = getInfo();
```

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Declaring Variables

- **Variables may be declared with `var`, `let`, or no keyword**
  - `var` makes a variable local to a function
  - `let` makes a variable local to a block
  - All other variables are global
- **Prefer `let` to declare variables**
  - Limits their scope to inside the block they are declared

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Static Types

- **Code is generally more robust if static type checking is used**
  - Typing restricts the value of a variable
- **TypeScript encourages variables and function returns to be typed**
  - Not available in JavaScript
- **Syntax is `variable : type`**
  - TypeScript supports types of:
    - `boolean`, `number`, `string`, `array`, `tuple`, `enum`, `object`, `void`
  - Special type of `any` – where the type is unknown

```
function someFunction() : string {
  let id : number;
  let flightNumber : string;
  return flightNumber;
}
```

- **Type declarations are not mandatory**

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Interfaces

- **Interfaces constrain the "shape" of objects**

```
interface Flight{
  id : number;
  flightNumber : string;
  origin : string;
  destination : string;
  price : number;
}
```

: type used to declare a type

```
let flight1298 : Flight =
    {"id": 11, "flightNumber" : "FS1298", "origin":
  "LAX", "destination" : "LHR", "price" : 99.99};
```

- **If the id was "Flight 11" what would happen?** _____

- **JavaScript will still be generated by the transpiler even when there are errors**

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Classes

- **Classes are templates for objects**
  - Describing both data and behavior
- **Data fields become properties on the generated JavaScript objects**
- **Methods look like function declarations**
  - Without the `function` keyword
  - Converted to JavaScript and added to object prototypes
- **Object constructor must be named `constructor()`**

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Classes

```
class AirlineFlight implements Flight {
  id : number;
  flightNumber : string;
  origin : string;
  destination : string;
  price : number;

  constructor(  flight : Flight ){
        this.id = flight.id;
        this.flightNumber = flight.flightNumber;
        this.origin = flight.origin;
        this.destination = flight.destination;
        this.price = flight.price;
  }

  showFlightInfo() : string {
        return this.flightNumber + " : " + " "  +
        this.origin + " " +  this.destination;
  }
}
```

Implements `Flight`, so must have these variables

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Creating Objects From Classes

- **Objects are instantiated with the `new` keyword**
  - By calling an object constructor that has the same name as the class
  - This calls a method named `constructor` in the class
- **Methods and properties accessed using `'.'`**

```
let aFlight = new AirlineFlight(flight);
document.body.innerHTML = aFlight.showFlightInfo();
```

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Modules

- **Each TypeScript file is a module**
- **Variables, functions, and classes are not visible outside the module**
  - Unless exported

```
export interface Flight{ … }
```

- **Consuming code must import declarations before use**

```
import { Flight } from "./pathToFlightModule";
```

No `.ts` on the filename

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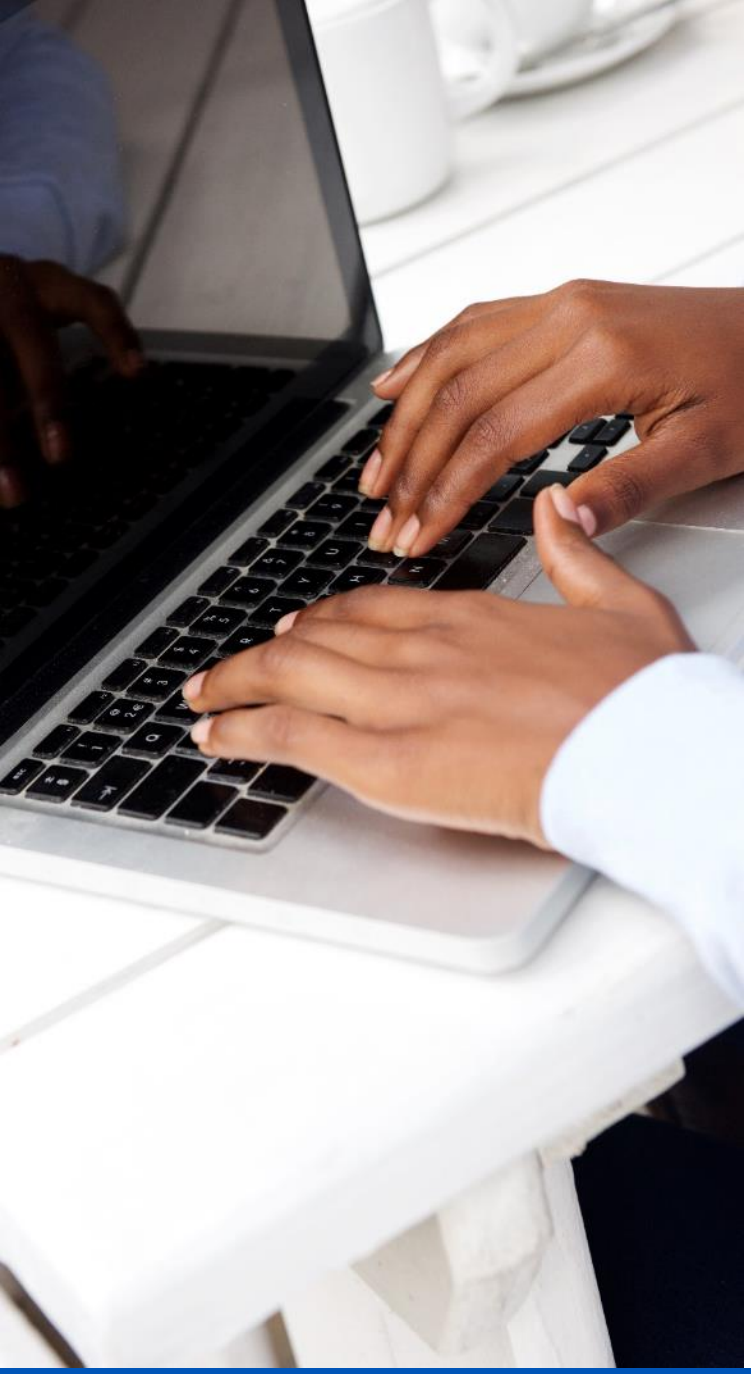

Hands-On Exercise 1.2

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 1.2: Introducing TypeScript

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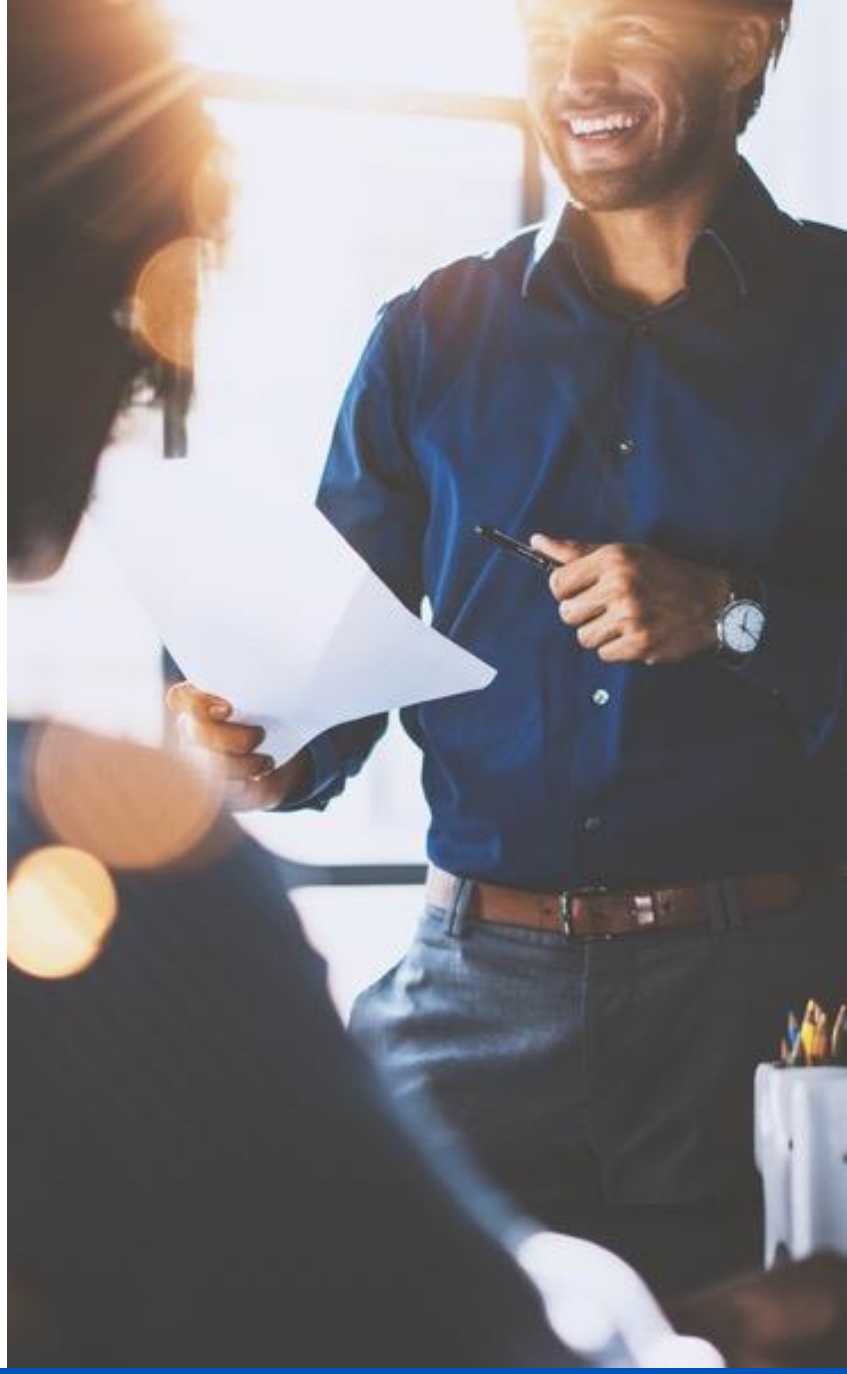
Objectives

- Learn how Angular eases the development of modern GUI applications
- Learn how to configure an Angular environment
- Learn how to navigate the architecture of Angular
- Learn essential TypeScript programming skills



GUI = graphical user interface

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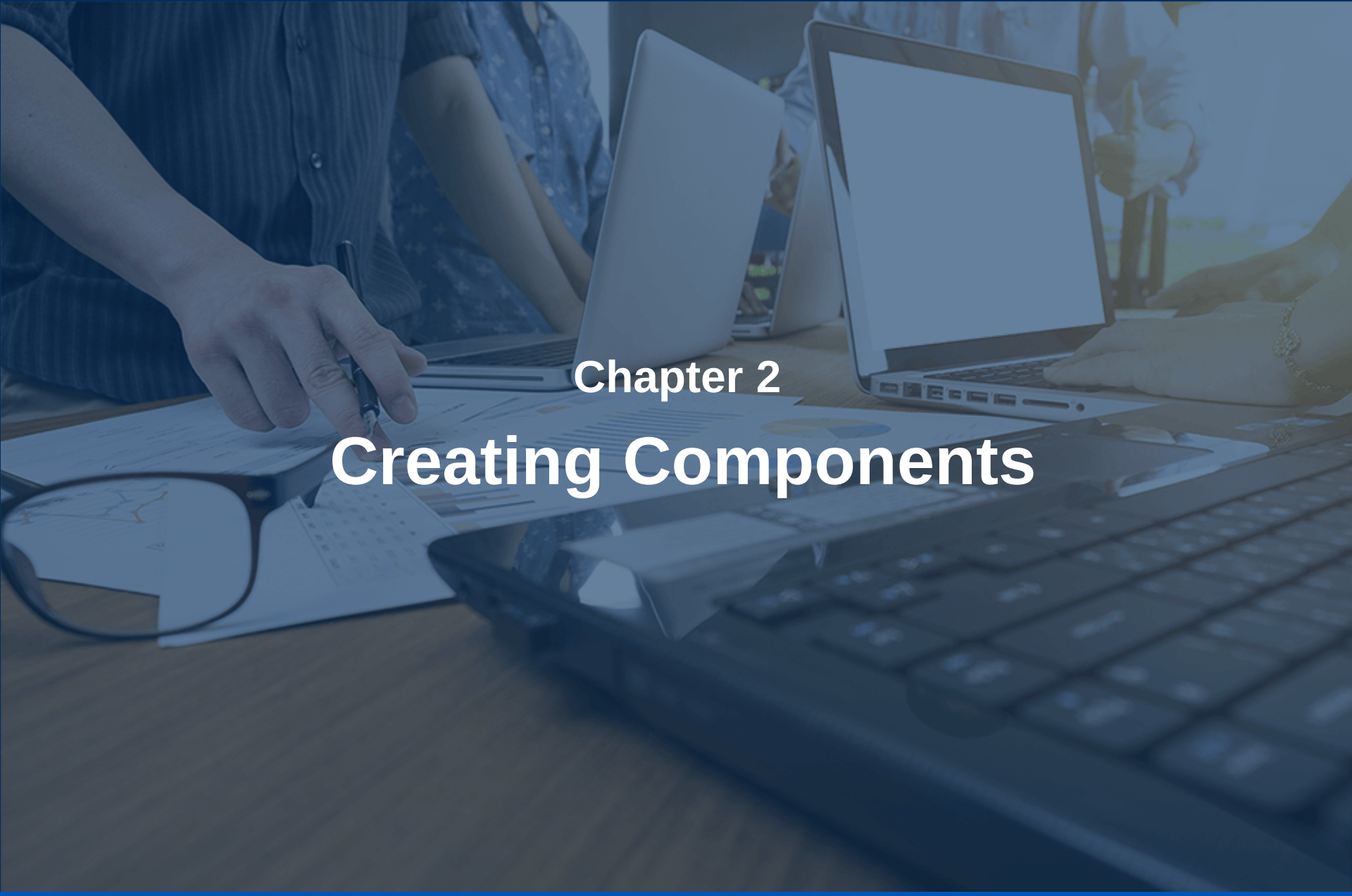

Chapter 2

Creating Components

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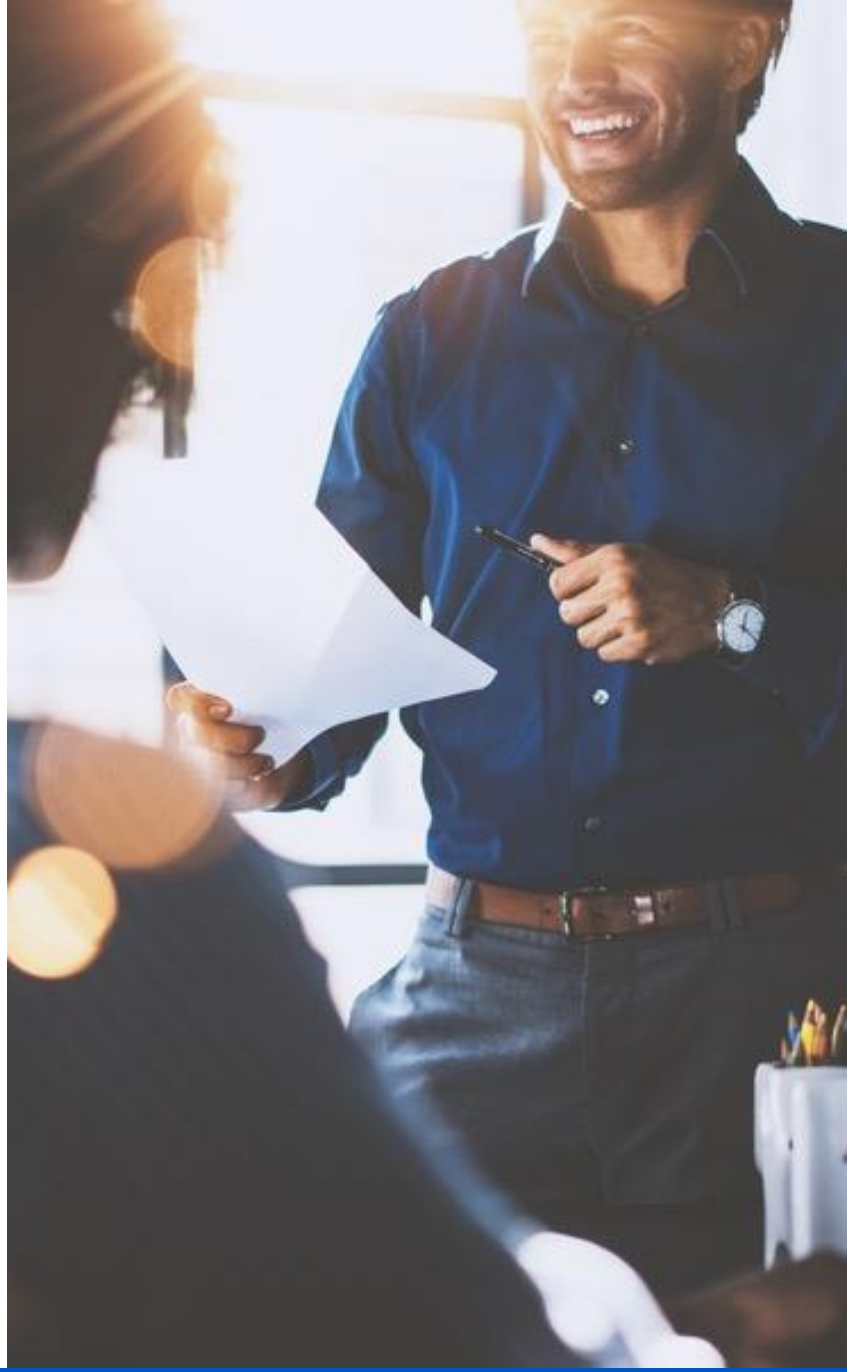
Objectives

- Create Component definitions
- Specify behavior and relationships with metadata
- Control visual appearance with templates
- Bind data to templates
- Generate repeating and conditional templates structures



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Contents

Role and Structure of Components

- Angular Modules
- Component Metadata
- Component Templates
- Debugging Techniques
- Controlling Appearance
- Repeating Data

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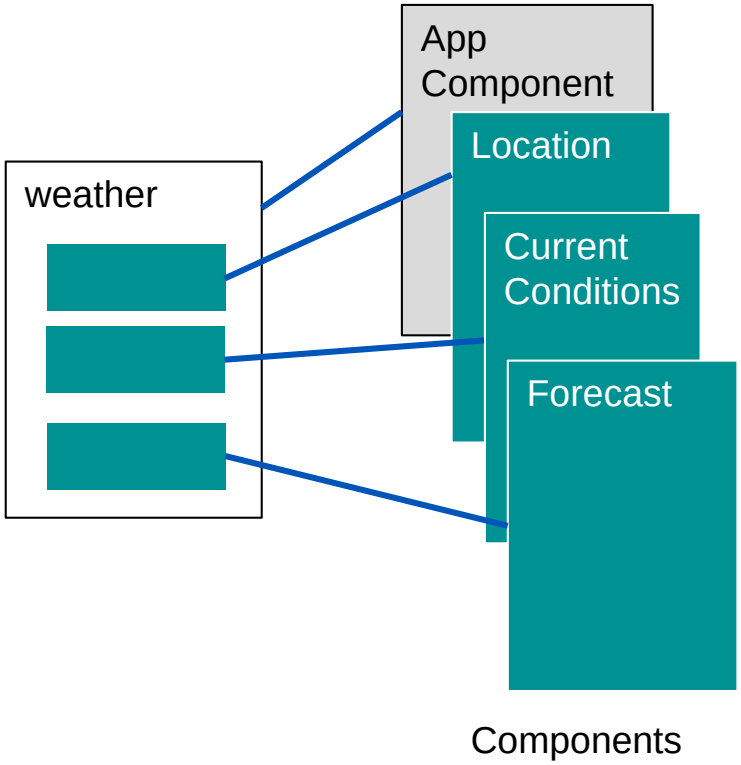
Angular Components

- **The building blocks of Angular**
- **A Component controls part of the screen**
  - A view
- **Defines the visual appearance**
  - Through a template
- **Controls the behavior**
  - Through a TypeScript class



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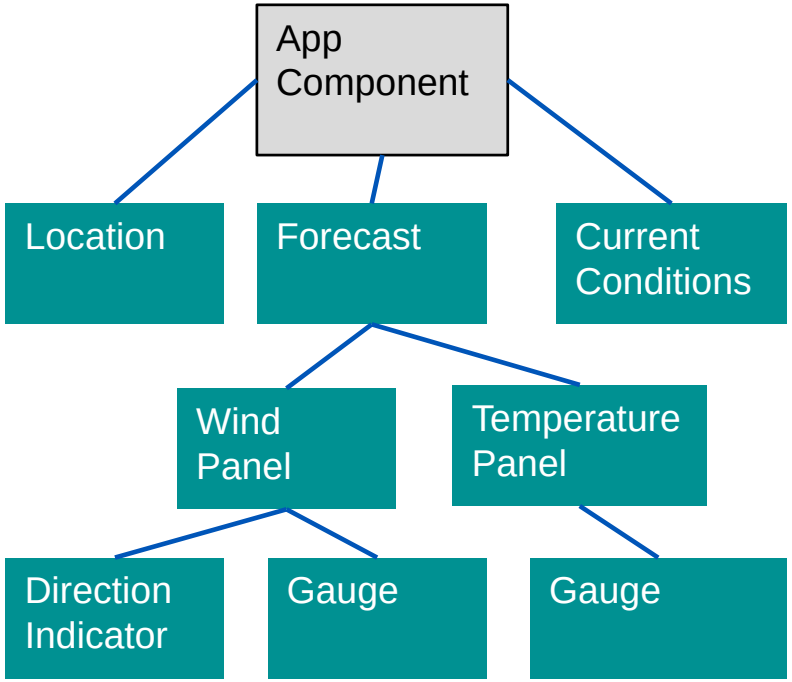
Component Hierarchies

- **Components may be composed of other Components**
  - They form a hierarchy
- **Components may be reused as children of multiple Components**



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Component Structure

- **Four elements to a Component**
  - Metadata
  - TypeScript Class
  - Template
  - Styling
- **Metadata and the class declaration defined in the main `*.component.ts` file**
- **Template and styling normally placed in external files**
- **Template and styling can be placed inside the metadata section**
  - Avoid for all but the simplest Components

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Example Component TypeScript File

app.component.ts

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

@Component({
  selector: 'app-root',
  templateUrl: 'app.component.html',
  styleUrls: ['app.component.css']
})

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

Metadata

Class

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TypeScript Imports

- **Angular is composed of multiple TypeScript modules**
  - Which must be imported before being used in code
- **Two styles of import**
  - System imports
    - Make functionality defined in system modules available to our code

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

Components to import

Module identifier

  - Local imports
    - Importing code from other source files in our project

```
import { GaugeComponent} from './gauge/gauge.component';
```

Relative path

Note: The `@` symbol in `@angular` is part of the module name—it has no other significance

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2.1: Resolving `Imports`

Do Now

- **Angular code requires `imports` for multiple modules**
- **The WebStorm editor usually adds `import` statements automatically**
- **We have added the TypeScript Importer extension to Visual Studio Code**
  - Provides assistance with `imports`
- **If all else fails**
  - Use the documentation

Example: find the correct `import` for `Component`

1. **Open `angular.io/api` in a browser**
2. **You should see three text boxes. In the Filter box type `Component`**
3. **Click on `Component` in the list of matching types**
4. **Near the top of the page you should see `npm package: @angular/core`**
5. **Which tells us the `import` will be:**

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

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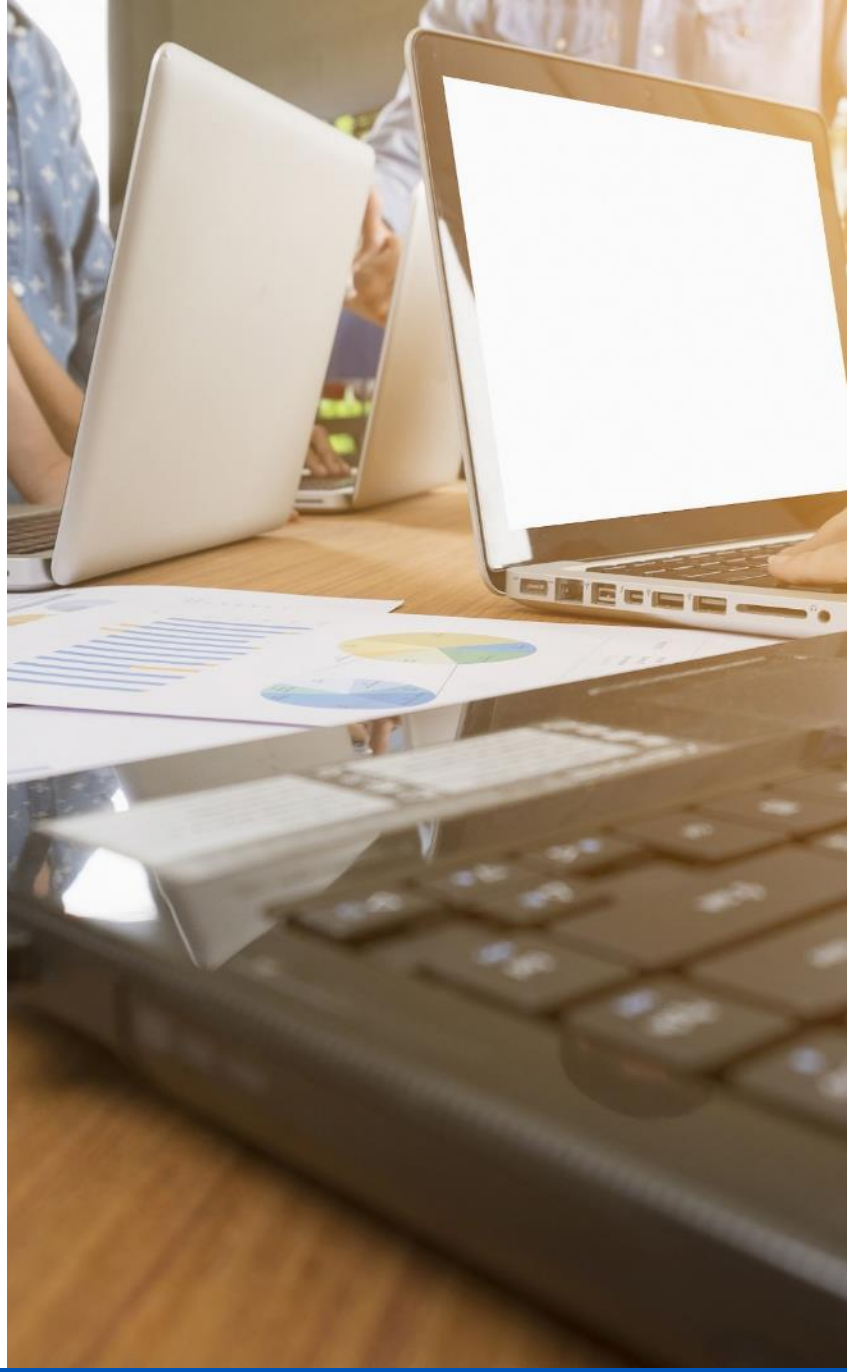

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Introducing Modules

- **Angular application Components must be defined within modules**
  - Allows grouping of related functionality
- **Every Angular application must have at least one module**
  - The *root* module
  - Additional modules are known as feature modules
- **Angular modules contain one or more Components**
- **Angular modules are *not* the same as TypeScript modules**
  - TypeScript modules are a single source file
    - Made visible to another source file through an `import` statement
  - Angular modules provide metadata instructing Angular how to process Components
    - Loaded at runtime as part of the bootstrap process
    - Or loaded by the Component Router

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Structure of an Angular Module

- **Angular modules are classes**
  - Decorated with `@NgModule`
  - Imported from `@angular/core`
  - Provides metadata about the module
  - Metadata is defined as an object literal
    - Passed as a parameter to the `@NgModule` decorator
    - `@NgModule({…})`

- **Metadata properties include**
  - `declarations`—identifies the Components, Directives, and pipes contained in the module
  - `imports`—references to Angular modules needed by this module
  - `providers`—used for dependency injection
  - `bootstrap`—the Component to load when the module is bootstrapped

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Example Module

app.module.ts

```
import { BrowserModule } from '@angular/platform-browser';
import { NgModule } from '@angular/core';
…
import { AppComponent } from './app.component';

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

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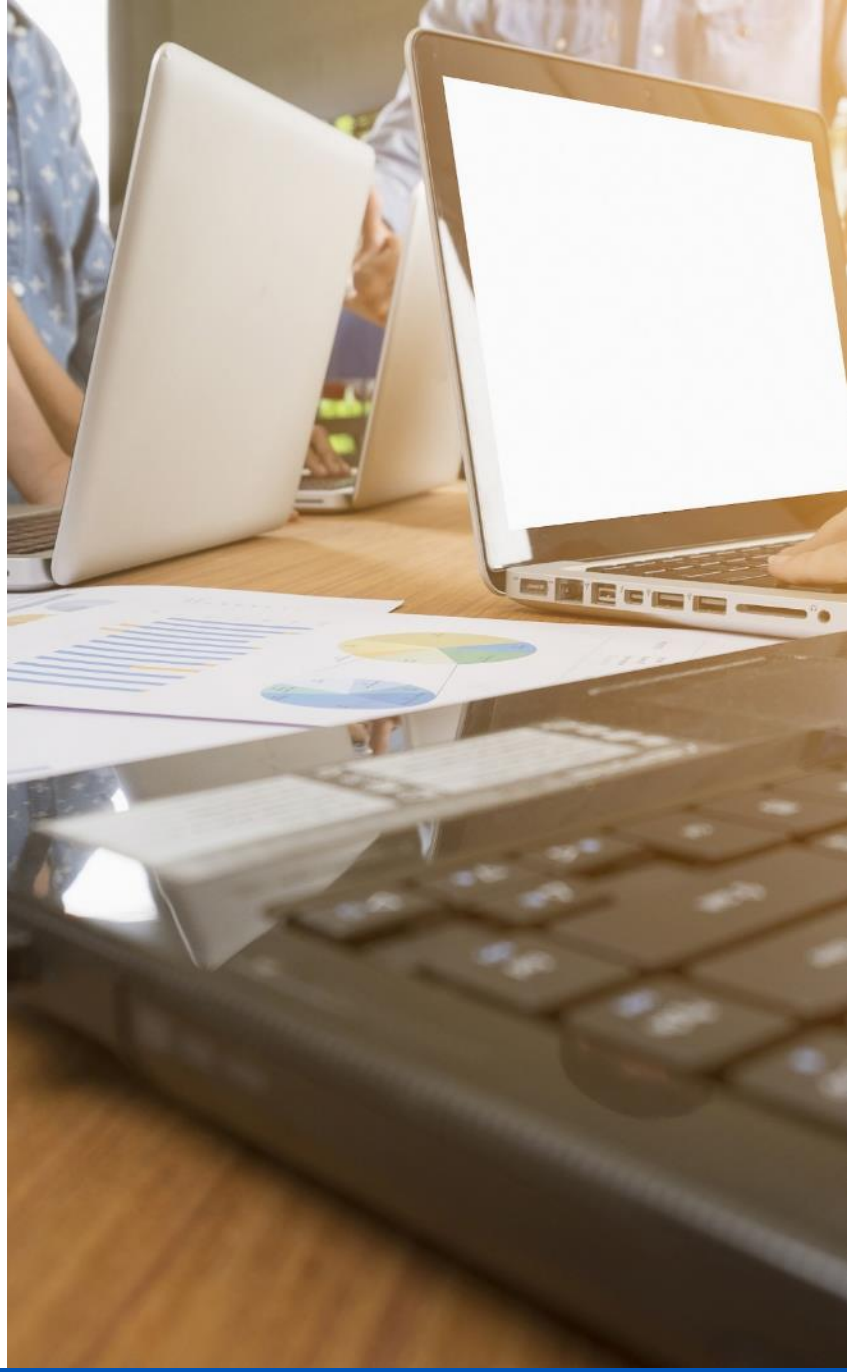

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Component Metadata

- **Defined by the `@Component` decorator**
  - Imported from `@angular/core`

```
@Component({
  selector: 'app-root',
  templateUrl: 'app.component.html',
  styleUrls: ['app.component.css']
})
```

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Component Metadata Breakdown

- **`selector`—CSS selector**
  - Matches the element in the parent Component or HTML page that identifies where this Component is to be placed

index.html

```
<body>
  <app-root>Loading...</app-root>
</body>
```

There are other metadata properties; they will be introduced as needed.

- **`templateUrl`—relative path to the HTML template file**
- **`styleUrls`—an array of relative URLs to CSS files for this Component**
  - CSS can also be applied globally if included in the containing HTML page

There are other metadata properties; they will be introduced as needed.

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Class Declaration

- **Component classes must be exported**
- **Properties and methods may be marked `private`**
  - Stops them being used from other components
- **Private fields and methods are not visible in the template**
  - Though, unfortunately, they may work with older (pre Angular 8) development builds!

```
export class AppComponent {
  private title = 'app works!';

  onClick(){
    this.title='new title';
  }
}
```

Property

Method

`private` would mean the `title` field would not be visible in the template!

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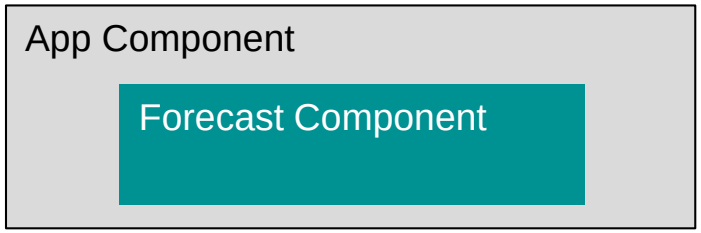
Multiple Components

- **Components can be composed of Components**
  - As we already know…
- **Position of child Component is defined by the template of the parent**
- **Child Components must be declared in a Module**
- **To add a child component**
  1. Import the Component into the `.ts` file for the module
  2. Add the child Component class name to the `declarations` property of the `@NgModule` metadata
  3. Add an element matching the CSS selector of the child to the HTML template of the parent



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Multiple Components Example—Module

app.module.ts

```
import { ForecastComponent } from
  './forecast/forecast.component';

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

1

2

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Multiple Components Example—Parent Template

app.component.html

```
<h1 (click)="onClick()">
  {{title}}
</h1>
<app-forecast></app-forecast>
```

3

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Multiple Components Example—Child Component

forecast.component.ts

```
@Component({ …
  selector: 'app-forecast', …
})
export class ForecastComponent {…}
```

forecast.component.html

```
<p>
  Weather is expected
</p>
```

- **If a Component is declared in the `declarations` property of the `@NgModule` metadata**
  - Angular will look for templates with CSS selectors matching those Components
- **If HTML matching a CSS selector is found**
  - The declaring Component is displayed at that point in the parent template

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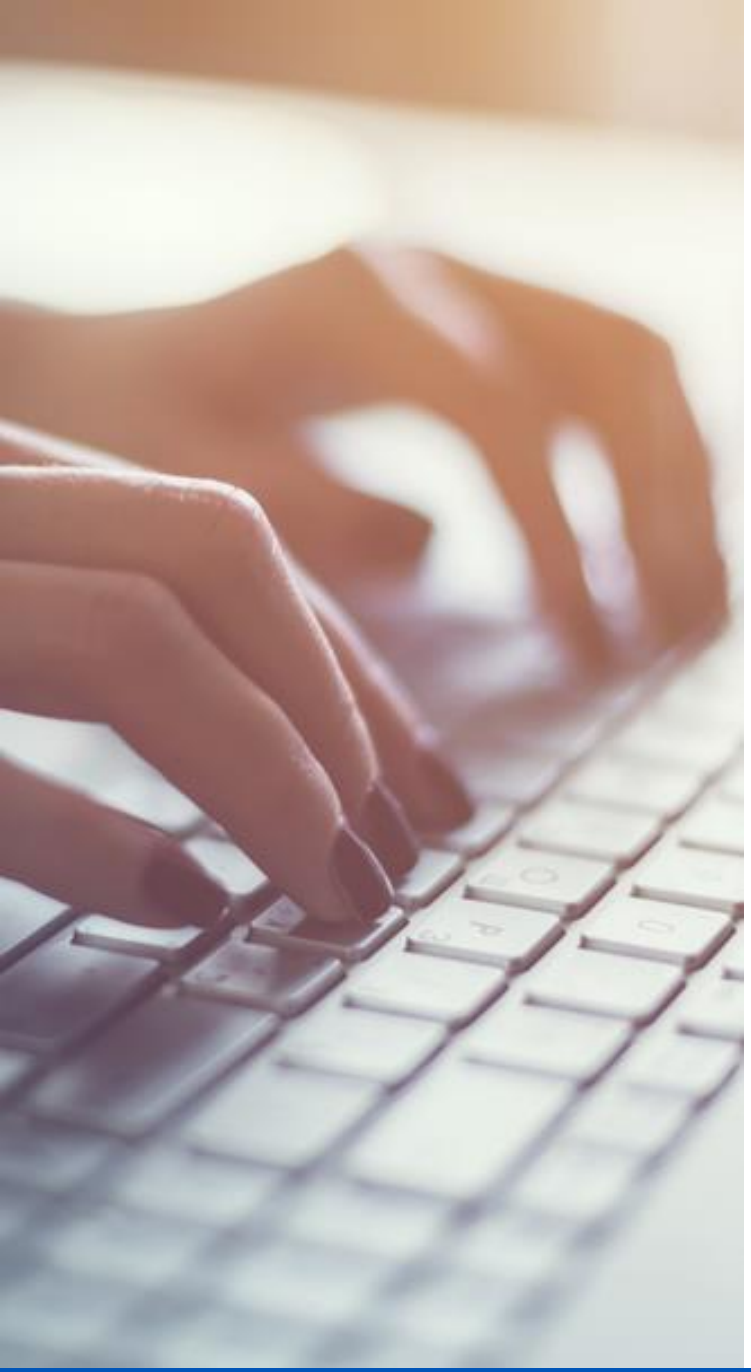

2.2: Multiple Components

Do Now

- In your Exercise Manual, please refer to Do Now 2.2: Multiple Components

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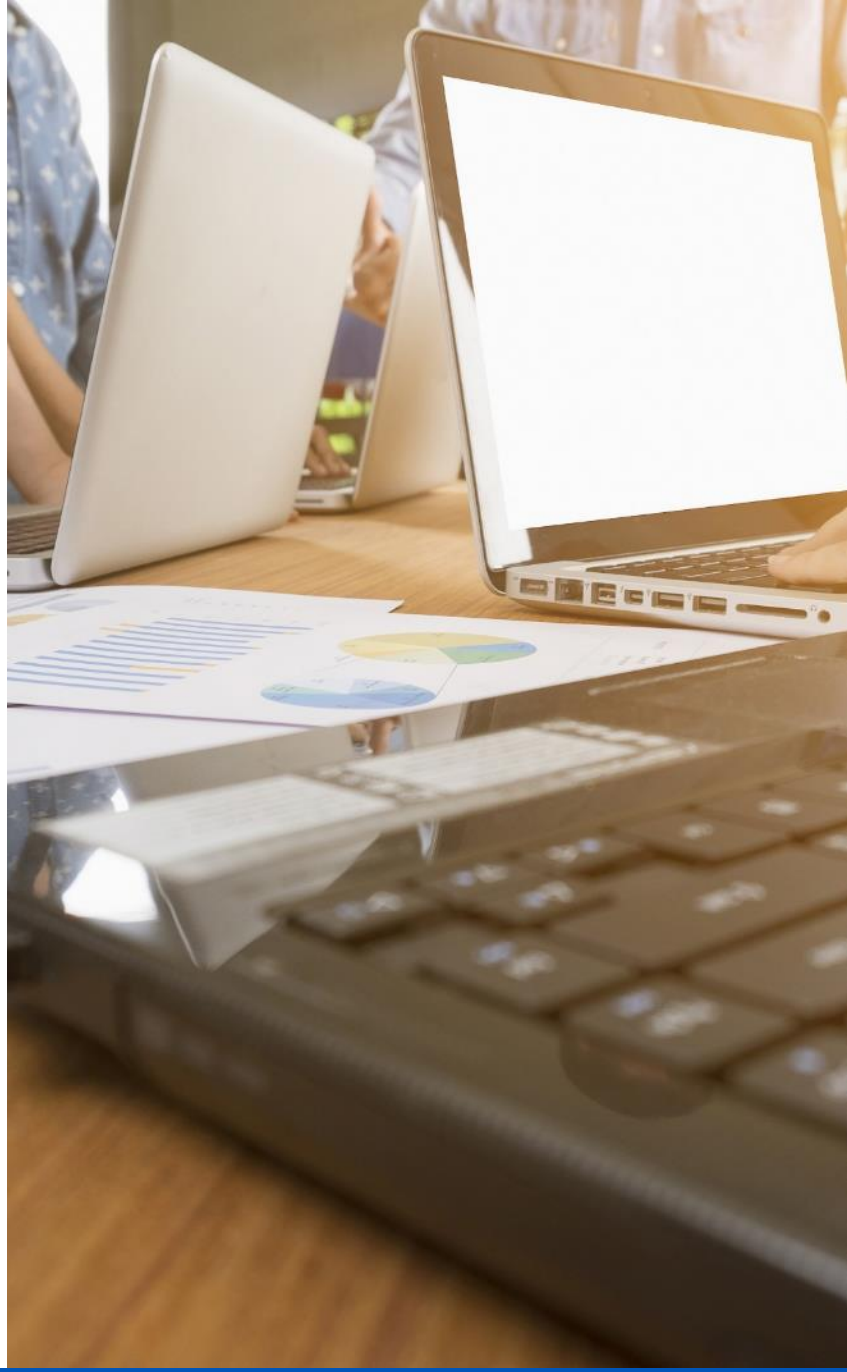

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Angular Template

- **Templates define the view for a Component**
- **Using HTML 5 syntax**
  - Plus some additions—bindings
  - Minus some restrictions
- **Binding Types**
  - One-way—data source to view
    - Interpolation `{{expression}}`
    - Property `[target]="expression"`
  - One-way from view to data source
    - Event ()
  - Two-way
    - `Banana in a box [()]`

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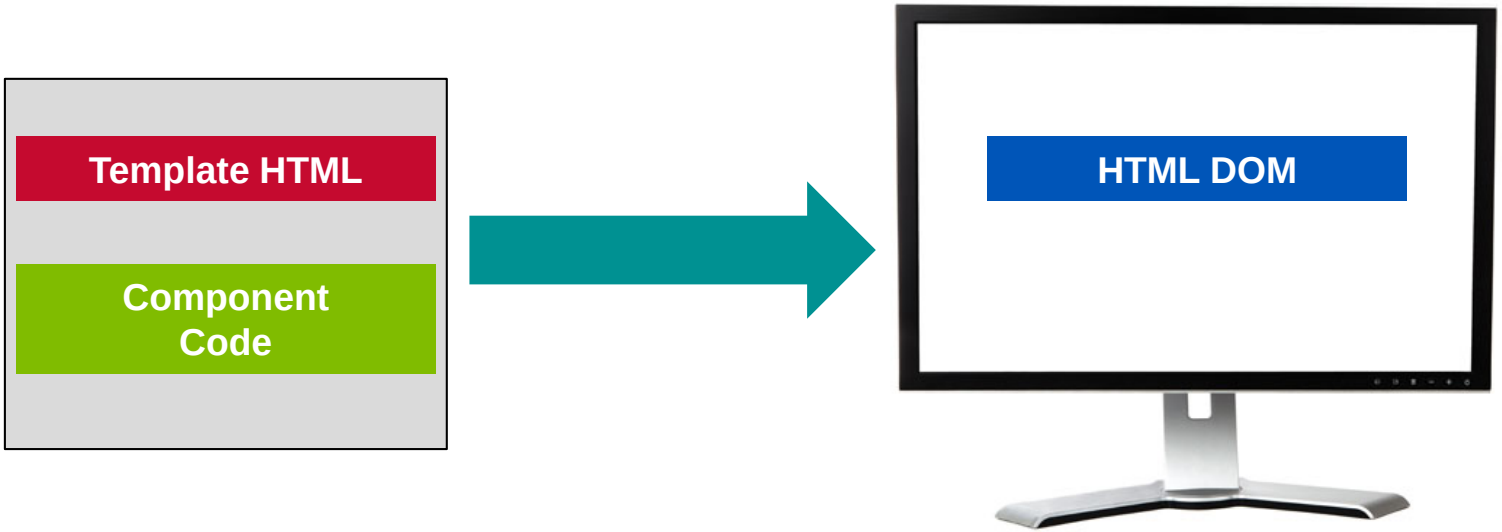
Template Rendering

- **Templates are the source of the HTML output to the browser**
  - Angular generates the browser HTML DOM
  - By combining interpolated values from the Component with the template



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Interpolation

- **Calculated values inserted into the template output**
- **Syntax: `{{expression}}`**
- **`expression` is a template expression**
  - Often the name of a property of the Component
- **Interpolation may be used**
  - As the body of an HTML element
  - As the value of an HTML attribute

```
<h1 (click)="onClick()">
  {{title}}
  <img src="{{weatherImgUrl}}">
</h1>
<app-forecast></app-forecast>
```

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Template Expressions

- **Statements written in a template expression language**
  - An Angular-specific variant of JavaScript
- **Angular executes the expression and assigns the value to a target**
  - HTML element or attribute
  - Other binding targets
- **Prohibited expressions**
  - In interpolation statements: anything that has a side effect
    - For example, modifies something
      - `=`, `+=`, `-=`, `*=`, `++`, `--`, …
      - `new`
  - In all expressions
    - Chaining expressions with `;` or `,`
    - Bitwise operators `|` and `&`
- **Additional operators**
  - Pipe `|`
  - Safe navigation operator `?.`

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Template Expression Context

- **Expression context for `<script>` in a web page is global namespace**
  - Can access objects like `window` and `document`
- **Expression context for Angular expressions is the current Component**
  - `{{title}}` accesses the title property on the current Component
  - `"onClick()"` is the `onClick()` method of the current Component
- **Template expressions cannot access anything in the global namespace**
  - `window`, `document`, `console`, `Math.*`

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Sample Interpolation Expressions

```
export class WindComponent {

  windSpeedKnots : number = 20;
  instabilityIndex : number = 1.8;
}
```

```
 <li>Wind Speed (Knots) - {{windSpeedKnots}}</li>
  <li>Wind Speed (MPH) - {{windSpeedKnots * 1.1}}</li>
  <li>Max Speed (Knots) –
              {{windSpeedKnots * instabilityIndex}}</li>
```

- Wind Speed (Knots) - 20
- Wind Speed (MPH) - 22
- Max Speed (Knots) - 36

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Property Binding

- **Sets the value of a property to the value of an expression**
  - `[target]="expression"`
  - Data goes one way—from expression to target property
- **Target property may be**
  - An HTML DOM property

```
<button [disabled]="buttonDisabled">Update Weather</button>
```

  - A Component property

```
<app-current-weather [preferedUnits]="'Knots'"></app-current-
  weather>
```

Important: Square brackets for property bindings

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Square Brackets?

- **The normal form of a property binding is**
  - `[target]="expression"`
- **Cumbersome if the expression is a string**
  - `[target]="'string expression'"`
- **An alternative form is to omit the [ ]**
- **Expression is then assumed to be a string**
  - `target="string expression"`
  - i.e., not evaluated as an expression

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Event Binding

- **Bind event handlers to events**
  - `(event)="eventHandler()"`
- **The event may be**
  - A DOM event—`click`, `mouseover`, `mouseout`, …
  - A custom event from a Component
- **The `eventHandler()` is a method on the Component**
  - Or an expression (with side-effects) in the template

```
<button (click)="myClickHandler()">Update Weather</button>
```

Important: Round brackets for event bindings

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Canonical Form Bindings

- **Angular offers an alternative syntax for bindings**
- **Property bindings**
  - Either `[target]="expression"`
  - Or `bind-target="expression"`

```
<button bind-disabled="buttonDisabled">Update
  Weather</button>
```

- **Event bindings**
  - **`(event)="eventHandler()"`**
  - **`on-event="eventHandler()"`**

```
<button on-click="myClickHandler()">Update Weather</button>
```

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Two-Way Bindings

- **Used to both display a property and update it when the user changes it**
  - For form data processing
  - Works with a special directive: `ngModel`
- **`[(ngModel)]="property"`**

```
<input [(ngModel)]="city">
```

- **Canonical syntax**

```
<input bindon-ngModel="city">
```

Tip: Looks like a banana in a box! `[()]`

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Single-File Components

- **Splitting a Component into multiple files is good practice**
  - May be overkill for small Components
- **Template HTML and CSS may be embedded in the Component metadata**
  - Use backtick (`) character for multi-line entries

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

@Component({
  selector: 'app-forecast',
  template: `<p>
    Weather is expected
  </p>`,
  styles: ['p {color:blue;}']
})
export class ForecastComponent  {
}
```

`template` replaces `templateUrl`

`styles` replaces `styleUrls`

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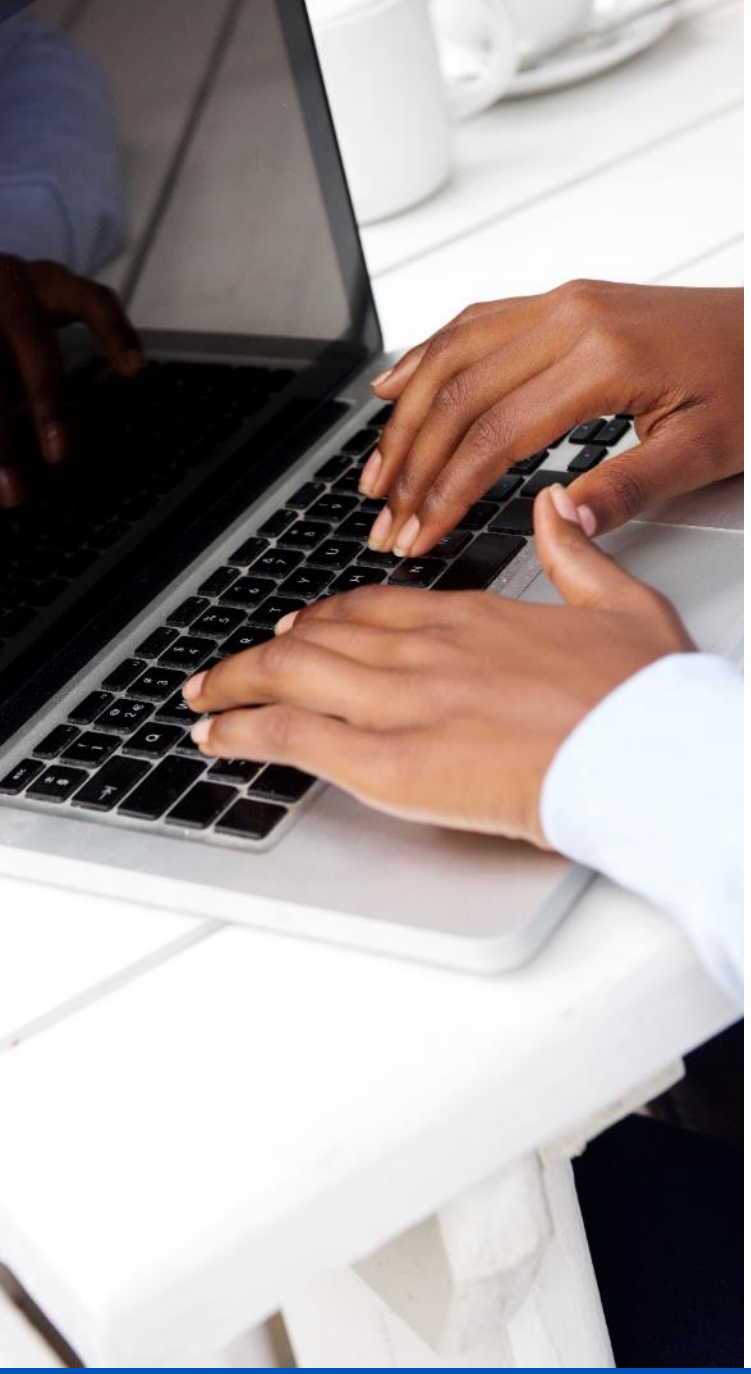

Hands-On Exercise 2.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 2.1: Creating an Angular Component

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Exercise Debrief

Debrief

- **You have seen how to create a Component**
- **Applications have lots of them**
- **The good news**
  A. Angular CLI provides a mechanism to do the repetitive stuff for you
     - Creates all the files and skeletons for you
  B. In future exercises, we will use Angular CLI wherever possible

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Debugging and Troubleshooting

- **Frameworks are great**
  - Saves vast amounts of effort
    - When it all works!
- **Fault-finding can be challenging**
  - Until you know how

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Debugging Tools

- **TypeScript can be debugged with**
  - Chrome Web Developer tools
  - Visual Studio
- **Augury plug-in for Chrome**
  - Angular explorer

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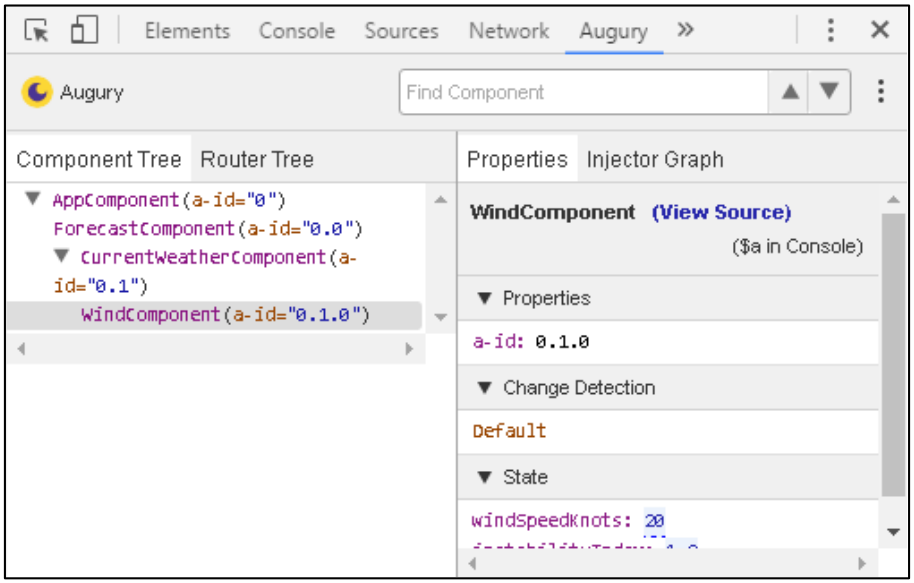
Augury

Demo

- **A Chrome extension**
  - Add to Chrome from **Settings | Extensions | Get more extensions**
- **Use to explore the Angular Component tree**
  - View Source button takes you to the source for the selected Component



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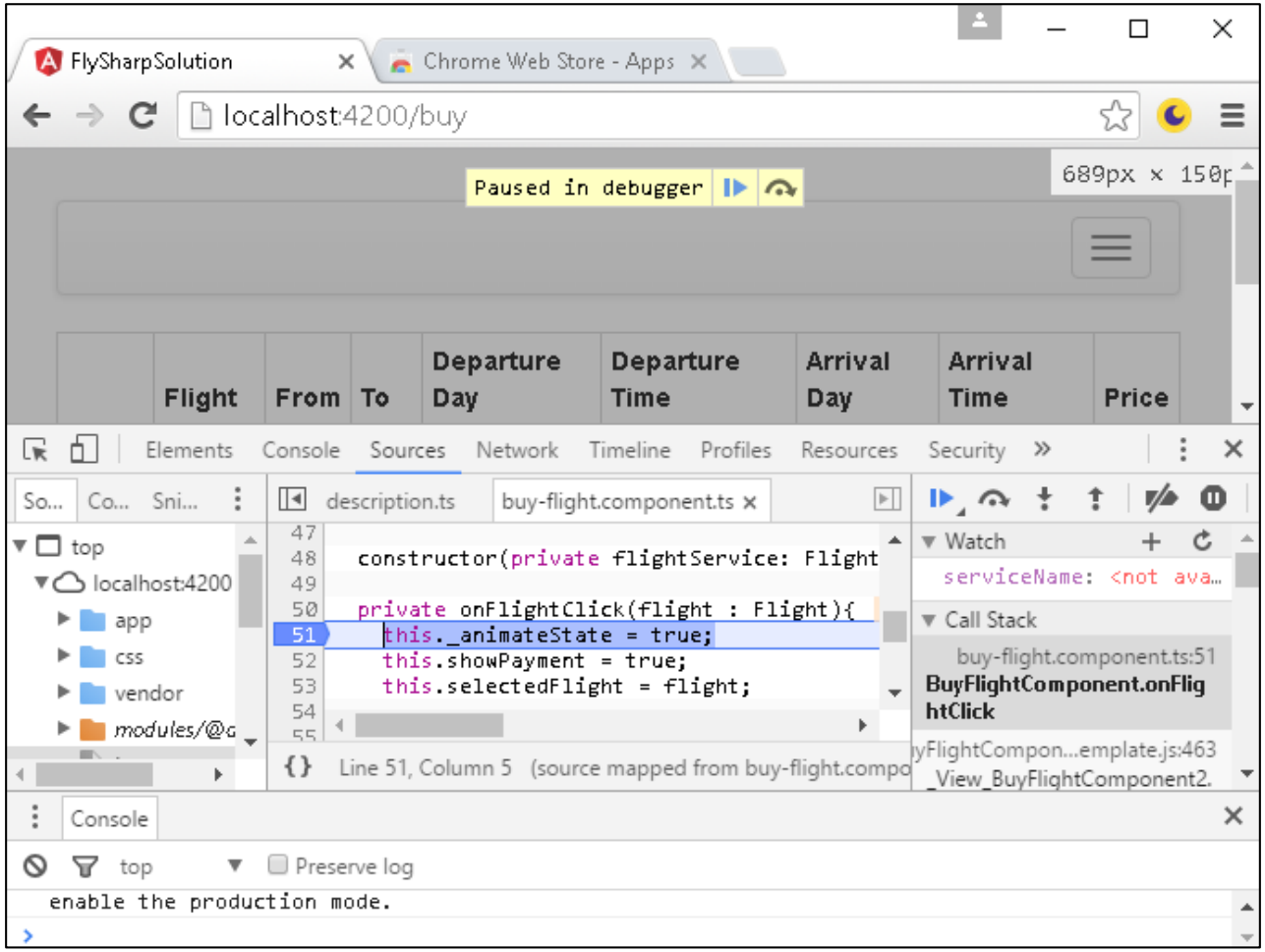
Debugging With Chrome Web Developer Tools

- **Chrome Web Developer tools allows debugging of TypeScript**



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What to Do When Nothing Is Displayed

- **Occasionally you will have a situation where**
  - No errors are reported by the TypeScript compiler
  - Nothing is displayed
- **Don’t panic!**
  - Open the developer console on your browser (`F12`)
  - Check whether the console output is visible
  - If there are lots of errors looking like

    `Error Uncaught (in promise)…`
    - It’s most likely a problem with the template HTML
      - Missing " on the end of attributes is very common problem
      - Check for unclosed element tags
- **If you are lucky**
  - The console may tell you the exact error
  - Read the message
  - Try copying the console message into an editor
    - You may see more information

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Sample Template Parsing Error

Demo

- **Can you see the error?**

```
EXCEPTION: Template parse errors:
Parser Error: Unexpected token ')' at column 27 in [showPayment =
  !showPayment)] in BuyFlightComponent@3:49 ("
<tbody>
  <tr *ngFor="let flight of flights">
      <td><button class="btn btn-primary btn-sm" [ERROR -
  >](click)="showPayment = !showPayment)">Buy</button></td>
      <td>{{flight.flightNumber}}</td>
      "): BuyFlightComponent@3:49
```

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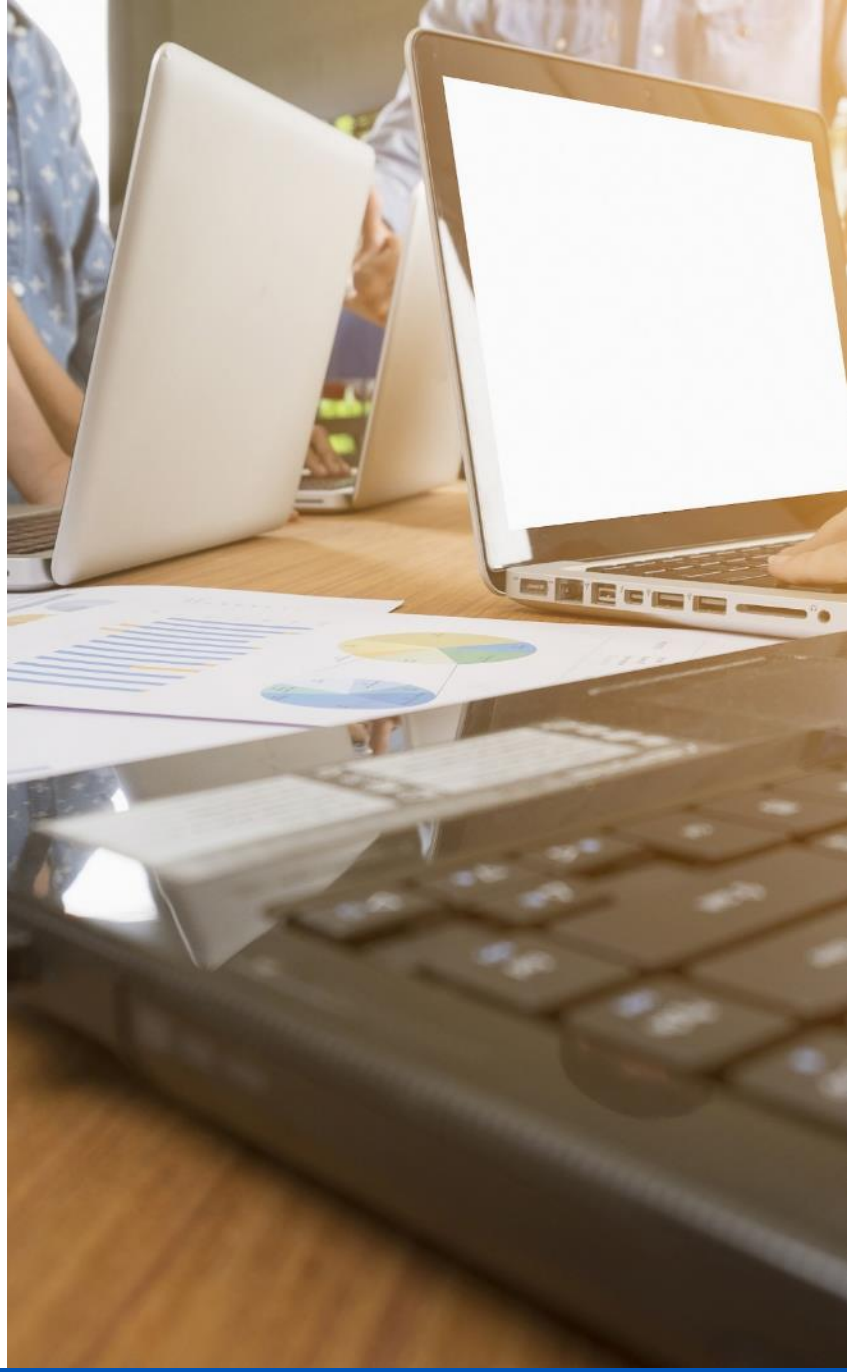
Contents

- Role and Structure of Components
- Angular Modules
- Component Metadata
- Component Templates
- Debugging Techniques

Controlling Appearance

- Repeating Data



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NgClass Binding

- A built-in directive to simplify CSS class control
- Allows direction manipulation of CSS classes associated with an element

```
<li [class.highlight]="highlightSpeed">Wind Speed (Knots) -
  {{windSpeedKnots}}</li>
```

If `highlightSpeed` is truthy

```
<li class="highlight">Wind Speed (Knots) -
  {{windSpeedKnots}}</li>
```

If `highlightSpeed` is falsey

```
<li>Wind Speed (Knots) - {{windSpeedKnots}}</li>
```

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NgClass Directive

- Use ngClass directive to associate multiple classes with an element

Template

```
<li [ngClass]="classes">Wind Speed (MPH) - {{windSpeedKnots
  * 1.1}}</li>
```

TypeScript

```
classes : string[] = ["listStyle",
                      "highlight",
                      "indent"];
```

HTML

```
<li class="listStyle highlight indent">Wind Speed (Knots) -
  {{windSpeedKnots}}</li>
```

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NgStyle Binding

- **NgStyle binding: `[style.propertyName] = "expression"`**
  - Where expression evaluates to a CSS property value

Template

```
<li
  [style.color]="highlightSpeed ? 'red' : 'green'">
  Wind Speed (Knots) - {{windSpeedKnots}}</li>
```

TypeScript

```
highlightSpeed : boolean;
```

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NgStyle Binding and Directive

- **NgStyle directive: [ngStyle] = "expression"**
  - Where expression returns an object that is a set of styles

Template

```
<li [ngStyle]="getStyles()">Wind Speed (MPH) -
  {{windSpeedKnots * 1.1}}</li>
```

TypeScript

```
getStyles() {
    return {
      'font-family' : 'Arial, Helvetica, sans-serif',
      'color' : 'cyan',
      'font-style' : 'italic'
    }
  }
```

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Content Hiding

- **Common to have HTML that is conditionally displayed**

Template

```
<div [style.display]="raining ? 'block' : none" >
  Bring an umbrella!
</div>
<div [style.display]="sunny ? 'block' : none">
  Don't forget the sun screen!
</div>
```

- **`style.display = 'none'` prevents the content from being displayed**
  - But it is still in the DOM
- **Hiding content with CSS is very common**
- **Is it a good idea?**

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Conditional Generation of Content With `*ngIf`

- **CSS content hiding can slow both rendering and change detection**
  - What if the conditional Component had nested Angular Components?
- **`*ngIf` allows conditional content generation**
  - If the condition is false then no DOM content is created

Template

```
<div *ngIf="raining" >
  Bring an umbrella!
</div>
<div *ngIf="sunny">
  Don't forget the sun screen!
</div>
```

Tip: Huge potential performance benefits

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Choices With ngSwitch

- `[ngSwitch]="expression"` specifies the condition to be tested
- The `ngSwitchCase` matching the result of the expression will be generated
- Two version of `ngSwitchCase`
  - `[ngSwitchCase]="expression"`
  - `ngSwitchCase="literal"`
- If nothing else matches: `ngSwitchDefault` case is generated

Template

```
<span [ngSwitch]="conditions">
  <template [ngSwitchCase]="'raining'">Bring an
  umbrella!</template>
  <template ngSwitchCase="sunny">Don't forget the sun
  screen!</template>
 <template ngSwitchDefault>If you are in the UK, it could do
  anything!</template>
</span>
```

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Contents

- Role and Structure of Components
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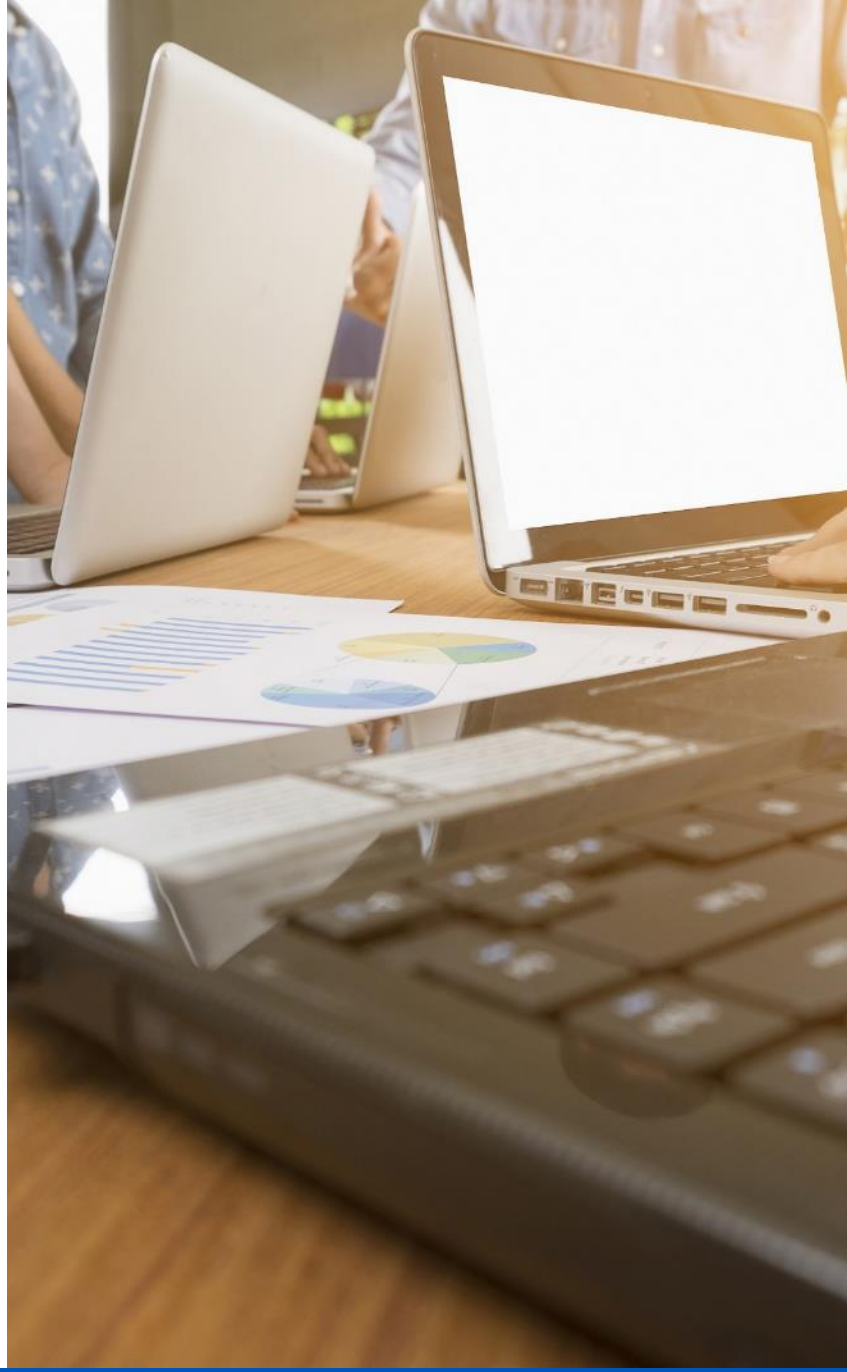
- Component Metadata
- Component Templates
- Debugging Techniques
- Controlling Appearance
- **Repeating Data**



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Displaying Repeating Data

- **`*ngFor` supports the display of repeating data**
  - Specify an array or other iterable collection to display
- **Define a loop variable name**

```
<tr *ngFor="let tempVar of collection">
```

- **Define a block of HTML populated by the loop variable**

```
<td>{{tempVar}}</td>
```

- **`*ngFor` will repeat the populated HTML once for each item in the collection**

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Repeating Data With *NgFor

Template

```
<ul>
  <li *ngFor="let stat of stats">{{stat.date}} -
       {{stat.temperature}}        {{stat.tempUnits}}</li>
</ul>
```

TypeScript

```
export class WeatherStatsComponent {

  stats: Stats[] = [{
    'date': "July 14",
    'temperature': 23,
    'tempUnits': 'C'
  }, {
    'date': "July 15",
    'temperature': 13,
    'tempUnits': 'C'
  }…];
```

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Loop Index Values

- **The keyword `index` can be used to populate a variable**
  - Providing a count of iterations

```
<li *ngFor="let tempVar of collection; let i = index">
       Item {{i}} – {{tempVar}}
</li>
```

- **Other `ngFor` keywords**
  - All are Boolean values
  - `first` true if the item is the first one
  - `last` true if the item is the last
  - `even` true if the index is even
  - `odd` true if the index is odd

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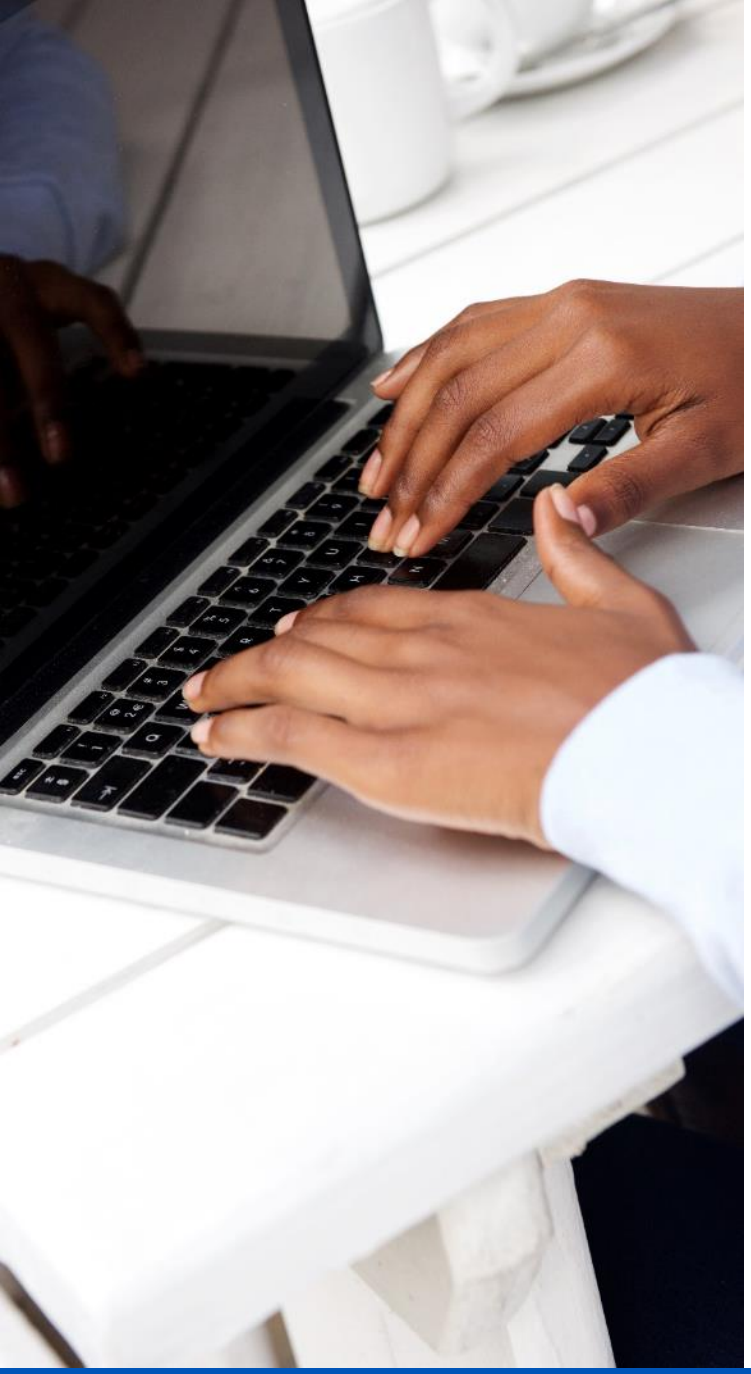

Hands-On Exercise 2.2

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 2.2: Displaying Repeating Data

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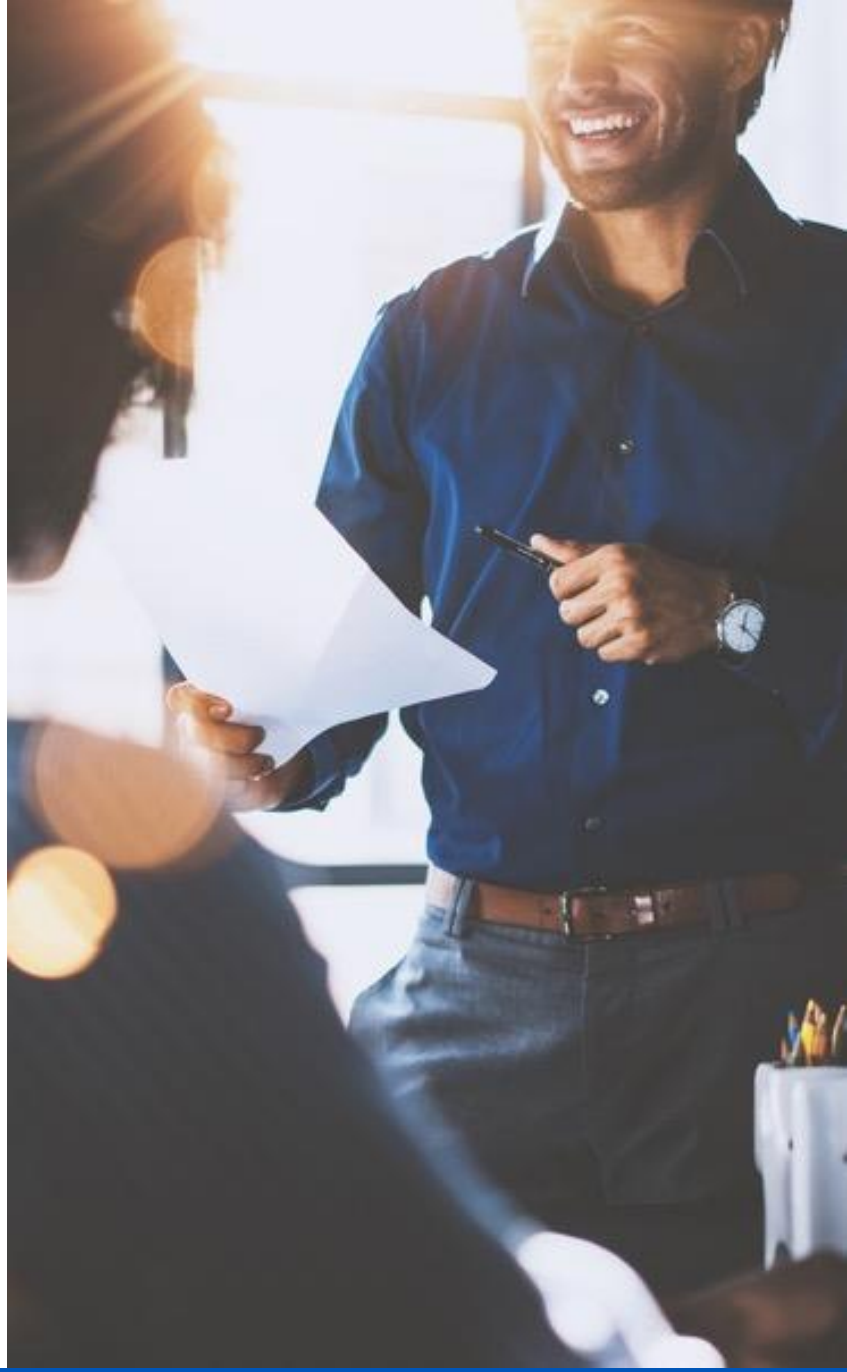
Objectives

- Create Component definitions
- Specify behavior and relationships with metadata
- Control visual appearance with templates
- Bind data to templates
- Generate repeating and conditional templates structures



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Chapter 3

Dependency Injection

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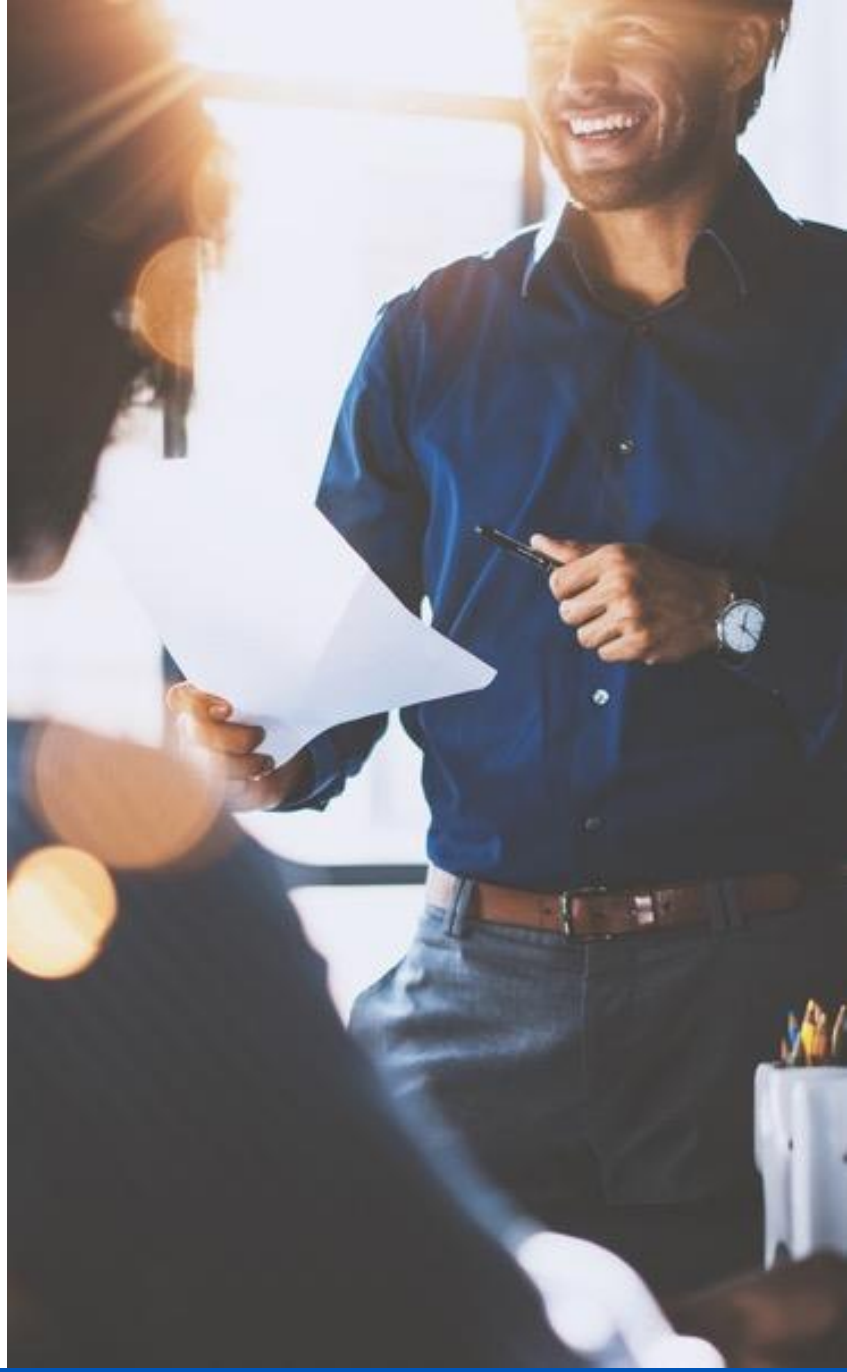
Objectives

- Learn how Angular implements dependency injection
- Learn how to interact with the Angular Component lifecycle



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Contents

Dependency Injection

- Lifecycle Events

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Dependency Injection

- **The need for injection**
  - In Angular, the view is composed of Components
    - In turn composed of Components
    - Angular handles the wiring of these Components for us
  - Angular Components often depend on other data
    - HTTP access
    - Service objects—for sharing model information
- **Angular provides a mechanism to provided resources to Components**
  - Dependency injection

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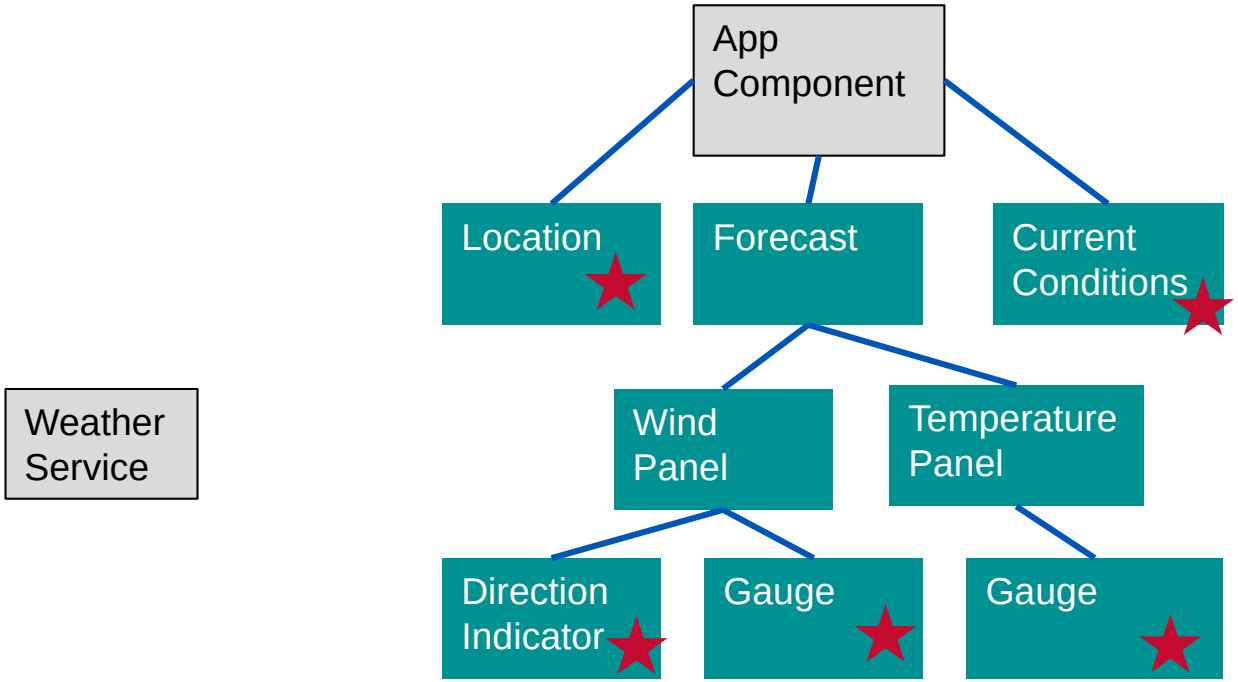
Resource Sharing With Dependency Injection

- Consider our Component hierarchy for the weather app
- Data is provided by the WeatherService
- Consumed by all the Components with the ★
- How to share the WeatherService?



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Sharing Resources

- **Option 1: Each consuming Component creates a separate instance of the service**
  - Hard to share data this way
    - Each instance is completely separate
    - May have serious performance impacts
- **Option 2: Create the service at the top level and pass it to each Component as we create it**
  - Problem: In Angular, we do not directly create the Components
    - Angular does!
- **Option 3: Provide a mechanism to tell Angular that the Components need to access the service**
  - Angular then injects references to the service
    - All Components share a single instance of the service
  - Dependency injection

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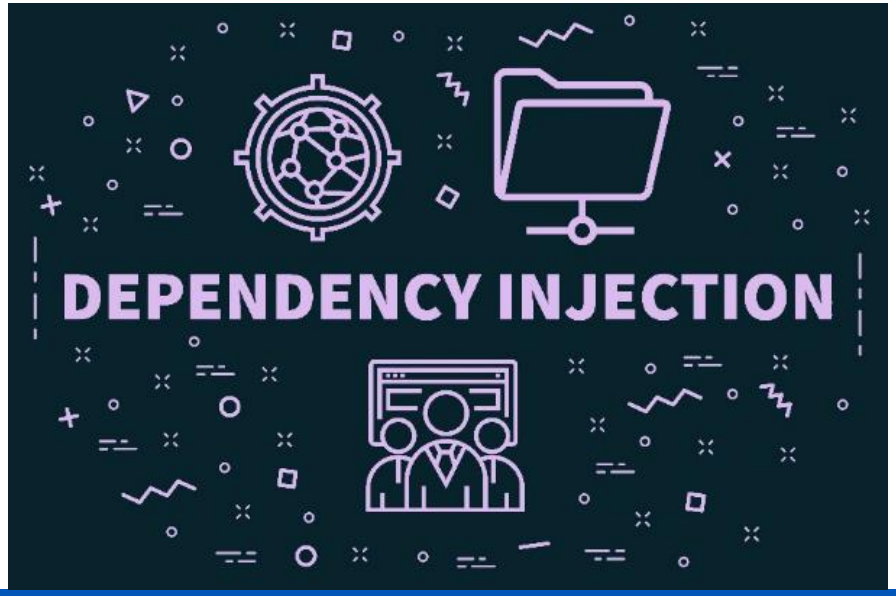
Implementing Dependency Injection

1. Define an `Injectable` class
2. Declare `providers`
3. Specify injection points on consuming Components



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1. Define an `Injectable` Class

- **Creating classes for injection is simple**
  - Classes must be decorated with `@Injectable()`

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

@Injectable()
export class WeatherService {

  constructor() {}

}
```

Don't forget the ()

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2. Declare `Providers` in a Module

- **Dependency injection requires a provider of objects to inject**
  - Often described as a factory
  - Creates instances of the classes, and make them available to inject
- **Providers may be declared at the Module level**
  - Makes Components available to any Component within the module
- **Add a `providers` property to the `@NgModule` declaration**

app.module.ts

```
@NgModule({
  declarations: [
    AppComponent, HomeComponent, BuyFlightComponent
  ],
  imports: [
    BrowserModule,
  ],
  providers: [WeatherService],
  bootstrap: [AppComponent]
})
```

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`Provider` Declaration via Decorators

- **The `@Injectable()`decorator may also be used to specify a provider**

```
@Injectable({
    providedIn: 'root'
})
```

- **The `providedIn` property specifies which module the injector should use as the container of the provided injectable**
- **Possible values:**
  - 'root'—the root module
  - a type—the class of a module
  - null—default indicates it is provided explicitly

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3. Declare `Providers` in a Component

- **Components may also act as a providers**
  - May even be a provider for themselves
- **Add a `providers` property to the `@Component` declaration**
  - An array of `Class` names

app.component.ts

```
@Component({
  …
  providers: [WeatherService],
  …
})
```

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4. Specify Injection Points on Consuming Components

- **Constructor declarations define injection points**
  - Angular will try to satisfy any arguments specified in the constructor
    - From the available `providers`
- **If a provider matching the argument cannot be found**
  - The class will not be constructed
    - The code will fail!
  - Unless the argument is marked `@Optional()`
- **`private` and `public` arguments to constructors become fields of the class**
  - Default arguments are only available within the constructor

```
export class WindComponent {
 …
 constructor(private weatherService : WeatherService) {}
 …
 ngOnInit() {
    this.windSpeed = this.weatherService.getWindSpeed();
  }
}
```

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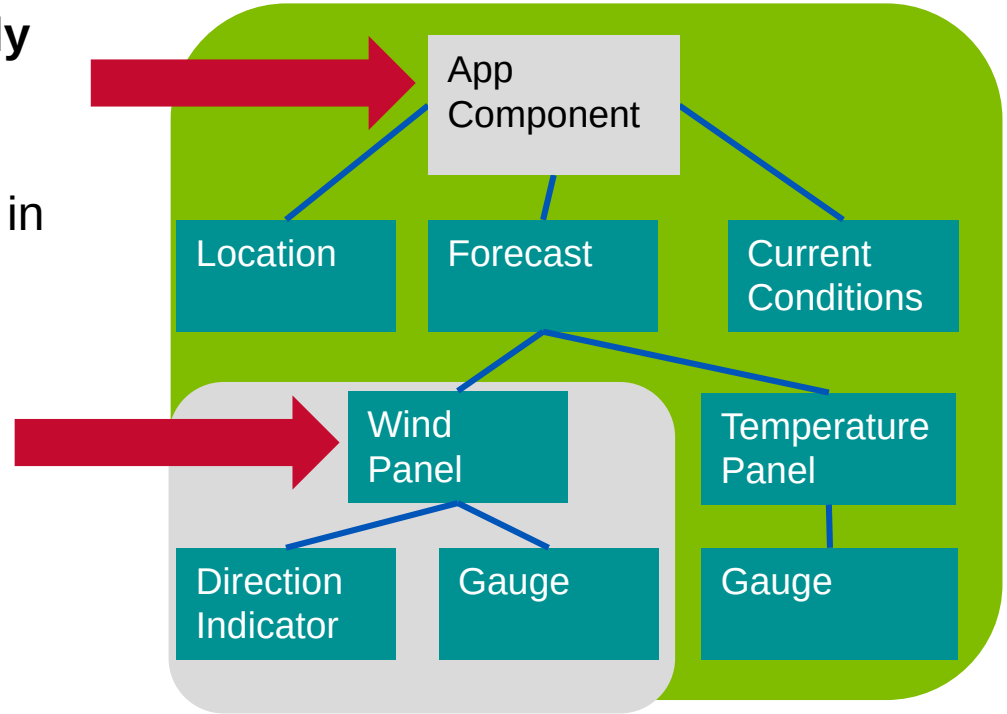
Injection Hierarchy

- **Every Component inherits all injectables from its parent hierarchy**
  - Typically, the module
- **Injectables created as providers in a `Component`**
  - May be injected into the `Component` that declares them
  - Or into any child of that `Component`
- **`A provider` class should normally only be specified once within a hierarchy**
  - Multiple declarations may result in multiple instances
    - Not normally the desired behavior



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Contents

- Dependency Injection

Lifecycle Events

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Component Lifecycle

- **Angular Components and Directives have a clearly defined lifecycle**
  - Creation
  - Rendering
  - Creating and rendering children
  - Checking for changes to data-bound properties
  - Removing the Component from the DOM
- **Lifecycle hooks are methods added to Components and Directives**
  - Invoked when lifecycle events occur

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Lifecycle Example—`OnInit`

- **Put initialization code in the `ngOnInit()` method**
  - Databound properties are all initialized before this method is called
- **`ngOnInit()`is defined by the `OnInit` interface**
- **Declaring that the class `implements OnInit` is optional**
  - Good practice—reduces the risk of code errors not being detected

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

export class WindComponent implements OnInit {
  windSpeed : number;
  constructor(private weatherService : WeatherService) {}

  ngOnInit() {
    this.windSpeed = this.weatherService.getWindSpeed();
  }
}
```

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Common Lifecycle Hooks

- **Hooks available to both Components and Directives**
  - `ngOnInit()` defined by `OnInit`
    - Called after Angular has initialized data-bound properties
    - Commonly used for Component initialization
  - `ngOnChanges()` defined by `OnChanges`
    - Called after Angular updates a data-bound property
    - Receives details of the modified property as a `SimpleChange` object
      - Contains details of current and previous values
  - `ngDoCheck()` defined by `DoCheck`
    - Called on every change detection run
      - Very often
    - Allows custom code to check for changes that Angular does not detect
  - `ngOnDestroy()` defined by `OnDestroy`
    - Cleanup before destruction of Component or Directive
      - Used to detach observables and event handlers

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View Lifecycle Hooks

Reference

- **For Components only**
  - `ngAfterViewInit` defined by `AfterViewInit`
    - After Angular creates the Component's child view(s) and `ngOnInit()` completes on those views
  - `ngAfterViewChecked` defined by `AfterViewChecked`
    - After Angular checks the bindings of the Component's view(s)
- **Content Projection—external Component output is injected into the current Component at a designated location**
  - Has additional lifecycle methods
  - `ngAfterContentInit` defined by `AfterContentInit`
    - After Angular projects external content into its view
  - `ngAfterContentChecked` defined by `AfterContentChecked`
    - After Angular checks the bindings of the external content that it projected into its view

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Lifecycle Event Sequence

- `ngOnChanges`
  - before `ngOnInit` and when a data-bound input property value changes
- `ngOnInit`
  - after the first `ngOnChanges`
- `ngDoCheck`
  - during every Angular change detection cycle
- `ngAfterContentInit`
  - after projecting content into the Component
- `ngAfterContentChecked`
  - after every check of projected Component content
- `ngAfterViewInit`
  - after initializing the Component's views and child views
- `ngAfterViewChecked`
  - after every check of the Component's views and child views
- `ngOnDestroy`
  - just before Angular destroys the Directive/Component

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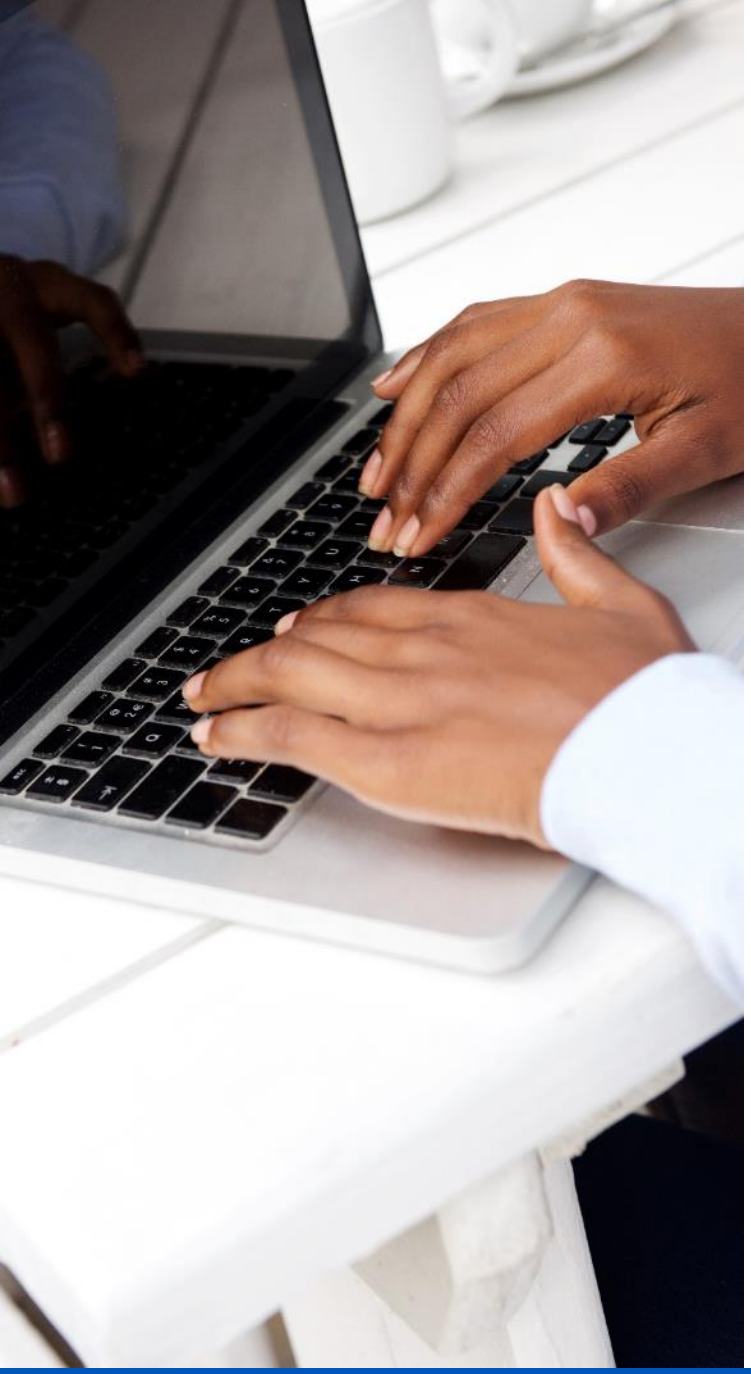

Hands-On Exercise 3.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 3.1: Injecting a Service

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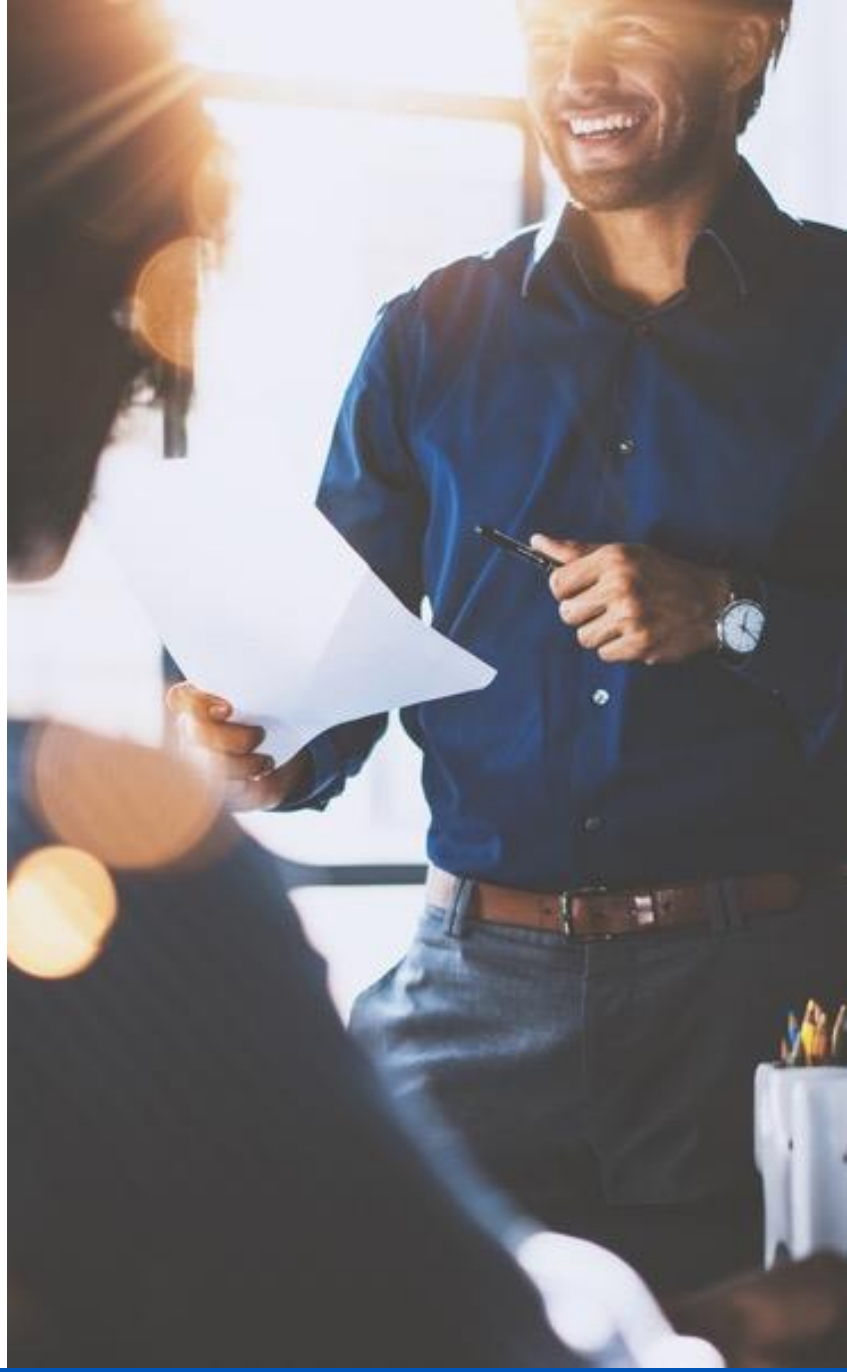
Objectives

- Learn how Angular implements dependency injection
- Learn how to interact with the Angular Component lifecycle



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Chapter 4

Testing Angular

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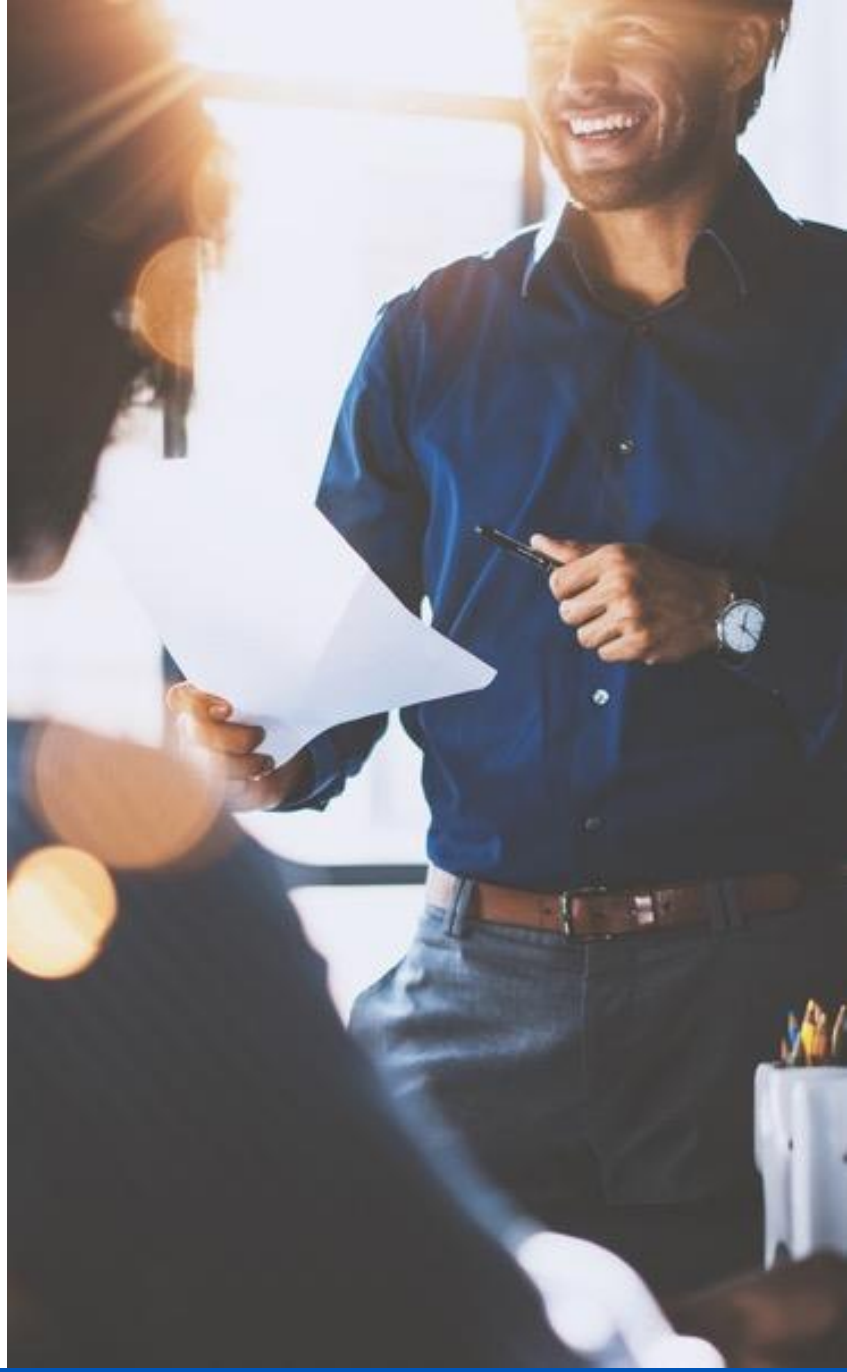
Objectives

- Test Angular Components
- Create isolated unit tests
- Perform end-to-end (E2E) testing



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Contents

Testing Strategies

- Arrow Functions
- Unit Testing
- E2E Testing

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Testing Granularity

- **Testing is essential**
- **A good philosophy is that if you have not tested it, then it does not work!**
- **User interface code is challenging to test**
  - Users do not always behave as we expect
  - Small changes to appearance can easily break tests
  - Checking DOM structures can be tedious
- **Testing options**
  1. Manual testing of complete application
  2. Automated testing of complete application
  3. Automated testing of each component in isolation
- **Option 1 may be acceptable for very small applications**
- **Generally need a combination of all three**

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Unit Testing

- **Test functionality of each component in isolation**
- **Process**
  - Create an instance of the object under test
  - Apply external conditions to it
  - Check the results
- **Validate that it behaves as expected with normal input**
- **Validate that it handles error conditions correctly**
- **Unit tests should**
  - Test a single component
  - Run quickly
  - Provide good coverage of the component under test
- **Well-written unit tests improve developer productivity**
  - Much quicker to run a test than to simulate user input manually

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Integration and End-to-End Testing

- **Integration testing**
  - Verifies that components interact correctly
- **End-to-end testing validates the entire system**
  - Apply use cases to the application
    - Verify it behaves correctly
- **Integration and E2E tests, while important,**
  - Should be regarded as secondary to unit testing

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Contents

- Testing Strategies

Arrow Functions

- Unit Testing
- E2E Testing

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Arrow Functions

- **Angular makes extensive use of asynchronous functionality**
  - Do something and call a function on completion
- **Both test code and code under test need to specify call-back functions**
- **Simplified by TypeScript (and ES2015) arrow functions**

```
(arg1, arg2) => { // arrow function body }
```

- **Arrow functions can be used anywhere an anonymous function can be used**

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Example Arrow Functions

- **Arrow functions are an alternative syntax for anonymous function declarations**

TypeScript

```
this.http.get(url)
     .map().do((res) => console.log("Result" + res));
```

Older JavaScript

```
this.http.get(url)
     .map().do(function(res){
               console.log("Result" + res);
  }
);
```

- **Shorthand syntax if there is only one argument**

```
res => console.log("Result" + res);
```

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Contents

- Testing Strategies
- Arrow Functions

Unit Testing

- E2E Testing

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Unit Testing With Jasmine

- **Jasmine is "a behavior-driven development framework for testing JavaScript code"***
- **Defines**
  - Suite of tests wrapped in a call to the Jasmine `describe()` function
    - Takes a string describing the suite and an arrow function
  - Individual *specs* (tests) defined by calling the Jasmine `it()` function
    - Takes a string describing the test and an arrow function which is the test
- **Angular CLI automatically creates Jasmine test specs for each component generated**
  - With a file extension of `spec.ts`
- **The generated tests are a starting point**

*Jasmine: Behavior-Driven JavaScript, http://jasmine.github.io

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Anatomy of a Jasmine Test Suite

Suite

CurrentWeatherComponent.spec.ts

```
import {CurrentWeatherComponent} from
        './forecast.component';

describe('Component: CurrentWeather', () => {

  it('should create an instance', () => {
    let component = new CurrentWeatherComponent ();
    expect(component).toBeTruthy();
  });

});
```

Name of Component under test

Spec—a test

This auto-generated spec passes if the `CurrentWeatherComponent` can be created

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Anatomy of an Individual Jasmine Spec

Simple description of the test

CurrentWeatherComponent.spec.ts

```
it('should create an instance', () => {
   let component = new CurrentWeatherComponent();
   expect(component).toBeTruthy();
 });
```

The expected behavior

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Test Dependencies

- **Problem: What if the component under test has dependencies?**
  - The constructor would need the dependencies supplied

```
let component = new CurrentWeatherComponent( dependency );
```

- **Dependencies must be provided by the test framework**
- **A `beforeEach( fn() )` function is used to initialize tests**
  - The provided function is executed before each spec is executed
- **`TestBed` is used to provide and initialize the dependencies**

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Creating a Test Environment

- **The simple test on the previous slides has another flaw**
  - It only allows direct testing of the Component class
    - Not DOM interactions
- **The Angular class `TestBed` provides**
  - A configurable test module
    - To satisfy dependencies
  - A DOM framework
    - So that the Components HTML DOM output may be verified

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TestBed

- **`TestBed` is used to create an environment for the component under test**
- **Created in two phases**
  - Each performed in a `beforeEach()`
- **Phase 1—Create the testing module**
  - `TestBed.configureTestingModule(module_metadata)`
  - `module_metadata` is a module definition based on `@NgModule`
  - The last phase of the module creation - `compileComponents()`
    - Must be performed asynchronously
      - Due to Jasmine constraints
- **Phase 2—Create a test *fixture***
  - Used to perform the tests
  - Typical tests use both the fixture and the component under test
  - Only executed when the first phase has completed

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TestBed Configuration—Part 1

- **Compile a test module**

CurrentWeatherComponent.spec.ts

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


  beforeEach(async(() => {
    TestBed.configureTestingModule({
      declarations: [ CurrentWeatherComponent ],
       providers: [WeatherService]
    })
    .compileComponents();
  }));

  // Phase 2 goes here

});
```

Perform asynchronously

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TestBed Configuration—Part 2

CurrentWeatherComponent.spec.ts

```
describe('CurrentWeatherComponent', () => {

  // Previous slide content here

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

});
```

`component` and `fixture` now ready to use in subsequent test specs

- **`fixture.detectChanges` runs a change detection cycle**
  - Syncs DOM with component properties

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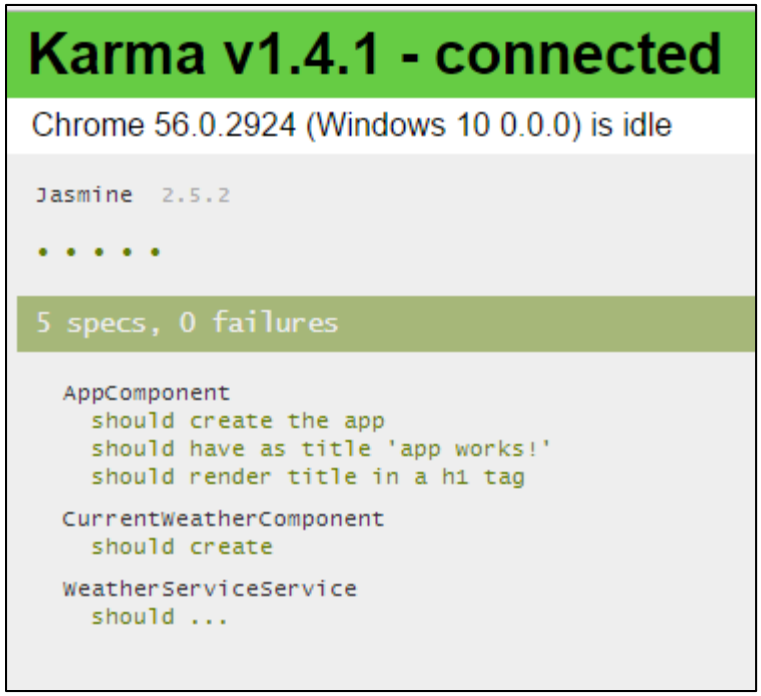
Working Test With All Dependencies Satisfied

- With the `TestBed` configured, we can now test the Component

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



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Mocking

- **One small problem!**
  - If we inject a component, then our test is testing both the component under test and the injected component
- **Solution: Mocking**
  - Create a minimal object that satisfies the injection requirement
- **Mock object(s) should be defined with the test code**
  - Provide known values to support test expectations
- **The Mock class must be defined before the test**

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Mock Weather Service

- **Mock weather service is the minimum code to satisfy the test**
  - Structure must match the object being mocked
- **A minimal mock for the `WeatherService`**

```
let mockWeatherService = {};
```

- **Mock code can evolve as the tests develop…**

```
class MockWeatherService {
  getWeather() : Observable<Weather[]>{
    return new Observable<Weather[]>();
  }
  savePreferences(preferences: Preferences ){}
  updatePreferences(preferences: Preferences ){}
  getWindSpeed(){}
  getForecast( location : string ){}
}
let mockWeatherService = new MockWeatherService
```

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Providing the Mock Object

- **The mock object must be added to the available providers, replacing the real object**
  - Real provider

```
providers:    [WeatherService]
```

  - Mock provider

Class being mocked

```
providers: [{provide: WeatherService,
             useValue: mockWeatherService }]
```

Mock to use

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Mocking Components

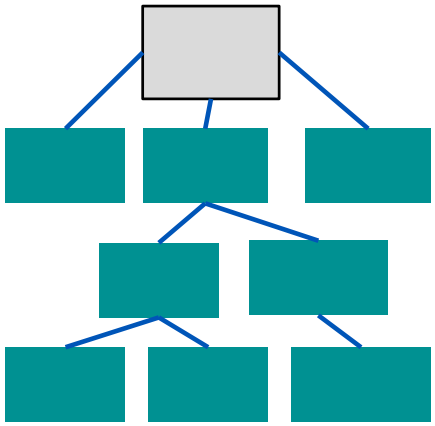
- **Components with child components**
  - Have elements in their templates referencing the child component

app-component.html

```
<app-buy-flight></app-buy-flight>
```

- **If the `TestBed` does not find components matching these selectors**
  - It will cause the test to fail

- **Solution: mock components**
  - Define a mock class
  - Decorate with `@Component` and a selector matching the component to be mocked
  - Use an empty template
    - Unless you *really* need to interact with the child template



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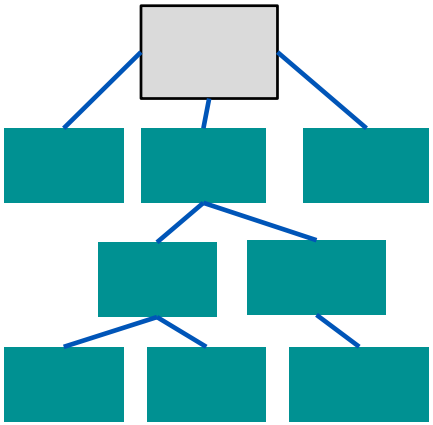
Mocking Components—Example

- **Solution: mock components**

app-component.html

```
<app-buy-flight></app-buy-flight>
```



Empty template

Selector

```
@Component({
template: '',
selector: 'app-buy-flight'
})
class MockBuyFlightComponent {}

describe('AppComponent', () => {
  beforeEach(async(() => {
    TestBed.configureTestingModule({
    imports: […],
    declarations:AppComponent, MockBuyFlightComponent]});
```

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Running Jasmine Tests With Angular CLI

- **Angular CLI will automatically run all the Jasmine unit tests using Karma**
  - Simply run `ng test` from the command line
    - Automatically rebuilds and tests each time a file is saved
  - A browser running Karma is launched to host the tests

```
Karma v1.4.1 - connected
Chrome 56.0.2924 (Windows 10 0.0.0) is idle

Jasmine 2.5.2

• x x • •

5 specs, 2 failures

Spec List | Failures

AppComponent should have as title 'app works!'

Expected 'app does not work!' to equal 'app works!'.

Error: Expected 'app does not work!' to equal 'app works!'.
```

```
Karma v1.4.1 - connected
Chrome 56.0.2924 (Windows 10 0.0.0) is idle

Jasmine 2.5.2

• • • • •

5 specs, 0 failures

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

CurrentWeatherComponent
  should create

WeatherServiceService
  should ...
```

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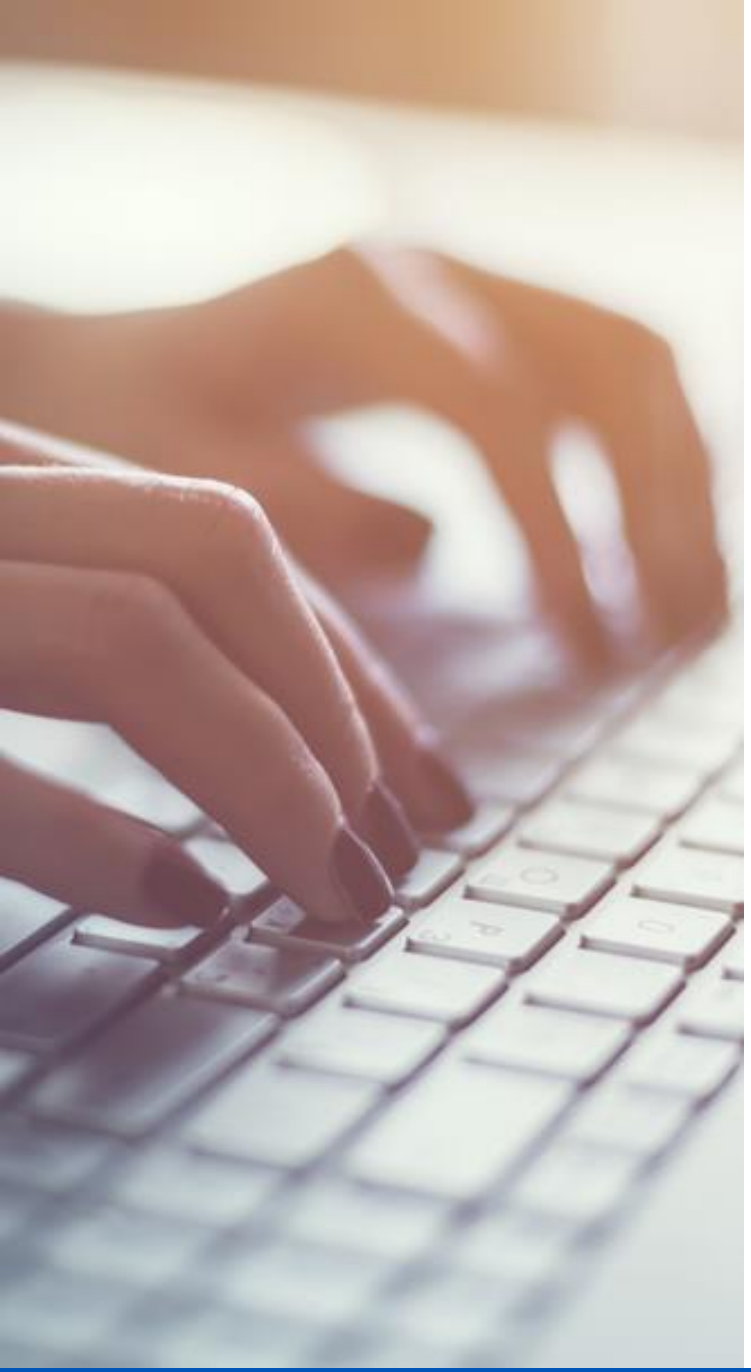

4.1: Execute a Test

Do Now

- In your Exercise Manual, please refer to Do Now 4.1: Execute a Test

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Testing a Component—Code Under Test

- **Example Component has a button which, when clicked, is disabled until the other button is clicked**

Update Weather | Enable Other Button

```
<button [disabled]="buttonDisabled"
       (click)="onClick()">Update Weather
</button>
<button [disabled]="!buttonDisabled"
               (click)="onClickOther()">Enable Other Button
</button>
```

```
buttonDisabled : boolean = false;

onClick(){ this.buttonDisabled = true;}

onClickOther(){ this.buttonDisabled = false;}
```

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Testing a `Component` Directly—Test Spec

- **The spec**
  - Calls the click method
  - Checks the state of the `buttonDisabled` property

```
it('the button should be enabled after onClickOther()',
   ( ) => {

     component.buttonDisabled = true;
     component.onClickOther();
     expect(component.buttonDisabled).toBeFalsy();

   });
```

`component` was initialized in `beforeEach()`

Direct access to methods and properties of the `component` under test

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Testing a `Component` via DOM Interaction

- **The spec**
  1. Locates the button to click via a CSS lookup
  2. Triggers a click event
  3. Locates the newly disabled button
  4. Checks the state of the `disabled` property

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Locating Controls

- **Interaction via the HTML DOM requires location of HTML controls**
  - Typically via CSS selectors
- **Consider using `id` attribute to create unique control locators**
  - Makes CSS selectors simpler and more robust

```
<button [disabled]="buttonDisabled"  id="updateButton"
       (click)="onClick()">Update Weather
</button>
<button [disabled]="!buttonDisabled" id="otherButton"
       (click)="onClickOther()">Enable Other      Button
</button>
```

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Testing a Component via DOM Interaction

```
it('the update button should be enabled after clicking the other
  button',( ) => {

  let buttonEle =
    fixture.debugElement.query(By.css('#otherButton'));

  buttonEle.triggerEventHandler('click', null);

  let updateButtonEle =
    fixture.debugElement.query(By.css('#updateButton'));

    expect(updateButtonEle.nativeElement.disabled)
          .toBeFalsy();
  });
```

1

2

3

4

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Testing Services via Dependency Injection

- **Services can be tested very simply using Jasmine**
  - Simply create the object and verify behavior
- **Angular CLI creates more flexible service tests by default**
  - Use the `TestBed` to make dependencies available

```
describe(WeatherService', () => {
  beforeEach(() => {
    TestBed.configureTestingModule({
    providers: ['WeatherService]
  });
});

it('should be created',
  inject([WeatherService], (service: WeatherService) => {

  expect(service).toBeTruthy();
}));
```

Configure `TestBed` with service to test as a provider

`inject` function makes the service available to the arrow function

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Test Recommendations

- **Create one test suite per component**
- **Each spec within the suite should**
  - Have a clear description
  - Be fine-grained
    - Test only one thing
- **Specs should build on each other**
  - Test simple things first
  - Gradually test more complex issues

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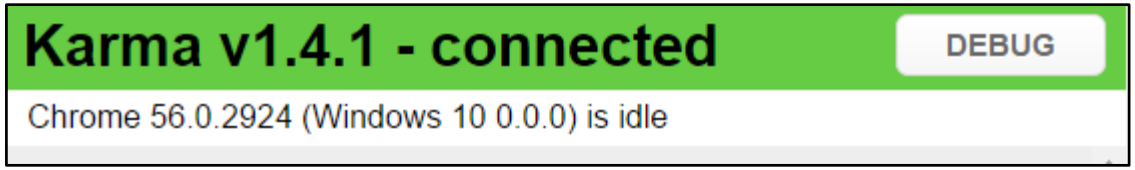
Debugging With Karma

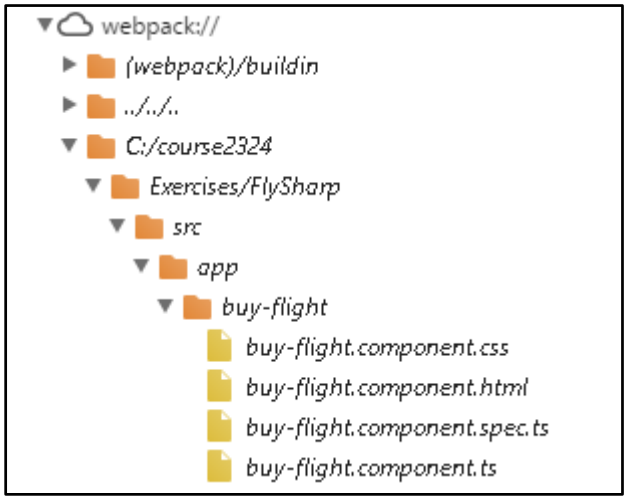
Demo

To debug a test running under Karma:

1. **Click the DEBUG button in Chrome**



2. **In the new page, open Web Developer Tools**
3. **Select the Sources tab**
4. **Browse to your test code**
5. **Set a break-point in your code**
6. **Refresh the browser to run your code**
7. **Close all Chrome instances when you are done**



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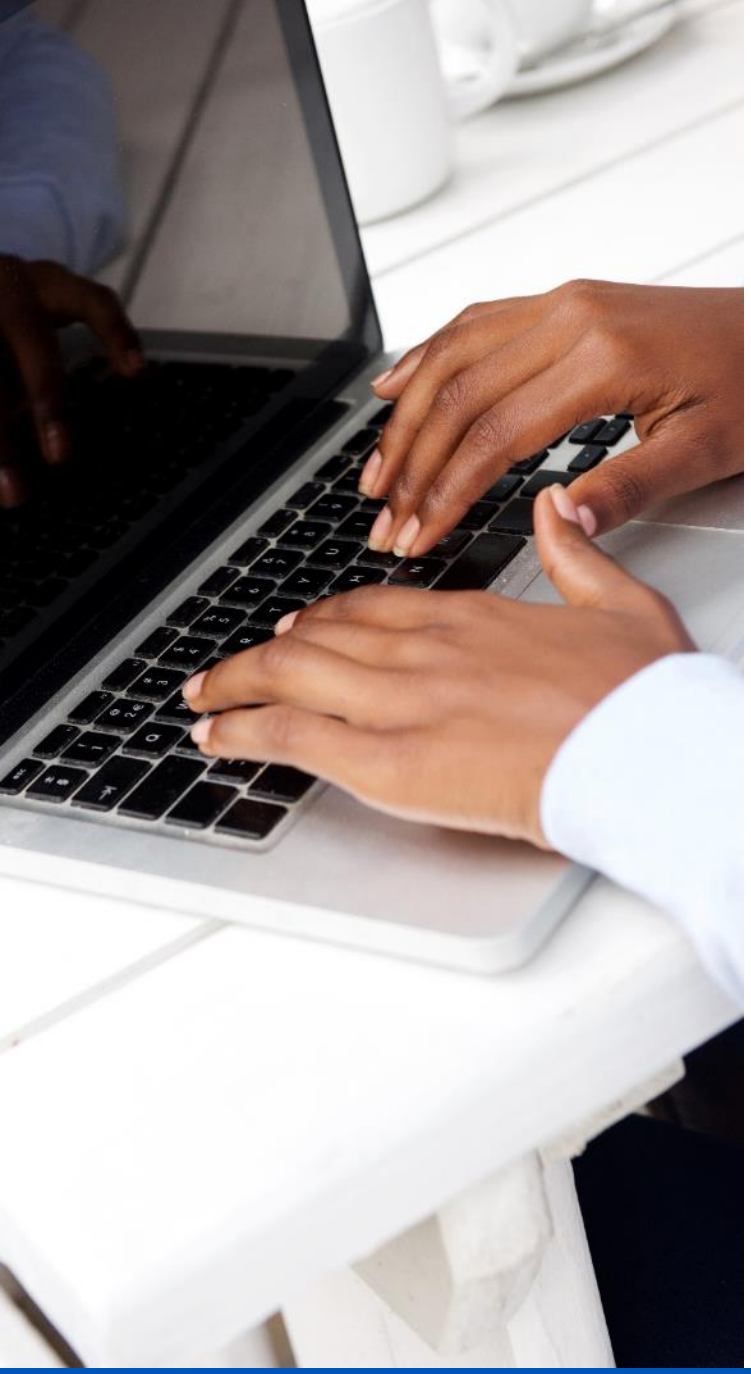

Hands-On Exercise 4.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 4.1: Unit Testing

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Contents

- Testing Strategies
- Arrow Functions
- Unit Testing

E2E Testing

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End-to-End (E2E) Testing

- **Testing the complete application**
  - Apply use cases and check results
- **Angular can be tested with Protractor**
  - Automates Jasmine tests on the application running in the browser
  - Caution: Protractor was created to test Angular JS 1 applications
    - Has many Angular JS–aware functions
      - Which may not work with Angular
    - Expect an Angular version soon
- **E2E testing is a powerful mechanism for checking that previously tested components work together**
- **Angular CLI generates a framework for E2E testing when a new project is created**

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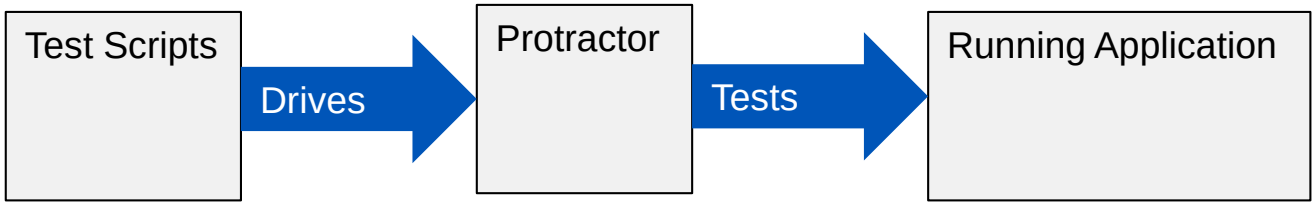
Testing With Protractor

- **Protractor**
  - Driven by test scripts
    - `*.e2e-spec.ts`—the overall test script
      - Uses Jasmine syntax
    - `*.po.ts`—page objects
      - Code to interact with the HTML DOM
- **Instructions in the scripts simulate user input**
  - Protractor applies those instructions to the DOM
    - Fetches modified state from the DOM
    - Validates resultant state



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A Protractor E2E Test

- **Jasmine driver script**
  - Uses `describe`, `beforeEach`, and `it` as we have seen

app.e2e-spec.ts

```
import { MyAppPage } from './app.po';

describe('fly-sharp App', function() {
  let page: FlySharpPage;

  beforeEach(() => {
    page = new FlySharpPage();
  });

  it('should display message saying app works', () => {
    page.navigateTo();
    expect(page.getParagraphText()).toEqual('my-app works!');
  });
});
```

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A Protractor E2E Test

- **Page accessor class provides user input simulation and results accessor**
- **The `by.css()` selector uses CSS selectors to specify data**
  - Works well with Angular

app.po.ts

```
export class FlySharpPage{
  navigateTo() {
    return browser.get('/');
  }

  getParagraphText() {
    return element(by.css('my-app-app h1')).getText();
  }
}
```

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Testing DOM Behavior

- **Selecting multiple items**

```
return (element.all(by.css('ul li')));
```

- **Counting items**

```
return (element.all(by.css('ul li'))).count();
```

- **Clicking elements**

```
clickForecastLink() {
   element(by.css('#forecast')).click();
 }
```

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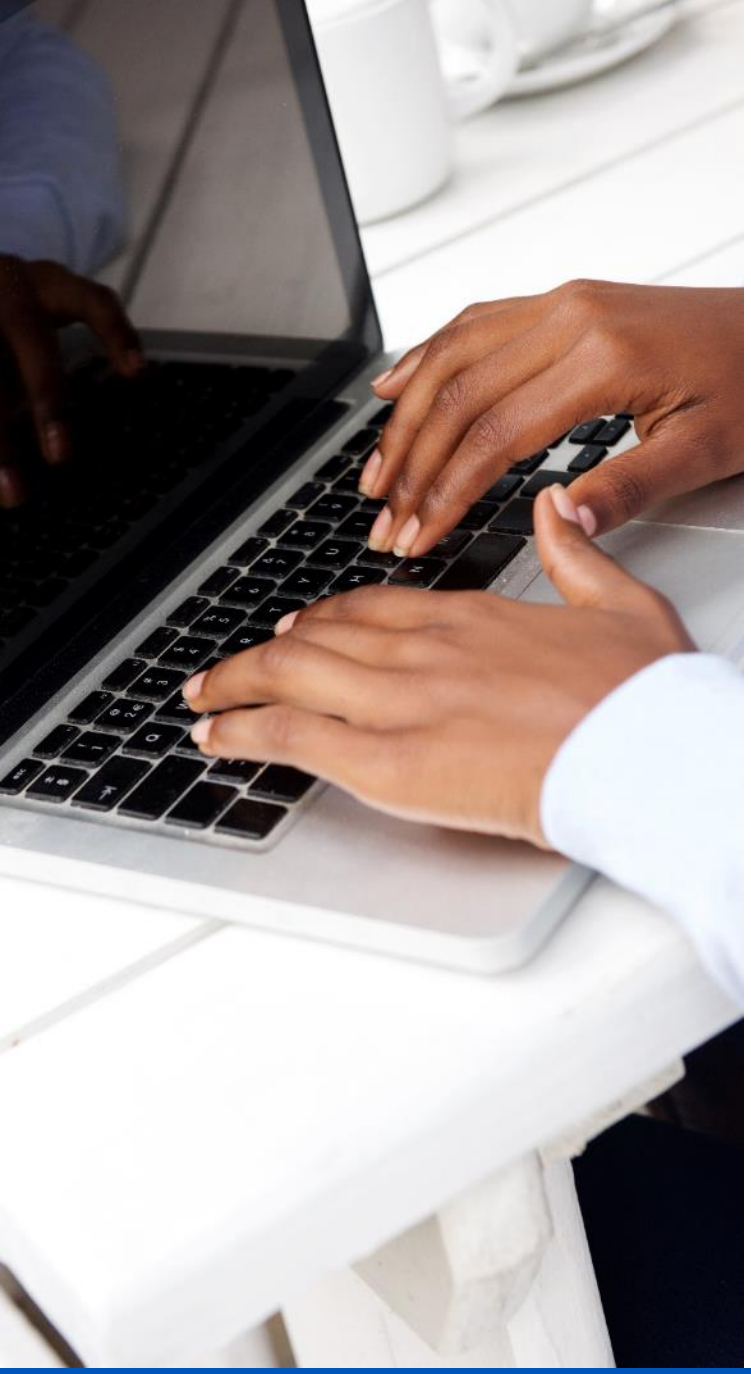

Hands-On Exercise 4.2

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 4.2: End-to-End Testing

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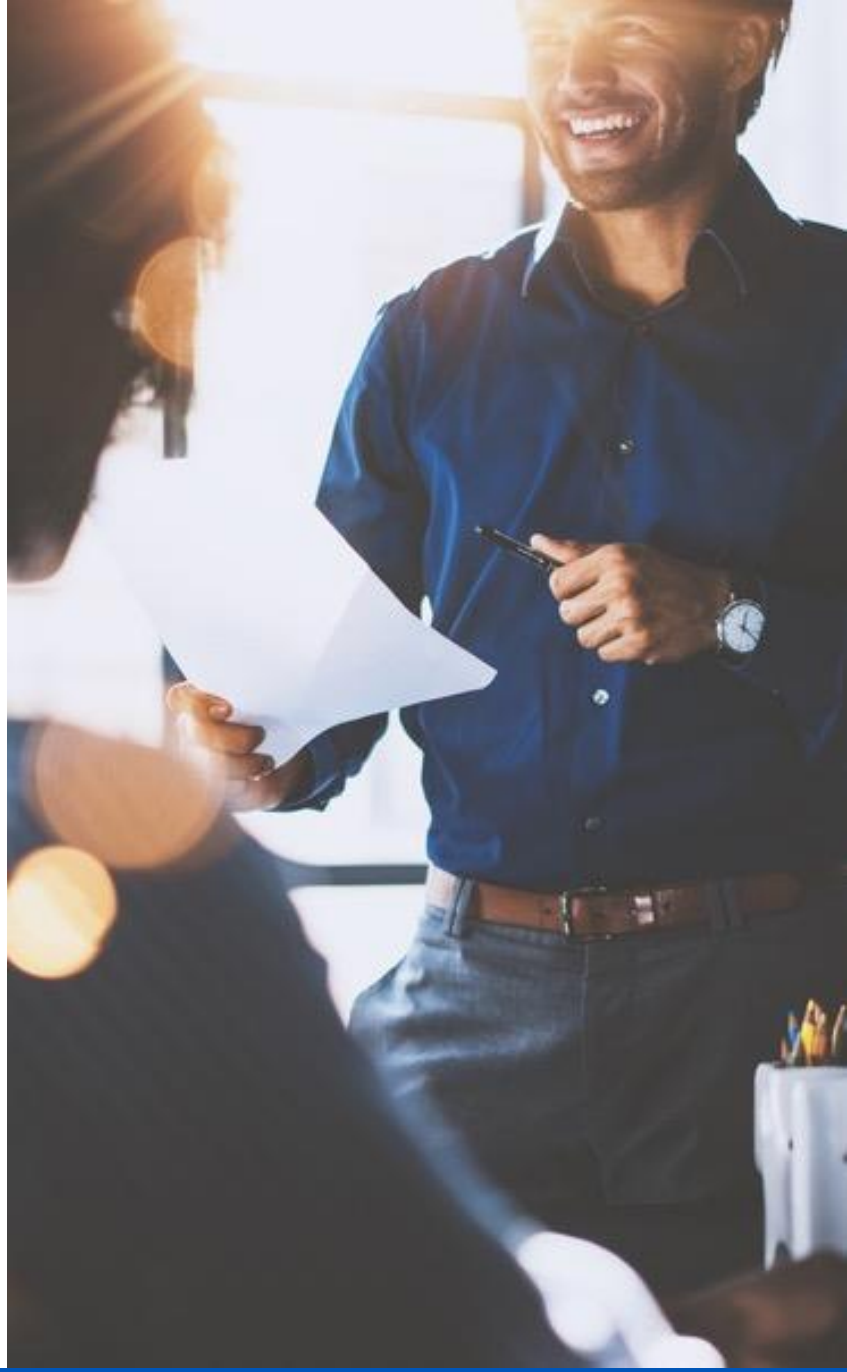
Objectives

- Test Angular Components
- Create isolated unit tests
- Perform end-to-end (E2E) testing



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Chapter 5

Component Interaction

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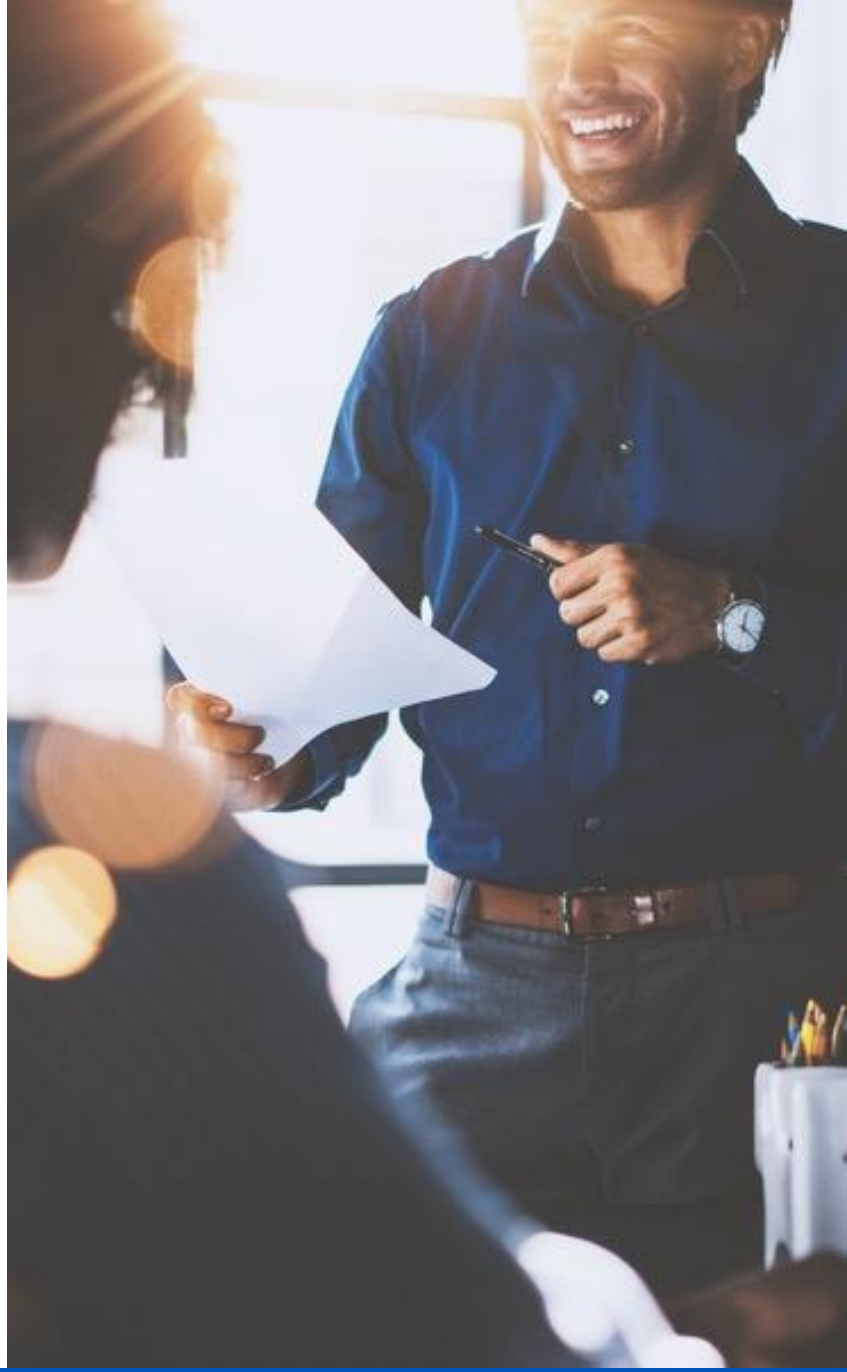
Objectives

- Exchange information between Components
- Display data from parent Components
- Define event emitters and handlers
- Share information with service Components



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Contents

Component Interactions

- Property Bindings
- Events
- Direct Communication

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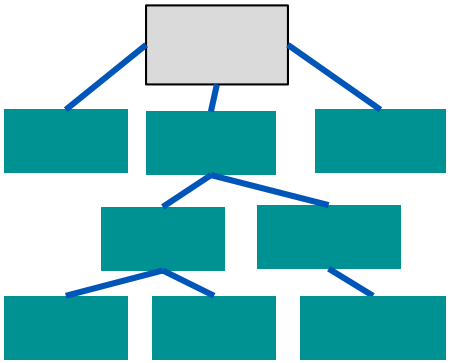
Interacting Components

- **Angular Components each have**
  - Their own screen area
  - Their own data
- **They may have**
  - Parents
  - Children
- **For the application to function**
  - Information must be communicated between Components



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Component Interactions

- **Example interactions**
  - Buttons on parent Component enabled only when fields are filled on child
  - Data in child Component modified by selection in a parent
  - Events broadcast by a Component
  - Events triggered by user actions
- **Angular techniques for handling interactions**
  - Input bindings
    - Intercepting input changes with a setter
    - Intercepting input changes with a lifecycle event
  - Local template variables
  - Event handling
  - Event generation
  - `ViewChild`
  - Shared Components

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Contents

- Component Interactions

Property Bindings

- Events
- Direct Communication

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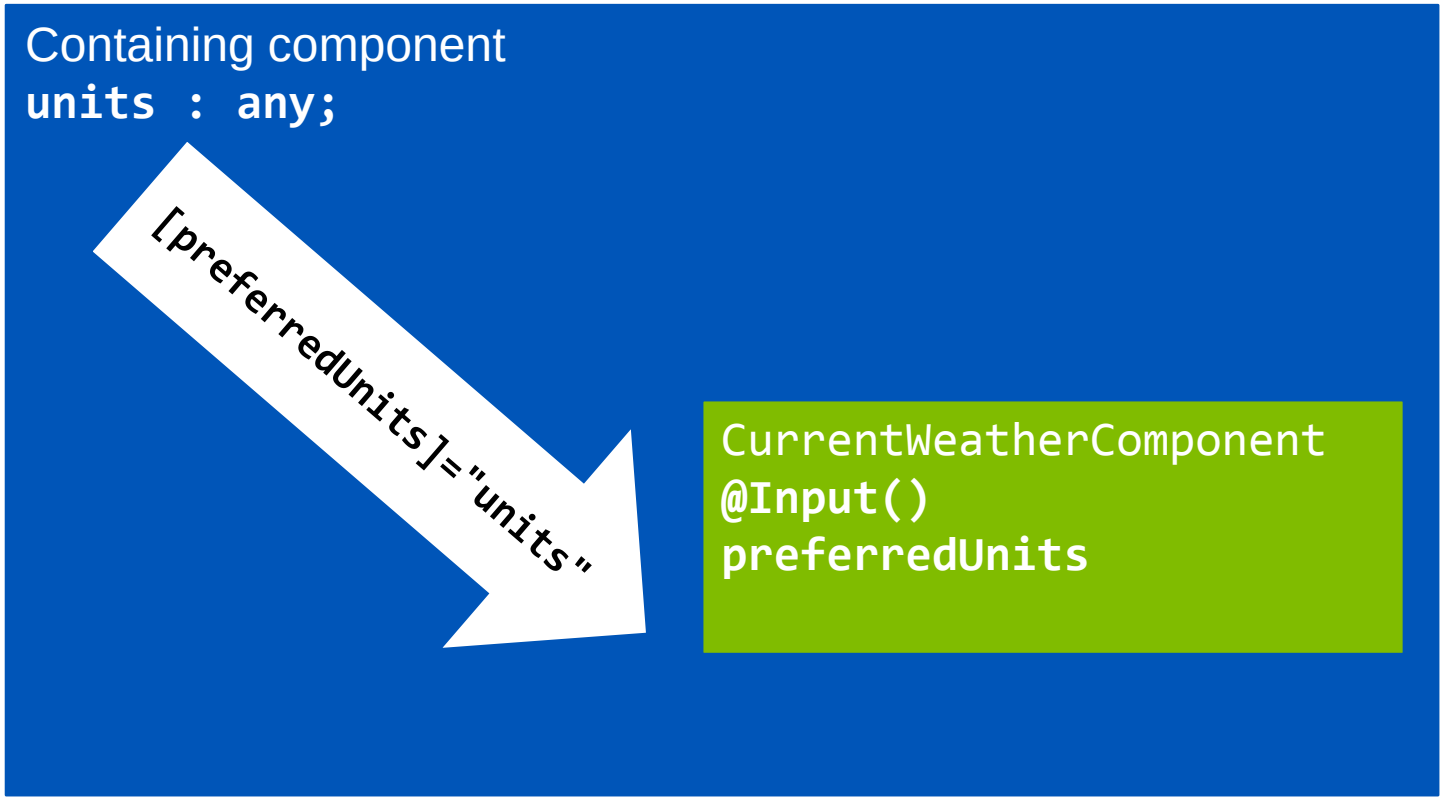
Input via a Property Binding

- **In our example**
  - Changes to `units` on the containing (parent) Component
    - Will automatically be copied to `preferredUnits` on the child Component



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Input via a Property Binding

- **Property bindings—`[target]="expression"`**
- **Can set properties on both the DOM and Components**
  - Example sets the `preferredUnits` property of the `app-current-weather` Component to the value of the units property on its containing parent

```
<app-current-weather [preferredUnits]="units"></app-current-
  weather>
```

- **The field on the class of the Component must be decorated with `@Input()`**

```
export class CurrentWeatherComponent implements OnInit {

    @Input()
    preferredUnits : string;
…
```

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Intercepting Changes to Bound Properties

- **Logic in a Component may need to be notified of a change to a bound property**
  - For example, to trigger loading of resources or change button state
- **Two mechanisms available**
  - Providing a property setter
    - One method per property to be checked
  - Overriding the `ngOnChanges()` lifecycle method
    - Single method for all property changes

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A Property Setter

- **TypeScript setter syntax**
  - `set propertyName( prop : type)`
  - NB: Variable used to store property must have a different name to the method

```
set preferedUnits(preferredUnits : string) {
    this._preferredUnits = preferredUnits;
    console.log("New value is: " + preferredUnits );
    doStuff();
}
```

- **Getter syntax**
  - Can have getter or setter or both

```
get preferredUnits() : string {
    return this._preferredUnits;
}
```

- **The `@Input()` decorator must be placed immediately before the setter**

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Override ngOnChanges()

- **`ngOnChanges()` is called every time a bound property is modified**
- **Input parameter is an array of `SimpleChange` objects**
  - Each providing the `currentValue` and the `previousValue`

```
ngOnChanges(
        changes:{[propertyName: string]: SimpleChange }) {

  if (changes['preferredUnits'] !== undefined) {
        let value =
                changes['preferredUnits'].currentValue;
        console.log("New value is: " + value );
       doStuff();
  }
}
```

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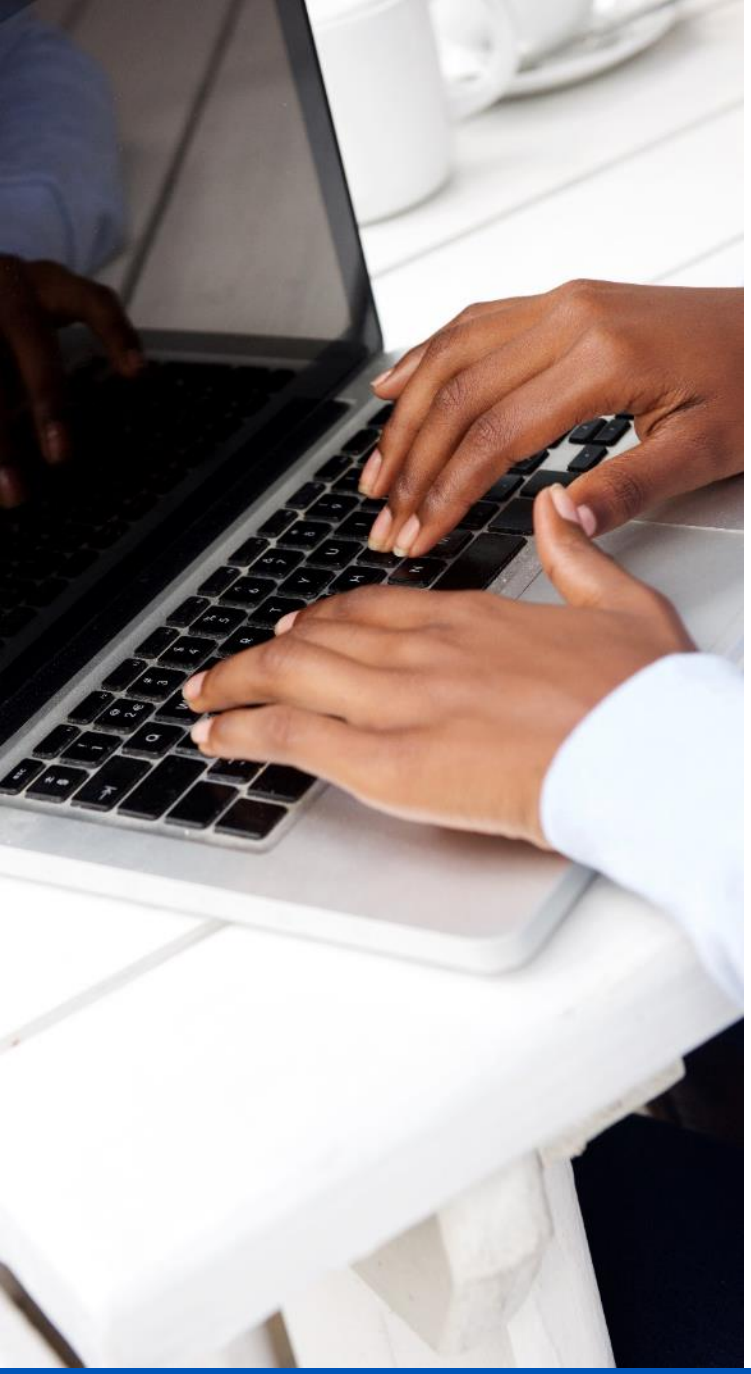

Hands-On Exercise 5.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 5.1: Implementing Input Bindings

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Contents

- Component Interactions
- Property Bindings

Events

- Direct Communication

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Emitting Events

- **Components may emit events**
- **Events are created by an `EventEmitter` field**
  - Must be decorated with `@Output()`
  - The emitted event will have the same name as the variable

```
export class CurrentWeatherComponent {

 @Output()
 weatherUpdated : EventEmitter<string>;
  …
   constructor() {
    this.weatherUpdated = new EventEmitter<string>();
  }
  …
  onClick(){
     this.weatherUpdated.emit(this.currentCity);
  }
```

The data type of the event

`emit()`triggers the event

The payload of the event

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Consuming Events

- **To consume an event from a Component**
  - Declare an event binding in the template
    - Binds the event emitter to a handler method
  - Use the `$event` keyword to pass the event to the handler

app.component.html

```
<app-current-weather
 (weatherUpdated)="onWeatherUpdated($event)">
</app-current-weather>
```

Name of event emitter

Method to invoke when event occurs

`$event` keyword passes event to the handler

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Consuming Events—Event Handler

- **The event handler is a method on the Component class**
  - Accepts a single parameter
    - The event data

app.component.ts

```
onWeatherUpdated( city : string ){
   console.log("City is : " + city);
 }
```

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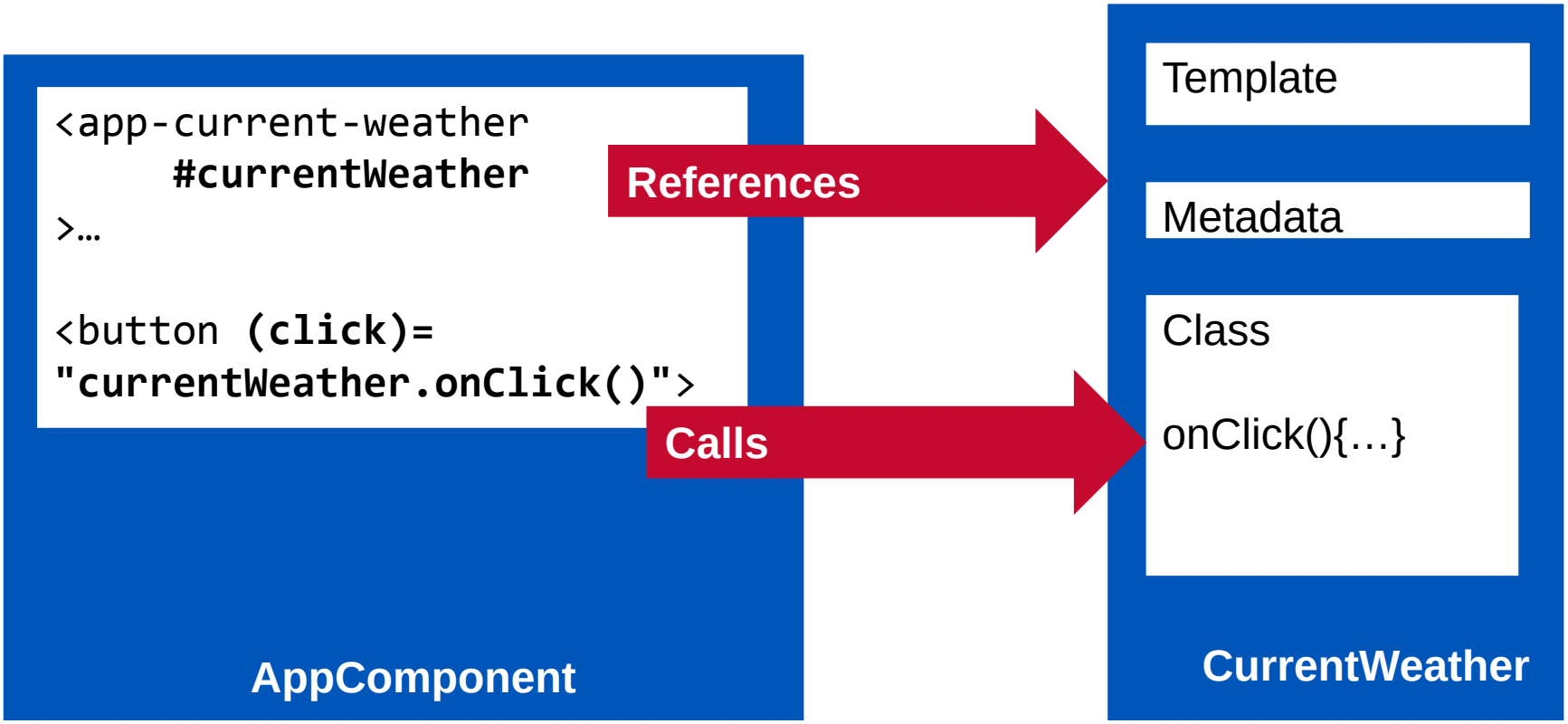
Template Reference Variables

- **Allow access from the template of one Component**
  - To the properties and methods of another



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Template Reference Variables

- **A mechanism to allow a parent Component to access methods and properties on a child Component**
  - Only works within templates
    - Not the Components class

1. **Define a reference variable for a Component**
   - The **#** character indicates that a reference variable is being declared
   - Variable becomes a reference to the Component in whose start tag it is declared

2. **Use that variable to access the Component elsewhere in the template**

```
<app-current-weather #currentWeather …></app-current-weather>

<app-weather-stats></app-weather-stats>

<button (click)="currentWeather.onClick()">Update Child
  Weather</button>
```

1

2

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Pseudo Key Events

- **DOM key events may all be bound**
  - `keydown`, `keypress`, `keyup`
- **Pseudo events allow event handlers to be bound to a single key**
- **Example: Update the user field of a Component with the value of the `<input>` control**
  - When the `<Enter>` key is pressed

```
<input #userInput (keyup.enter)="user=userInput.value">
```

Reference variable

Pseudo event binding

- **Examples of pseudo key events**
  - `keydown.a`, `keypress.2` ..
- **Special values**
  - `keyup.space`, `keyup.dot`

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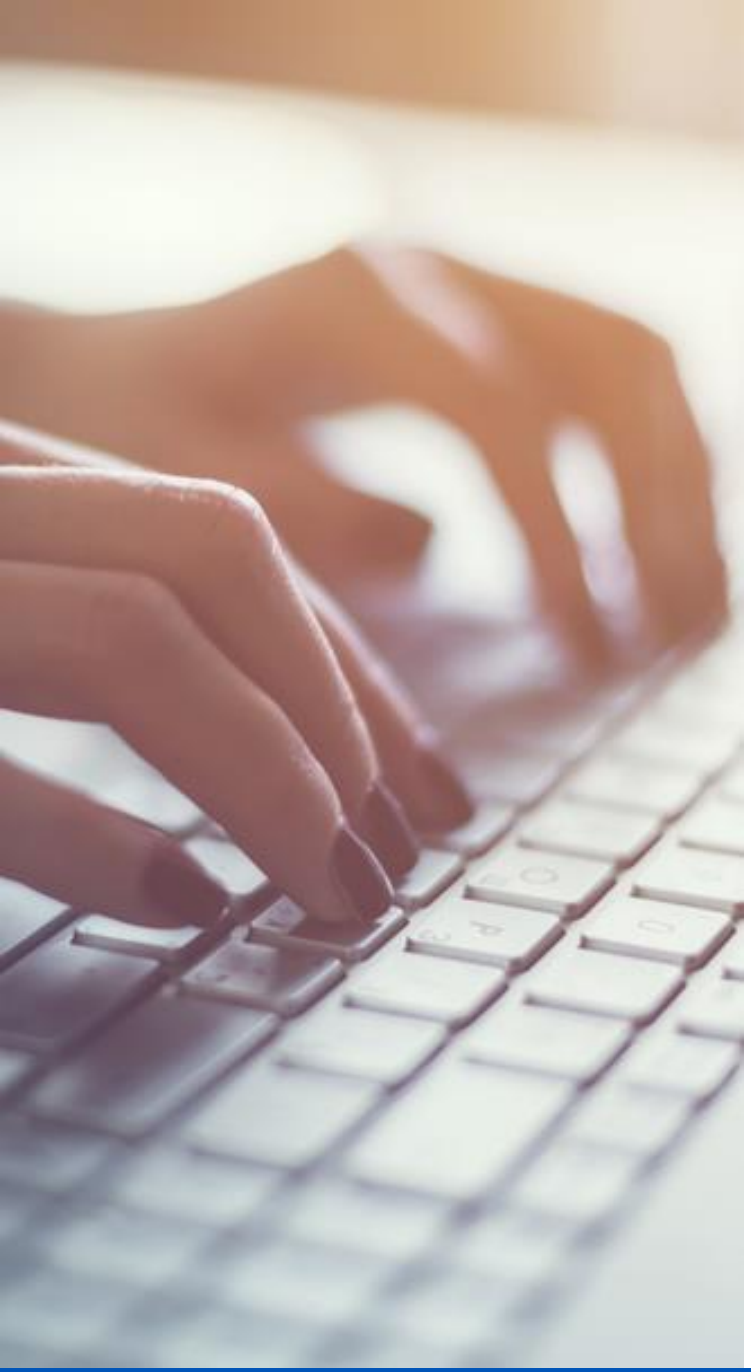

5.1: Pseudo Key Events in Action

Do Now

- In your Exercise Manual, please refer to Do Now 5.1: Pseudo Key Events in Action

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Contents

- Component Interactions
- Property Bindings
- Events

Direct Communication

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@ViewChild

- **`@ViewChild` allows direct access to all non-private members of the child Component**
  - Template reference variable is limited
    - Allows access to the child only from the template
- **Angular uses DI to populate the `@ViewChild` variable**

```
export class AppComponent {

  @ViewChild(CurrentWeatherComponent)
  currentWeatherComponent : CurrentWeatherComponent;

 private onClick(){
    this.title='new title';
    this.currentWeatherComponent.currentCity = "Tokyo";
  }
```

Class of `@ViewChild` variable

Access members and variables of the view child

DI = dependency injection

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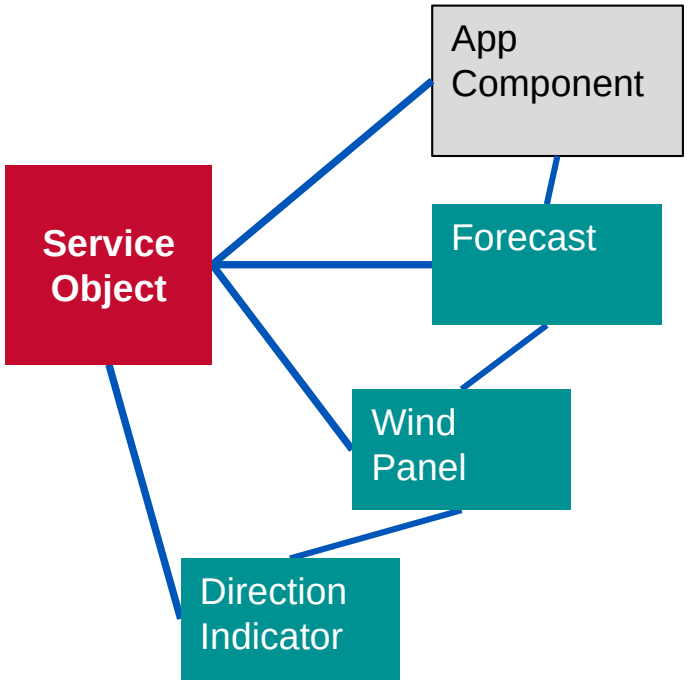
Communication via Shared Service Objects

- **Dependency injection (DI) provides another communication option**
  - Shared service objects
- **In Chapter 3, we showed that a service can be shared across multiple Components using DI**
  - Can use the service to share data between all Components that access it
- **Sharing model data with an injected service object is best practice**
- **Use event handlers and property bindings for sharing all data other than the model**



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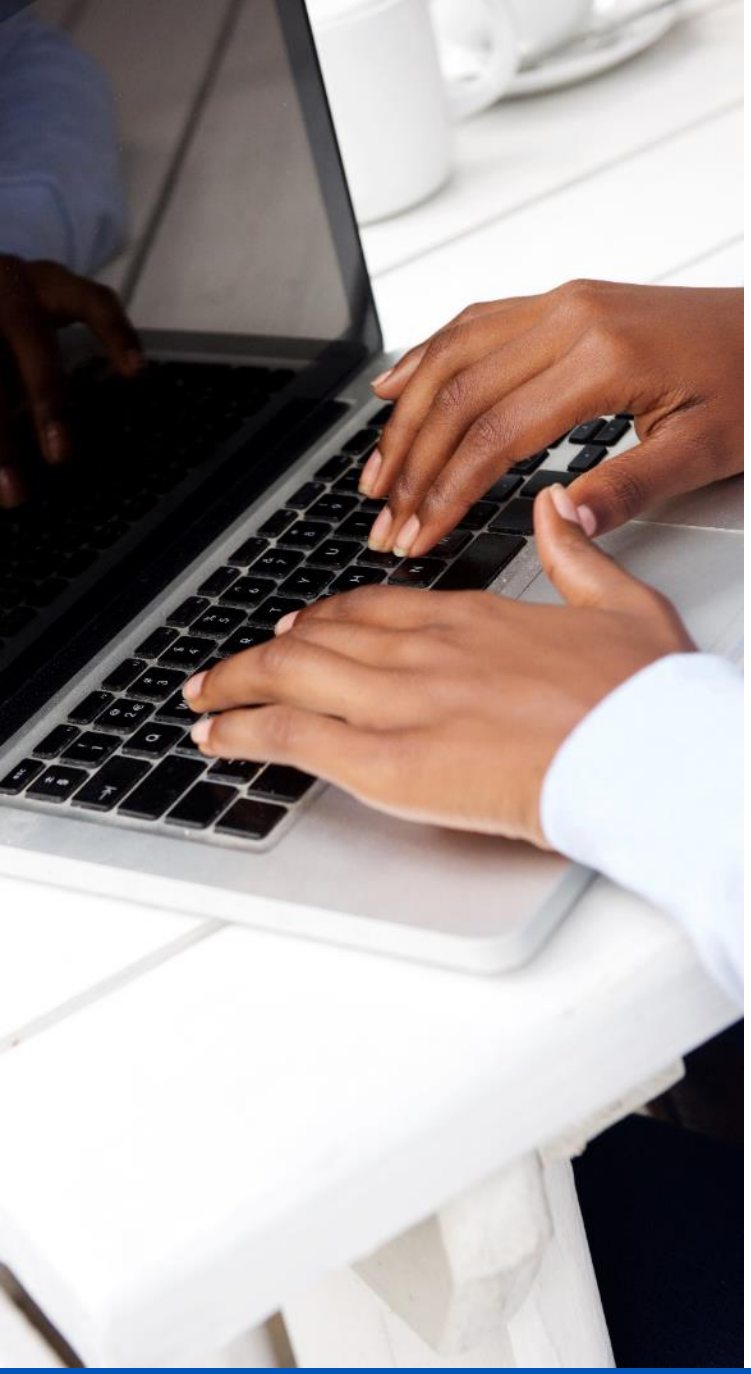

Hands-On Exercise 5.2

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 5.2: Event Handling

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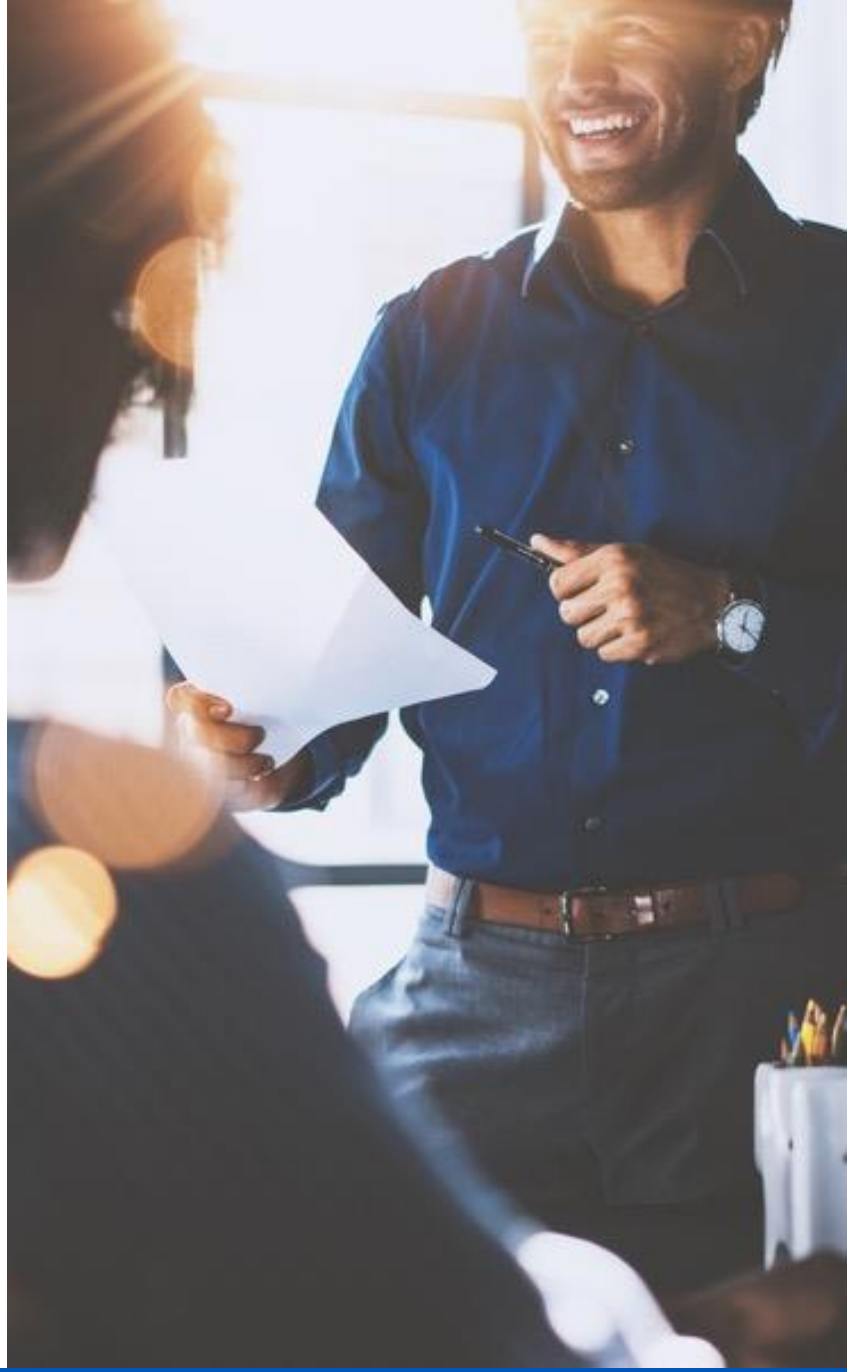
Objectives

- Exchange information between Components
- Display data from parent Components
- Define event emitters and handlers
- Share information with service Components



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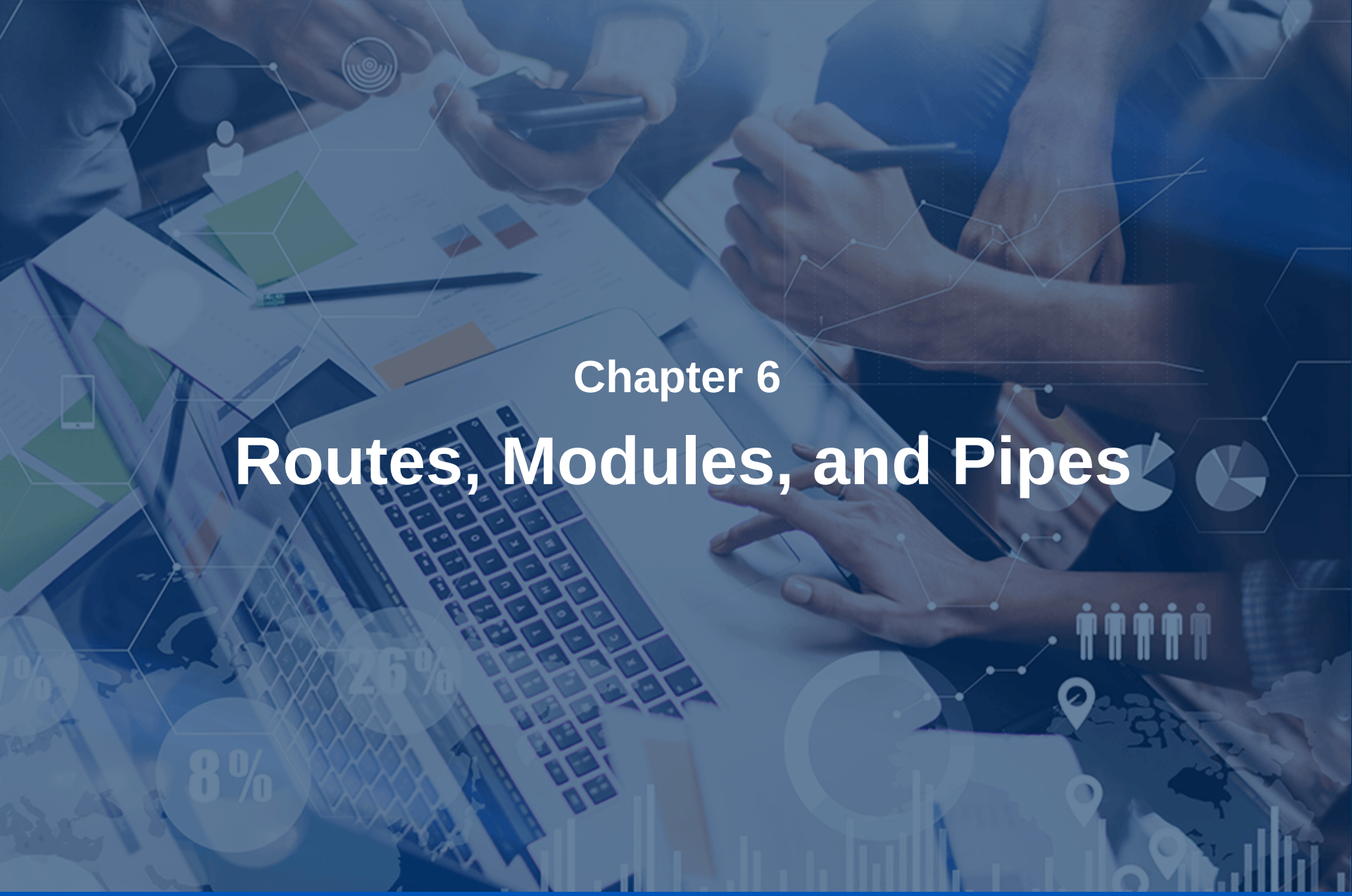


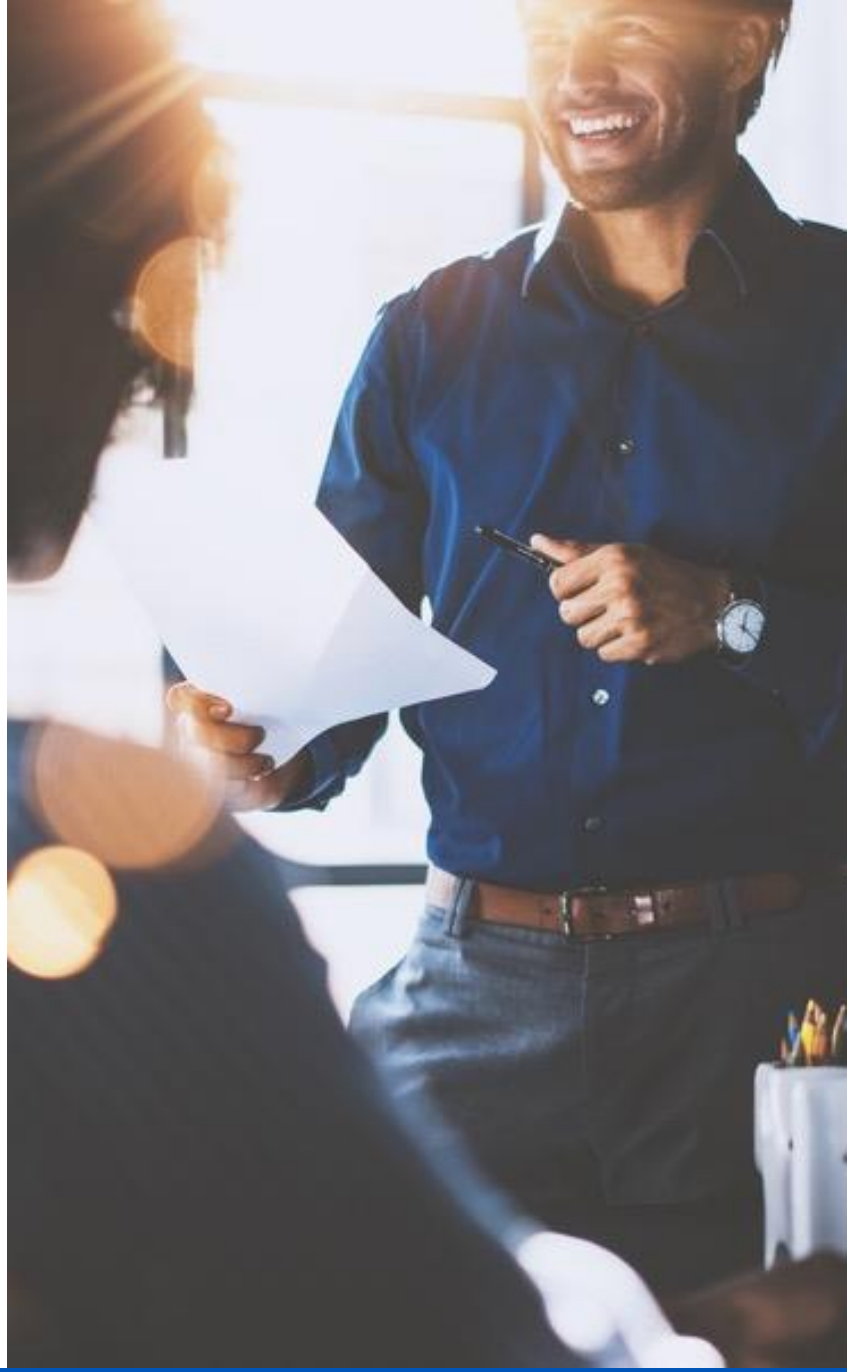
Chapter 6

Routes, Modules, and Pipes

LEARNING TREE INTERNATIONAL

Objectives

- Implement navigation with the Component Router
- Declare routes and configure the router
- Interact with the router programmatically
- Transform data with pipes



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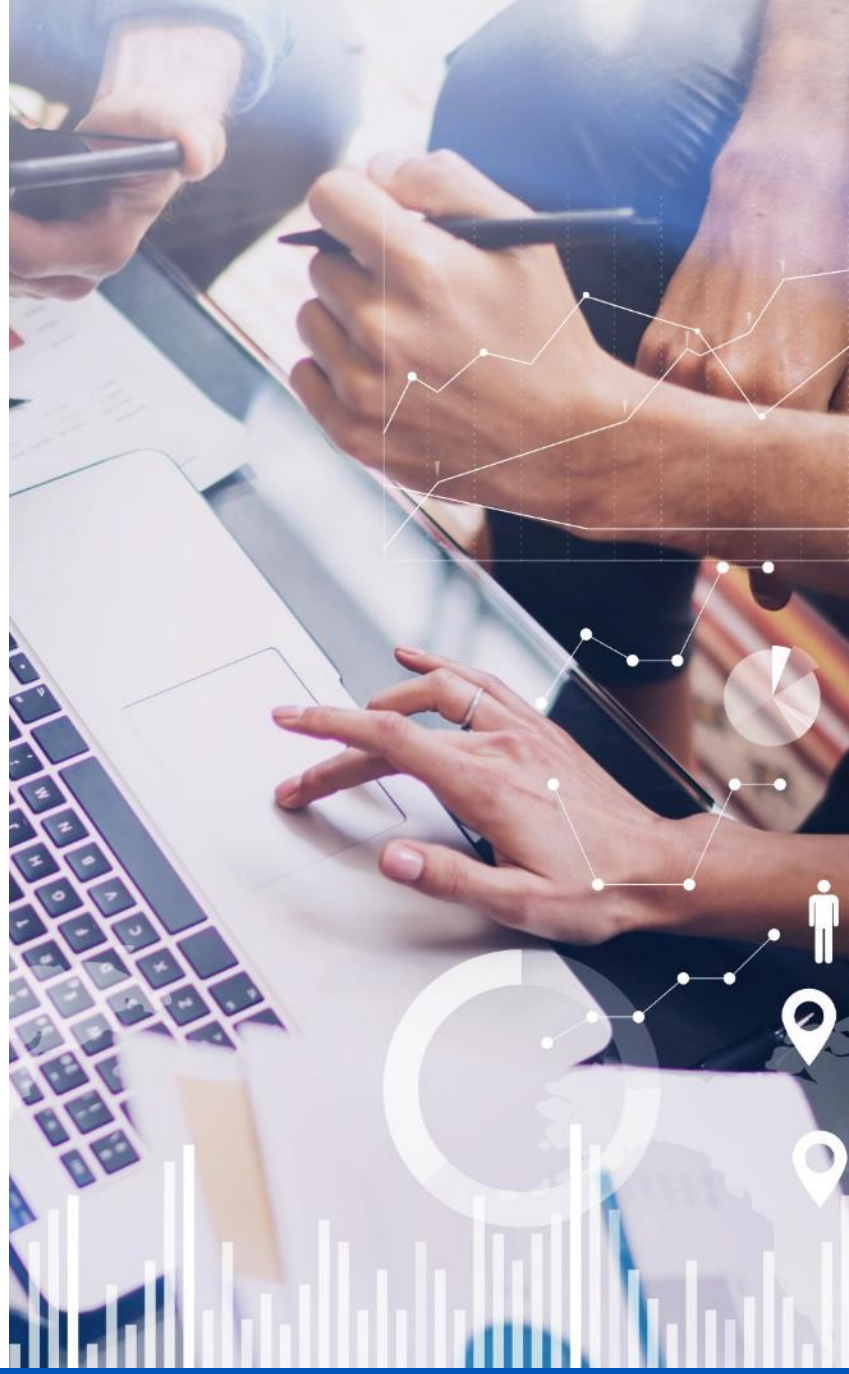
Contents

The Component Router

- Routing and Feature Modules
- Pipes



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Introducing the Component Router

- **The router provides a navigation mechanism**
  - Browser URLs control which Angular Component to display
- **Routing controlled**
  - By browser URL
  - By Back/Forward buttons
  - By binding to links in a page
  - Programmatically
- **Benefits**
  - Works well with a tab-style view paradigm
  - Provides multiple independent Component trees
  - Reduces load times

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Configuring the Component Router

- **Steps**
  1. Configure the router environment
  2. Define navigation routes
  3. Bind routes to templates
  4. Programmatic navigation

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1. Configure the Router Environment

- **Add a `<base>` element to the `index.html` page**
  - Used to resolve relative paths within the application
  - Required to allow JavaScript to push URLs onto the browser history

```
<base href="/">
```

- **If your application will be hosted on a path within your server**
  - http://www.myserver.com/myangularapp/
  - The `<base>` `href` attribute should include the path

```
<base href="/myangularapp/">
```

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The Router Configuration Module

- **The router is configured by a collection of path/Component pairs**
  - `path: 'home', component: HomeComponent`
    - When the URL is `/home`, the `HomeComponent` will be displayed

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2. Define Navigation Routes

- **Routes are defined in an array**
- **Each array element consists of**
  - A path
    - Relative to the application base path
  - A Component to activate when the path is matched

```
const routes: Routes = [
  { path: '', component: HomeComponent },
  { path: 'home', component: HomeComponent },
  { path: 'forecast', component: ForecastComponent },
  { path: 'preferences', component: PreferencesComponent }
];
```

- **A route with a `path` of `''` should be provided**

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Bootstrapping the Router

- **To use the router**
  - The application module provides router configuration via dependency injection
- **Add `RouterModule.forRoot(routes)`to the module `imports`**
  - `routes` is the `Routes` array defined previously
- **Dependency injection makes the router configuration available to any Component**

app.module.ts

```
const routes: Routes = […

@NgModule({
 declarations: […]
 imports: [
       RouterModule.forRoot(routes),
  ]
});
```

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3. Bind Routes to Templates

- **The top-level (application shell) Component must provide a `<router-outlet>`**
  - The location for the Components specified by the router to be displayed

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

- **Navigation links are provided by the `<a>` element**
  - Using a binding to `routerLink` instead of an `href` attribute

```
<a routerLink='/home'>Home</a>
```

Matches the path in the `router` config

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Redirecting Routes

- **A route with a path of `''` should be provided**
  - But this path may *not* have an obvious mapping to a Component
- **Redirects offer a solution**
  - `redirectTo`: the path to activate
  - `pathMatch`: how to evaluate the path
    - `full`: must match the entire path
    - `prefix`: matches a path which starts with the path in the route

app.routes.ts

```
const routes: Routes = [
  {
    path: '',
    redirectTo: '/home',
    pathMatch: 'full'
  },
  { path: 'home', component: HomeComponent },…
];
```

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Parameterizing Routes

- **Routes may be specified as having a data Component**
  - For example, identifying which forecast location to use

```
{ path: 'forecast/:location', component: ForecastComponent }
```

- **If the supplied URL was `http://…./forecast/Toronto`**
  - The `location` parameter would be `Toronto`
- **`path` declarations can have multiple placeholders for parameters**
  - `forecast/:location/:units`

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Retrieving Route Parameters

- **Route parameters are accessed via `ActivatedRoute`**
  - Automatically supplied via dependency injection
- **`ActivatedRoute.params` returns an Observable**
  - Calls our function with an array of parameters when available
  - Route parameter can be extracted from the array

Injected

```
constructor(private route: ActivatedRoute,
            private weatherService : WeatherService ){}

ngOnInit(){
   this.route.params.subscribe(params => {
     this.location = params['location'];
   });
}
```

Extract the route parameter called `'location'`

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4. Programmatic Navigation

- **Any Component may use the router for navigation**
  - Add a Router argument to the constructor
    - The dependency injector automatically provides the router
- **Use `Router.navigate()` to perform routing**
  - Router path prefixed with a `'/'`

```
constructor( private router : Router ) {}

onClickWarnings(){
  this.router.navigate(['/warnings'])
}
```

Path must start with /

```
<button (click)="onClickWarnings()">Warnings</button>
```

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Adding Path Parameters Programmatically

- **Route parameters may be added to the array passed to `navigate()`**

```
{ path: 'forecast/:location', component: ForecastComponent }
```

```
 onClickForecast(){
    let theLocation = "Paris";
    this.router.navigate(['/forecast', theLocation ]);

  }
```

- **Path may have multiple parameters**

```
'forecast/:location/:units'
```

- **Supplied array must provide elements for the path**
  - Each placeholder in the path
    - The array must be ordered to match the path specifier

```
this.router.navigate(['/forecast', location, units ]);
```

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Query Parameters

- **URL data can be sent as query parameters**
  - An alternative to path parameters
  - Useful when parameters are optional
- **Query parameters are sent as `name=value` pairs at the end of the URL**
  - Separated from the URL by a `?`
  - `http://…./forecast?location=Toronto&units=Celsius`
- **Query parameters are not declared in the router configuration**

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Retrieving Query Parameters

- **Query parameters are also accessed via `ActivatedRoute`**
  - In the `queryParams Observable`

```
constructor(private route: ActivatedRoute, …){}

ngOnInit(){
  this.route.queryParams.subscribe
      (params => {
              this.location = params['location'];
      });
}
```

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Adding Query Parameters Programmatically

- **Query parameters are added to the request as an object with a property `queryParams`**
- **`queryParams` is converted to the query parameters in the URL**
  - Each property becoming a query parameter

```
{ path: 'forecast', component: ForecastComponent }
```

```
onClickForecastByQuery(){
    let location = “Toronto";
    let units = "Celsius";
    this.router.navigate(['/forecast'],
        {queryParams :
        {'location' : location, 'units' : units}});
}
```

- `http://…./forecast?`**`location`**`=Toronto&`**`units`**`=Celcius`

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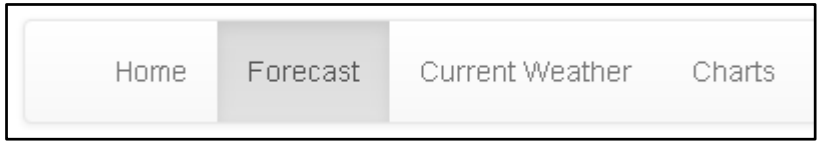
Showing the Active Route in the Template

- **A CSS class may be toggled to show the active route**
- **Add the `routerLinkActive` directive to an element**
- **The specified class is added to the element**
  - If that element or it's child matches the current active route



Class `'active'` is added to the `<li>` if the active route is `/forecast`

```
<li routerLinkActive="active" >
  <a routerLink='/forecast'>Forecast</a>
</li>
```

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Route Guards

- **Prevent routes being activated/deactivated**
- **Based on some programmatic condition**
  - Perhaps whether the user has logged it?
- **Guards are specified in the Routes object**

```
const routes: Routes = [
  { path: '', component: HomeComponent },
  { path: 'home', component: HomeComponent },
  { path: 'forecast', component: ForecastComponent,
                          canActivate: [RouteGuard] },
  { path: 'preferences', component: PreferencesComponent }
];
```

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canActivate canDeactivate Guards

- **CanActivate**
  - Prevents routes being activated until a condition is met
  - Returns true to indicate a route can be activated

```
@Injectable()
export class RouteGuard implements CanActivate {
  canActivate() {
    console.log('RouteGuard#canActivate called');
    if(some_condition) return true;
    return false;
  }
}
```

- **canDeactivate**
  - Similar structure, but returns true if it is OK to leave the current page
- **Guards may return a Boolean or an `Observable<Boolean>`**

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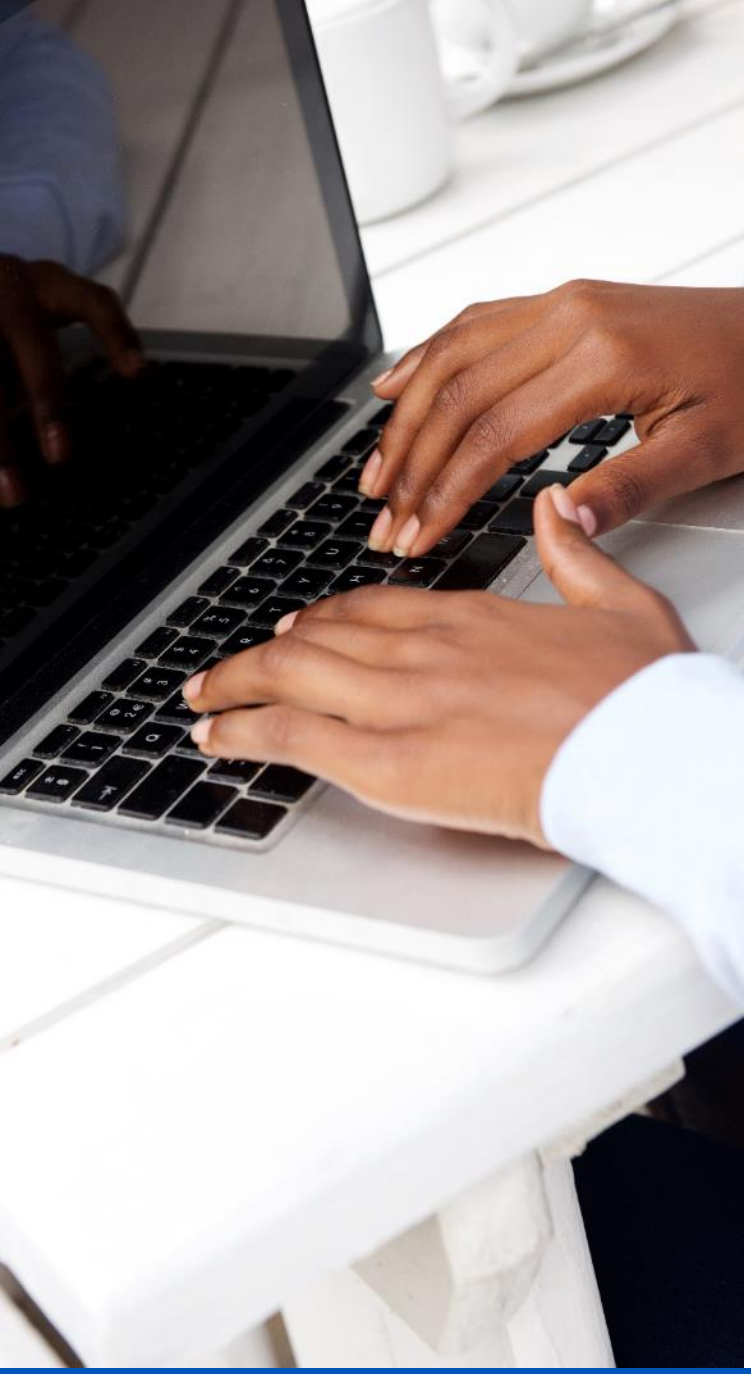

Hands-On Exercise 6.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 6.1: Integrating the Component Router

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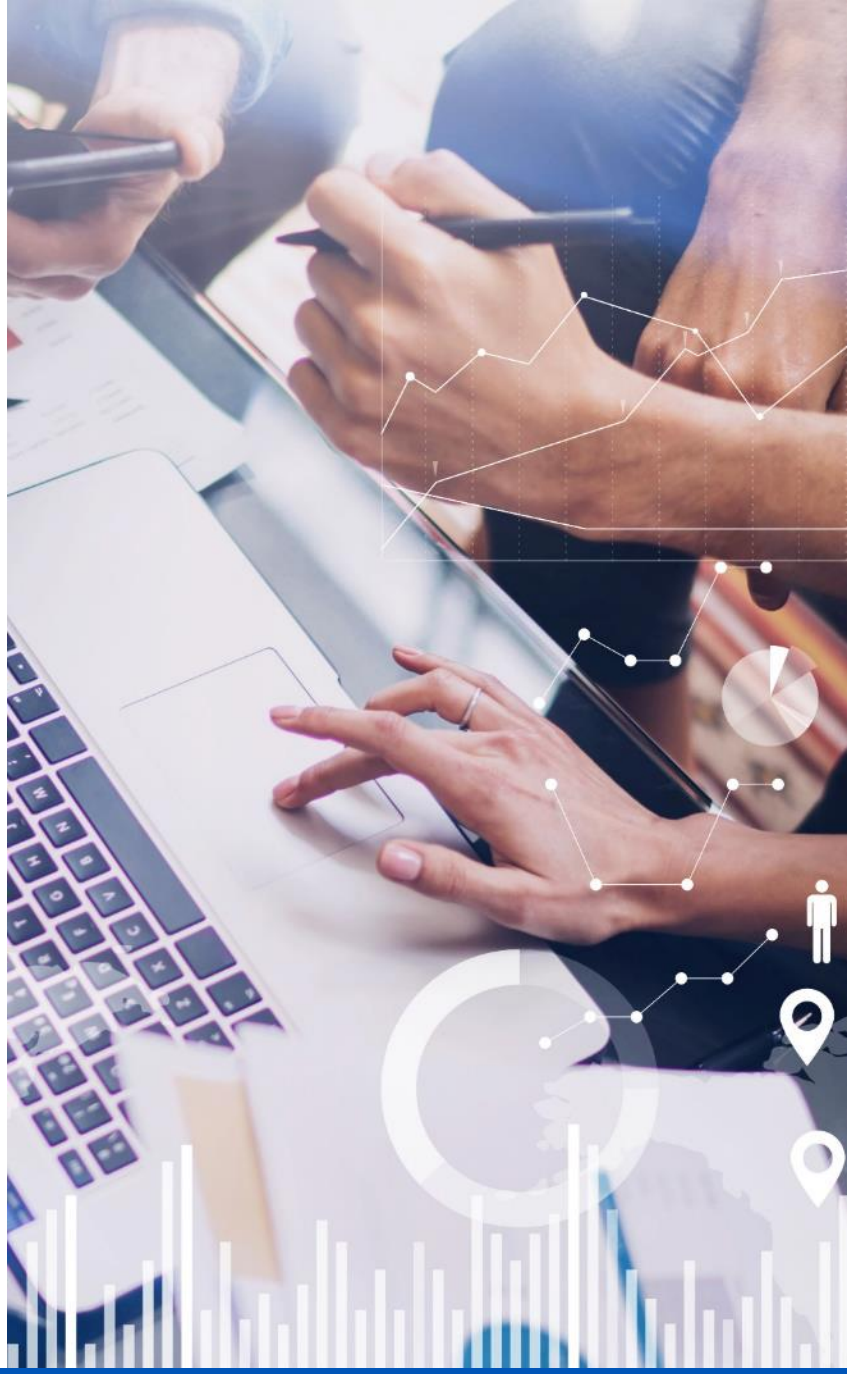
Contents

- The Component Router

Routing and Feature Modules

- Pipes



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Feature Modules Revisited

- **Angular code (components, directives, services, pipes, …)**
  - Must be placed in a module
- **Every application must have a minimum of a root module**
  - It may have feature modules
- **Feature Modules may be used to**
  - Package reusable code
  - Improve performance through lazy loading
  - Provide logical grouping of code

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Creating a Feature Module

- **Angular CLI makes module creation simple**

```
ng generate module CustomerAccountsModule
```

- **Generated module is very basic**
  - Does not actually do anything

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

- **As with the root module, declarations must be added**

```
declarations: [AccountComponent]
```

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Exposing Module Content

- **Module content is made available to the application in various ways**
  - Dependent on the purpose of the module and the content
- **Code is published from a module by**
  - Direct export (using `exports` property of `@NgModule`)
  - As a provider (using `providers` property of `@NgModule`)
  - Lazy loading via the component router

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Routing Modules

- **Routing modules allow routes to be separated from other code declarations**
  - Considered good practice but not required

AccountsRoutingModule.ts

```
const routes: Routes = {
  path: 'account',
  component:AccountComponent
}];

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

Routes collection defined as normal

`forChild()` used as this is a feature module

`RouterModule` (with the new routes) exported

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Importing Routes From a Routing Module

- **Module to be imported is added to the `imports` property of `@NgModule`**
  - Loads the module eagerly
    - Before it is needed

```
@NgModule({
  imports: [
    CommonModule,
    AccountsRoutingModule,
    ReactiveFormsModule,
    FormsModule
  ],
  declarations: [AccountComponent]
})
export class AccountsModule { }
```

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Lazy Loading

- **Modules may be loaded on-demand by the component router**
- **Uses the `loadChildren` property of the `Routes` object**
  - Instead of component

Route definitions for root component

```
{
   path: 'myflights',
   component: MyFlightsComponent
 },

 {
   path: 'account',
   loadChildren: loadChildren: () => import('./accounts/accounts.module')
       .then(mod => mod.AccountsModule)
}
```

"Normal" route definition

Module loading route

Class

Path

- **`loadChildren` property uses an arrow function to import the module**
- **It then uses the `then` function of a `Promise` to load the module**

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Lazy Loading Route Resolution

- **In our example**
  - The path in the root module is `'account'`
  - The path in the accounts module is also `'account'`
- **The path to the `AccountComponent` is therefore:**
  - `http://localhost:4200/account/account`
- **The feature module may define many routes**
  - Each will define a path relative to the path from the root (or parent) module
  - Examples:

```
http://localhost:4200/account/account
http://localhost:4200/account/address
http://localhost:4200/account/history
…
```

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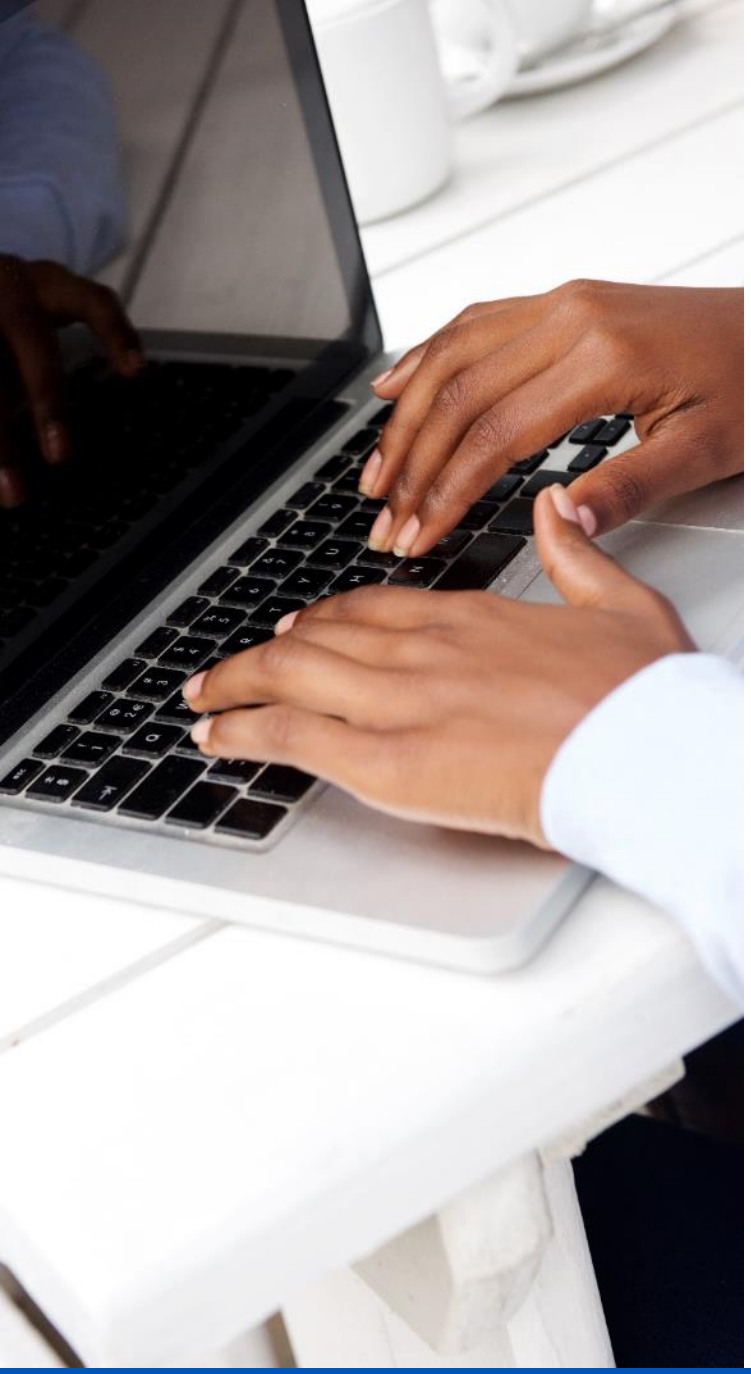

Hands-On Exercise 6.2

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 6.2: Creating a Feature Module

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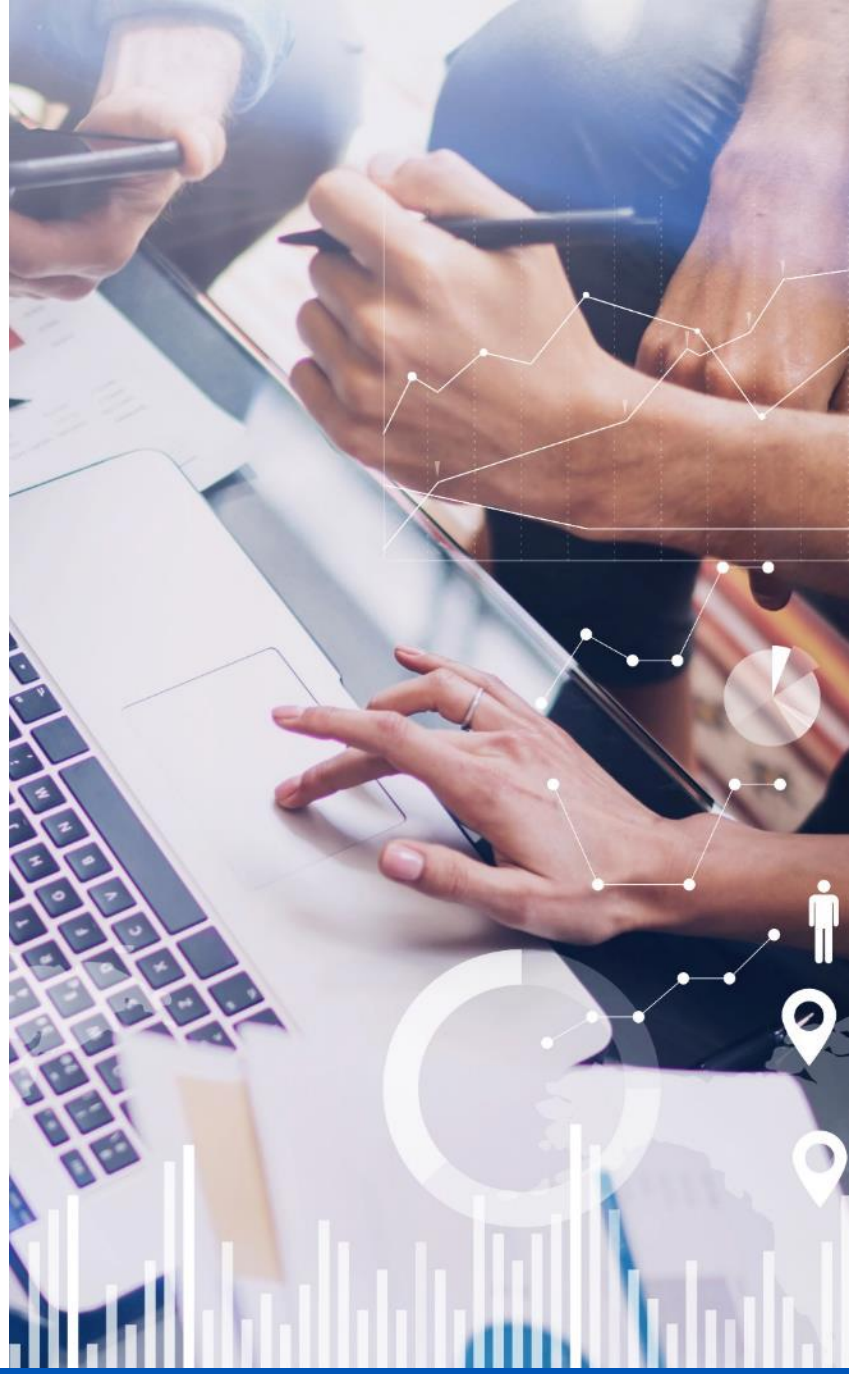
Contents

- The Component Router
- Routing and Feature Modules

Pipes



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Introducing Pipes

- **Pipes provide data transformation**
  - Formatting dates
  - Calculating and displaying percentages
  - Converting text case
  - Internationalization
- **Many built-in pipes**
  - CurrencyPipe—formats a number as local currency
  - DatePipe—formats a date
  - LowerCasePipe—converts text to lower case
  - JsonPipe—converts input object to JSON
    - Useful for debugging

JSON = JavaScript Object Notation

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Using Pipes

- **Pipes are used in templates**
- **Within interpolation {{}} expressions**

Built-in date pipe

```
<p>Weather for {{ forecastDate | date }}</p>
```

Pipe symbol

- **Pipes may be parameterized**
  - Parameters separated from pipe name by a `':'`

```
<p>Weather for {{ forecastDate | date : "MM-dd-yyyy" }}</p>
```

- **Standard pipes are automatically available in all modules**
  - Custom pipes must be registered in the module declarations

See documentation on DatePipe for full formatting information

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Binding and Chaining

- **Pipes parameters may be bound to Component properties**

```
<p>Weather for {{ forecastDate | date : dateFormat }}</p>
```

`dateFormat` is a Component property

- **Pipes may be chained**

```
<p>Weather for
{{ forecastDate | date : dateFormat | lowercase }}</p>
```

  - Example formats date, then outputs in lowercase

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Custom Pipes

- **Custom Pipes**
  - Are a class with a `@Pipe()` decorator
  - `name` property of the decorator is the name used in the template
- **Must implement `PipeTransform`**
  - Provide a method called `transform()`
  - `transform()` returns a string to display
- **`transform()` takes the value to transform and any optional arguments**
- **Example: Appends the wind speed units to the wind speed**
  - Usage:

```
<li>Speed - {{windSpeedKnots  | windSpeed }}</li>
```

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Custom Pipe Implementation

wind-speed.pipe.ts

```
@Pipe({
  name: 'windSpeed'
})

export class WindSpeedPipe implements PipeTransform {

  transform(value: any, args?: any): any {
    return value + " knots";
  }

}
```

Pipe name

Pipe implementation

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Declare Custom Pipes in the Module

- **Custom pipes must be declared in the `@NgModule` metadata**

app.module.ts

```
@NgModule({
  declarations: [
    HomeComponent,…
    WindSpeedPipe
  ],
  imports: […
```

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Multiple Parameters

- **Multiple parameters may be supplied to a pipe**
  - Separated by colons `":"`
  - Order must match `transform()` method

```
{{windSpeedKnots  | windSpeed : 'MPH' : 0.91 }}
```

- **Parameters are passed to the `transform()` method as method arguments**

```
export class WindSpeedPipe implements PipeTransform {
  transform(value: any,
                units : string = "knots",
                conversion : number = 1.0 ): string {
    return value * conversion + " " + units ;
  }
}
```

- **Use default argument values to make parameters optional**

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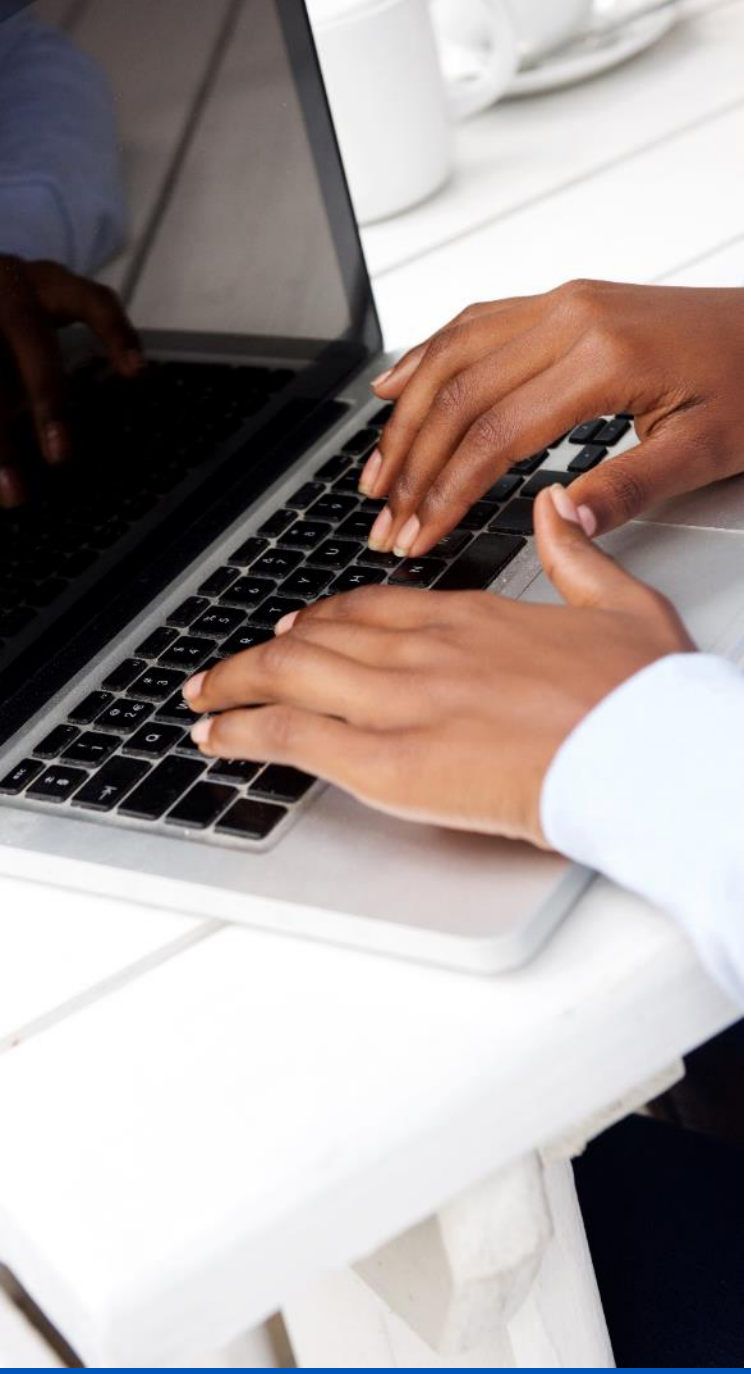

Hands-On Exercise 6.3

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 6.3: Creating a Custom Pipe

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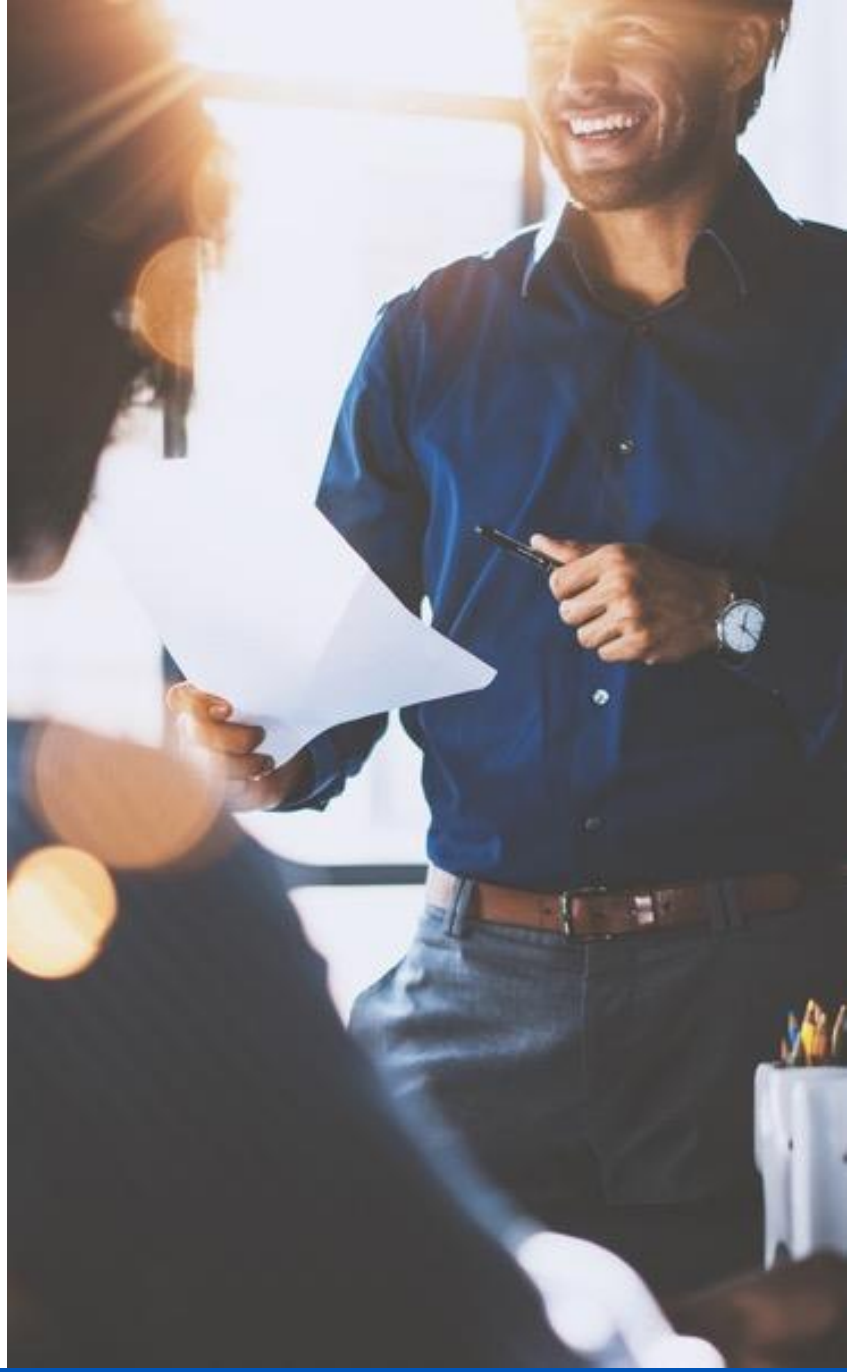
Objectives

- Implement navigation with the Component Router
- Declare routes and configure the router
- Interact with the router programmatically
- Transform data with pipes



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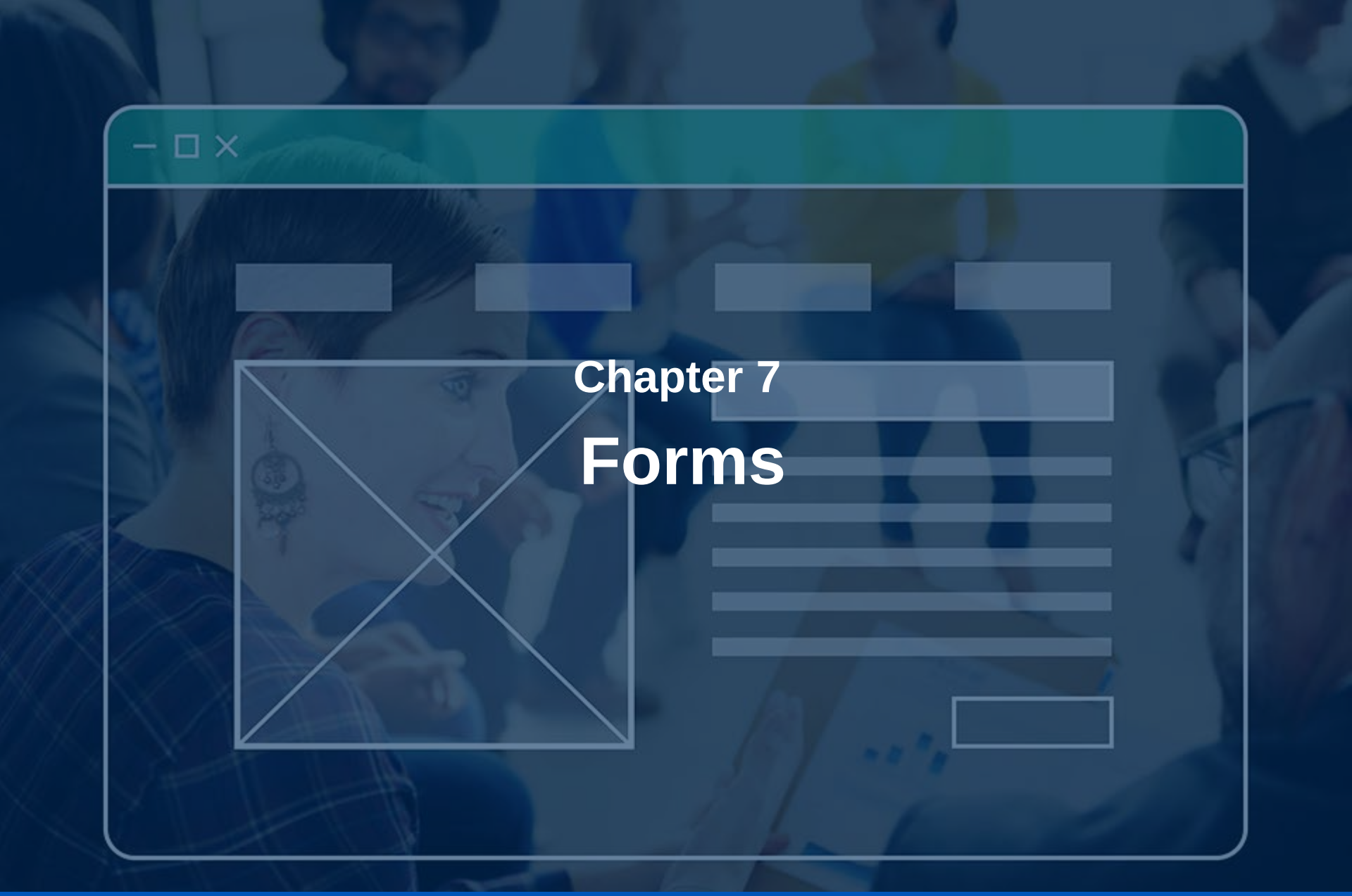


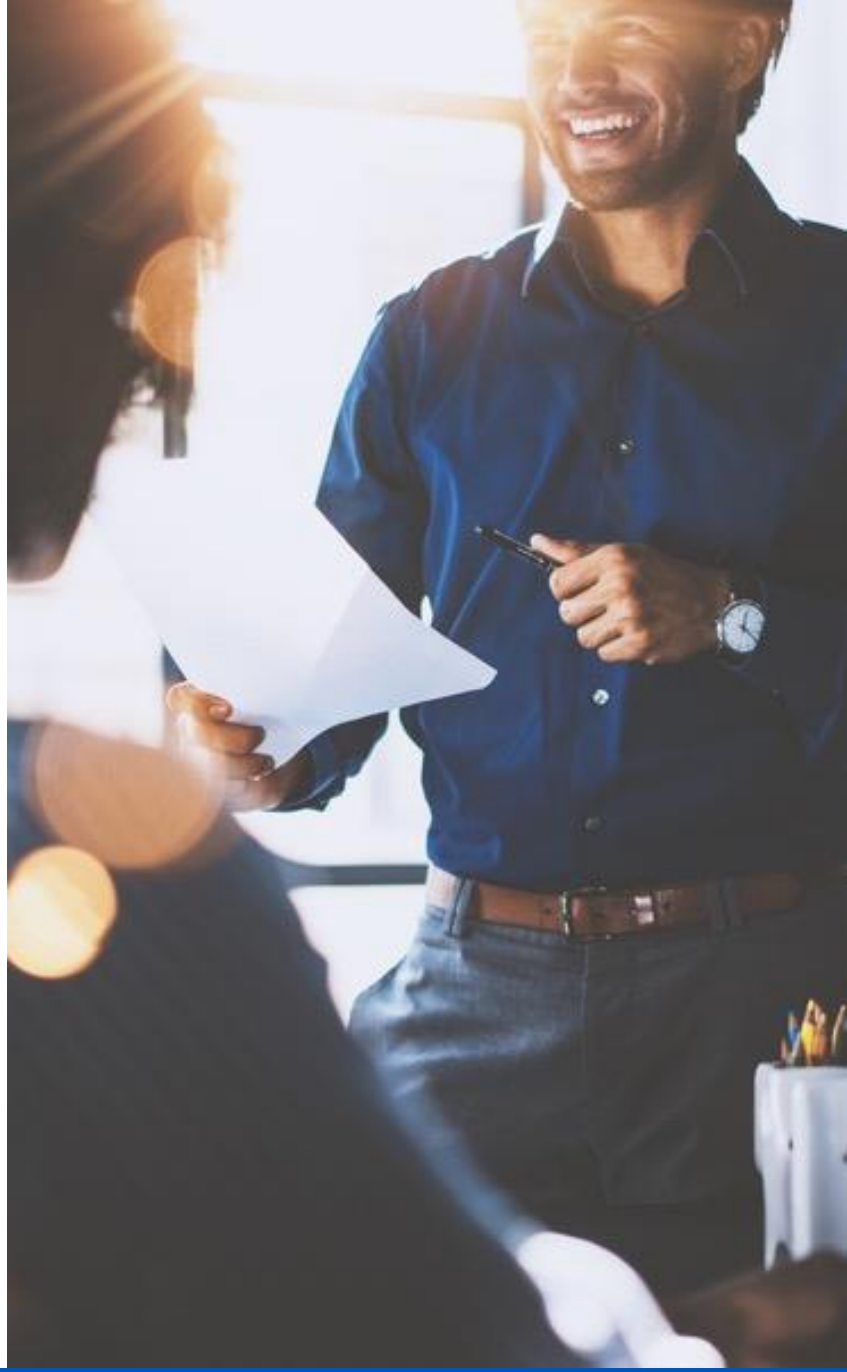
Chapter 7

Forms

LEARNING TREE INTERNATIONAL

Objectives

- Define a form data model
- Build a template-driven form
- Provide validation and feedback
- Develop a reactive form



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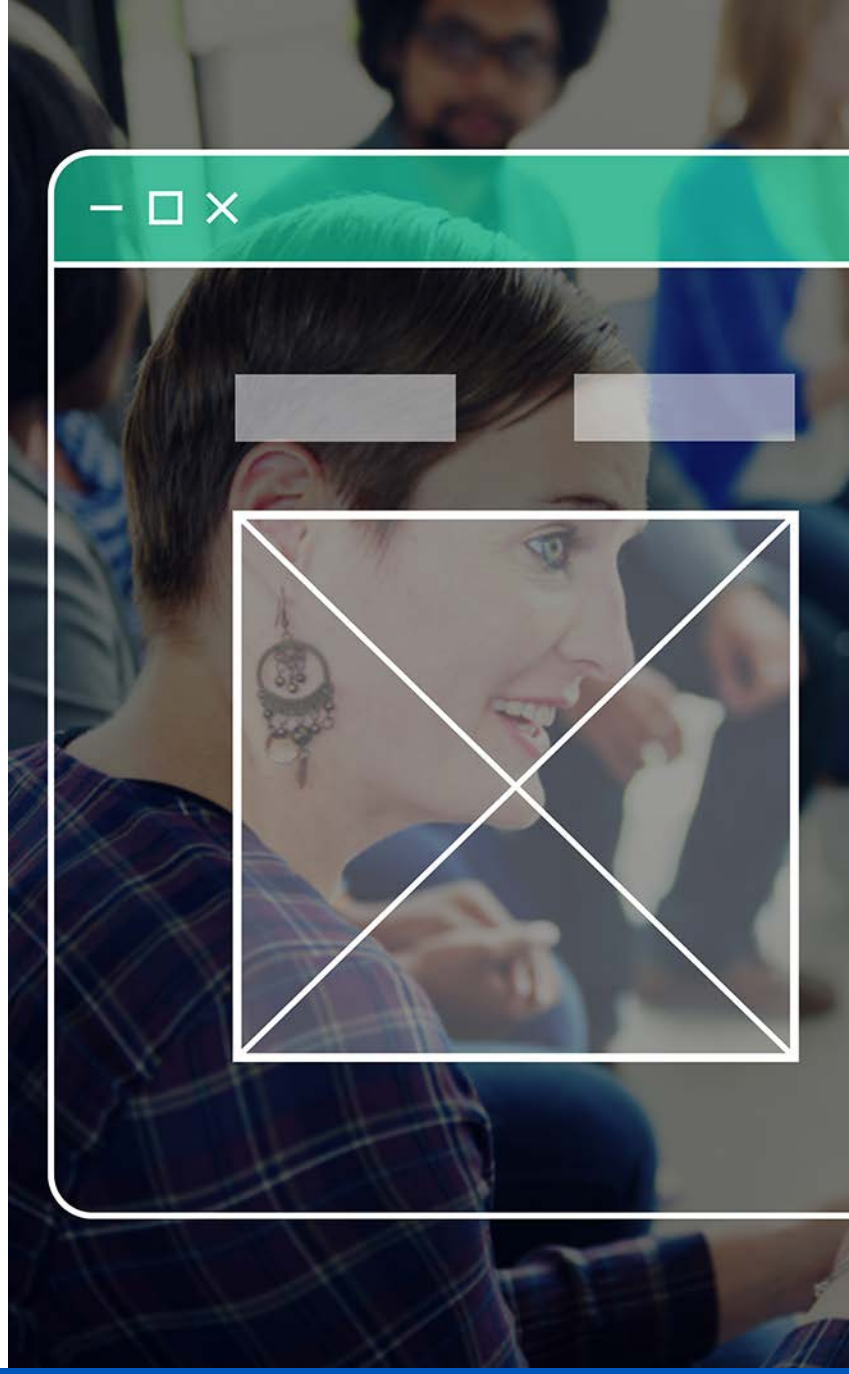
Contents

Form Processing

- Template Driven Forms
- Validation and Feedback
- Reactive Forms



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Angular Forms

- **Angular forms provide data-bound input forms**
- **Features**
  - Bi-directional data binding
  - State tracking
  - Visual feedback via CSS classes
  - Display of validation errors
- **Form processing is handled by `FormGroup`**
  - Two related methods of building `FormGroup`
- **Template driven**
  - Angular builds a `FormGroup` from the HTML template
  - The simplest solution
- **Reactive**
  - Developer defines a `FormGroup` with the `FormBuilder`
    - Associates it with the form
  - Offers more flexibility and custom validations

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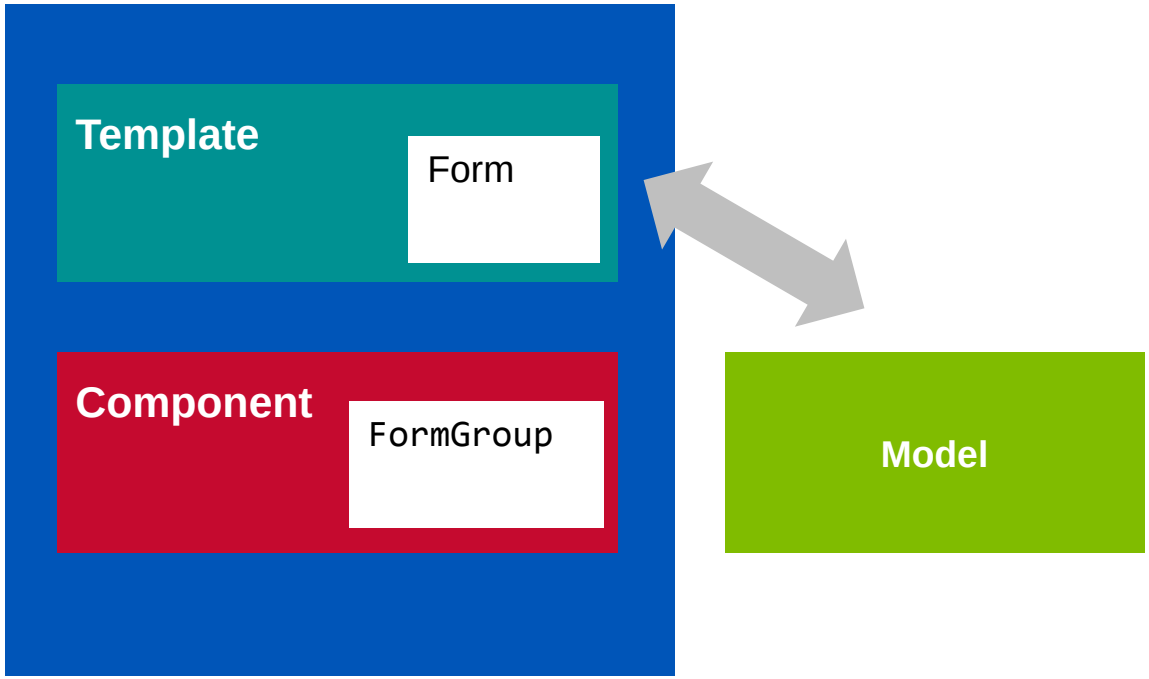
Form-Processing Architecture

- **Forms build on the Component architecture**
- **Component template defines a form**
  - HTML plus form directives



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Form Data Model

- **Forms are data-bound**
  - Fields in the HTML form are bound to model fields in the Component
  - The form and underlying data model are synchronized
- **Ideally, create a model object to represent the form data**
  - Model object should have fields to represent each control in the form
- **Our example is capturing user preferences for the weather application**

preferences.ts

```
export class Preferences {
  constructor(
    public name: string,
    public location: string,
    public temperatureUnits: string,
    public speedUnits: string,
    public forecastLength: number
  ){}
}
```

`public` arguments to a constructor become properties of the object

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Form Template

- **Minimal form template**
- **Standard HTML 5**
- **Note the use of `required` validation attributes**
  - Angular uses standard HTML 5 validation markup

preferences-form.component.html

```
<form>
  <div>
    <label for="name">Name</label>
    <input id="name" type="text" name="name" required>
  </div>
  <div>
      <label for="location">Location</label>
      <input id="name" type="text" name="location" required>
  </div>
  <button type="submit" >Submit</button>
 </form>
```

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Contents

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Template Driven Forms

- Validation and Feedback
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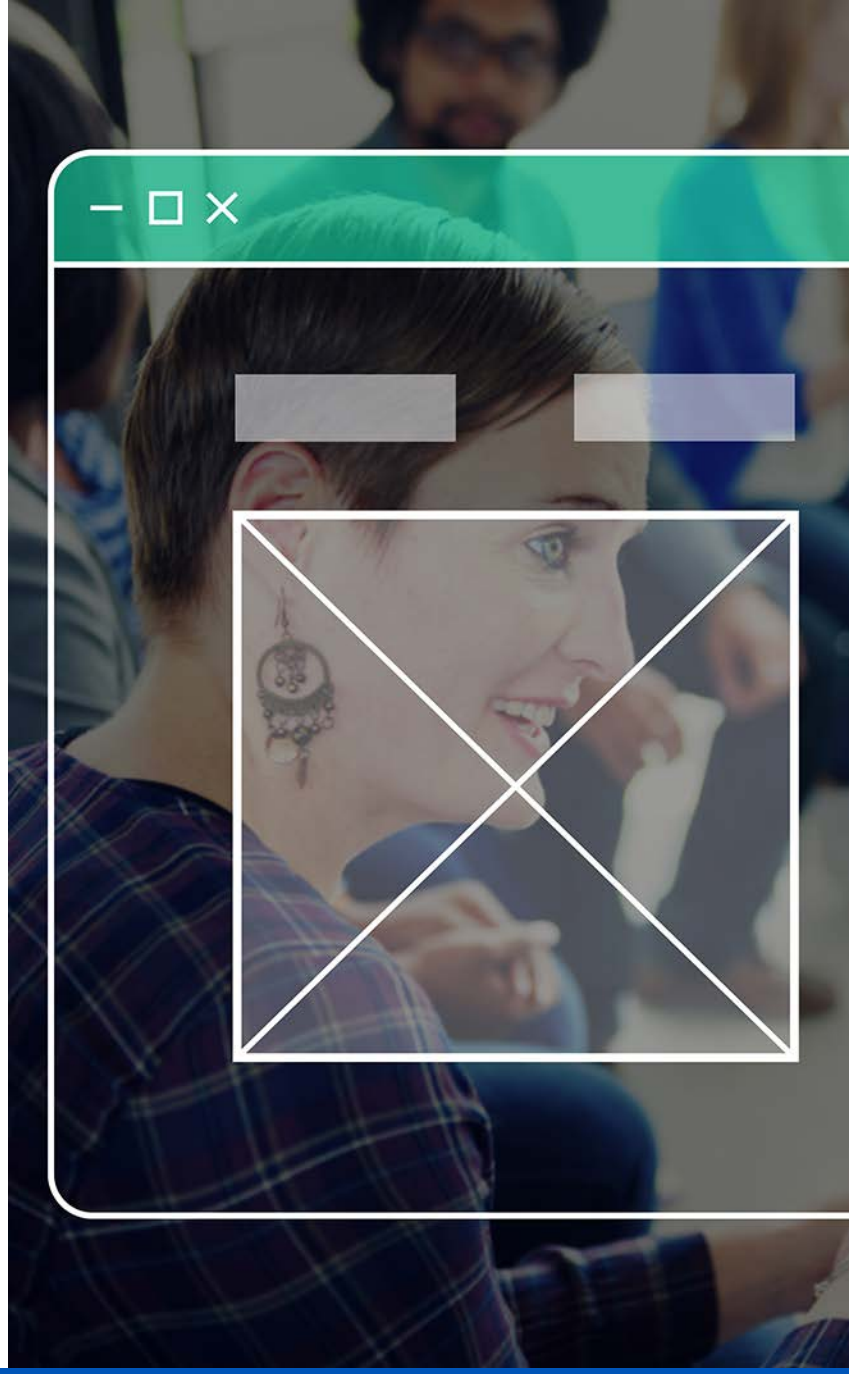

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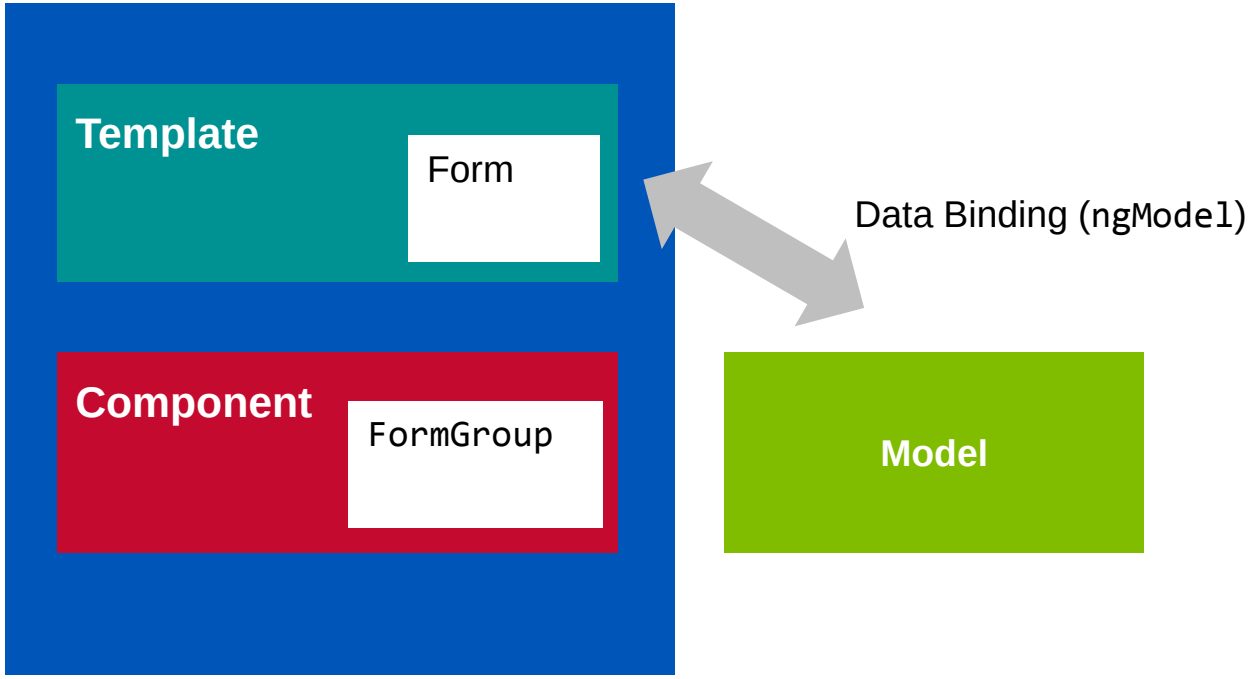
Template Driven Form-Processing Architecture

- **In the template driven paradigm**
  - Form data is bound to a model by `ngModel`
  - Angular keeps the model and form synchronized



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The Form Hosting Component

- **A normal Component template**
  - With the addition of a model property
- **The example has initial model data**

preferences-form.component.ts

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

@Component({…
  templateUrl: 'preferences-form.component.html',
})
export class PreferencesFormComponent {

  model = new Preferences(  "Long John Silver", "Treasure
        Island", "F", "Knots", 10 );

}
```

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Form Directives

- **Data is bound to the form model using the `NgForm` directive**
  - One of several directives used by forms
- **Specified in `@NgModule` by adding `FormsModule` to the `imports`**

app.module.ts

```
@NgModule({
  declarations: [
    AppComponent,
],
  imports: [
    BrowserModule,
    FormsModule,
    routing
  ],…})
```

- **Some versions of Angular CLI add the `import` statements automatically**

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Binding to the Form Model

- **Binding is performed in the template**
  - Add attributes to the form input fields
- **Bind input field to model with `[(ngModel)]="model property name"`**
  - Two-way binding
  - Remember the "banana in a box" binding `[()]`
- **Bound form field elements *must* have a name attribute**

preferences-form.component.html

```
<input type="text" name="units" required
       [(ngModel)]="model.units" >
```

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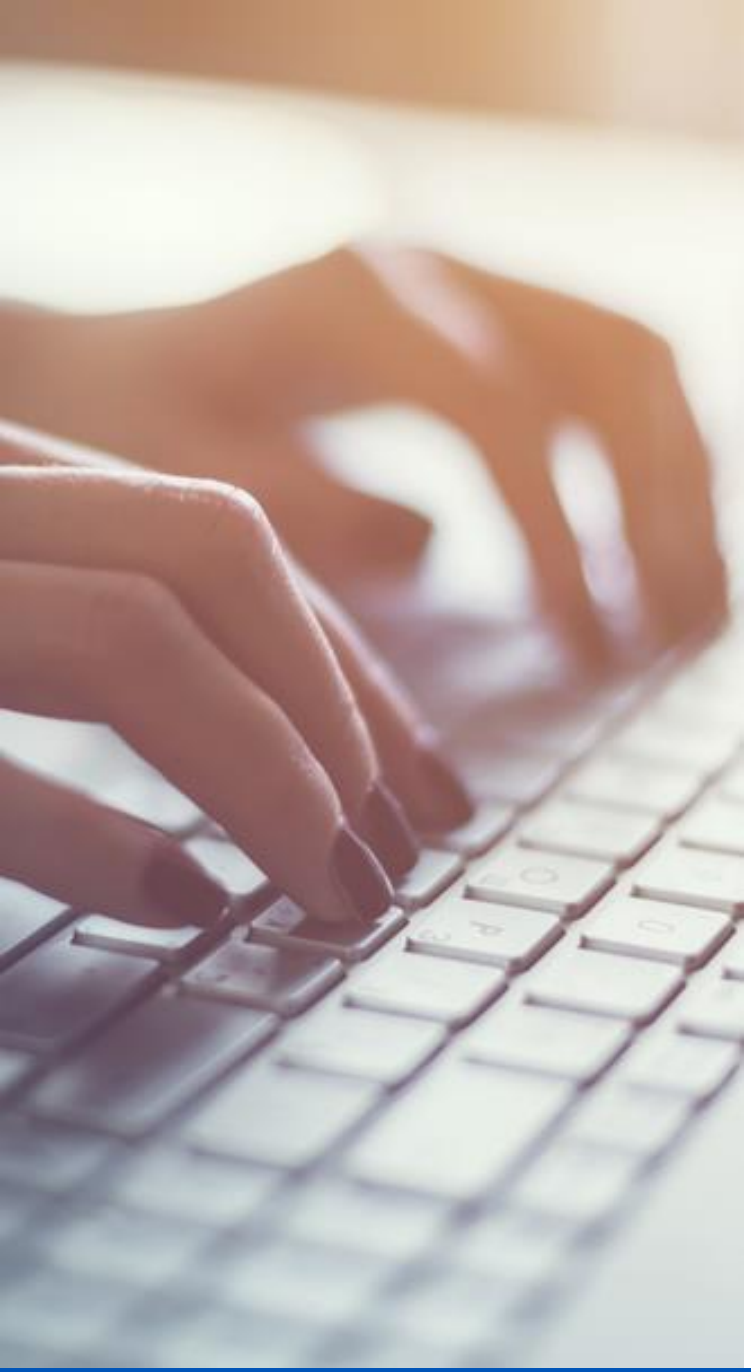

7.1: Form Bindings

Do Now

- In your Exercise Manual, please refer to Do Now 7.1: Form Bindings

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Populating Selection Data

- **Options for select controls may be populated from the model**
  - Use template directives to generate the `<option>` elements

preferences-form.component.html

```
<select … [(ngModel)]="model.temperatureUnits"
  name="temperatureUnits">
  <option *ngFor="let unit of temperatureUnits"
       [value]="unit">{{unit}}</option>
</select>
```

preferences-form.component.ts

```
temperatureUnits = ['F', 'C', 'K'];
```

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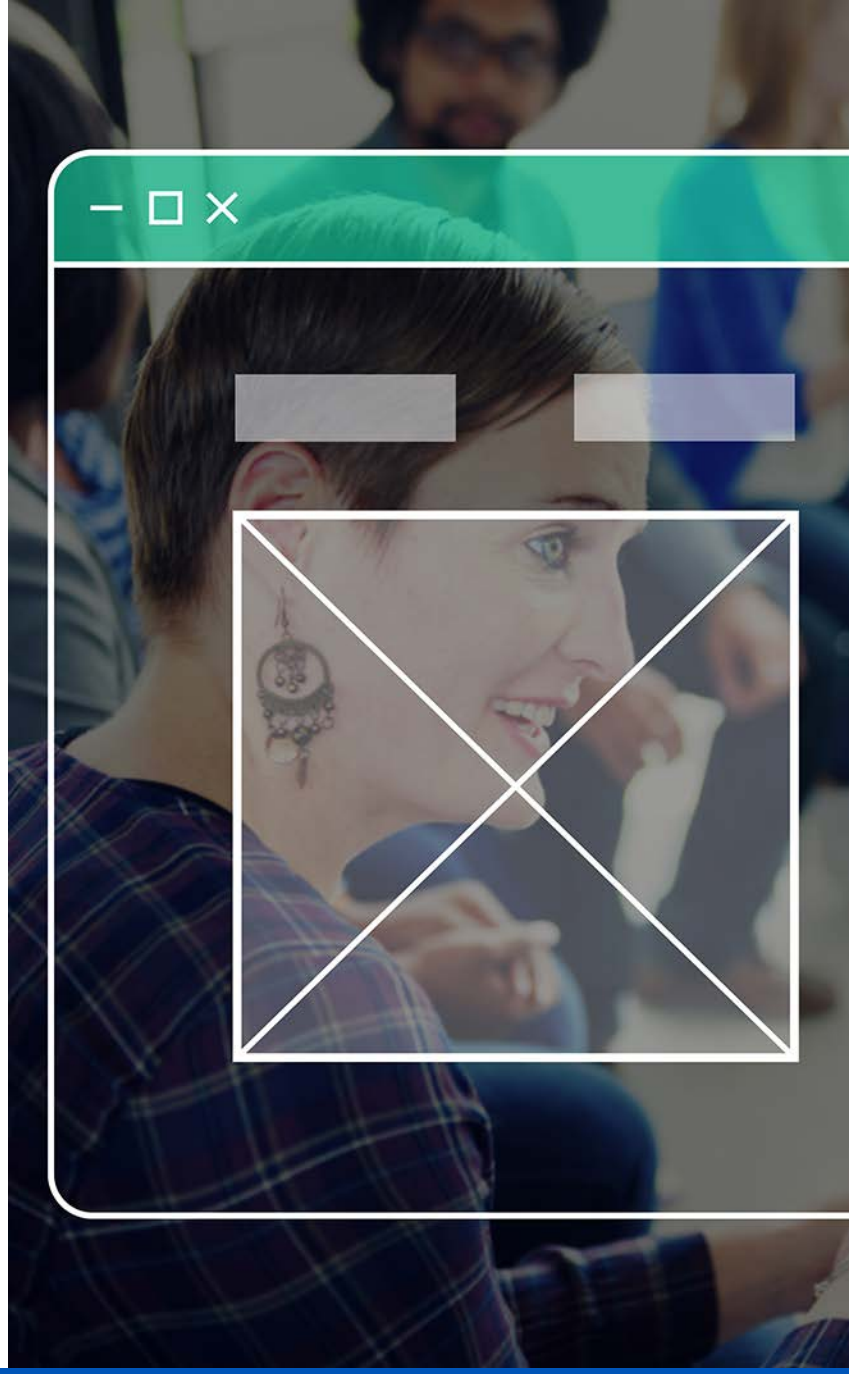
Contents

- Form Processing
- Template Driven Forms

Validation and Feedback

- Reactive Forms



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Input Validation

- **Input validation assists users in creating the correct content**
- **`NgForm` provides mechanisms to give immediate feedback to users**
  - Through CSS styling
  - Through conditional content display
- **`NgForm` validations are built by processing the HTML 5 validation attributes**

Caution:
Input validation does not protect server-side applications from attack
- There are many tools and techniques that attack servers directly
  - Bypassing client validation

See also Learning Tree Course 940 Securing Web Applications, Services, and Servers

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CSS Validation Feedback

- **The built-in `ngControl` directive automatically adds CSS classes to controls**
  - Based upon the current validation state

State	Class	
	State True	State False
Control touched	`ng-touched`	`ng-untouched`
Value changed	`ng-dirty`	`ng-pristine`
Control valid	`ng-valid`	`ng-invalid`

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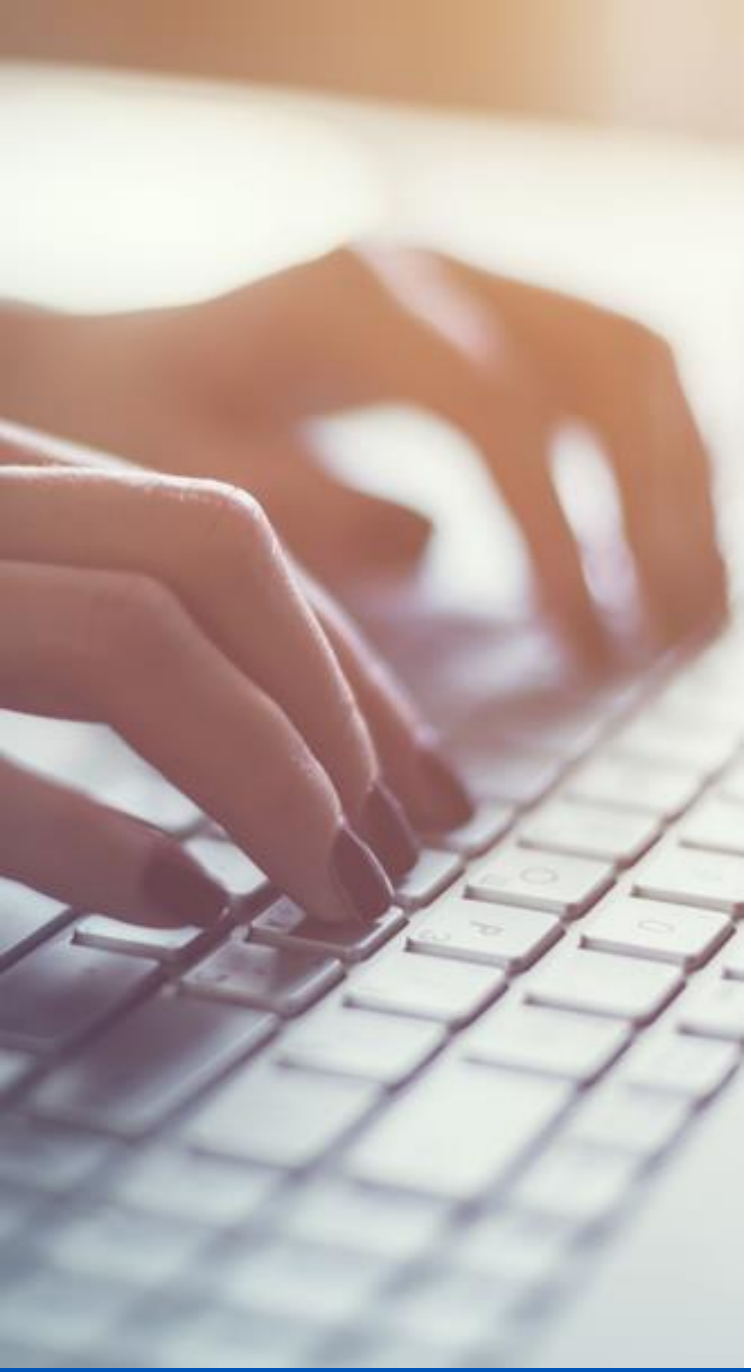

7.2: CSS Validation Feedback

Do Now

- In your Exercise Manual, please refer to Do Now 7.2: CSS Validation Feedback

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Feedback Through Conditional Display

- **May be useful to have detailed feedback messages**

```
<input type="text" class="form-control" required
  [(ngModel)]="model.name" name="name">
<div>To make this valid you must…</div>
```

- **The `ngModel` directive allows this**
  1. Associate a template local variable with the `ngModel` directive
  2. Use the variable to test the control state

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Conditional Display of Error Messages

1. Associate a template variable called `name` with `ngModel`

```
 <input type="text" class="form-control" required
  [(ngModel)]="model.name" name="name" #name="ngModel">
<div [hidden]="name.valid || name.pristine" >
        Name is required
</div>
```

2. Test `ngModel` state

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Form Submission

- **Form submission is handled by the `ngSubmit` directive**
  - Bound to `ngSubmit` attribute of the form element
- **`ngSubmit` invokes the specified handler when the form submit button is pressed**

```
<form (ngSubmit)="onSubmit()" #theForm="ngForm">

  <button type="submit">Submit</button>

</form>
```

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Testing Form Validity With `NgForm`

- **Angular automatically adds an `NgForm` directive to the `<form>`**
  - It is exported as `ngForm`
- **Binding a template variable to `ngForm` allows checking of the form state**
  - `ngForm.form.valid` is true if all the controls are valid

```
<form (ngSubmit)="onSubmit()" #theForm="ngForm">

<button type="submit" [disabled]="!theForm.form.valid">
Submit</button>

</form>
```

Disable the submit button unless the form is valid

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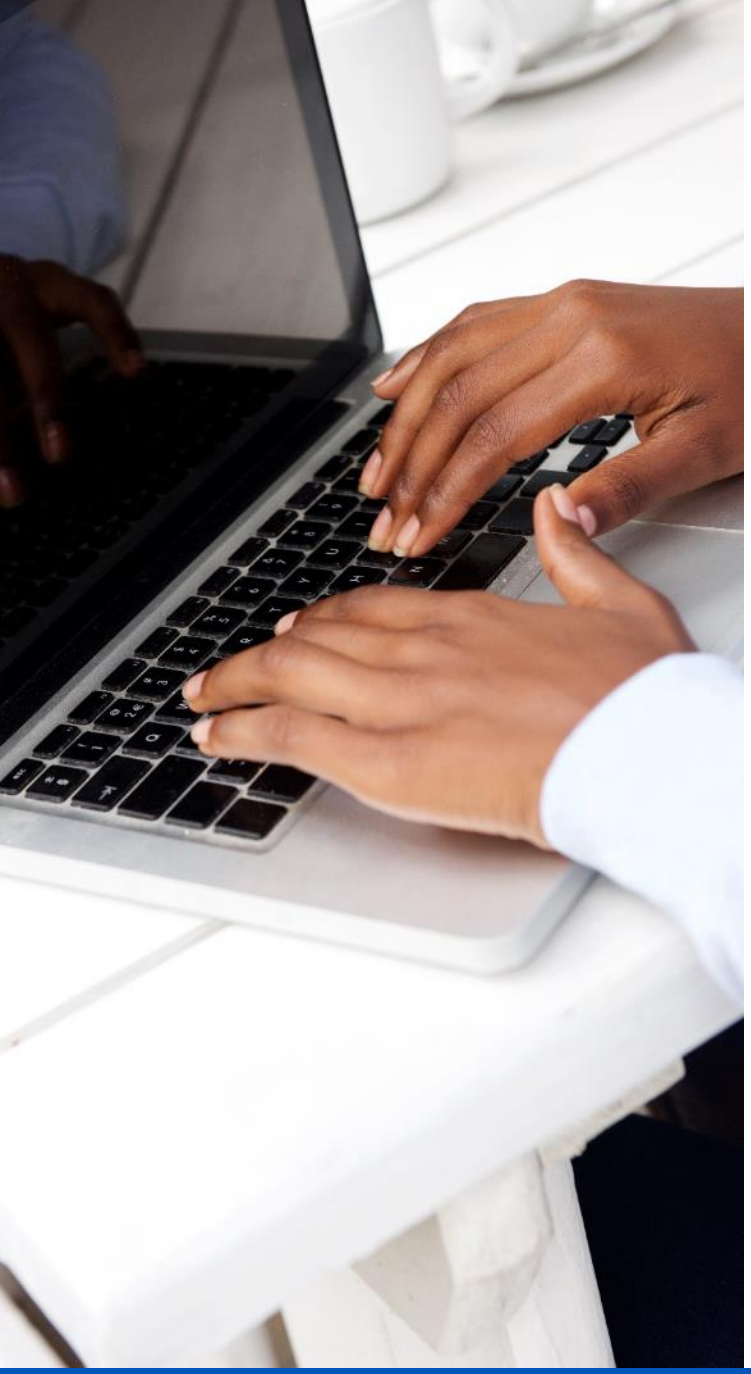

Hands-On Exercise 7.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 7.1: Implementing a Form With `ngModel`

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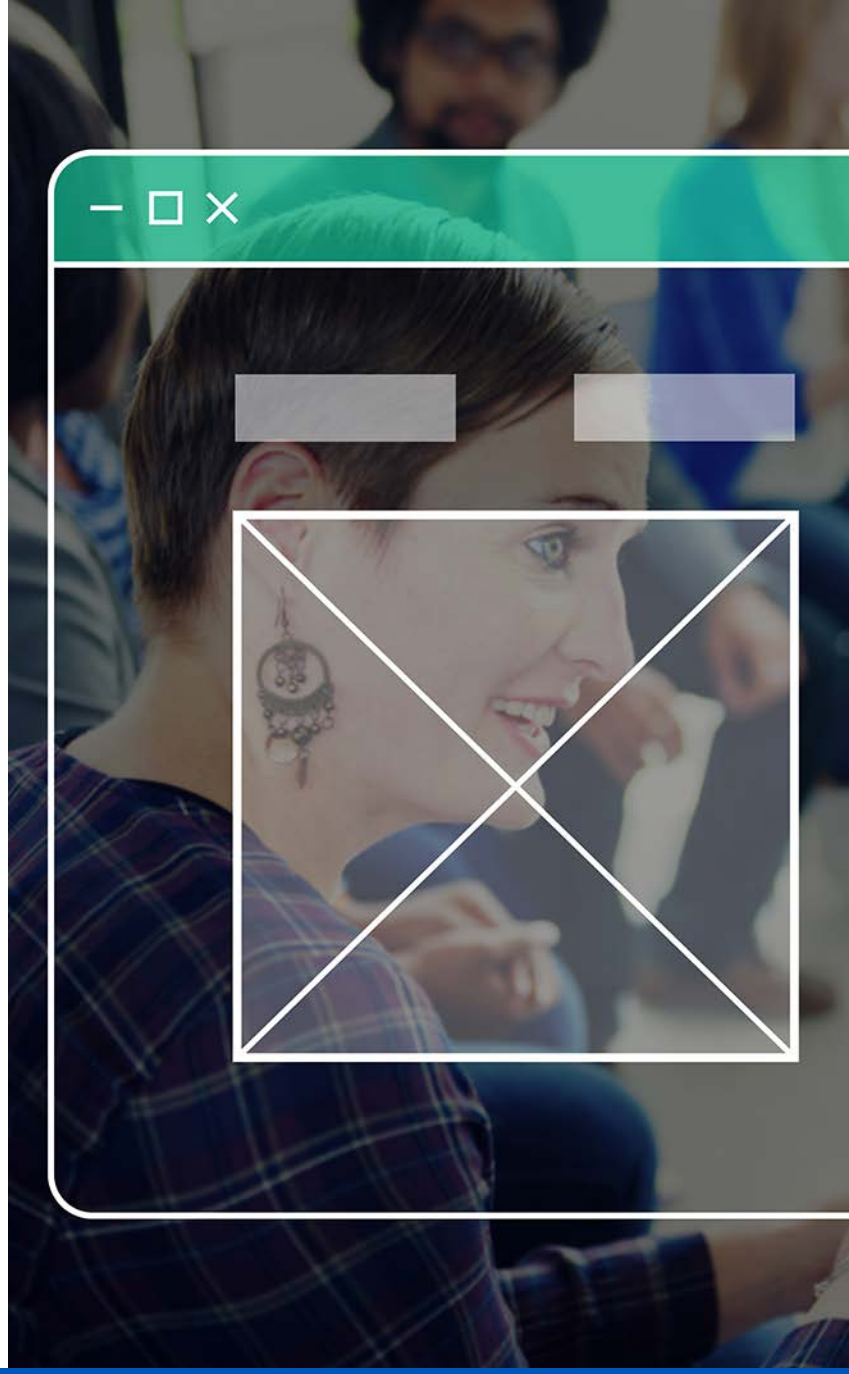
Reactive Forms



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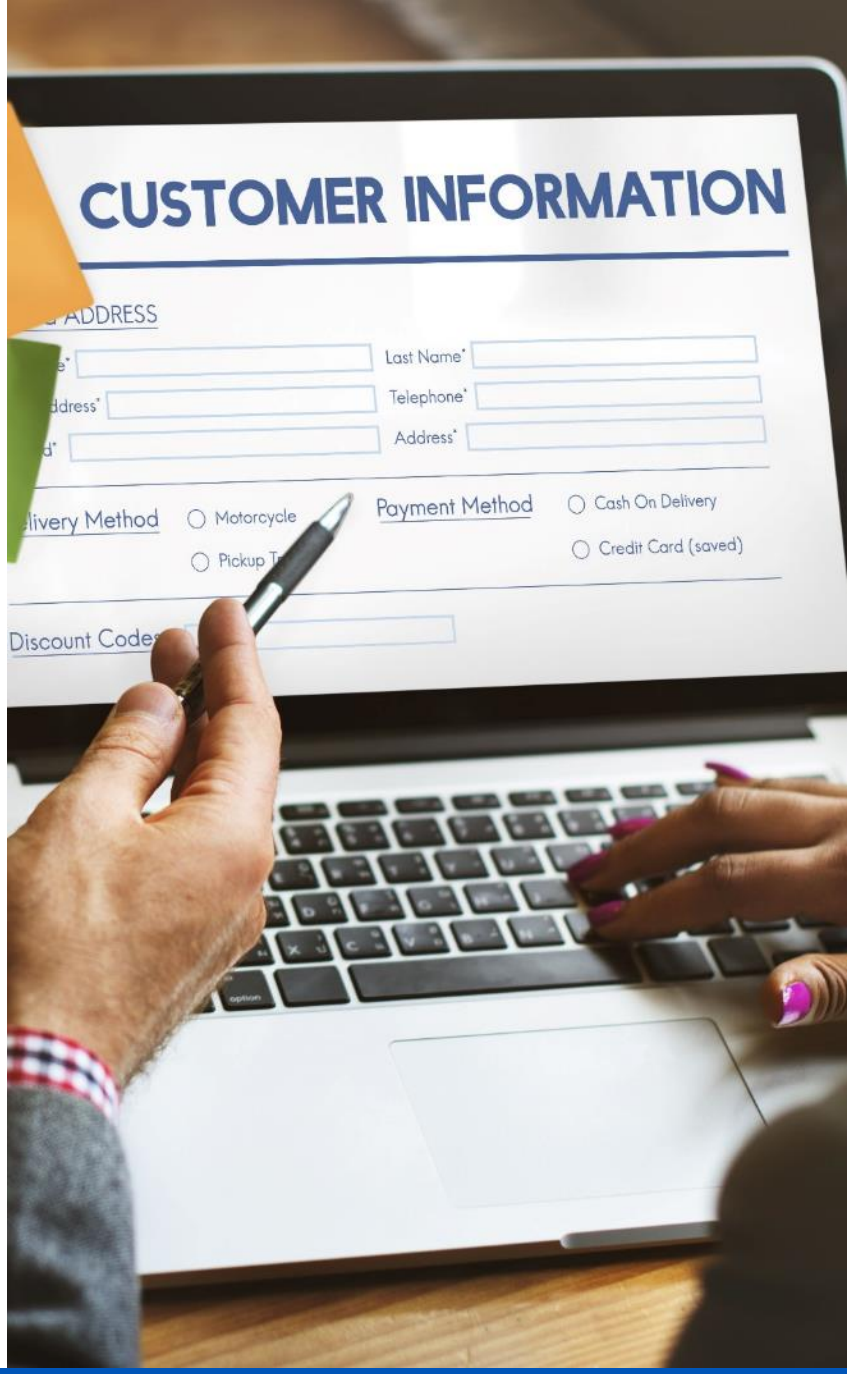
Reactive Forms

- **Reactive Forms provide an alternative mechanism for building forms**
  - Provides more control at the cost of increased complexity



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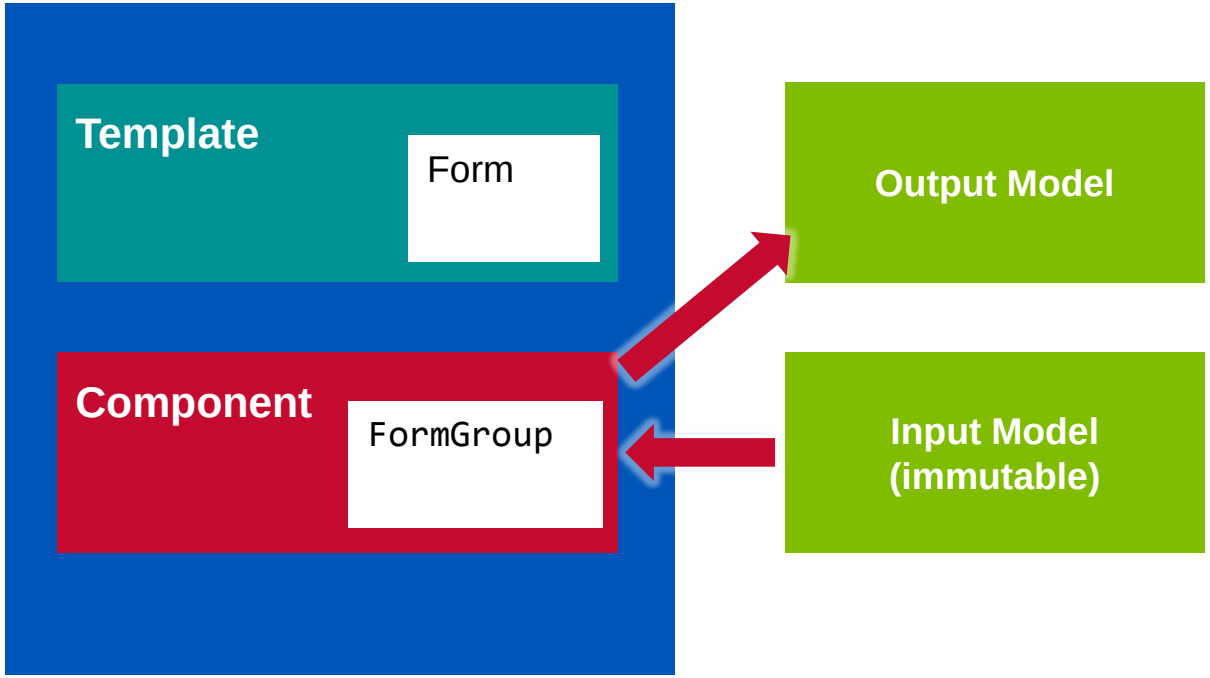
Reactive Form Processing Architecture

- **In the reactive form paradigm**
  - The `FormGroup` is created in the Component
    - Then associated with the form in the template
  - Code in the Component then
    - Populates the `FormGroup` from the model
    - Pulls data from the `FormGroup` to an output model



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`FormBuilder`

When working with reactive forms:

- **`FormGroup` is created using `FormBuilder`**
  - Instead of automatically from the form template
- **`FormBuilder` increases control of form processing**
  - Moves validation from templates into code
- **Building reactive forms with `FormBuilder`**
  1. Create a `FormGroup` using `FormBuilder`
  2. Associate the `FormGroup` with a form template
  3. Provide feedback by interacting with the `FormGroup`
  4. Populate the `FormGroup` with data from the model
  5. Pull data from the `FormGroup` when form is submitted

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1. Create a FormGroup With `FormBuilder`

1. **Module must import `ReactiveFormsModule`**
   - Can coexist with `FormsModule`
2. **`FormBuilder` is injected into the `Component` constructor**
3. **Use `FormBuilder` to create a `FormGroup`**

payment.component.ts

```
export class PaymentComponent {

  payForm: FormGroup;

  constructor(formBuilder : FormBuilder ){

    this.payForm= formBuilder.group({…})
  }
```

2

3

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Defining the Form

- `FormBuilder.group()` creates a `FormGroup`
- Argument is a collection of key/Control pairs

```
this.payForm=
      formBuilder.group({
      'name': […],
     'address': […],
     'email': […],
  …
});
```

Form field name

Parameter map to create a Control

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Defining the Controls

- **The parameter map for each control consists of**
  - A default value - used if there is no model
  - A validator
    - Specifying the validation to perform on the control
    - Built-in validators
      - `required`, `minLength`, `maxLength`, `pattern`
    - Custom validators may be created

```
… formBuilder.group({
  'name': ['', Validators.required],
  'address': ['', Validators.required],
  'email': ['', Validators.pattern("^[A-Za-z0-._...")],
        …
});
```

Default value—or populate from the model

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Multiple Validations

- **Multiple validations may be composed into a single validation**
  - For example, combining required and minimum length validations
- **Use `Validators.compose[validator, validator,…]` to create the validation**

```
… formBuilder.group({
  'name': ['',
       Validators.compose(
              [Validators.required,
               Validators.minLength(5)])],
  'address': ['', Validators.required],
  'email': ['', Validators.pattern("^[A-Za-z0-._...")],
       …
});
```

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2. Associate the `FormGroup` With the Form Template

- **To use the `FormGroup`**
  - Use the `formGroup` directive to bind the form to the `FormGroup`
  - Use `formControlName` to bind each control to the corresponding property of the `FormGroup`
    - Replaces the `name="…"` attribute

```
<form [formGroup]="payForm" (ngSubmit)="onSubmit()">

   <div …>
     <label for="name">Name</label>
     <input type="text"
       formControlName='name'>
   </div>
…
```

- **Form controls must not use `ngModel` bindings**
  - Deprecated in Angular 6, removed in 7

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3. Provide Feedback

- **The same CSS classes as in template-driven forms are available**
  - The controls are all using `ngControl`
    - `ng-touched`, `ng-dirty`, etc.
- **Controls may be accessed in the template via the `FormGroup`**
  - `formGroup.controls`
  - For example, `payForm.controls.email.valid`

```
<form [formGroup]="payForm"
   <div …>
     <label for="name">Name</label>
     <input type="text"
       formControlName='name'>
   </div>
   <div *ngIf="!payform.controls.name.valid">
       The name field is invalid because…
   </div>
```

Conditional error display

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4. Populate the Form With Model Data

- **Reactive forms do not bind to the model**
- **Developer may populate the `FormGroup` data from the model**
- **`FormGroup` provides 2 methods**
  - `setValue(model : Object)` – model must match the fields in the `FormGroup`
    - Throws an error if there is not a one-to-one match
  - `patchValue(model: Object)` – populates those fields that match
    - Does not throw an error

```
model = new Payment(…);
…
this.payForm.setValue(this.model);
```

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5. Pull Data From the `FormGroup`

- **Data is typically extracted from the form when the submit button is pressed**
  - But can be done at any time
    - e.g., `ngOnChanges()`
- **The form data may be accessed via the `value` property of `FormGroup`**

```
const formData = this.payForm.value;
```

- **An object with properties which hold the current values of the form**

```
const address = formData.address;
```

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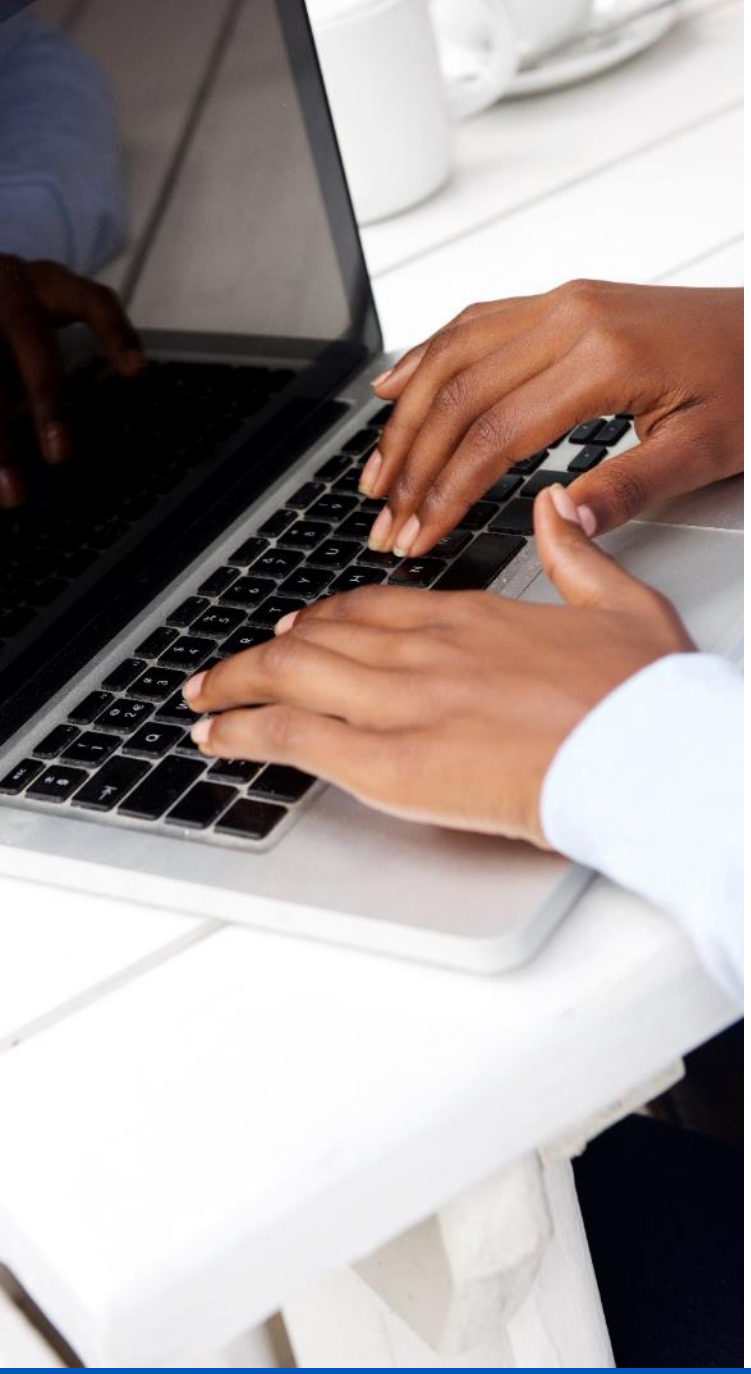

Hands-On Exercise 7.2

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 7.2: Creating Reactive Forms

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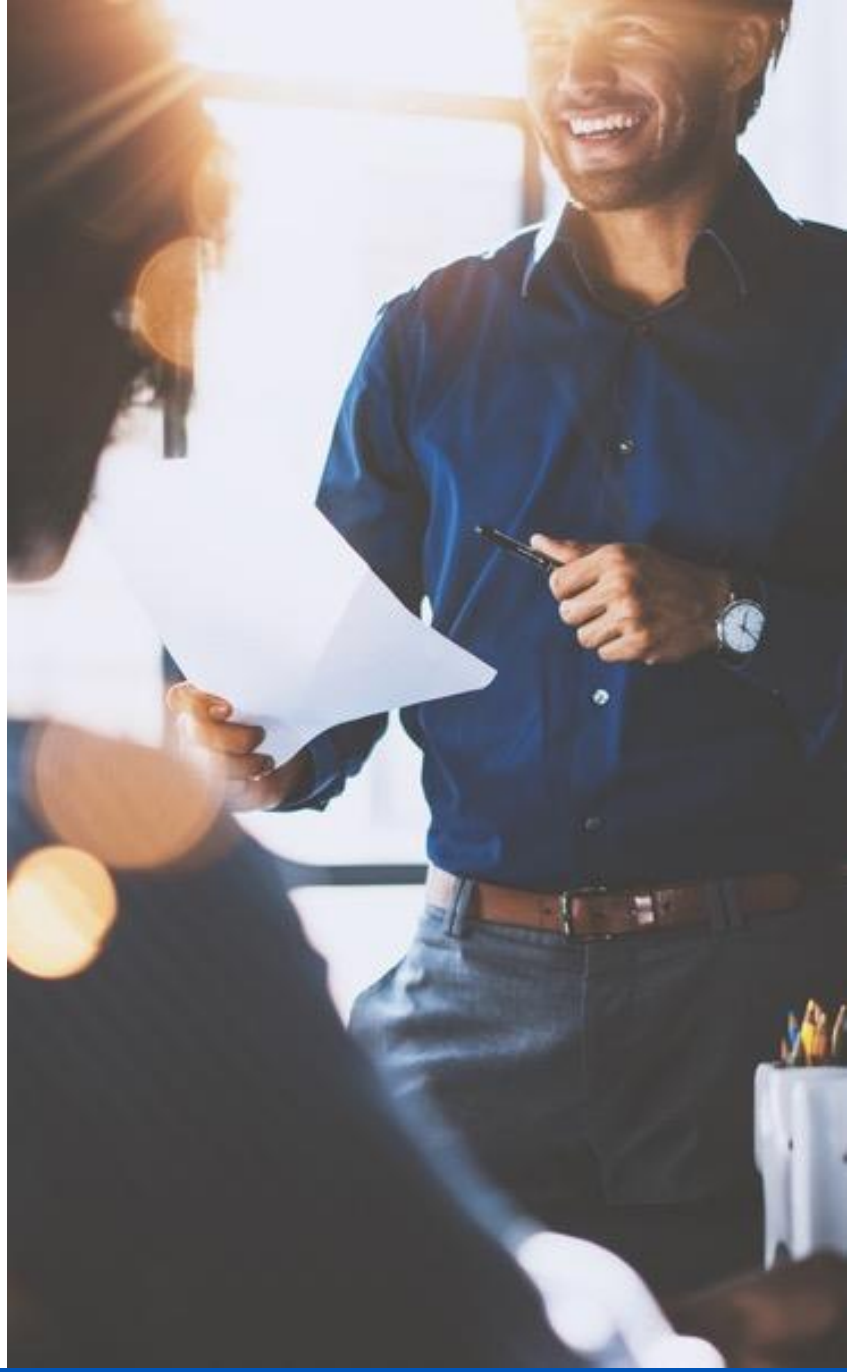
Objectives

- Define a form data model
- Build a template-driven form
- Provide validation and feedback
- Develop a reactive form



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Chapter 8

Managing Asynchronous Behavior

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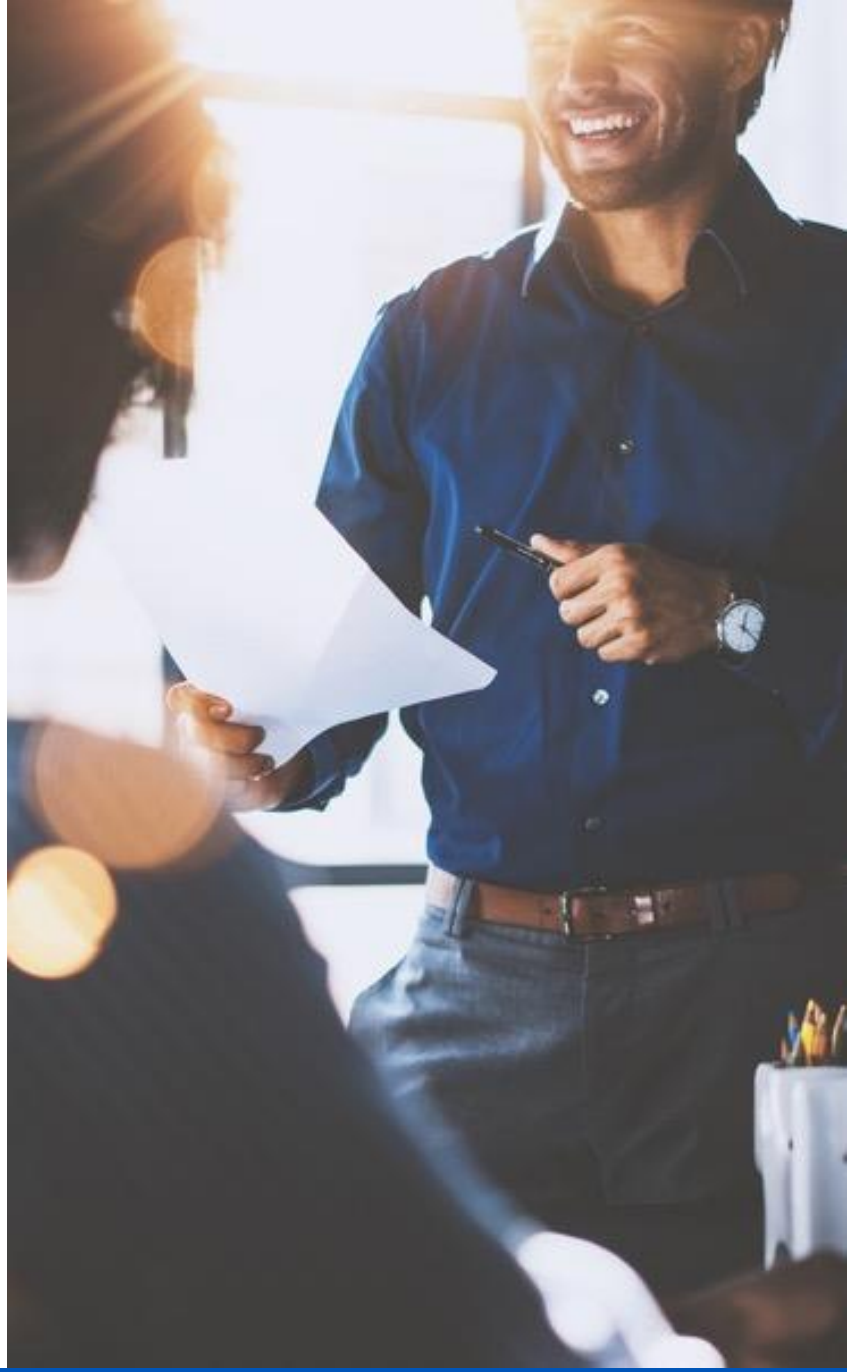
Objectives

- Incorporate Promises and Observables
- Optimize Change Detection
- Communicate with REST APIs



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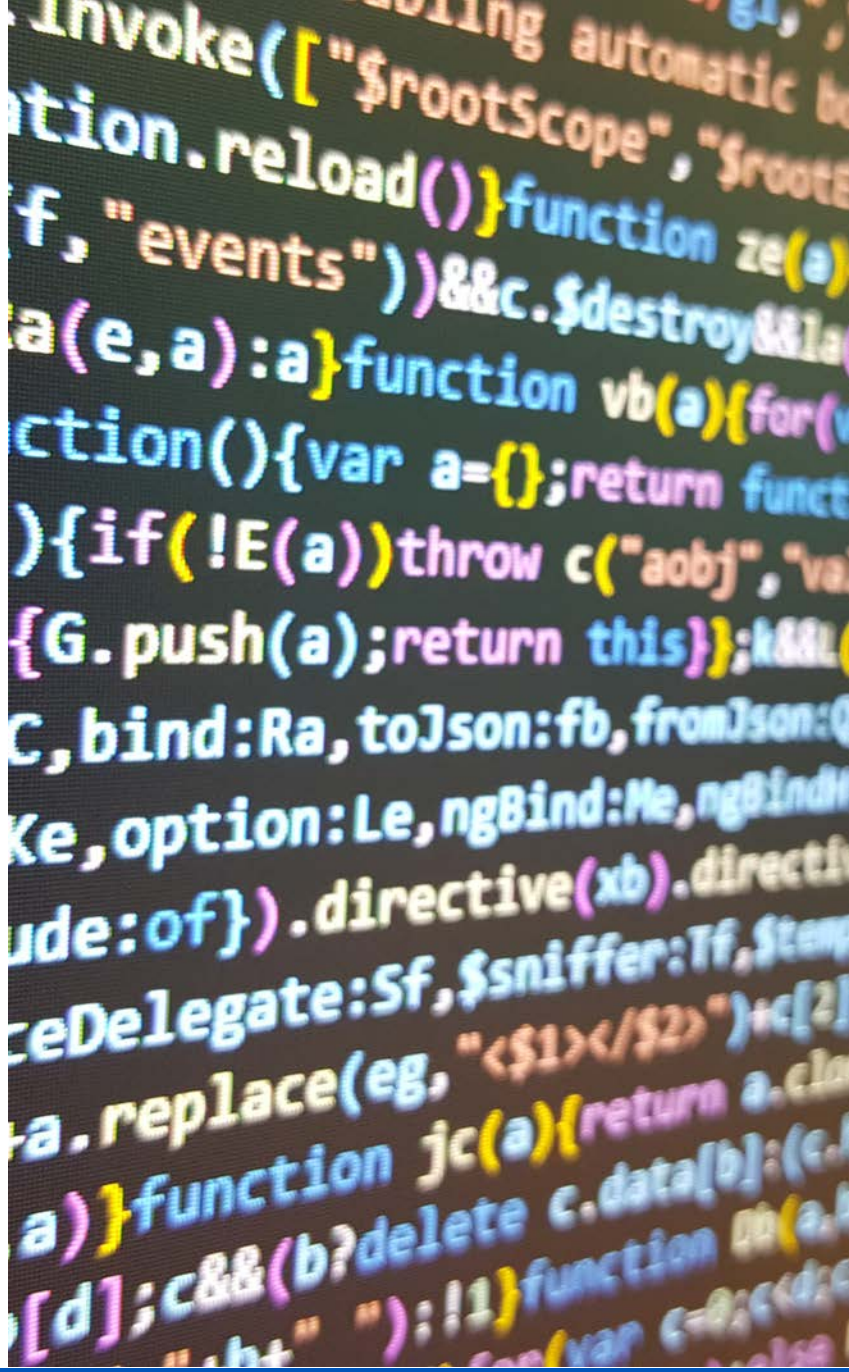
Asynchronous Behavior

- Change Detection
- Web Service APIs
- Integrating the Http Client



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Asynchronous Behavior

- **Code that performs its work at some future time**
  - When triggered
- **Asynchronous triggers**
  - Timers
    - `setTimeout()`, `setInterval()`
  - DOM event handlers
    - `onClick()`…
  - `XMLHttpRequest` (XHR) object
    - Generates events when data is loaded or an error occurs
  - Geolocation events
  - Web Workers

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Approaches to Asynchronous JavaScript

- **Three options**
  - Callback functions
  - Promises
  - Observables

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Callbacks

- **Calling code requests behavior**
  - A timer in our example
- **Provides a function call when the behavior is complete**

```
setTimeout(function () {
    console.log('timeout 1');
    setTimeout(function () {
        console.log('timeout 2');
    }, 1000);
}, 1000);
```

- **Many limitations**
  - Complex nested code—the pyramid of doom
  - Try/catch cannot be used in the outer block
  - Handlers must be registered before the work is started

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Making Promises

- **Promises were developed specifically to handle XHR requests**
  - Adopted for many other cases
- **Promise consists of**
  - The work to perform
  - A call to the `resolve()` function if it worked
  - A call to the `reject()` function if it did not

```
this.promise = new Promise((resolve, reject) => {
  // do some work – perhaps create an HTTP connection
        …
  if (/* everything ok */) {
    resolve("Stuff worked!");
  }
  else {
    reject("Something failed");
  }
});
```

The code to do the work goes here

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Getting Results From a Promise

- **The work in a Promise starts as soon as the Promise is created**
  - Typically background work such as HTTP request
- **The results can be retrieved when we are ready for them**
- **Call `then()` on the promise**
  - Providing a function to call
    - Function is called as soon as results are ready

```
promise.then((msg)=>{console.log(msg);})
```

Function passed to `Promise` as resolve function

- **Call `catch()`to supply the reject function**

```
promise.then((msg)=>{console.log(msg);})
                .catch((err)=>{console.log(err);}
```

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Observables

- **A core component of Reactive programming**
  - Like Promises, they allow background activities to take place
- **Observables return data as a stream**
  - A collection that arrives over time
    - Like an array that is being gradually filled with data
- **Observables are lazy**
  - Work is performed only when a client subscribes
- **Observables can be canceled**
- **Observables clean up after themselves**
  - No need to deregister event handlers

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Creating Observables

- **Observables constructor takes a function**
  - Single parameter—an observer
- **Observer performs its work**
  - Sends results to observer by calling `observer.next(result)`

```
 createObserver() {
    this.data = new Observable((observer) => {
      let i=10;
      while(i--){
          setTimeout(() => {
              observer.next(i);
          }, 2000);
      }
      observer.complete();
    });
}
```

Send data to subscriber

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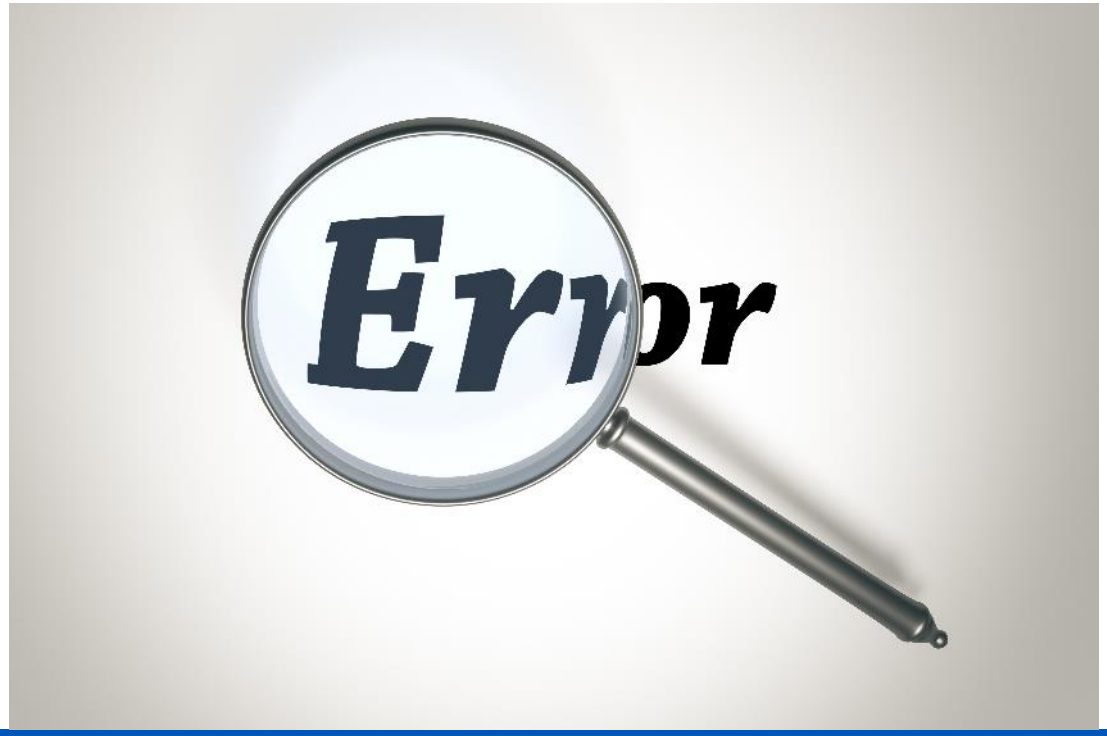
Observable Errors and Completion

- **The Observable reports errors by calling `observer.error( err: any)`**
- **May indicate completion by calling `observer.complete()`**
- **`error()` or `complete()` action is the last thing to be observed**
  - The Observer and Subscription are both terminated



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Observing Observables

- **Observers subscribe to the Observable**
  - Provide functions to call
    - When data is available
    - When errors occur (optional)
    - When the Observable is finished (optional)

```
let subscription = this.data.subscribe(
     (value) => this.values.push(value),
     (error) => this.errors += " " + error,
     () => this.done = true
   );
```

Data handler

Optional error handler

Optional completion handler

- **The subscription should be terminated**
  - `subscription.unsubscribe()`

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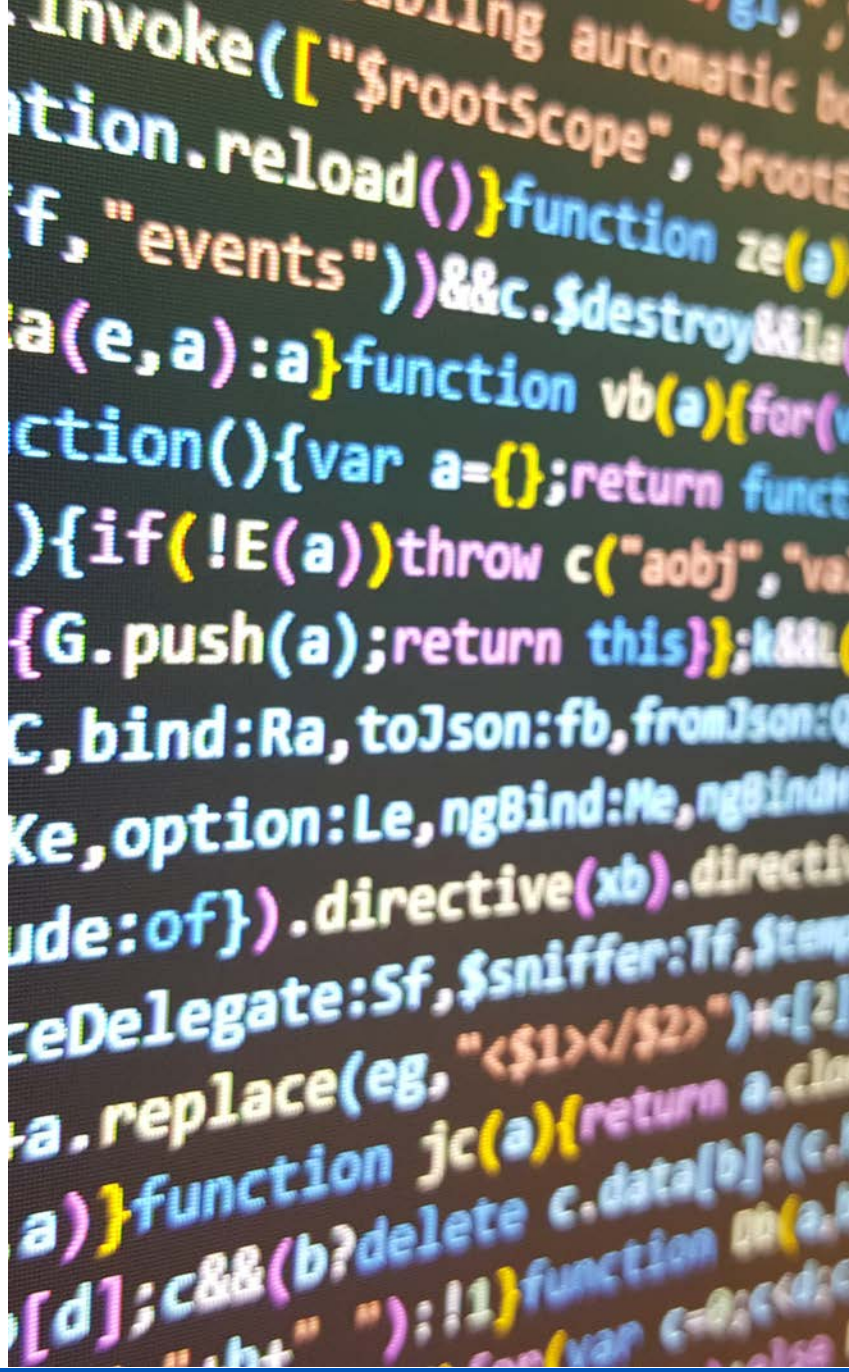
Contents

- Asynchronous Behavior

Change Detection

- Web Service APIs
- Integrating the Http Client



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Updating the View

- **Angular maintains a Component tree**
- **Each Component has a state—the model**
  - Which is reflected in the view
- **When the state of a Component changes**
  - Angular must update the view
    - Re-create all or part of the HTML DOM
- **Updating the entire view for every change could be very slow**
  - Resulting in poor response and a flickering display
- **Angular has a change detection strategy**
  - Identifies what has changed and updates the display

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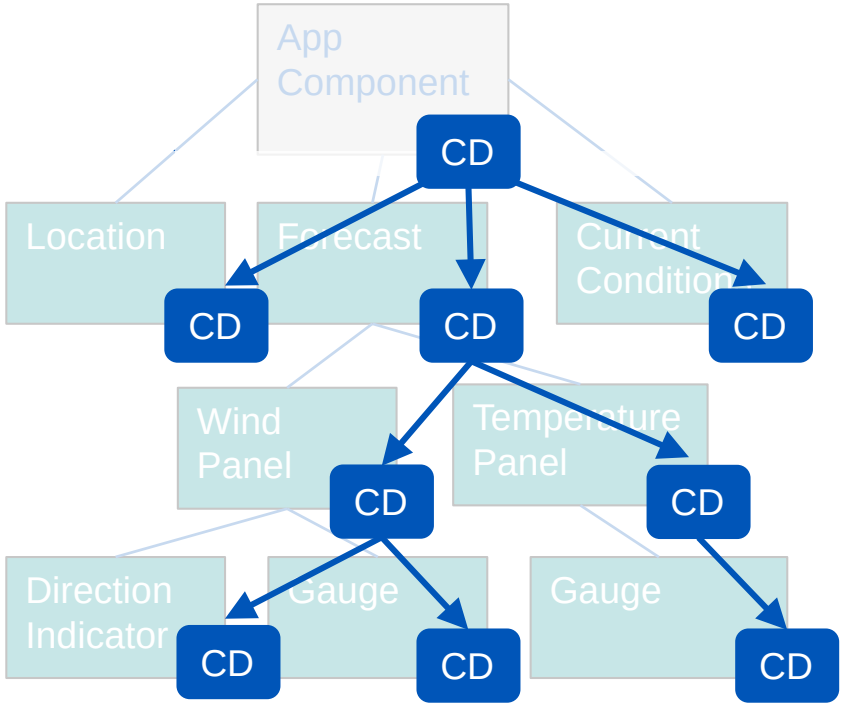
Change Detection

- **Angular automatically checks state periodically**
- **Checks for change**
  - Working top-down through the Component tree
  - Interrogates each Component's change detector
- **The Component change detectors are built automatically by Angular**
- **If any Component reports a change**
  - Angular updates the view



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Optimizing Change Detection

- **Default behavior**
  - Check every Component for any change
  - May give poor performance
    - Large Component trees on slow machines
- **Default change detection checks the content of every variable**
  - Examines the detailed structure of every object referenced from a Component
- **Change detection can be tuned**
  - Specify an alternative detection strategy
  - Add `changeDetection: ChangeDetectionStrategy.OnPush` to the Component metadata
- **`OnPush` changes the strategy to look for changes to object references**
  - Checks the values of the variables in the Component
    - Does not check the values of the variables referenced
- **The `OnPush` strategy applies to all Components in the hierarchy below the one where it is applied**

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Example of Change Detection

- **Changes to object references are always detected**

```
private date : Date;
…
doSomething(){
  this.date = new Date();
}
```

Object reference changed

- **Changes to the content of objects are only detected with default change detection**
  - Not when the strategy is `OnPush`

```
private date : Date;
…
doSomething(){
  this.date.setYear(1969);
}
```

Content object changed

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Notifying Angular of Change

- **Data arriving at Observables is not detected when strategy is `OnPush`**
  - Because the Observable's reference does not change
- **Solution: Subscription handler code must notify Angular of change**
  - Inject a `ChangeDetectorRef`
  - Call `markForCheck()` to notify Angular that the Component should be fully checked

```
constructor(
  private weatherService : WeatherService,
  private cd: ChangeDetectorRef){}
…
  this.weatherService.
        updatePreferences(this.model).subscribe(
        (id : number)=> {theId = id;
              this.cd.markForCheck()},
             (err)=> this.error = err
        );
```

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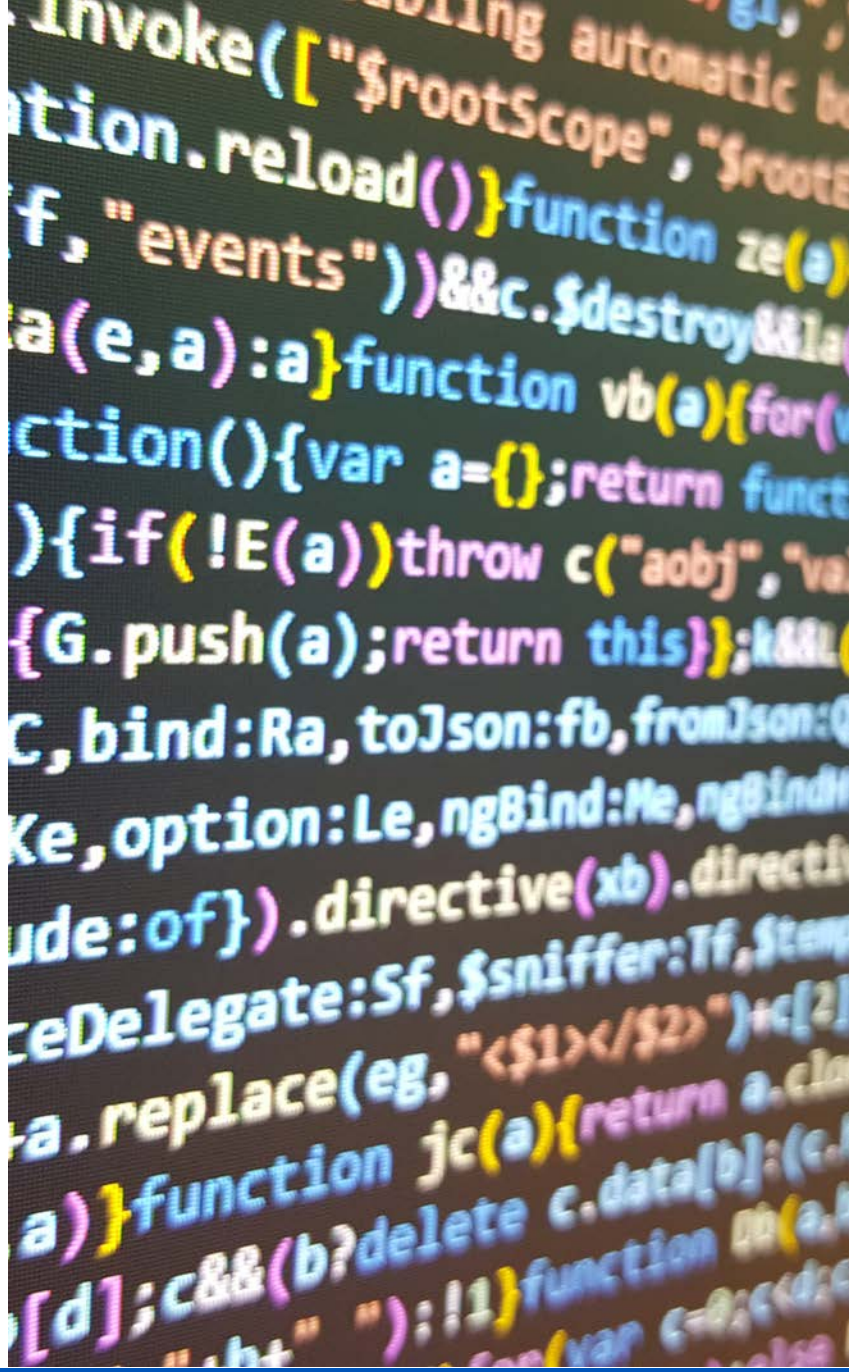

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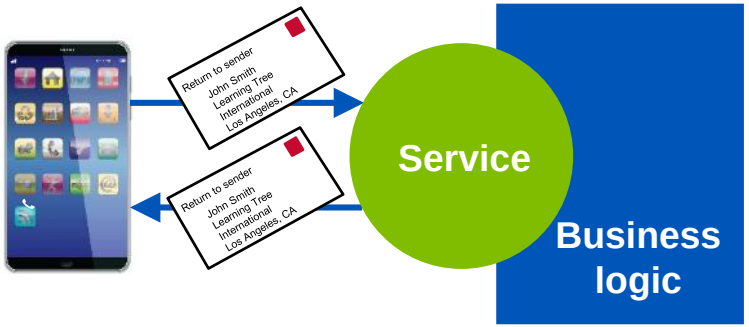
Integrating With the Server

- **Application data is commonly provided by a server-side application**
- **Communicated to the application via web services**
  - Also known as web APIs



- **Representational State Transfer (REST) services**
  - Lightweight, informal services
  - Data typically in JSON format
  - Easy to consume from JavaScript-based applications
- **Web services communicate over HTTP**

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Communicating Using HTTP

- **HTTP is the primary protocol for communicating on the web**
  - TCP/IP–based request/response protocol
- **Basic HTTP communication cycle**
  1. Client opens an IP connection to the server
  2. Client sends an HTTP request
  3. Server returns a response
  4. IP connection closed

- **HTTP request methods define behaviors**
  - `GET`: requests data from the server
  - `POST`: sends data to the server—analogous to a create
  - `PUT`: sends data—update
  - `DELETE`: deletes the specified resource

TCP/IP = Transmission Control Protocol/Internet Protocol

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JSON Format Overview

- **JSON is widely used for REST services**
  - Concise
  - Easy to process
- **Objects**
  - Objects begin and end with curly brackets (`{}`)
- **Object members**
  - Members consist of strings and values
  - Separated by a colon (`:`)
  - Members are separated by commas
- **Arrays**
  - Begin and end with brackets (`[]`) and contain values
  - Values are separated by commas

```
[{"dateTime":1467820008052,
  "skyConditions":"clear",
  "airPressure":1021.0,
  "windSpeed":18.0,
  "gustSpeed":24.5},
{"dateTime":1467820008052,
  "skyConditions":"clear",
  "airPressure":1029.0,
  "windSpeed":8.0,
  "gustSpeed":4.5}]
```

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Building a Web Service Client

- **To communicate with a web service**
  - Create an HTTP connection
  - Create a request from application data
  - Send the request
  - Parse the results
- **The Angular `HttpClient` class provides extensive support**

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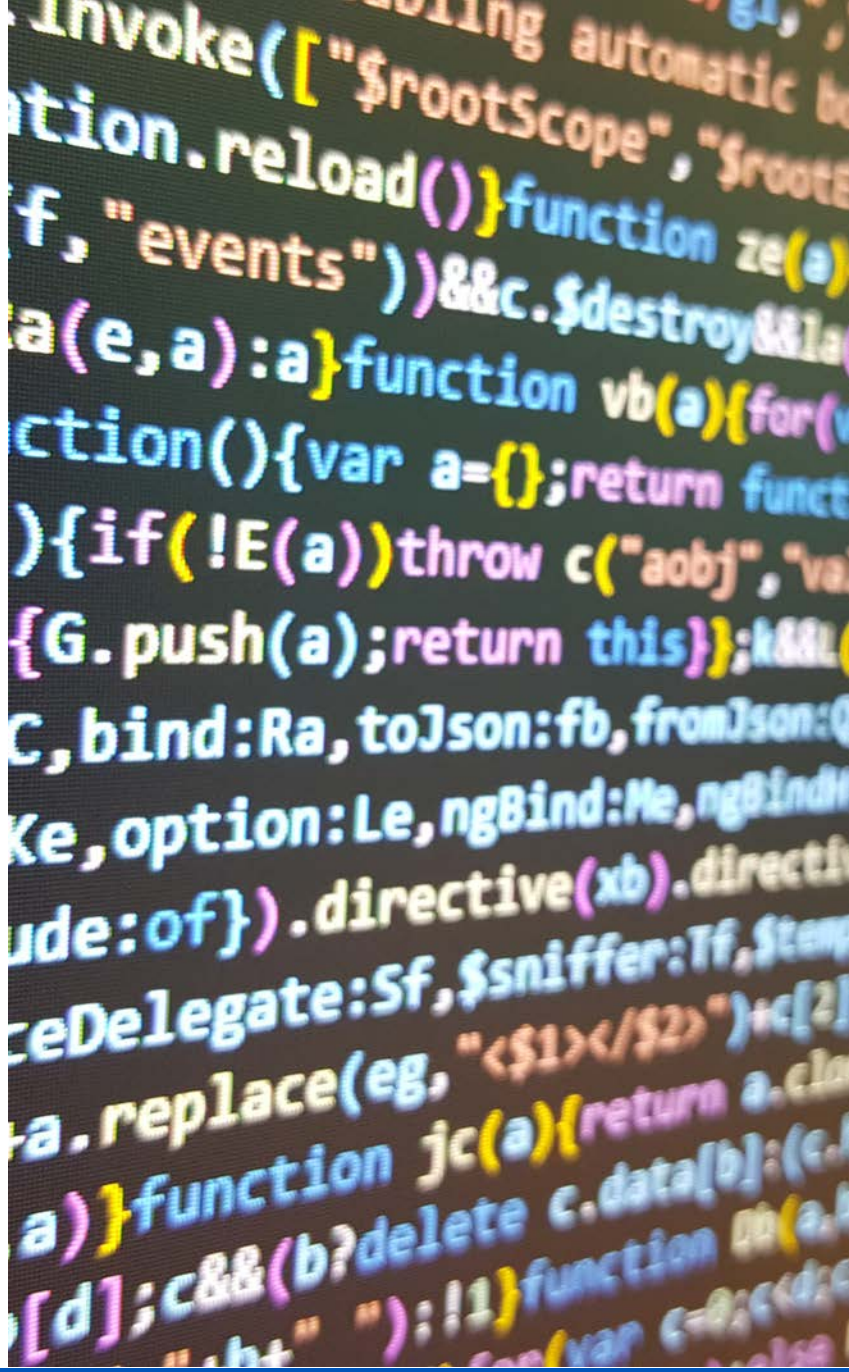
Integrating the HTTP Client



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Fetching Data From the Server

- **Weather server returns weather data in response to a `GET`**
  - `http://localhost:8080/weather/latest`
- **HTTP access code should be placed in a service class**

1. **Provide HTTP support**
2. **Inject `HttpClient` into service**
3. **Make the `GET` request**
4. **Convert the response to domain objects**
5. **Handle errors**
6. **Subscribe to the result**


```
[{"dateTime":1467820008052,
  "skyConditions":"clear",
  "airPressure":1021.0,
  "windSpeed":18.0,
  "gustSpeed":24.5},
{"dateTime":1467820008052,
  "skyConditions":"clear",
  "airPressure":1029.0,
  "windSpeed":8.0,
  "gustSpeed":4.5}]
```


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1. Provide HTTP Support

- **HTTP support is provided by `HttpClientModule`**
  - Must be declared in the `@NgModule imports`

app.module.ts

```
@NgModule({
  declarations: [
    AppComponent, …],
  imports: [
    BrowserModule,
    FormsModule,
    ReactiveFormsModule,
    HttpClientModule,
    routing
  ],
```

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2. `HttpClient` and Observable Support

- **Inject `HttpClient` into the constructor of the service**
- **HTTP code makes extensive use of Observables**
  - Provide imports for Reactive Extensions Observables
    - Avoid importing all of `rxjs`—it is huge!

weather.service.ts

```
import {Observable, throwError} from "rxjs";
import {catchError} from "rxjs/operators";

constructor(private http: HttpClient) {}
```

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3. Make the GET Request

- **Call `get()` on the `HttpClient` object**
  - Pass the URL as a parameter
- **Returns an `Observable<any>`**
- **Use `catch()` to specify the method to call if there is an error**

weather.service.ts

```
getWeather() {
  let url = "http://localhost:8080/weather/latest";

  let res : Observable;
  res = this.http.get(url)
}
```

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The `Get` Method Return Type

- **The response from `HttpClient` methods that return data is**
  - `Observable<any>`
- **There are multiple overloads that can be used to return different data types within the Observable**

```
get(url: string, options: …
```

`Options` object configures return types

- **Return types are configured by the `observe` and `responseType` properties of the `options` object**
- **Possible return types**
  - `string`
  - `ArrayBuffer`
  - `blob`
  - `HttpEvent`
  - `HttpResponse<any>`
- **See https://angular.io/api/common/http/HttpClient#get**

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Get Method Overloads

- **The type of the Observable returned from the `get()` method is defined by the options object**
  - Properties formally documented here

Signature of `HttpClient.get()`

```
get(url: string,
  options: {
    headers?: HttpHeaders | {
        [header: string]: string | string[];
    };
    observe?: 'events' | 'body' | 'response';
    params?: HttpParams | {
        [param: string]: string | string[];
    };
    reportProgress?: boolean;
    responseType?: 'arraybuffer' | 'blob' |
                                   'json' | 'text';
    withCredentials?: boolean;
}): Observable<any>
```

`observe` property

`responseType` property

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Basic `Get` Method Overloads

Reference

- **Return type of `HttpClient` `get` method determined by a combination of**
  - `Observe` (type of observable)
  - `Type` (data type of actual response)

observe	responseType	Return type
'body'	'arraybuffer'	Observable<ArrayBuffer>
'body'	'blob'	Observable<Blob>
'body'	'text'	Observable<string>
'events'	'arraybuffer'	Observable<HttpEvent<ArrayBuffer>>
'events'	'blob'	Observable<HttpEvent<Blob>>
'events'	'text'	Observable<HttpEvent<string>>
'response'	'arraybuffer'	Observable<HttpResponse<ArrayBuffer>>
'response'	'blob'	Observable<HttpResponse<Blob>>
'response'	'text'	Observable<HttpResponse<string>>

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HttpEvent and HttpResponse

Reference

- **On the previous slide, response may be wrapped in:**
- **`HttpResponse`**
  - Provides full access to the `HttpClient` response object
  - Properties include
    - `body`
    - `type`
    - `headers`
    - `status`
    - `statusText`
- **`HttpEvent`**
  - Union type for all possible events on the response stream
    - `HttpResponse`
    - `HttpSentEvent` (Indicates request sent to server)
    - `HttpHeaderResponse` (Headers, but no body)
    - `HttpProgressEvent` (Progress)
    - `HttpUserEvent` (Base class for user defined events)

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Get Methods for JSON Data

- **If the `responseType` is `'json'` the data is treated as an object**

```
get(url: string, options: {…}) : Observable<Object>
```

- **Return type may be specified using a generic type indicator**

```
get<T>(url: string, options: {…}) : Observable<T>
```

- **The value of observe still indicates if the returned data should be wrapped**
  - By `HttpEvent` or `HttpResponse`

observe	responseType	Return type
'body'	'json'	Observable<Object>
'event'	'json'	Observable<HttpEvent<Object>>
'response'	'json'	Observable<HttpResponse<Object>>

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4. Convert the Response to Domain Objects

- **The JSON data from `Http.get()` should be converted to domain objects**
  - Weather objects in our example
- **Use the generic version of `HttpClient.get<T>()`**
  - Returns an Observable that holds the specified type

```
public getWeather() : Observable<Weather[]>{
        return this.http.get<Weather[]>(url);
}
```

Defaults for the options object (2nd parameter) are `observe: 'body', type: 'json'`

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5. Handle Errors

- **Use the `Observable.pipe(fn)` to append an error handler to the `Observable` chain**
- **The function specified as the parameter to `catchError()`**
  - Will be invoked if an error occurs

```
"
getWeather() : Observable<Weather[]>; {
  let url = "http://localhost:8080/weather/latest";
  return this.http.get(url)
        .pipe(catchError(this.handleError));
}
private handleError (error: HttpErrorResponse )  {
       // Handle the error conditions
       // See next slide
}
"
```

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Error Handler

- **`HttpErrorResponse` contains the error information**
- **If `HttpErrorResponse.error` is an `ErrorEvent`**
  - Indicates a client side error
- **Otherwise assume it is a server-side error**
- **Error handler must return an `ErrorObservable`**

```
"private handleError (error: HttpErrorResponse ) {
    if(error.error instanceof ErrorEvent){
      // Client error
      console.error('Http communication error:', error.error.message)
    } else {
      // Server error
      console.error(`Server error: ${error.status}. Message body:
${error.error}`)
    }
    return throwError( 'Server error - is the REST server running?');
  }
"
```

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6. Subscribe to the Result

- Code so far has converted the HTTP response to `Observable<Weather[]>`
- Consuming code subscribes to the `Observable` to extract domain data

```
weather : Weather[];
error: any;

ngOnInit() {
  this.weatherService.getWeather().subscribe(
    (weather : Weather[])=>this.weather = weather,
    (error : any)=>this.error = error);
}
```

- Important: The request will not be sent until `subscribe()`is called

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Sending Data to the Server

- **Simple data may be sent to the server as query parameters**
  - Name = value pairs appended to the URL
  - `http://localhost:8080/weather/latest?location=Newcastle`
- **Appending values can be achieved**
  - Using string concatenation
  - With `URLSearchParams`

```
let weatherParams = new HttpParams();
weatherParams.set('location', location);
weatherParams.set('units', 'C');

return this.http.get<Weather[]>(url, {params: weatherParams
});
```

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Posting Data to the Server

- **Object data should be sent using `HTTP Post`, `Put`, or `Patch`**
  - Confidential data should also be sent using these methods
  - `POST` for create operations
  - `PUT` or `PATCH` used for update operations
- **Using `POST` is similar to `GET`**
  - Requires extra data
- **`HttpClient.post()` takes three parameters**
  1. `url`—the URL to send the request to
  2. `body`—the data to send —usually JSON
     - Create using `JSON.stringify()`
  3. `options`—configuration for the `HTTP POST`
     - Must provide an HTTP header of `Content-Type`
       - Use `application/json` for JSON data
     - May provide other HTTP headers such as `Accepts`

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Posting Data to the Server

```
savePreferences(preferences: Preferences ) :
                                          Observable<string> {
 let url = "http://localhost:8080/weather/preferences";      1
 let body = JSON.stringify( preferences );      2
 let headers =
     new HttpHeaders({ 'Content-Type': 'application/json' });
 let options = { headers: headers };      3

 return this.http.post<string>(url, body, options)
       .pipe(catchError(this.handleError));
}
```

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Other HTTP Methods

- **`put()` and `patch()` take the same arguments as `post()`**
- **`delete()` does not have a body**
- **The code is very similar in all cases**

```
post(url: string, body: any,
        options?: Object) : Observable<Response>

put(url: string, body: any,
        options?: Object) : Observable<Response>

delete(url: string,
        options?: Object) : Observable<Response>

patch(url: string, body: any,
        options?: Object) : Observable<Response>
```

- **There is no explicit type declaration for `options`**
  - It is described separately for each method

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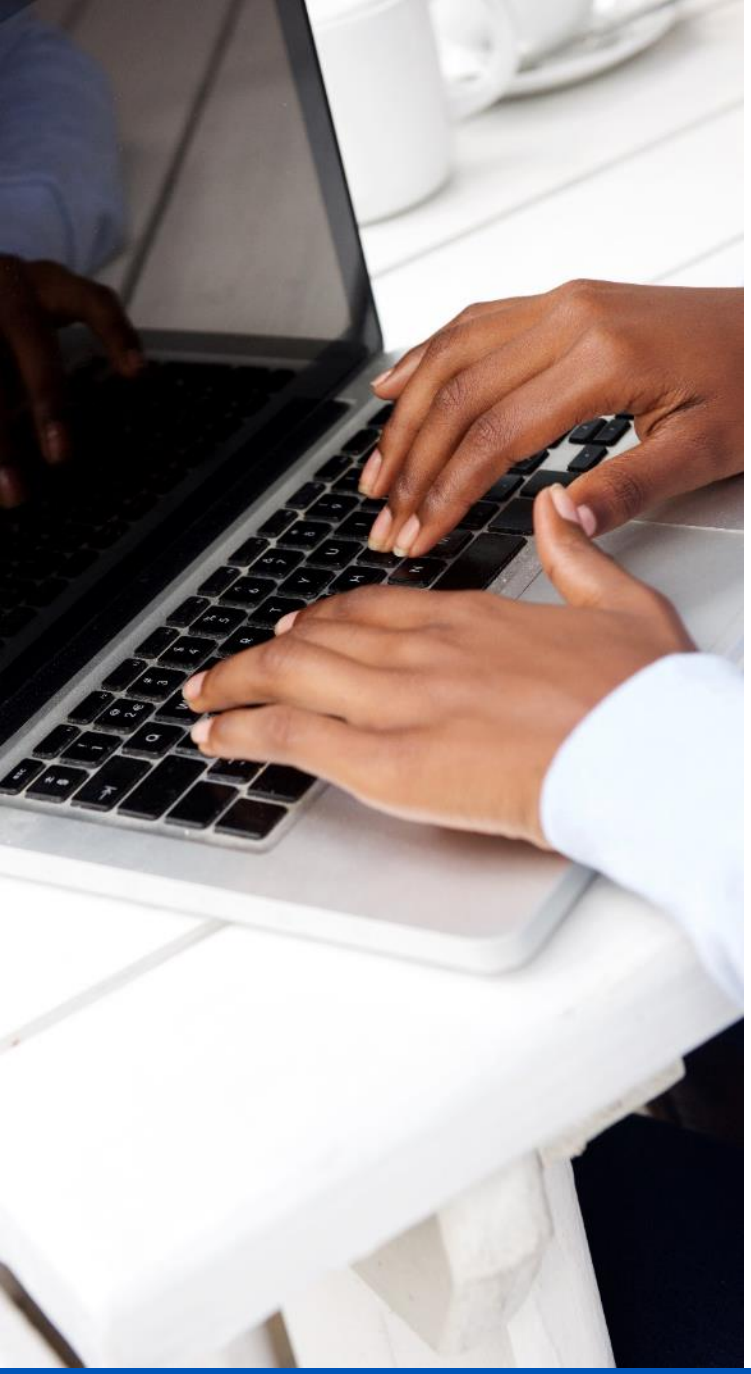

Hands-On Exercise 8.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 8.1: Communicating With a REST Server

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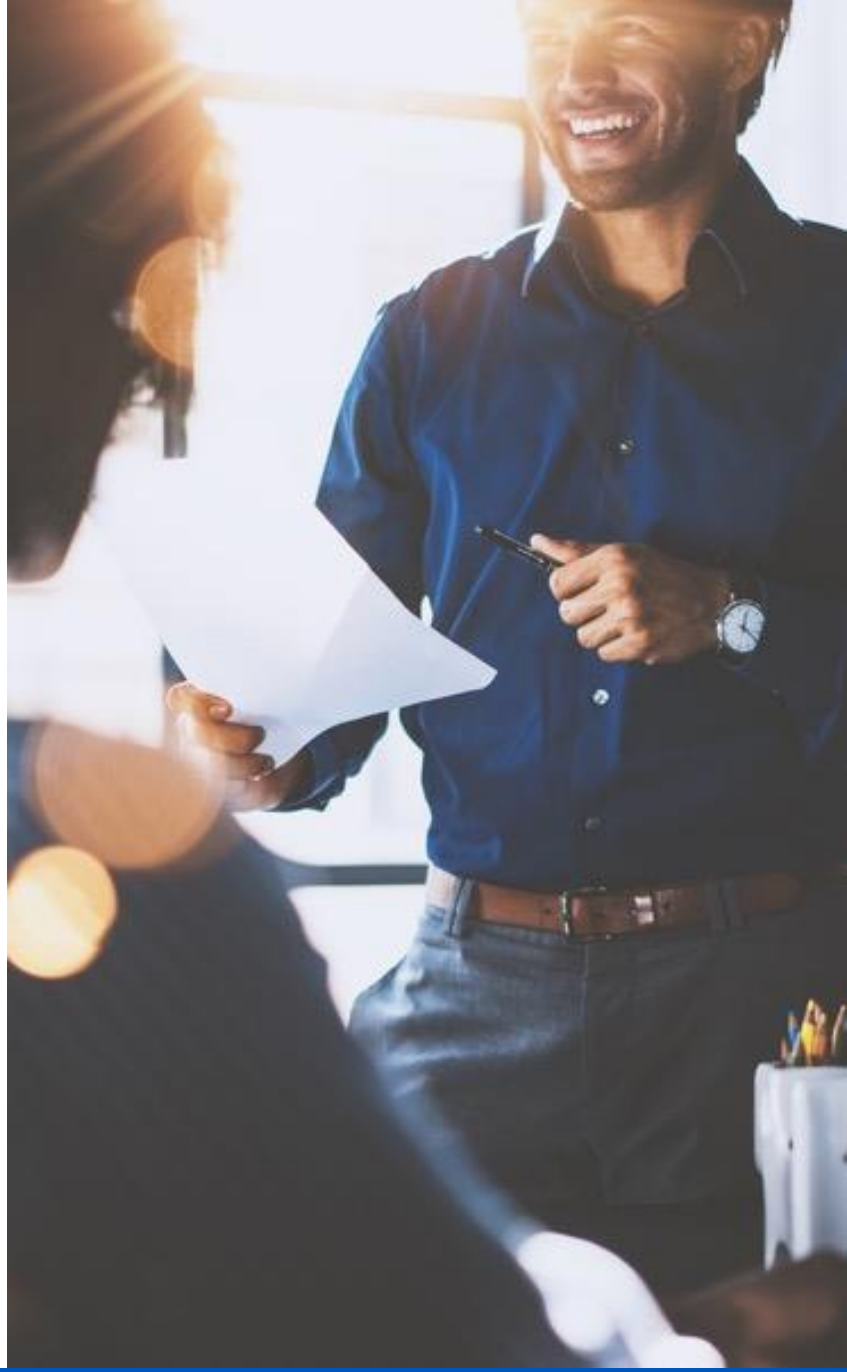
Objectives

- Incorporate Promises and Observables
- Optimize Change Detection
- Communicate with REST APIs



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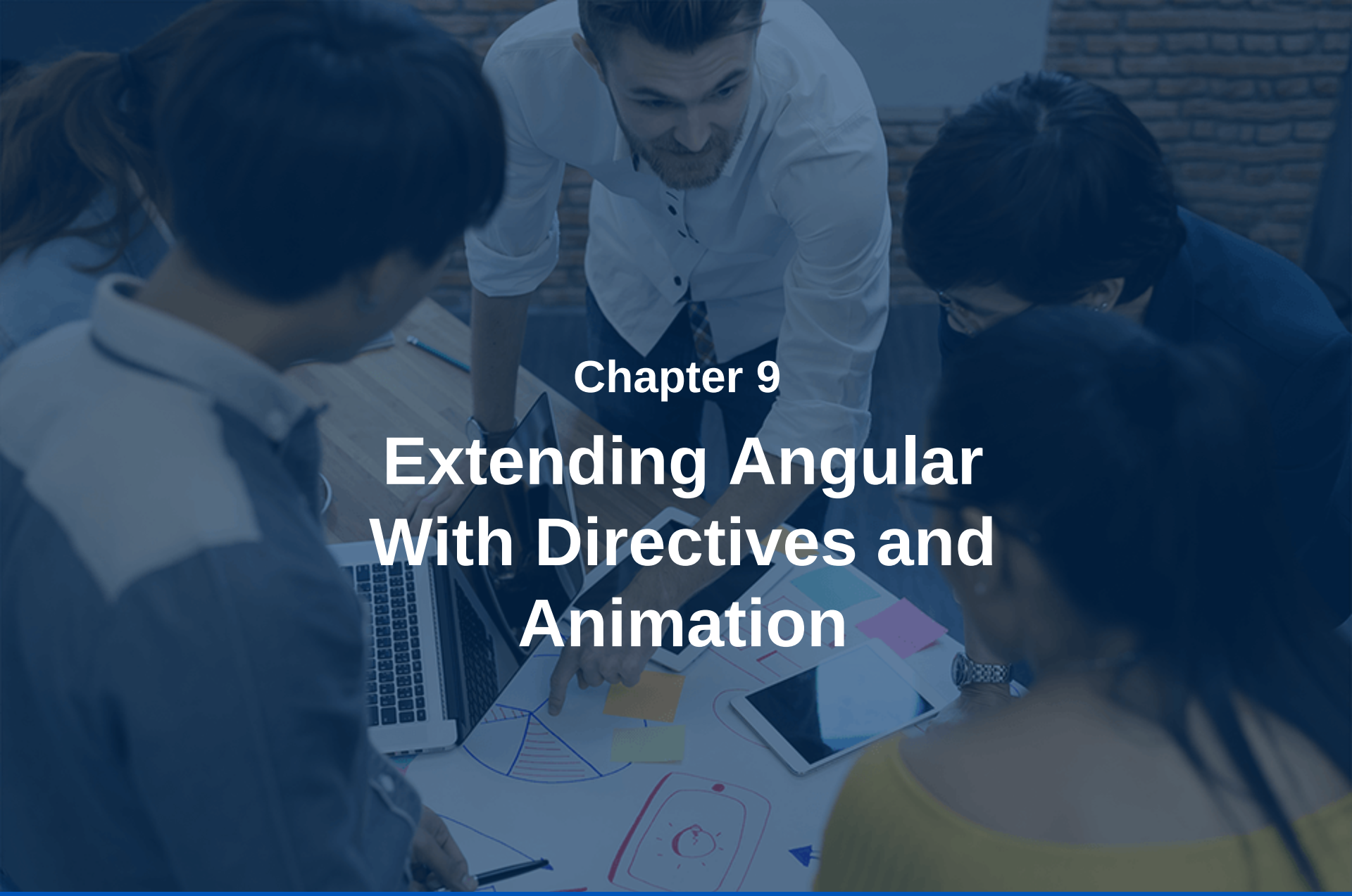

Chapter 9

Extending Angular With Directives and Animation

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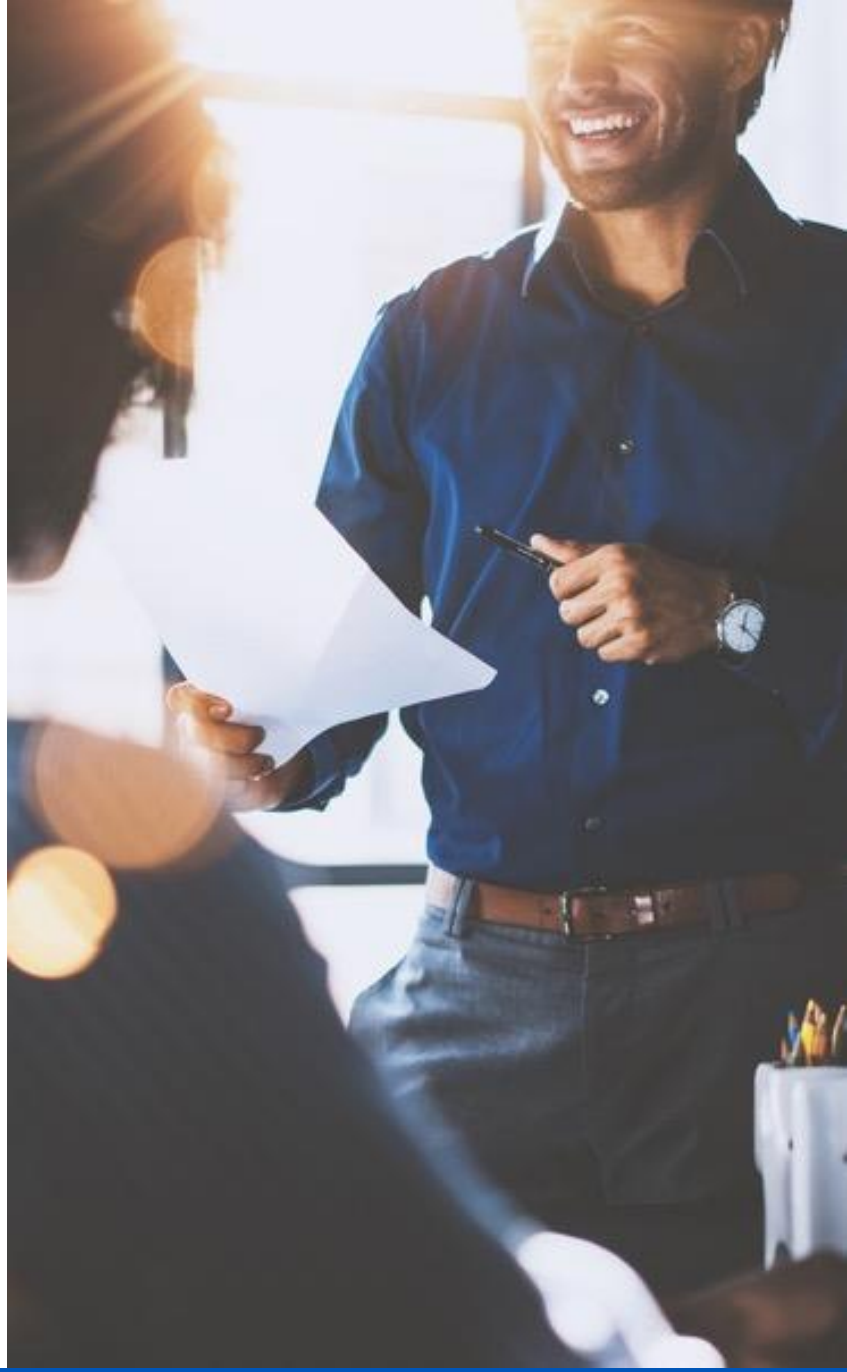
Objectives

- Differentiate directive types
- Build attribute directives
- Investigate structural directives
- Implement an animation



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Contents

Attribute Directives

- Structural Directives
- Animation

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Directives

- **Angular has three types of directives**
- **Components**
  - We've used extensively
- **Attribute directives**
  - Change the appearance or behavior of a DOM element
- **Structural directives**
  - Modify the DOM structure
    - Add or remove elements

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Attribute Directives

- Functionality applied when a matching attribute is present in a template
- Example: An attribute directive to match the attribute `MakeItBold`

```
<p MakeItBold>Some bold text</p>
```

- A directive is a class with an `@Directive()` decorator

```
@Directive({
  selector: '[MakeItBold]'
})

export class MakeItBold {
  constructor(el: ElementRef) {
    el.nativeElement.style.fontSize = '2em';
    el.nativeElement.style.fontWeight= 'bold';
  }
}
```

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Attribute Directive Details

- **The selector property specifies a CSS selector matching the attribute**
  - CSS selectors in `[ ]` match attributes
- **Angular injects a reference to the DOM element `ElementRef`**
- **`ElementRef.nativeElement` provides access to the corresponding DOM element**

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Applying the Attribute Directive

- **Two steps**
  1. Add the attribute to the template of a Component

```
<p MakeItBold>Some bold text</p>
```

  2. Add the directive's class name to the declarations property of the `@NgModule`

```
declarations: [MakeItBold]
```

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Binding Attributes

- **Attribute directives support binding**
  - Allowing configuration of directive behavior

```
<p [MakeItBold]="'2em'">Some bold text</p>
```

- **Directive must have an `@Input()` with a name matching the selector**
  - `MakeItBold` in our example

```
@Directive({
  selector: '[MakeItBold]'
})

export class MakeItBold {
  @Input()
  MakeItBold : string;
}
```

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Aliasing the `@Input`

- **The `@Input()` decorator can specify an alias**
  - Allowing the field name to fit better with the directive logic
- **The `@Input()` decorator can be assigned to a setter**

```
export class MakeItBold {

  constructor(private el: ElementRef) {
    el.nativeElement.style.fontWeight= 'bold';
  }

  @Input('MakeItBold')
  set fontSize(size : string){
    this.el.nativeElement.style.fontSize  = size;
  }

}
```

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Contents

- Attribute Directives

Structural Directives

- Animation

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Structural Directives

- **Angular has several built-in structural directives**
- **`ngIf`, `ngFor`, `ngSwitch`**
- **They manipulate the structure of the DOM**
  - Adding or removing DOM fragments as needed
- **Structural directives make use of an HTML5 element `<template>`**
  - A wrapper for an HTML fragment that is not initially rendered
    - Script in the page may display it

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Operation of `ngIf`

- `ngIf` is normally used as `*ngIf="some condition"`

```
<div
*ngIf="contentReady">
  {{content}}
</div>
```

- Angular interprets this as

```
<template [ngIf]="contentReady">
  <div>
    {{content}}
  </div>
</template>
```

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Implementation of `ngIf`

- **Simplified version of `ngIf`**
- **Similar to the attribute directive**
  - Has an `@Input` of `ngIf`

```
@Directive({selector: '[ngIf]'})
export class NgIf {
 constructor(private _viewContainer: ViewContainerRef,
              private _templateRef: TemplateRef<Object>){}
 @Input()
 set ngIf(newCondition: boolean) {
  if (newCondition){
       this._viewContainer
              .createEmbeddedView(this._templateRef);
  } else {
       this._viewContainer.clear();
  }
}
```

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Operation of `ngIf`

- **Two references injected into the constructor**
  - `ViewContainerRef`—allows access to the DOM around the element with the structural directive applied to it
  - `TemplateRef<Object>`—wrapper for the `<template>`

- **If the condition is true**
  - Render the template with:

```
this._viewContainer
            .createEmbeddedView(this._templateRef);
```

- **Else**
  - Replace the `<template>` with `<script></script>`

```
this._viewContainer.clear()
```

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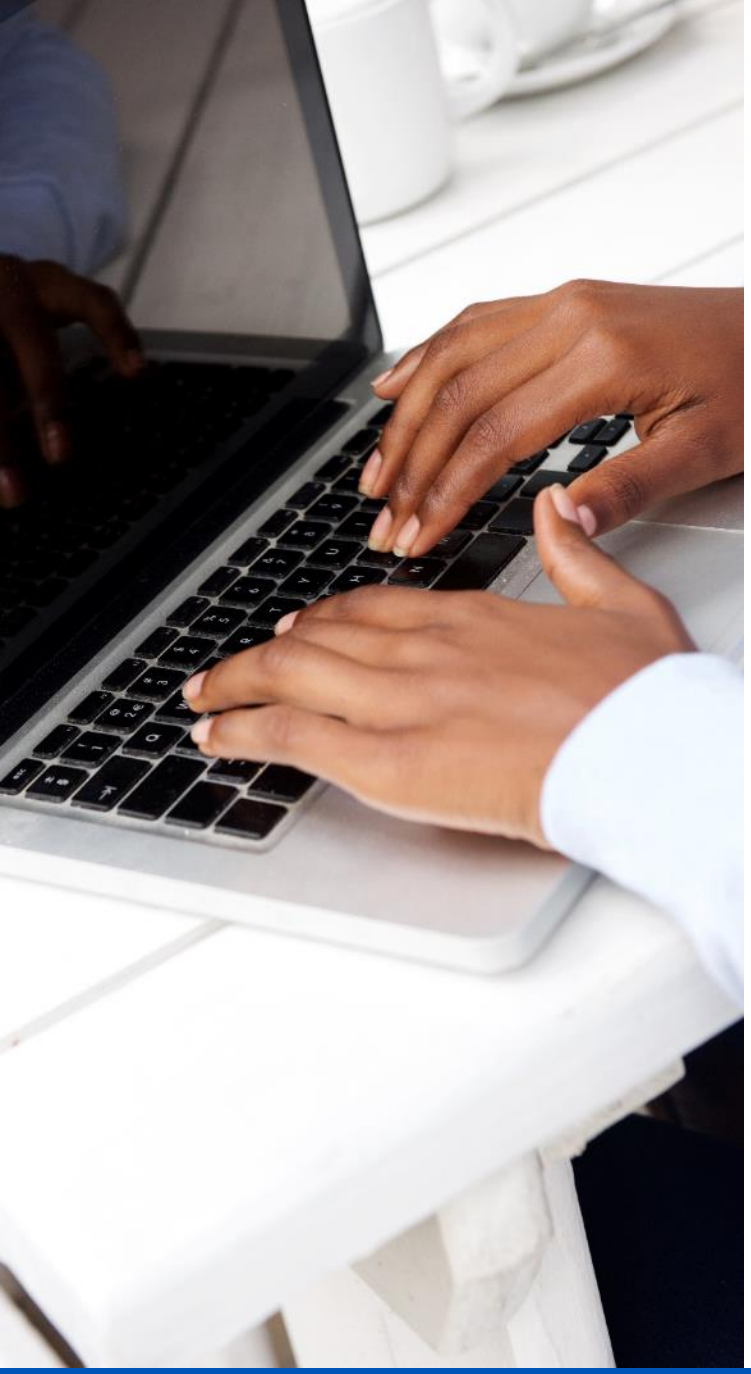

Hands-On Exercise 9.1

Exercise Manual

In your Exercise Manual, please refer to Hands-On Exercise 9.1: Creating an Attribute Directive

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Contents

- Attribute Directives
- Structural Directives

Animation

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Adding Animation

- **Animation can improve the user experience**
  - Smooth transitions
  - Gaining the user's attention
- **Animation also helps sell your product!**
- **Angular supports animation built on top of the Web Animation API**
  - Not supported by all browsers
  - Polyfill available: `https://github.com/web-animations/web-animations-js`
- **Animations are defined by states, transitions, and triggers**
  - State: the styling when in that state
  - Transition: defines visual effects when changing from one state to another
  - Triggers: define how an animation relates to a template

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Defining Animations

- **Animations are defined as a property of `@Component`**
  - `animations : [trigger, trigger]`
- **Triggers have a name**
  - One or more states
  - One or more transitions

```
animations: [
  trigger('myanimate', [
    state('on', style({
      opacity : 0
    })),
    state('off',   style({
      opacity : 1
    })),
    transition('on => off', animate('1000ms ease-in')),
    transition('off => on', animate('1000ms ease-out'))
])
```

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Adding Animation to a Template

- **Animation triggers are added to template elements**
  - As attributes: `@trigger-name`

```
<div [@myanimate]="animate"></div>
```

Binds animation trigger '`myanimate`' to the Component property `animate`

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Enabling Animation

- **To enable animation, your module must include the `BrowserAnimationsModule`**

```
import { BrowserAnimationsModule }
       from '@angular/platform-browser/animations';

@NgModule({
       …
   imports: [
    BrowserModule,
    FormsModule,
    HttpModule,
    BrowserAnimationsModule
  ],
       …
})
```

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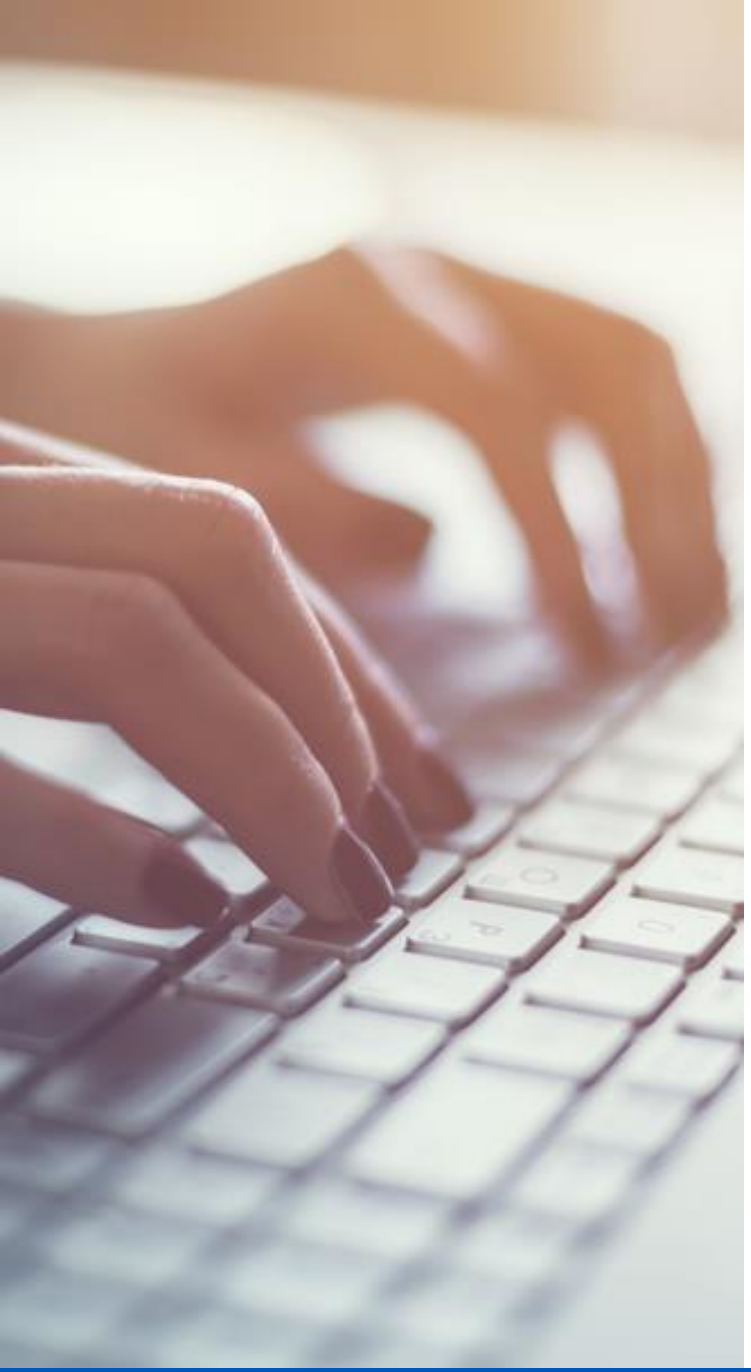

9.1: Animation in Action

Do Now

- In your Exercise Manual, please refer to Do Now 9.1: Animation in Action

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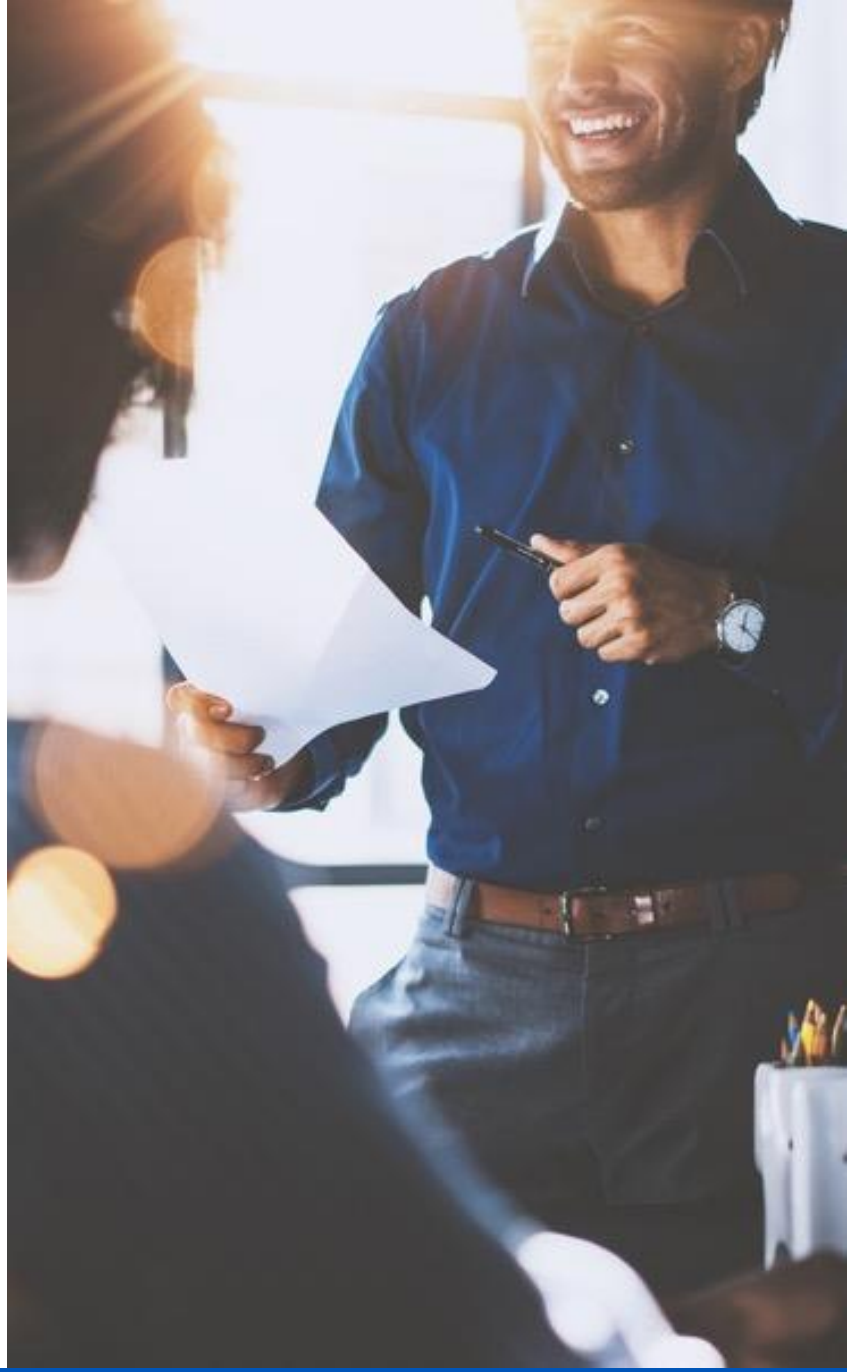
Objectives

- Differentiate directive types
- Build attribute directives
- Investigate structural directives
- Implement an animation



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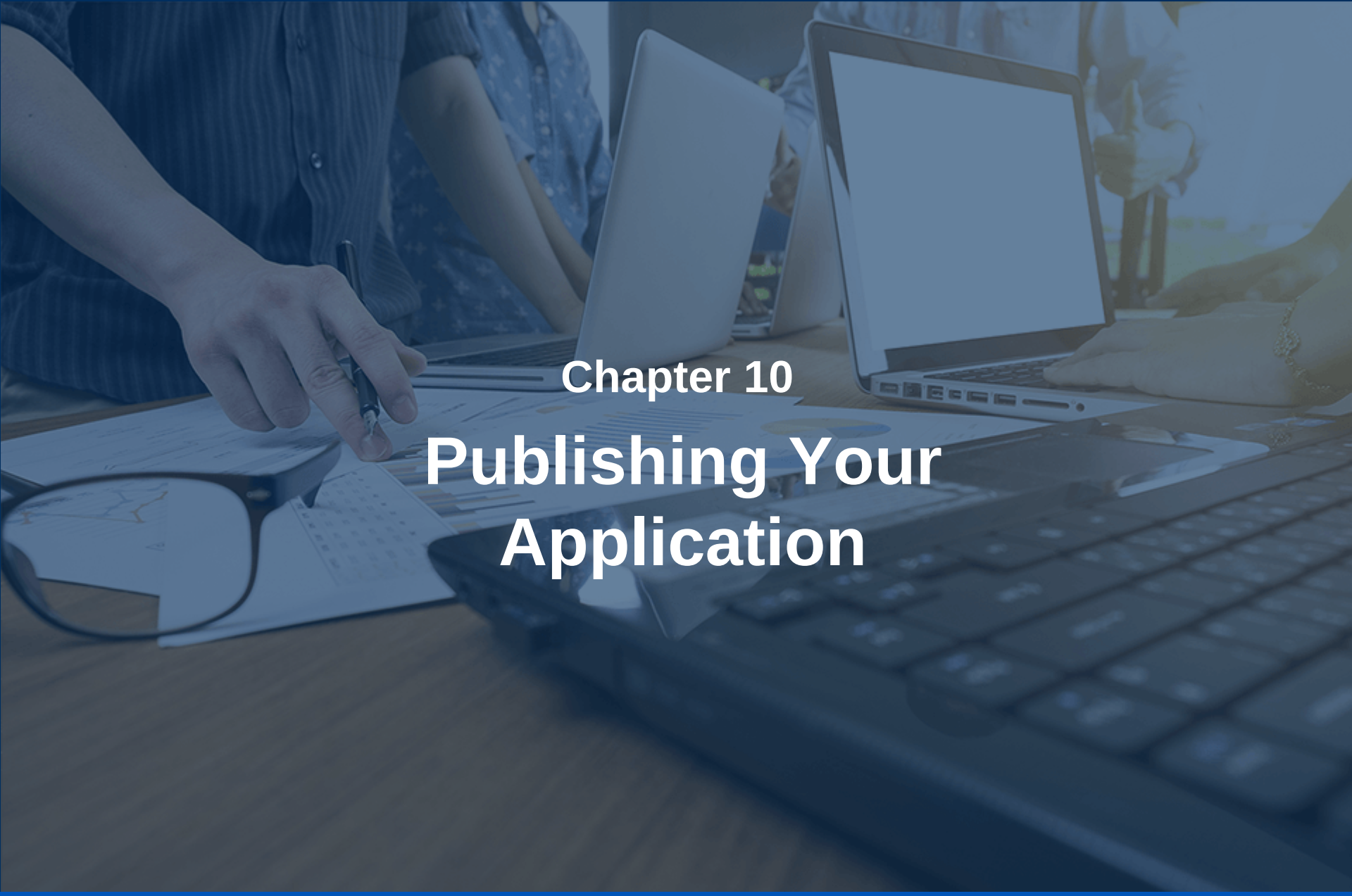


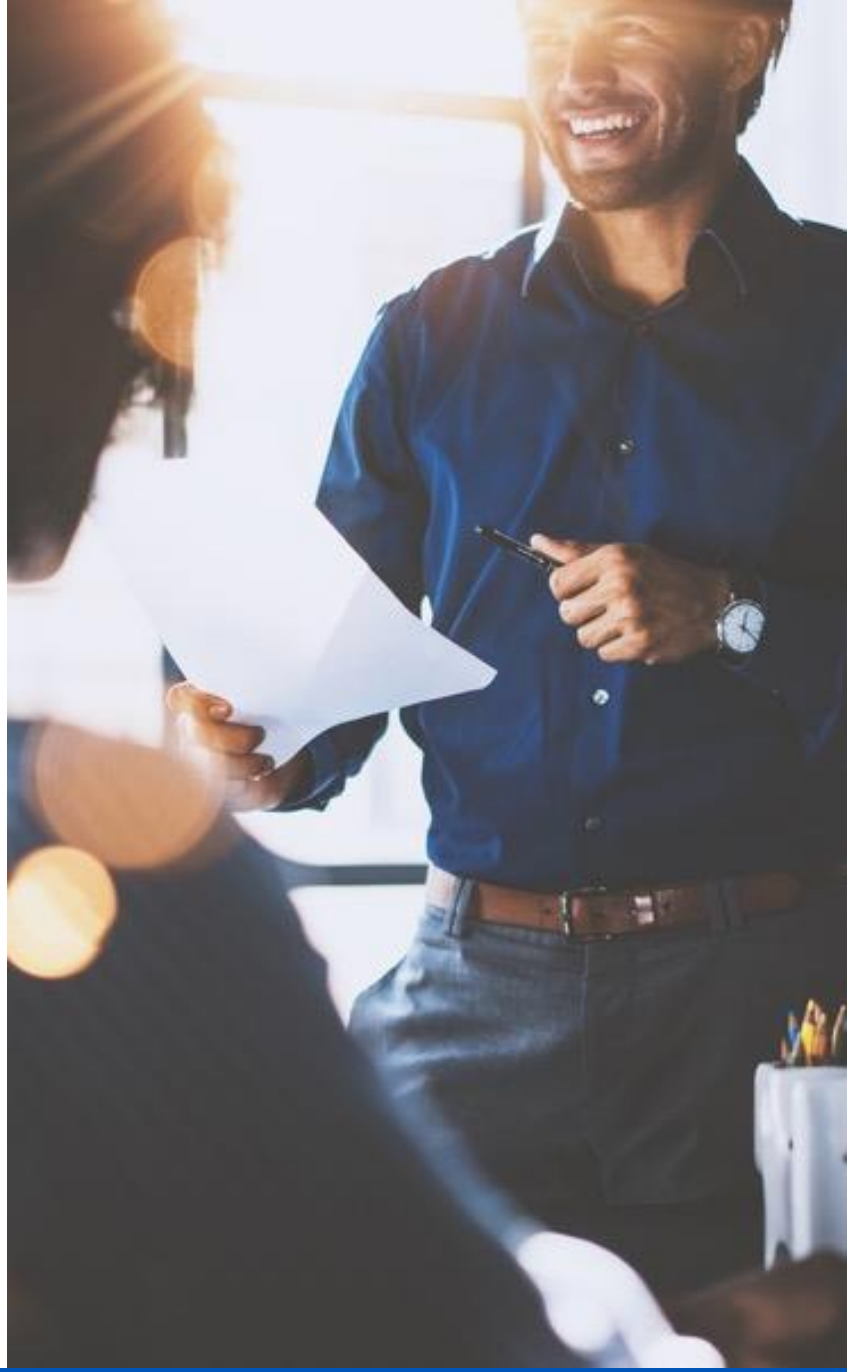
Chapter 10

Publishing Your Application

LEARNING TREE INTERNATIONAL

Objectives

- Prepare your application for publication
- Publish your application on a web server



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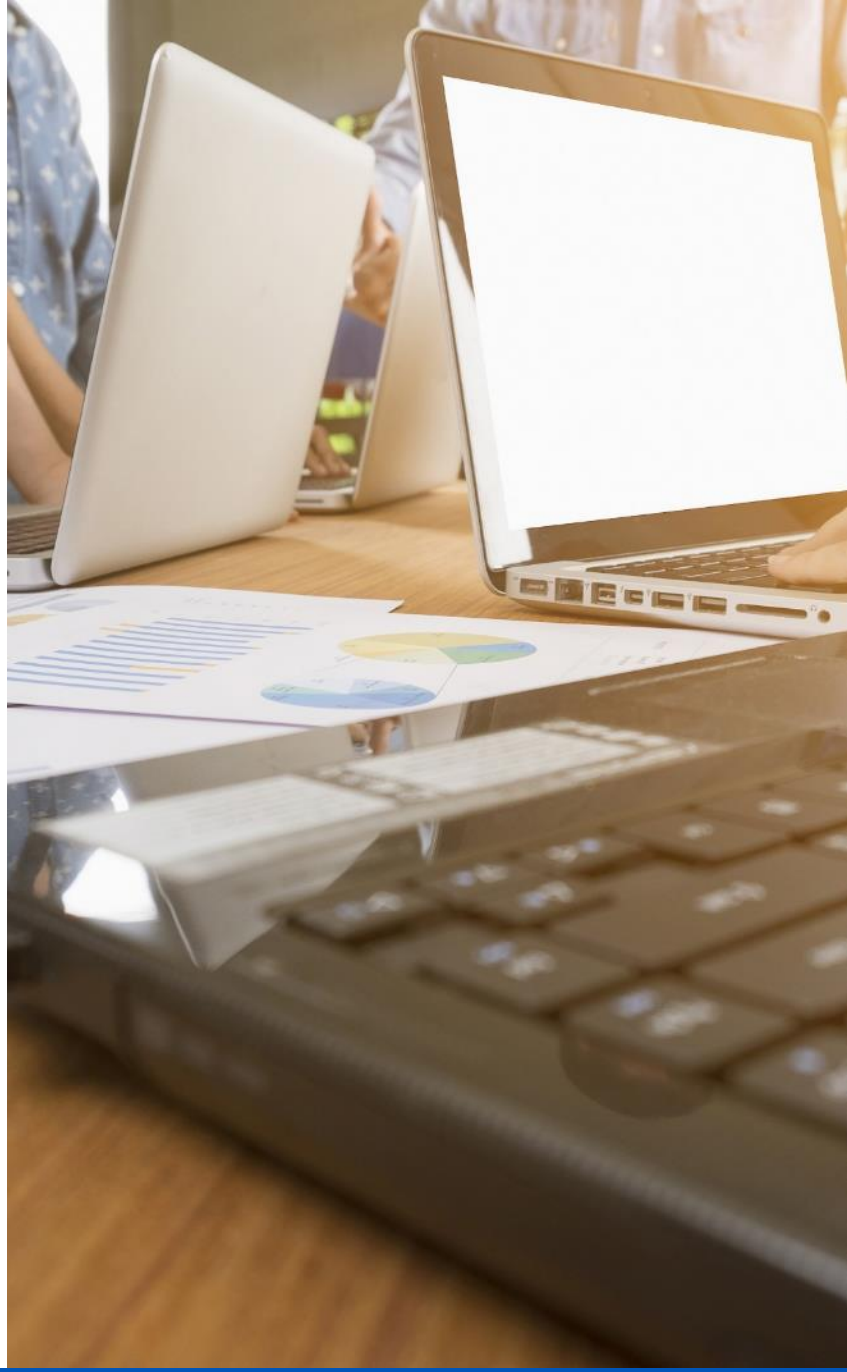
Contents

Preparing for Publication

- ► **Publishing to a server**



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Moving to Production

- **We have been working with our application on a development server**
  - Using `ng serve`
- **To publish we need to**
  - Run on a production server
    - IIS, Apache, Nginx, Lighttpd, etc.
  - Compress and bundle Javascript
  - Compress and bundle other resources

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Compressing and Bundling Javascript

- **An Angular application references a very large number of source files**
  - Referencing each one via a `<script>` tag would be slow and inefficient
- **In the development environment, Webpack bundles the application into a small number of files**
  - To aid debugging, these files are not compressed
- **In production, the bundle files should be as small as possible**
- **Achieved by two processes**
  - Tree-shaking—removal of unused code
  - Uglification—compresses Javascript with a number of techniques including
    - Removal of whitespace
    - Shortening of symbols

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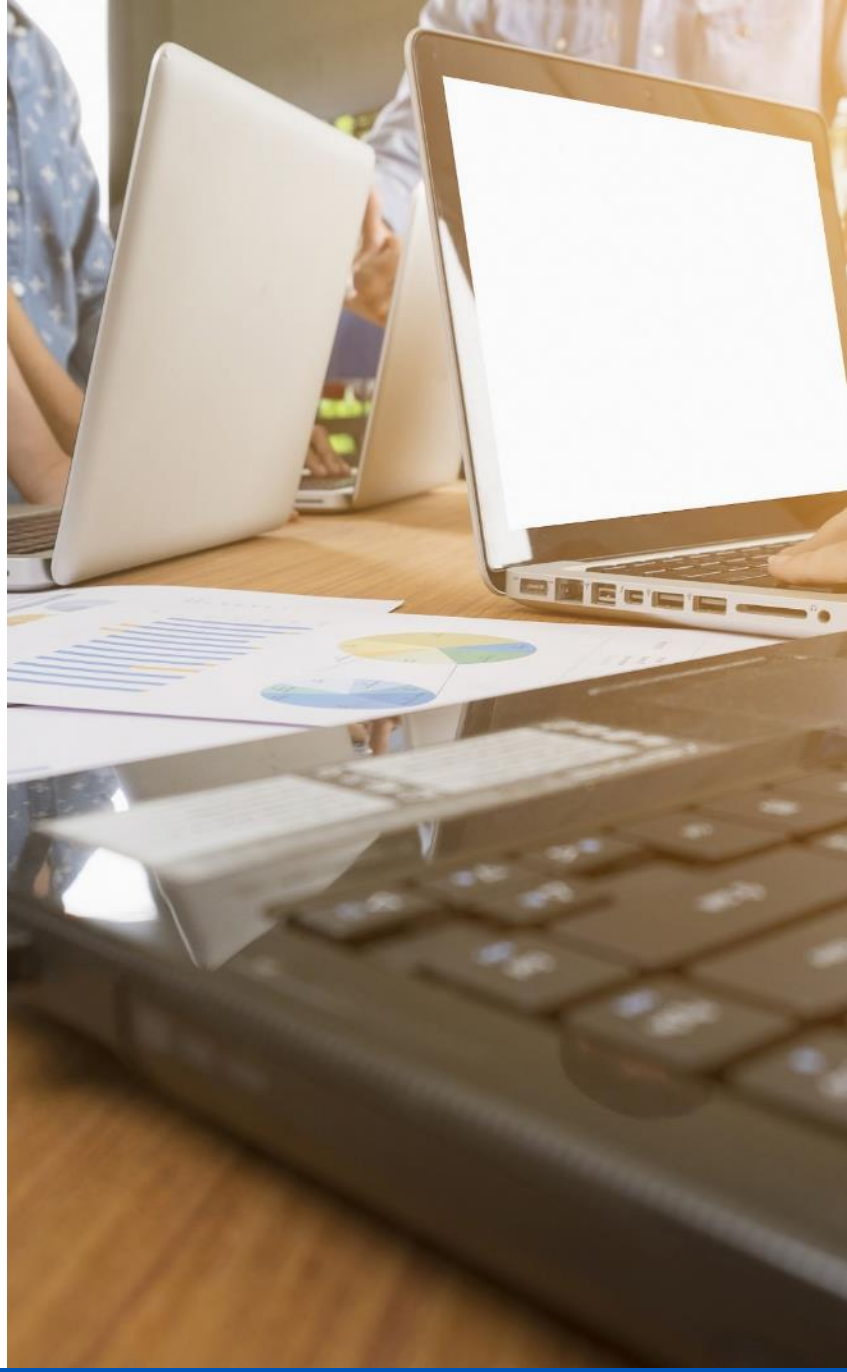
Contents

- ► **Preparing for Publication**

Publishing to a server



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Ahead-of-Time Compilation

- **The code we write for Angular components is not actually executable!**
  - It's a declaration of a component's appearance and behaviour
    - Not a set of steps to execute
- **Angular compiles component code to executable code in the form of component factories**
- **Compilation may be performed**
- **Just-in-Time (JIT)**
  - The browser runs the compiler before components are rendered
- **Ahead-of-Time (AOT)**
  - Components are compiled as part of the build process
- **The default behavior is JIT**
- **AOT may be enabled by adding the `--aot` flag to `ng serve` or `ng build`**

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Should You Use AOT?

- **If AOT is enabled**
  - Applications load faster
  - The downloaded bundles are smaller
    - No JIT compiler
  - Template errors are detected during build
  - Security is enhanced
    - Original component source not sent to the browser
- **But…**
  - There are restrictions on the content of the `@Component` metadata
    - Only a subset of JavaScript is supported
  - For details and work-arounds see: https://angular.io/guide/aot-compiler

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Browser Support—JavaScript

- **Angular code uses the latest JavaScript specifications and extensions**
  - May not be available on all browsers
- ***Polyfills* provide missing support**
  - Defined by contents of `src/polyfills.ts`
- **Code is automatically generated for both ES5 and ES2015 by the build process**
  - The `<script>` tags inserted into the HTML use `nomodule` / `type="module"`
    - To load the correct script dependent on browser support

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Browser Support—CSS

- **Some browsers require vendor specific prefixes for newer CSS features**
  - Example for the transition property:

```
-webkit-transition: all 4s ease;
-moz-transition: all 4s ease;
-ms-transition: all 4s ease;
-o-transition: all 4s ease;
transition: all 4s ease;
```

- **Angular applications should just specify the CSS3 standard property**
- **The build process will add vendor prefixes as required**
- **Uses a library called browserlist to define supported browsers**
  - Configured by a file called `browserlist` in the project root directory

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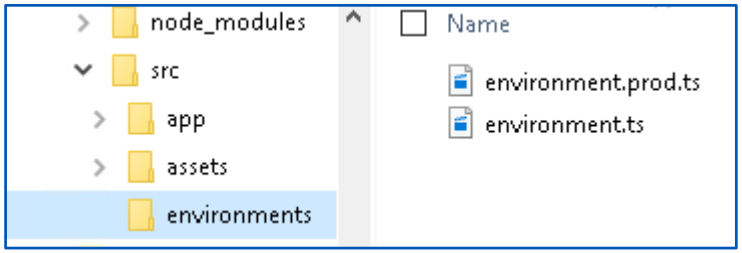
Production vs. Development Builds

- **The environments folder contains two files**
  - `environment.ts`
  - `environment.prod.ts`
- **May be used to define values that change between builds versions**




```
export const environment = {
  production: false,
  apiUrl: 'localhost:1234/flights'
};
```

environment.ts

```
export const environment = {
  production: true.
  apiUrl: 'prodhost.com:1234/flights'
};
```

environment.prod.ts

```
import { environment } from '../environments/environment;

export class FlightsService
  private serviceUrl = environment.apiUrl;
};
```

flights.service.ts

Value from `environment.prod.ts` in production build and from `environment.ts` in development

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Publishing With Angular CLI

- **Angular CLI can perform the build compression and bundling tasks for us**

```
ng build --prod --aot
```

- **There are many options to `ng build`**
  - View with `ng build –help`
  - `--prod` switch to the production version of `environment.ts`
    - Also suppresses the generation of .map files (used for debugging TypeScript)
  - `--aot` enable ahead-of-time compilation
- **Creates a set of files in the `dist` directory of our project**
- **These files can be copied directly to a production web server**

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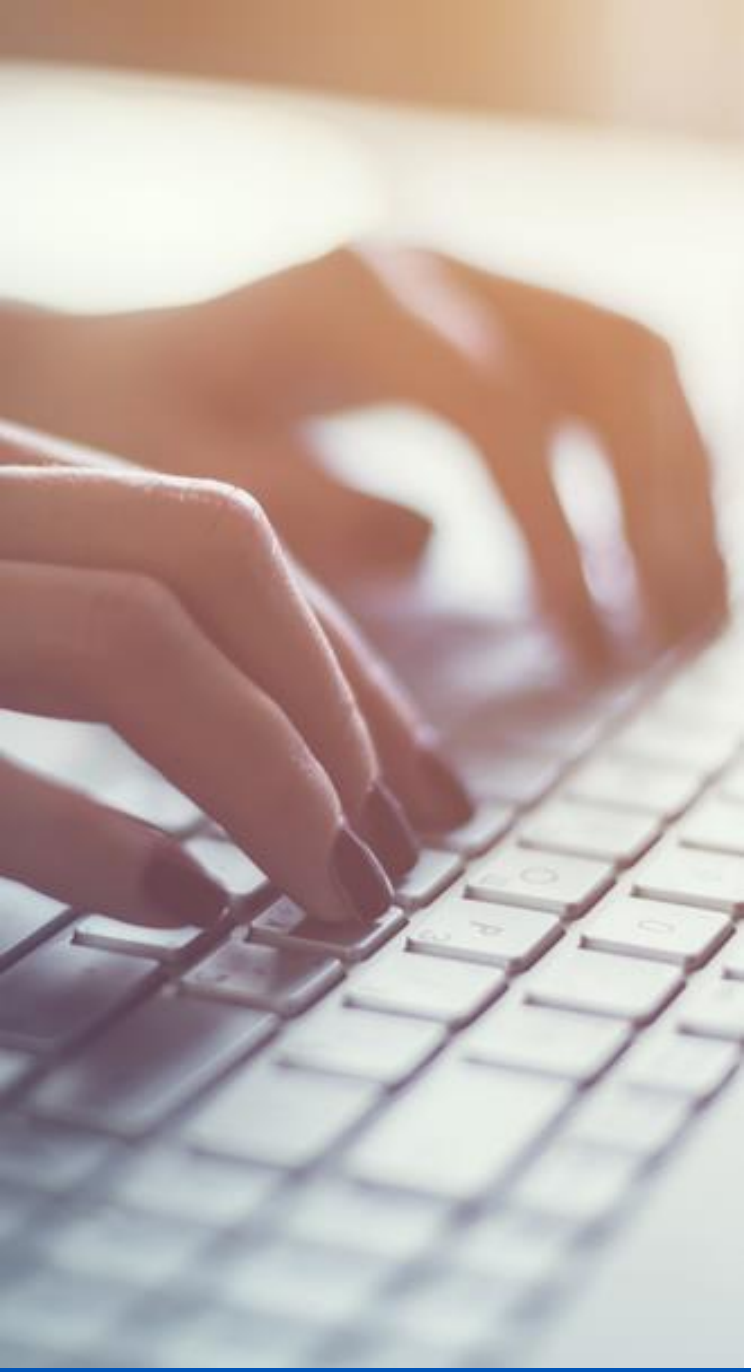

10.1: Publishing the `FlySharp` Application

Do Now

- In your Exercise Manual, please refer to Do Now 10.1: Publishing the `FlySharp` Application

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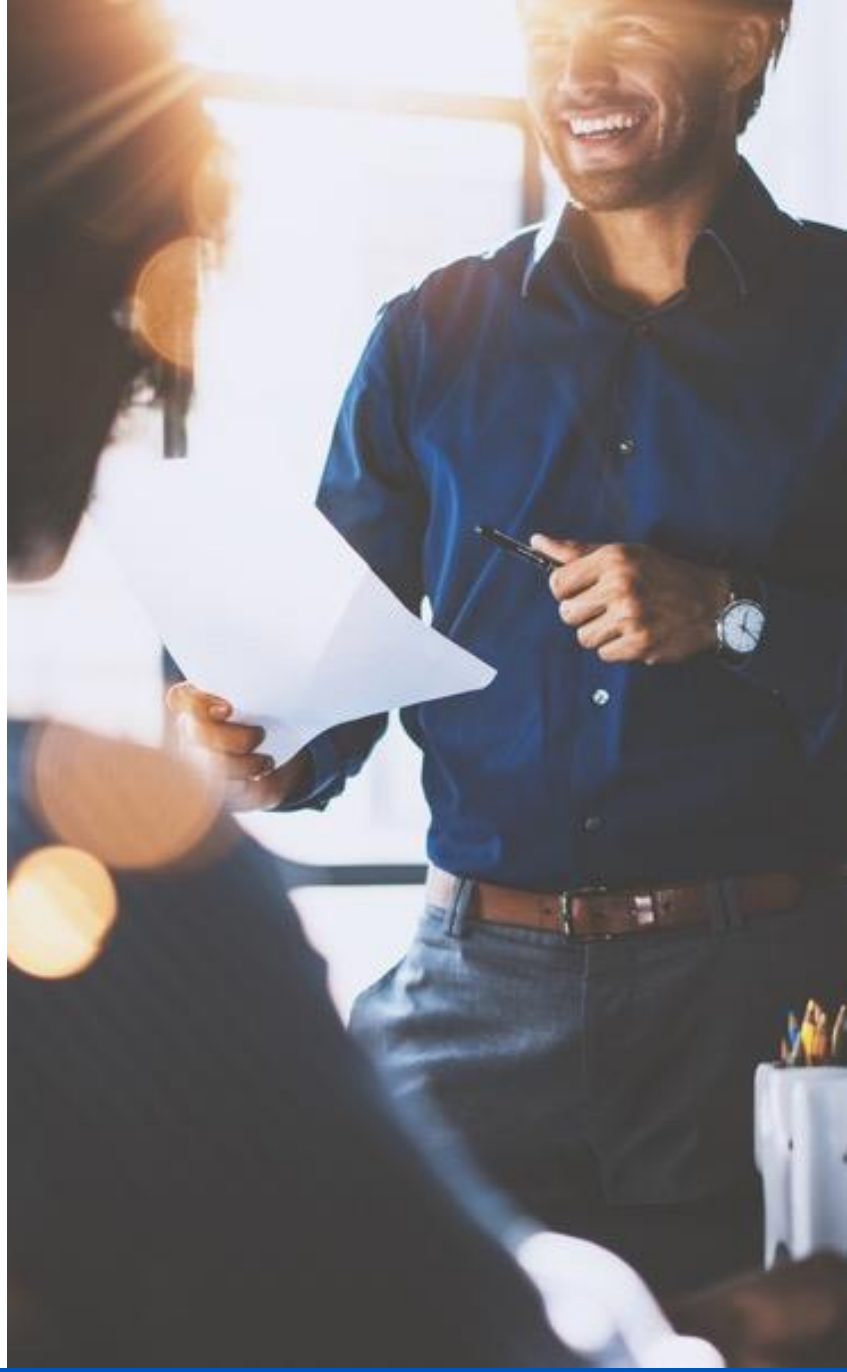
Objectives

- Prepare your application for publication
- Publish your application on a web server



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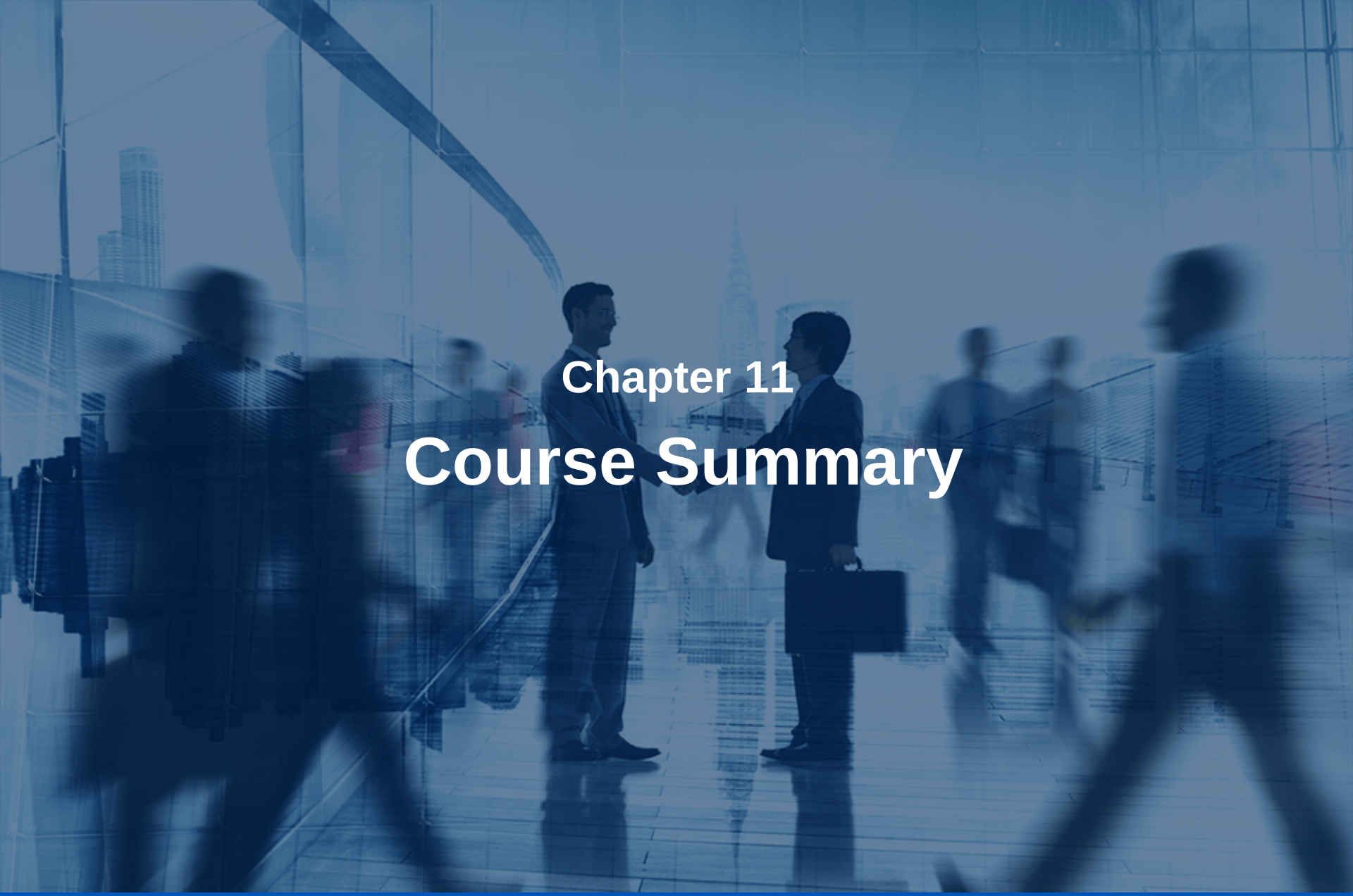

Chapter 11

Course Summary

LEARNING TREE INTERNATIONAL

Course Objectives

- Create well-structured Angular applications
- Develop Components using TypeScript, Templates, and Decorators
- Modularize applications with Feature Modules and the Component Router
- Add interactivity with event handlers and bindings
- Capture and validate input with template-driven and reactive forms
- Consume REST services using Observables

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Appendix A

Migrating From Angular JS 1

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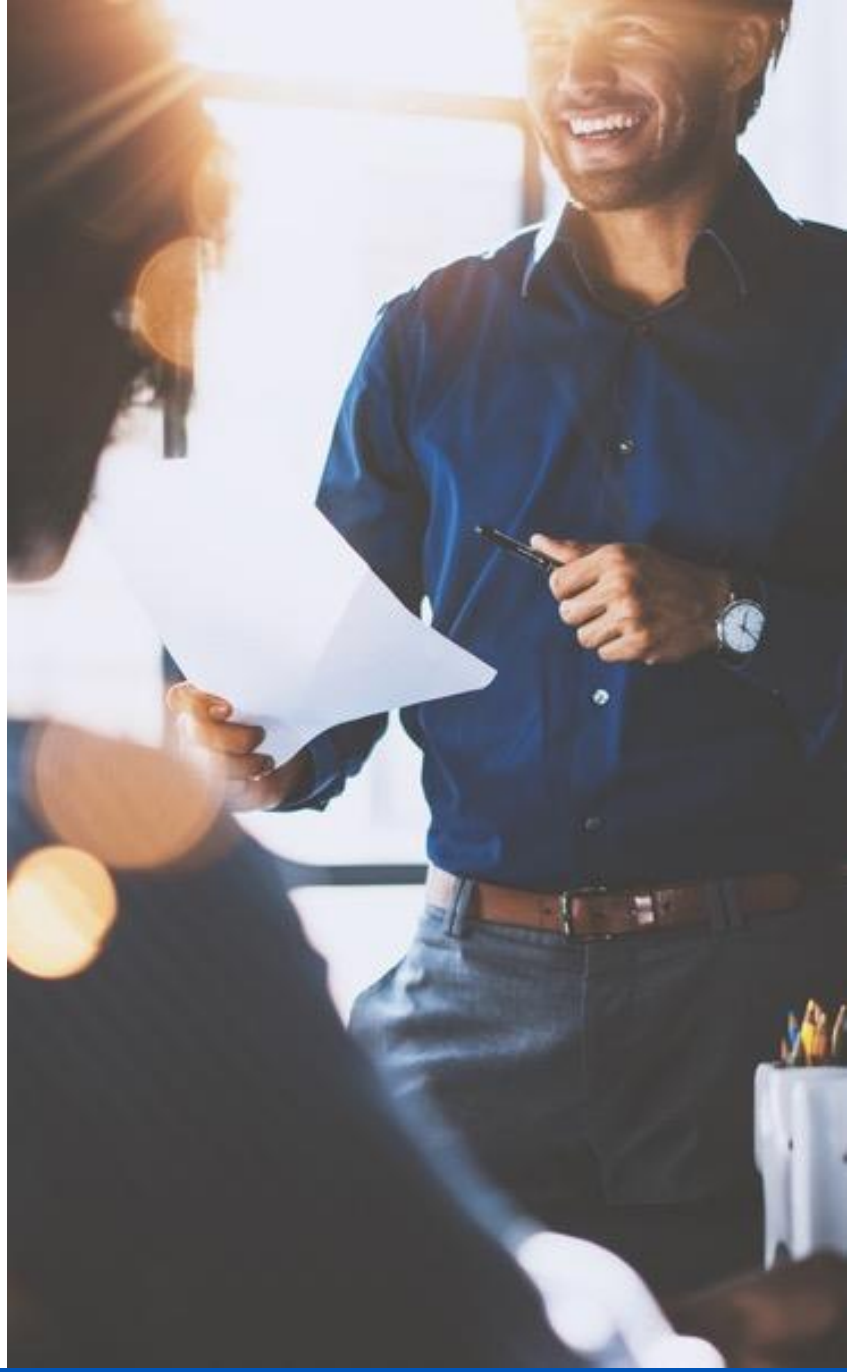
Objectives

- Combine Angular JS and Angular in a single application
- Incorporate Angular Components in an Angular JS application



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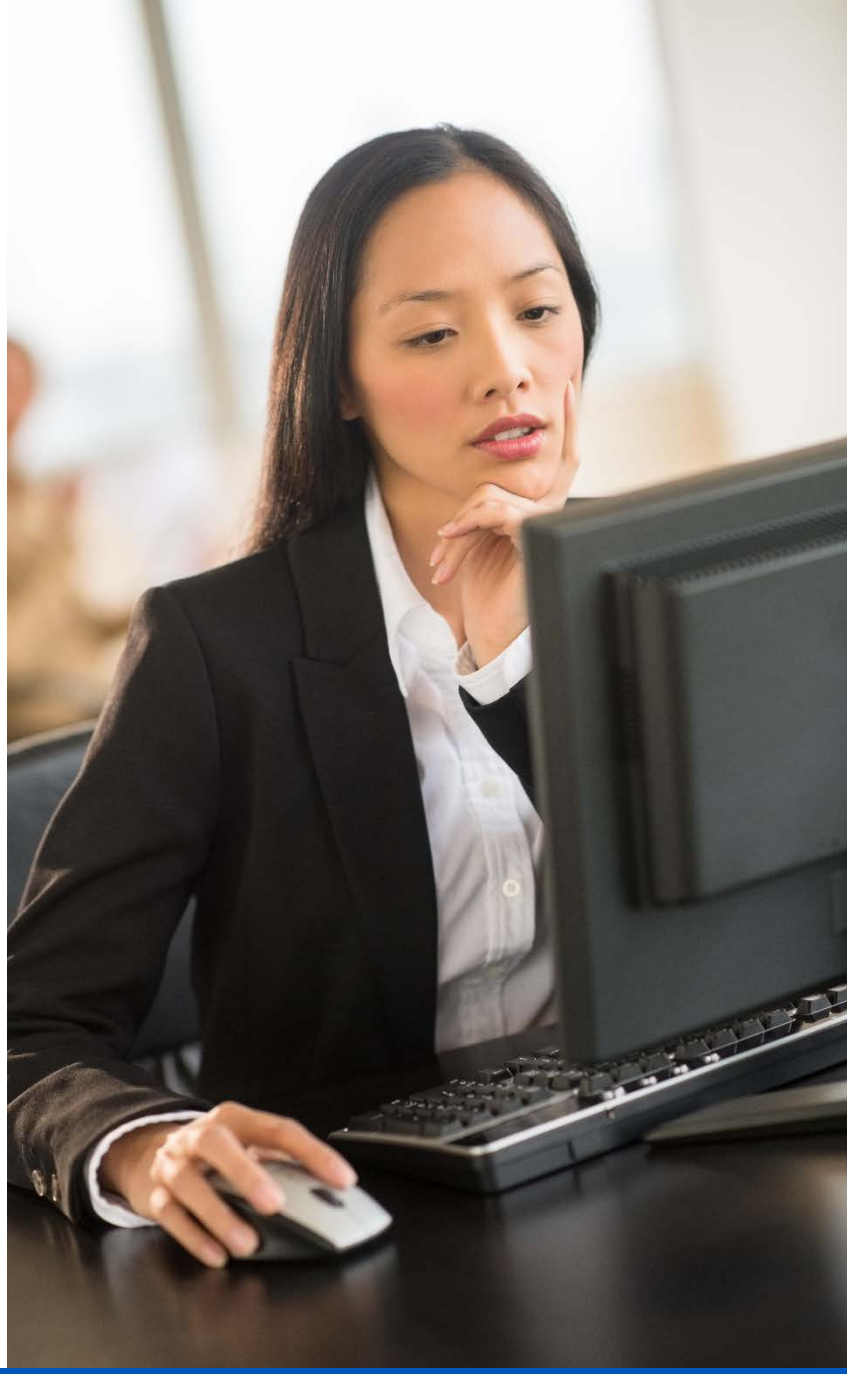
The Same But Different!

- **Angular is significantly different from Angular JS**
- **There is no backward compatibility…**
- ***But***
  - The `UpgradeAdapter` allows Angular and Angular JS applications to coexist
- **Angular Components may then be used in an Angular JS application**



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The Best Approach

- **The best, and sometimes easiest, approach to migration**
  - Take each Angular JS component/directive one at a time
    - Create a new Angular component
    - Copy the Angular JS template into the new component
    - Copy the Angular JS logic into the new component
  - Glue all the components together into a new application
- **Sometimes that is not possible**
  - Use the upgrade adapter

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The `UpgradeAdapter`

- **Runs both the Angular JS and Angular environments**
- **Bootstraps an Angular JS application**
  - In which Angular Components are available
- **Intended to allow gradual migration to Angular**
  - New features added as Angular Components and services
- **May be used as a development environment to safely migrate to A2**
- **Key concepts**
  - Application is booted as an A1 application
    - By the `UpgradeAdapter`
  - A2 Components can be downgraded to be used in A1
  - A1 Components can be upgraded and used by Angular

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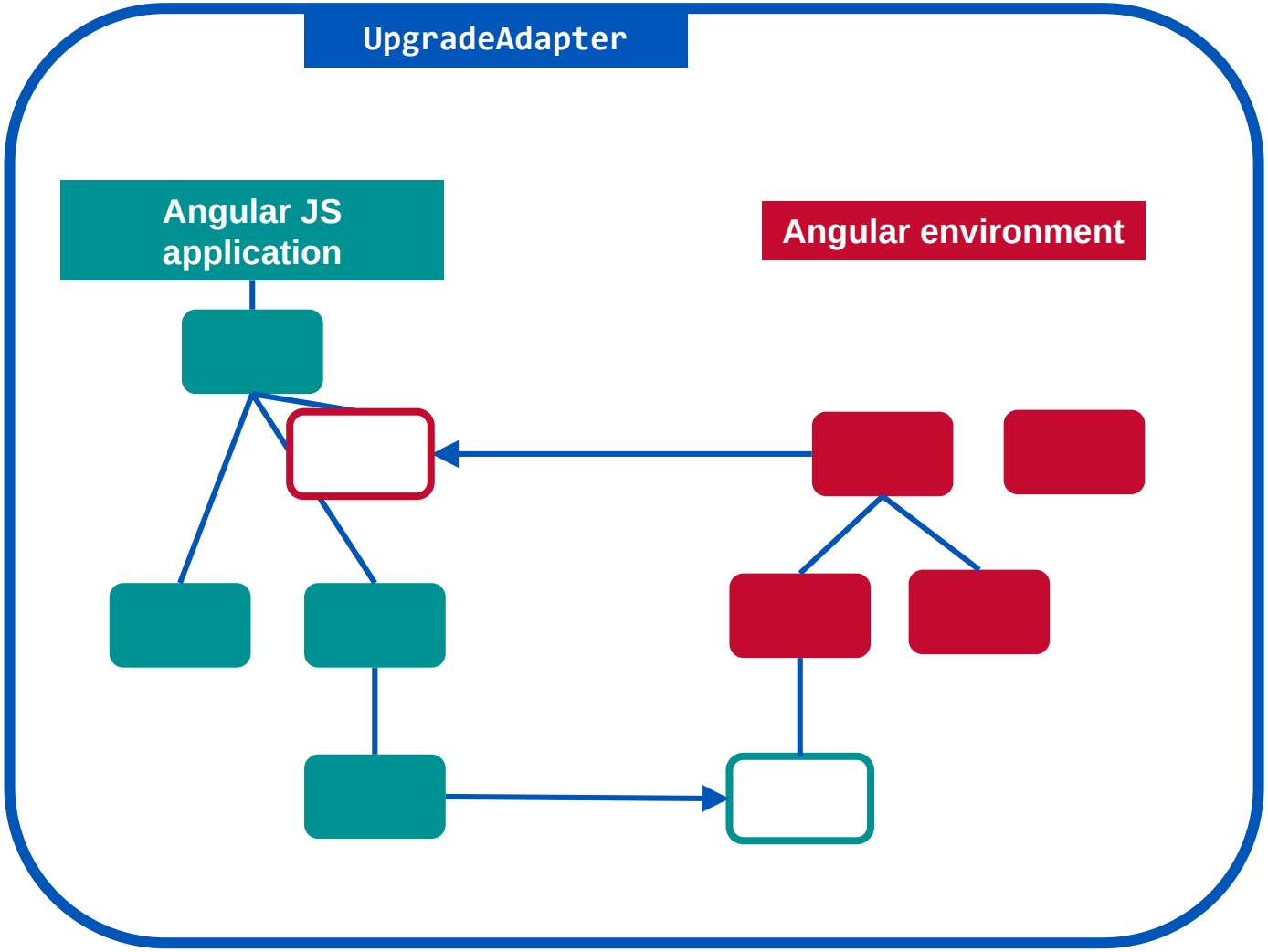
The UpgradeAdapter



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Crossing Boundaries

- **The `UpgradeAdapter` creates a hybrid application**
  - Angular JS 1 processes the root template
  - Angular Components are available via the adapter
- **The boundary between the two frameworks may be crossed**
  - By using a Component from the other framework
    - Angular 1 template uses an Angular Component
    - Angular template uses an Angular 1 Component
- **The adapter manages the injection tree to allow interoperation**

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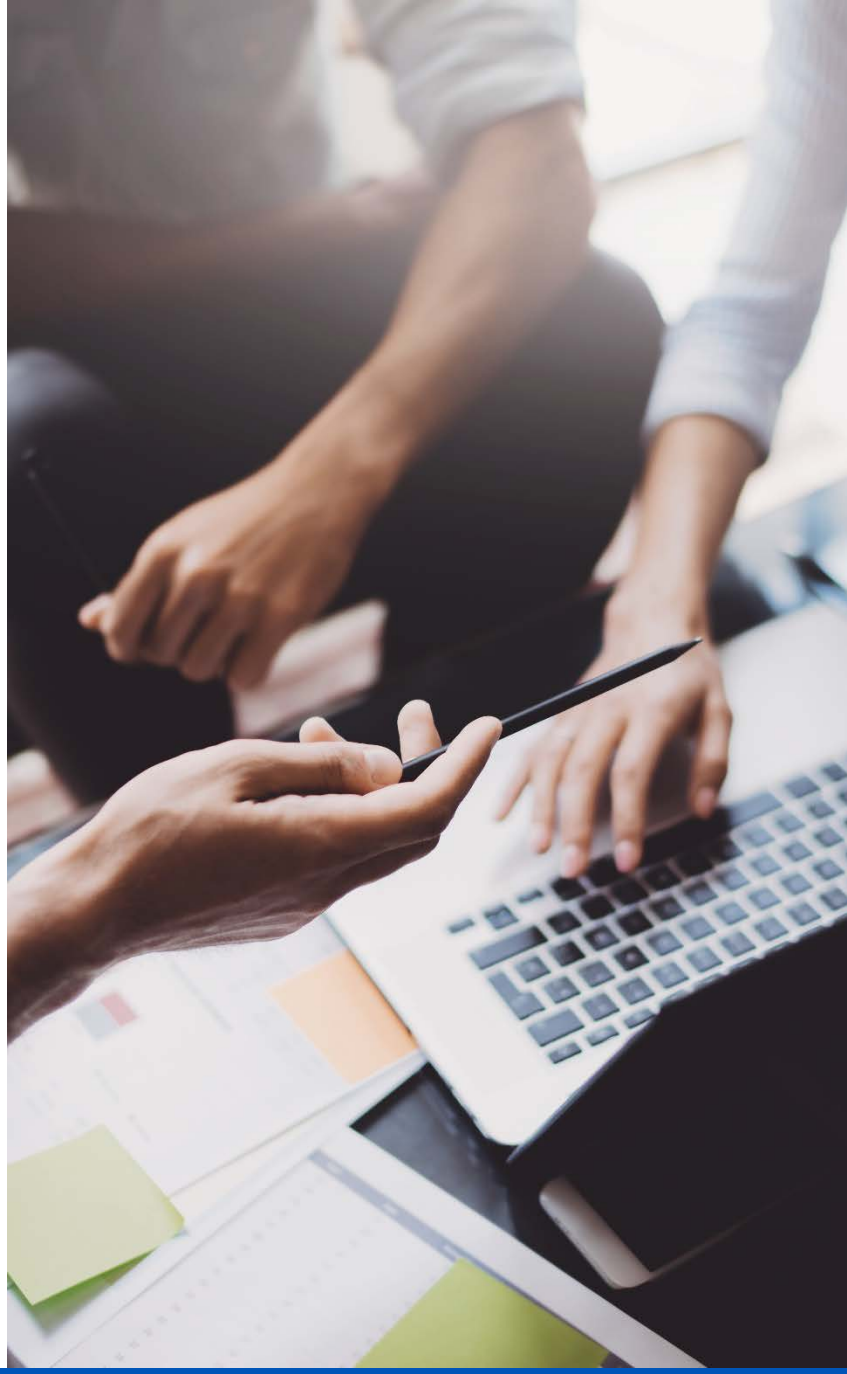
Before you Begin

- **Before using the upgrade adapter, you should**
  - Convert your Angular JS application to TypeScript
  - Convert your Angular JS application to 1.5+
  - Convert your directives to components
- **Not trivial**
  - See Angular JS documentation for converting to components



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Getting Started With the `UpgradeAdapter`

- **To use Angular JS and Angular together**
  - Must boot an Angular JS application with the `UpgradeAdapter`
    - As part of the Angular application
- **Once the two applications are working together**
  - Can run Angular components in the Angular JS application
  - Gradually migrate Angular JS components to Angular
- **Full instructions:**
  - https://angular.io/docs/ts/latest/guide/upgrade.html
  - Has some errors/omissions
- **Alternative: Use our starter app**
- **Clone** `https://mikejrway@bitbucket.org/mikejrway/course2324-js-angular.git`
  - Follow the instructions in the `README.md` file

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Bootstrapping

- **Angular JS template typically starts the application with `ng-app`**
  - The value of the attribute being the initial directive name

```
<body ng-app="phonecatApp" ng-strict-di>
```

- **Hybrid application must be bootstrapped from code**
  - `bootstrap` method of `UpgradeAdapter`

main.ts

```
platformBrowserDynamic().bootstrapModule(AppModule)
  .then(platformRef => {
        const upgrade =
                platformRef.injector.get(UpgradeModule) as
                                                UpgradeModule;
        upgrade.bootstrap(document.documentElement,
                                                ['phonecatApp']);
});
```

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Bootstrapping—The Angular Module

- **The Angular Module must provide `ngDoBoostrap()`**
  - Can be an empty method

```
@NgModule({
  declarations: [
    PhoneListComponent,
  ],
  imports: [
    BrowserModule, UpgradeModule, HttpModule
  ],
  providers: [
    Phone,
  ],

  entryComponents: [
    PhoneListComponent,
  ]
})
export class AppModule {
  ngDoBootstrap(){}
}
```

Instead of Bootstrap—tells Angular the start of the component hierarchy(ies)

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Making an Angular Service Available to Angular JS

- **Use `downgradeInjectable` to make a service available to Angular JS**

```
import { Injectable } from '@angular/core';
declare var angular: angular.IAngularStatic;
import { downgradeInjectable } from '@angular/upgrade/static';


@Injectable()
export class Phone {
  constructor(private http: Http) { }
  query(): Observable<PhoneData[]> {
    return …
  }
}
angular.module('core.phone')
  .factory('phone', downgradeInjectable(Phone));
```

- **Can now use the service with Angular JS in the usual way**
  - `static $inject = ['phone'];`

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Downgrading Angular Components

- **To use an Angular Component from Angular 1**
  - Downgrade it with the `UpgradeAdapter`!

main.ts

```
angular.module('phoneList')
 .directive(
   'phoneList',
   downgradeComponent({component: PhoneListComponent}) as
       angular.IDirectiveFactory
);
```

- **The downgraded Component follows the normal Angular JS 1 rules**
  - The directive name is converted to an element name using Kebab case

container.ts

```
<phone-list></phone-list>
```

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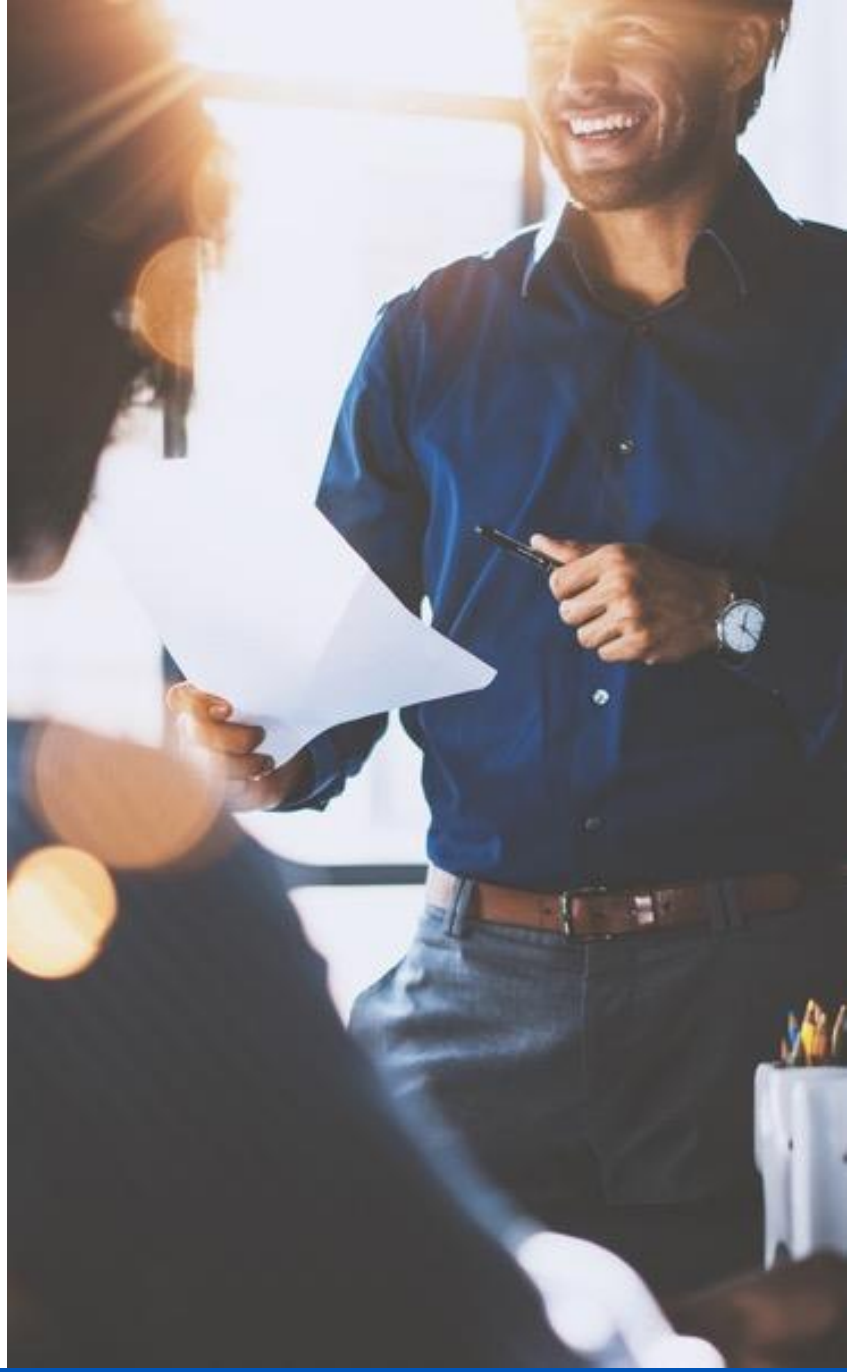
Objectives

- Combine Angular JS and Angular in a single application
- Incorporate Angular Components in an Angular JS application



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