

DEPENDENCY INJECTION

Ori Calvo, 2017

oric@trainologic.com

<https://trainologic.com>

The Pattern

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- The client delegates the responsibility of providing its dependencies to external code (the injector)
- The use of the new keyword or specific factory function is prohibited
- Creates a more testable & “composable” code
- Usually harder to debug since there is a lot of “magic” behind the scene

Angular POV

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- Application consists of components and services
- A component should ask a reference to a service (A.K.A dependency)
- Angular's injector is responsible for resolving all dependencies upon creation of the component
- Unlike Angular1 there are many injectors at runtime
 - ▣ A.K.A hierarchical injector

Basic Sample

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```
@Injectable()
export class ContactService {
  getAll(): Promise<Contact[]> {
    return Promise.resolve([
      {id: 1, name: "Ori"},
      {id: 2, name: "Roni"},
    ]);
  }
}
```

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

```
@Component({...})
export class AppComponent implements OnInit {
  contacts: Contact[];

  constructor(private contactService: ContactService) {
  }

  async ngOnInit() {
    this.contacts = await this.contactService.getAll();
  }
}
```

Dependency
Token (again)

Dependency
Token

How does it work ?

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- ❑ @angular/core offers a class named **ReflectiveInjector**
- ❑ It is a factory class which knows how to create an injector instance from a list of providers
- ❑ The injector knows how to instantiate a “service” based on its dependencies
- ❑ Services are singletons in the context of a single injector

Ingredients

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- **Token** – A unique value that can be resolved into a service
 - ▣ Must be of type **InjectionToken** or Type
 - ▣ The usage of a string is now deprecated
- **Provider** – Maps a token to a list of dependencies
- **Injector** – Holds a set of providers and is responsible for resolving dependencies
- **Dependency** – The “thing” that is being injected

ReflectiveInjector

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```
class MyClass1 {  
  dump() {  
    console.log("xxx");  
  }  
}
```

Very simple
scenario. There
are no
dependencies

```
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: MyClass1, useClass: MyClass1},  
])
```

Provider

Token

Resolving a
token

```
const obj = injector.get(MyClass1);
```

Don't get panic

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- We usually don't create injectors manually
- Angular creates several injectors during application bootstrapping
- The two most important
 - ▣ **PlatformRef** – All providers related to the platform
 - ▣ **NgModuleRef** – All providers defined by the application and sub modules

Class Provider

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□ Instead of writing

```
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: MyClass1, useClass: MyClass1},  
])
```

□ We can just use the class name

```
const injector = ReflectiveInjector.resolveAndCreate([  
  MyClass1,  
])
```

Value Provider

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```
class A {  
  dump() {  
    console.log("A");  
  }  
}
```

```
export const a = new A();
```

```
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: A, useValue: a},  
]);
```

```
const obj = injector.get(A);  
obj.dump();
```

Any 2nd party
global object can
be made
injectable

Factory Provider

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```
function createA(version: number) {  
  console.log(version);  
  
  return new A();  
}  
  
const VERSION = "VERSION";  
  
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: VERSION, useValue: 123},  
  {provide: A, useFactory: createA, deps: [VERSION]},  
]);  
  
const obj = injector.get(A);
```

Must specify
dependencies
manually

useClass Dependencies

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- ❑ JavaScript has no real Reflection capabilities and therefore below code fails to run

```
class MyClass1 {  
}  
  
class MyClass2 {  
  constructor(obj1: MyClass1) {  
  }  
}  
  
const injector =  
ReflectiveInjector.resolveAndCreate([  
  MyClass1,  
  MyClass2  
]);  
  
const obj = injector.get(MyClass2);
```

Angular knows
that the ctor has
1 parameter but
it cant tell the
parameter type

Error

Dependencies Metadata

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```
class MyClass1 {  
    dump() {  
        console.log("xxx");  
    }  
}  
  
class MyClass2 {  
    static parameters = [MyClass1];  
  
    constructor(obj1: MyClass1) {  
    }  
}  
  
const injector = ReflectiveInjector.resolveAndCreate([  
    MyClass1,  
    MyClass2  
]);  
  
const obj = injector.get(MyClass2);
```

Dependencies
are specified
manually

Typescript Metadata

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- Typescript is capable of generating “parameters” metadata automatically
- The metadata is generated only if decorating the class with a decorator
- The metadata is defined using the ECMA6 Reflection API
- Use the reflect-metadata shim
- Once Angular detects Reflect API it will use the metadata created by Typescript

Generated Metadata

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The
generated
JavaScript

```
var MyClass2 = (function () {
  function MyClass2(obj1) {
  }
  return MyClass2;
})();

MyClass2 = __decorate([
  Blabla(),
  __metadata("design:paramtypes", [MyClass1])
], MyClass2);
```

Metadata

```
function Blabla() {
  return function(ctor: any) {
    return ctor;
  }
}
```

Class
decorator
definition

```
class MyClass1 {
  dump() {
    console.log("xxx");
  }
}
```

```
@Blabla()
class MyClass2 {
  constructor(obj1: MyClass1) {
  }
}
```

Use the
decorator

@Injectable Decorator

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- A convenient decorator offered by Angular
- Like any other decorator it enforces Typescript to emit constructor metadata
- The name might be confusing
 - ▣ Implies the class's dependencies can be resolved automatically
 - ▣ Does not implies that you can inject the class into another class

Duplicates Token

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- ❑ You may specify the same token twice
- ❑ Last definition wins !!!
- ❑ It means you can override built-in Angular services

```
const injector = ReflectiveInjector.resolveAndCreate([
  {provide: "myService", useClass: MyClass1},
  {provide: "myService", useClass: MyClass2},
]);

const obj = injector.get("myService");

console.log(obj instanceof MyClass2);
```



True

Child Injector

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- Once creating an injector you cannot add new providers to it
 - ▣ By design → Allows for better optimization
- However, you can create a new child injector which “extends” it

```
const injector = ReflectiveInjector.resolveAndCreate([A]);  
const childInjector = injector.resolveAndCreateChild([B]);  
  
const a1 = injector.get(A);  
const a2 = childInjector.get(A);  
console.log(a1 == a2);  
  
const b = childInjector.get(B);
```



True

Components & Injectors

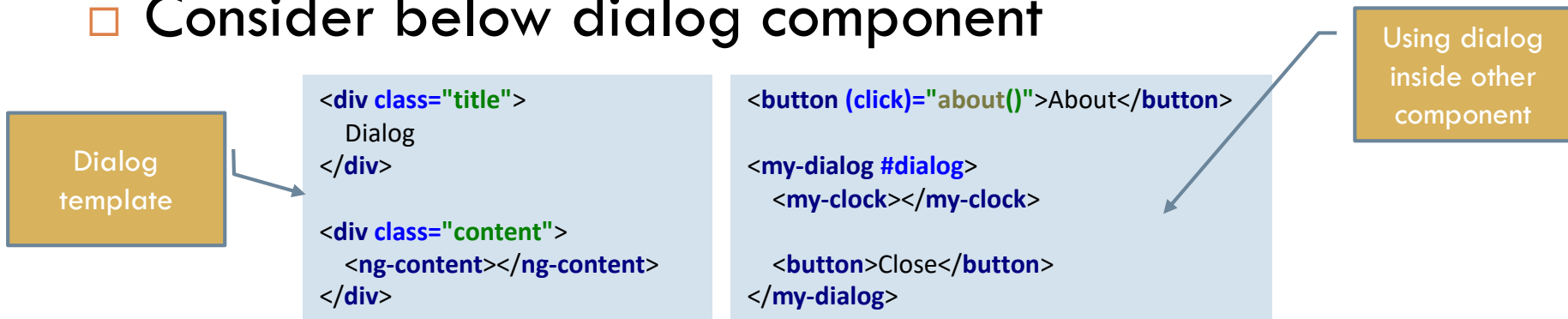
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- Each component has its own injector
- Each component can define new providers using
 - ▣ providers
 - ▣ viewProviders
- A component “enjoy” all providers defined by itself and its parent (up until the root component)
- So why do we need viewProviders ?

ng-content

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□ Consider below dialog component



- Should clock get access to providers defined by dialog ?
- Dialog may use **viewProviders** to publish services to its children only but not to clock

Overriding

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- A child injector may specify the same provider again
- In that case it will create a new instance object for the “redefined” provider

```
const injector = ReflectiveInjector.resolveAndCreate([MyClass1]);  
const childInjector = injector.resolveAndCreateChild([MyClass1]);  
  
const obj1 = injector.get(MyClass1);  
const obj2 = childInjector.get(MyClass1);  
  
console.log(obj1 == obj2);
```

False !!!

Aliasing

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- An existing provider may be “reused” and be configured as a provider for another token

```
const CORE_PROVIDERS = [  
  A  
];  
  
const injector = ReflectiveInjector.resolveAndCreate([  
  CORE_PROVIDERS,  
  B,  
  {provide: A, useExisting: B},  
]);  
  
const a = injector.get(A);  
const b = injector.get(B);  
console.log(a == b);
```

We assume
CORE_PROVIDERS is
a 3rd party
definition that cannot
be modified

True

InjectionToken

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- Below code fails to compile

```
interface IMyService {  
  doSomething(): any;  
}  
  
class MyService {  
  doSomething(): any {  
    console.log("MyService");  
  }  
}  
  
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: IMyService, useClass: MyService},  
]);
```

TS2693 error:
IMyService only
refers to a type, but
is being used as a
value here

InjectionToken

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- Creates an object wrapper around the interface

```
interface IMyService {  
  doSomething(): any;  
}  
  
const IMY_SERVICE = new InjectionToken<IMyService>("xxx");  
  
class MyService {  
  doSomething(): any {  
    console.log("MyService");  
  }  
}  
  
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: IMY_SERVICE, useClass: MyService},  
]);  
  
const obj = injector.get(IMY_SERVICE);  
obj.doSomething();
```

You may use any interface. However, it should be the one that resembles the service API

Optional Dependency

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```
class Config {  
}
```

```
@Injectable()  
class MyService {
```

```
  constructor(@Optional() config: Config) {  
    console.log(!!config);  
  }  
}
```

```
const injector = ReflectiveInjector.resolveAndCreate([  
  //Config,  
  MyService,  
]);
```

```
const obj = injector.get(MyService);
```

Dependency marked
as Optional may be
unresolved and
remain empty

False

Order does matter !

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- Below code compiles successfully but fails to run ☹️

Generated
JavaScript

```
var MyService = (function () {  
  function MyService(config) {  
    console.log(!!config);  
  }  
  return MyService;  
})();  
MyService = __decorate([  
  core_1.Injectable(),  
  __metadata("design:paramtypes", [Config])  
], MyService);  
var Config = (function () {  
  function Config() {  
  }  
  return Config;  
})();
```

Config is
undefined

```
@Injectable()  
class MyService {  
  constructor(config: Config) {  
  }  
}
```

```
class Config {  
}
```

```
const injector = ReflectiveInjector.resolveAndCreate([  
  Config,  
  MyService,  
]);
```

```
const obj = injector.get(MyService);
```

The error is "cannot
resolve all
parameters for
MyService"

forwardRef

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- Allows us to use a dependency token that was not initialized yet
- Must be initialized before resolving providers

```
@Injectable()
class MyService {
  constructor(@Inject(forwardRef(() => Config)) config: Config) {
    console.log(!!config);
  }
}

class Config {
}

const injector = ReflectiveInjector.resolveAndCreate([
  Config,
  MyService,
]);

const obj = injector.get(MyService);
```

Multi Provider

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- ❑ Register multiple providers with the same token
- ❑ When resolved, an array of services is returned

```
const injector = ReflectiveInjector.resolveAndCreate([  
  {provide: MyService, useClass: MyService, multi: true},  
  {provide: MyService, useClass: MyService, multi: true},  
]);
```

```
const arr = injector.get(MyService);  
console.log(arr);
```



Array of
MyService
objects

Multi Provider - Why

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- Extendibility mechanism
- Angular defines that token + basic implementation
- You may extend with your own providers
- Angular uses them all. For example,
 - ▣ APP_INITIALIZER
- You cannot mix regular and multi providers

Cyclic Dependency

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- Two different providers might be dependent on each other

```
@Injectable()
class MyService1 {
  constructor(@Inject(forwardRef(()=>MyService2)) private service2: MyService2) {
  }
}

@Injectable()
class MyService2 {
  constructor(private service1: MyService1) {
  }
}

const injector = ReflectiveInjector.resolveAndCreate([
  MyService1,
  MyService2,
]);

const obj = injector.get(MyService1);
```



Cyclic dependency
Angular does not support that !!!

Without forwardRef
MyService2 token is undefined

Resolving cyclic dependencies

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- The injector instance is itself an injectable service
- You can use it as a **service locator**
 - ▣ Some consider this pattern a bad practice
 - ▣ You may explore the injector's parent directly
- Break the cycle by deleting a dependency from the constructor and move it to a property/field

Resolving cyclic dependencies

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```
@Injectable()
class MyService1 {
  _service2: MyService2;

  constructor(private injector: Injector) {

  }

  get service2() {
    if(!this._service2) {
      this._service2 = this.injector.get(MyService2);
    }

    return this._service2;
  }
}

@Injectable()
class MyService2 {
  constructor(private service1: MyService1) {
  }
}
```

Caching the
dependency

Resolve it
on demand

@Self

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- Prohibit using the parent injector when resolving dependencies

```
@Injectable()
class MyService1 {
}

@Injectable()
class MyService2 {
  constructor(@Self() private service1: MyService1) {
  }
}

const injector = ReflectiveInjector.resolveAndCreate([
  MyService1,
]);

const child = injector.resolveAndCreateChild([MyService2]);
const obj = child.get(MyService2);
```

Error is
thrown

Can add
@Optional to
get null
dependency
instead of error

@SkipSelf

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- Always resolve dependency using parent injector

```
@Injectable()
class MyService1 {
}

@Injectable()
class MyService2 {
    constructor(@SkipSelf() private service1: MyService1) {
    }
}

const injector = ReflectiveInjector.resolveAndCreate([
    MyService1,
]);

const child = injector.resolveAndCreateChild([MyService1, MyService2]);

const service2 = child.get(MyService2);
const service1 = child.get(MyService1);
console.log(service1 == service2.service1);
```

False

Modules & Injectors

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- For each module Angular generates an injector
- The injector contains a flat list of all providers from “sub” modules and the current module

```
@NgModule({  
  imports: [  
    BrowserModule,  
    CommonModule,  
    Module1Module,  
  ],  
  providers: [  
    {provide: CommonService, useClass: MyService},  
  ],  
  bootstrap: [  
    AppComponent,  
  ],  
  declarations: [  
    AppComponent,  
  ],  
})  
export class AppModule {}
```

providers
win over
imports

Module Injector

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- The module injector is generated by Angular at runtime/AOT according to `@NgModule` metadata

```
AppModuleInjector.prototype.getInternal = function(token, notFoundResult) {  
  var self = this;  
  if ((token === jit_CommonService41)) { return self._CommonService_9; }  
  if ((token === jit_MainService35)) { return self._MainService_10; }  
  ...  
  return notFoundResult;  
};
```

Super
efficient. Do
we really
need that ?

Duplicated Service Instances

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- ❑ Angular flattens the providers list
- ❑ Last provider wins
- ❑ Therefore, no duplicated service instances at run time
- ❑ But what about lazy loading a module
 - ▣ In that case a new injector is created
 - ▣ If a provider is redefined → new service instance might be created ☹

Lazy load a Module

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Download the
module from
the server

Compile the
module and
get a factory

```
const {LazyModule} = await SystemJS.import("app/lazy/lazy.module.js");

const {ngModuleFactory, componentFactories} =
  this.compiler.compileModuleAndAllComponentsSync(LazyModule);

const moduleInjector = ngModuleFactory.create(this.injector);

const componentFactory = componentFactories[0];

this.marker.createComponent(componentFactory, 0, <any>moduleInjector);
```

Create the
component
with the new
injector

We must create a
new injector, else, the
component will be
service-less

The duplication is implicit

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Importing again
CommonModule
means a redefinition
of all its providers

```
@NgModule({  
  imports: [  
    CommonModule,  
  ],  
  providers: [  
    LazyService  
  ],  
  declarations: [  
    LazyComponent  
  ]  
})  
export class LazyModule {  
  constructor() {  
    console.log("LazyModule");  
  }  
}
```

This is a new
provider
downloaded with
the module

forRoot & forChild

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Specify
components for
both forRoot &
forChild

forRoot
specify
providers

```
@NgModule({  
  declarations: [CommonComponent],  
  exports: [CommonComponent]  
})  
export class CommonModule {  
  static forRoot(): ModuleWithProviders {  
    return {  
      ngModule: CommonModule,  
      providers: [  
        CommonService,  
      ]  
    };  
  }  
  
  static forChild(): ModuleWithProviders {  
    return {  
      ngModule: CommonModule,  
    };  
  }  
}
```

forChild does
not specify
providers

Summary

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- Angular offers its own DI mechanism
- Quite “standard”
- However, support the notion of child injector
- Be prepared to handle cyclic dependency errors