Angular Advanced Testing – introduction

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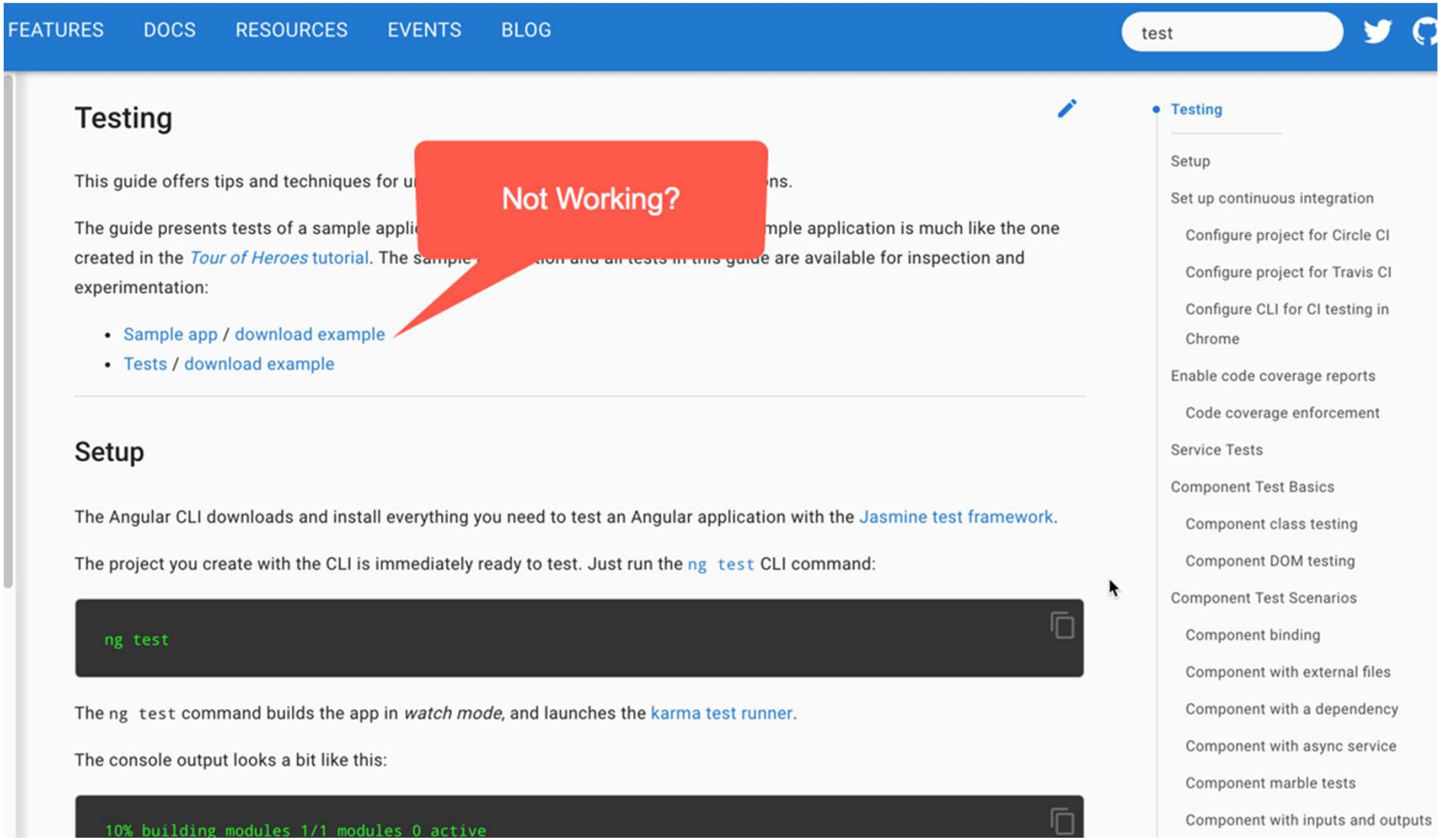
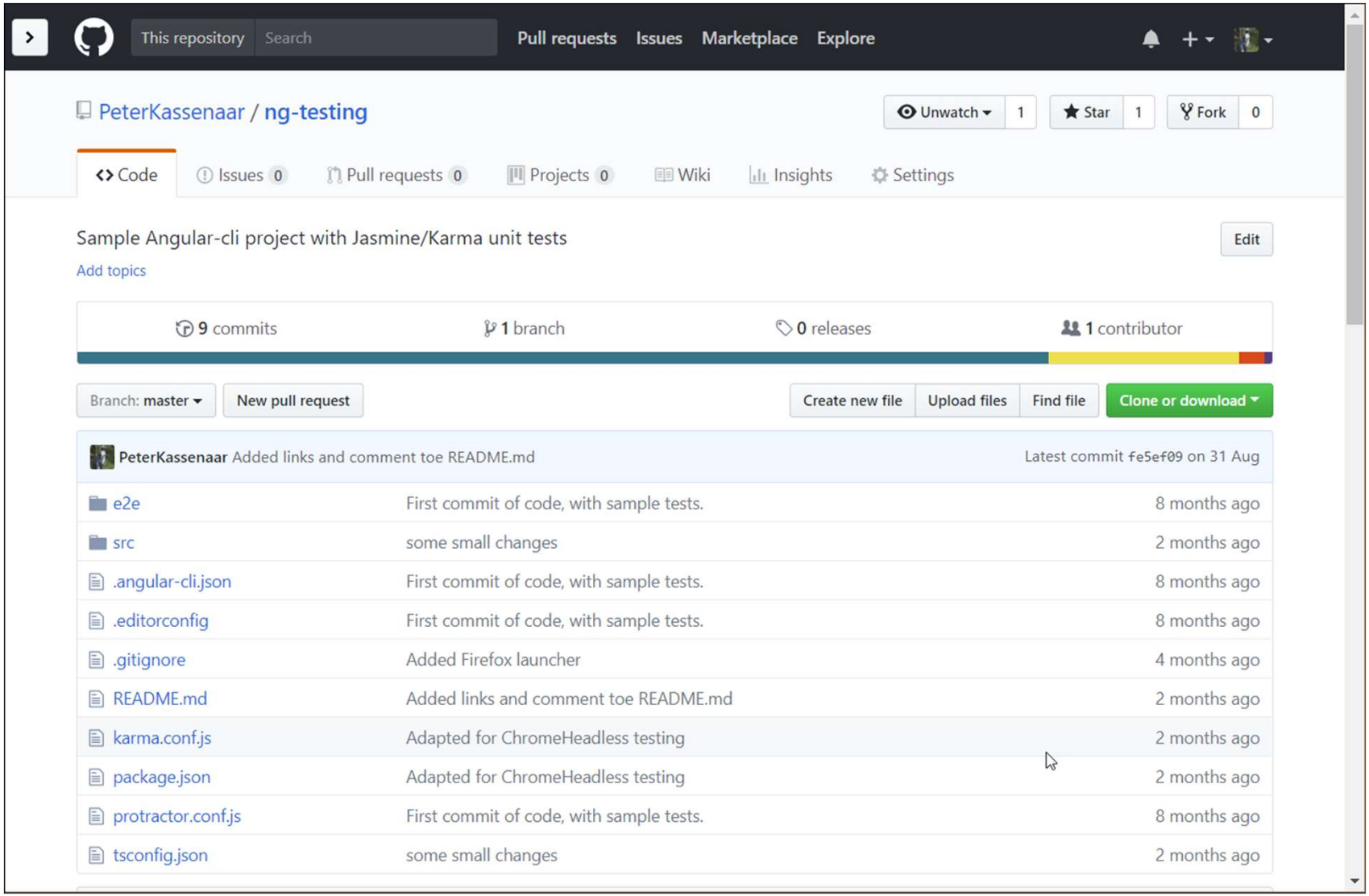
Official documentation



https://angular.io/guide/testing

Generic repo – not in `../examples` !

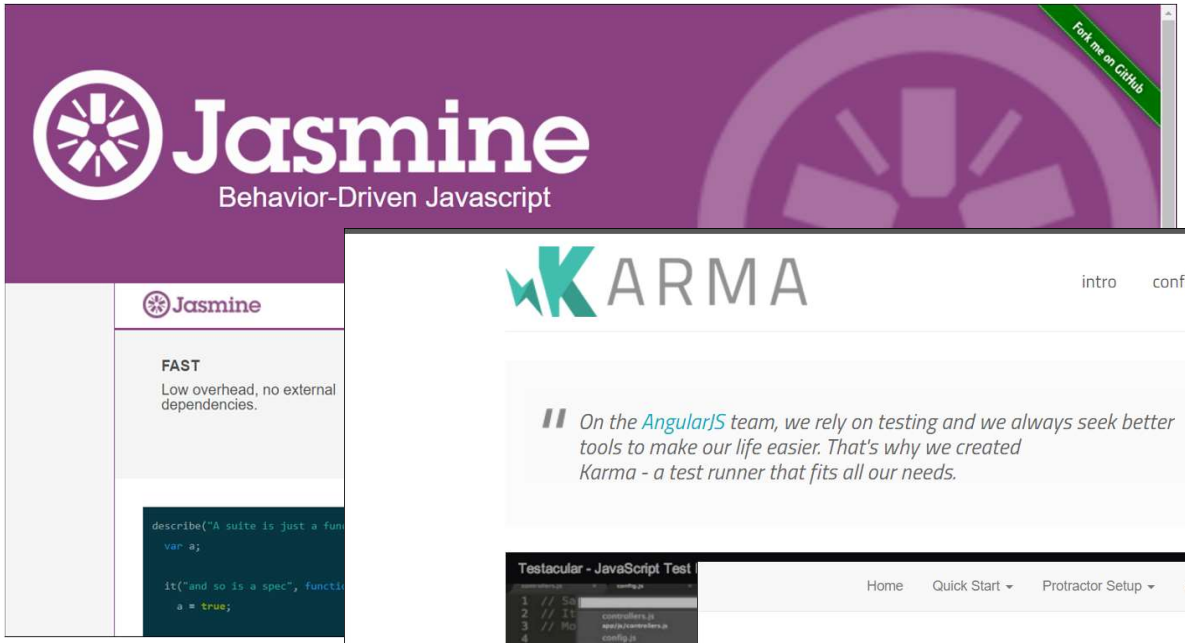


github.com/PeterKassenaar/ng-testing

Good introductory article

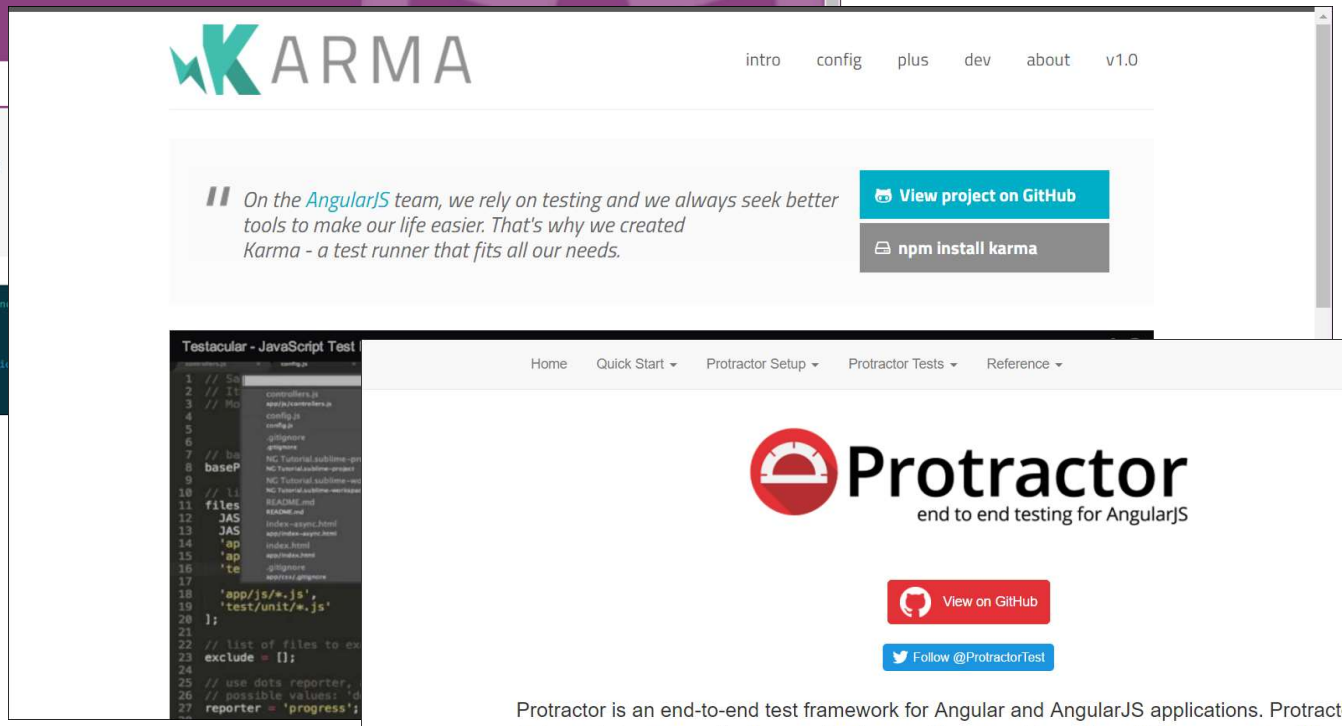
https://dzone.com/articles/talk-testing-with-angular-some-recipes

Tooling



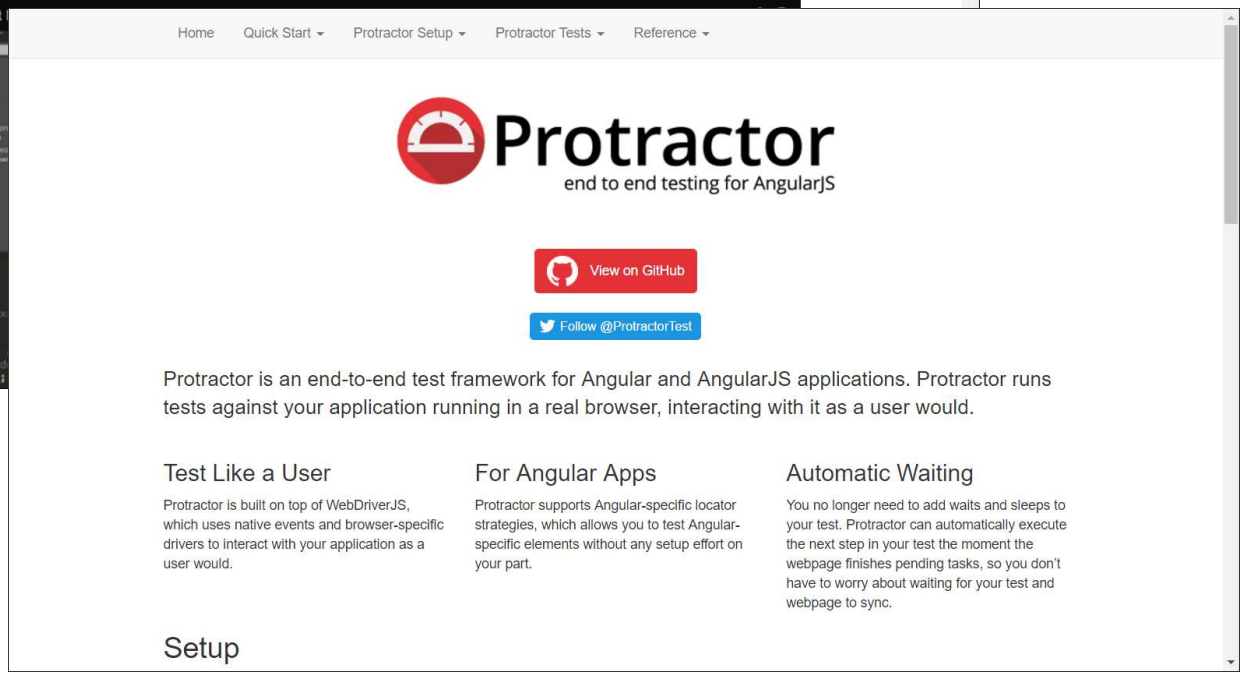
Jasmine:

Write Unit Tests & Specs



Karma:

Test Runner



Protractor:

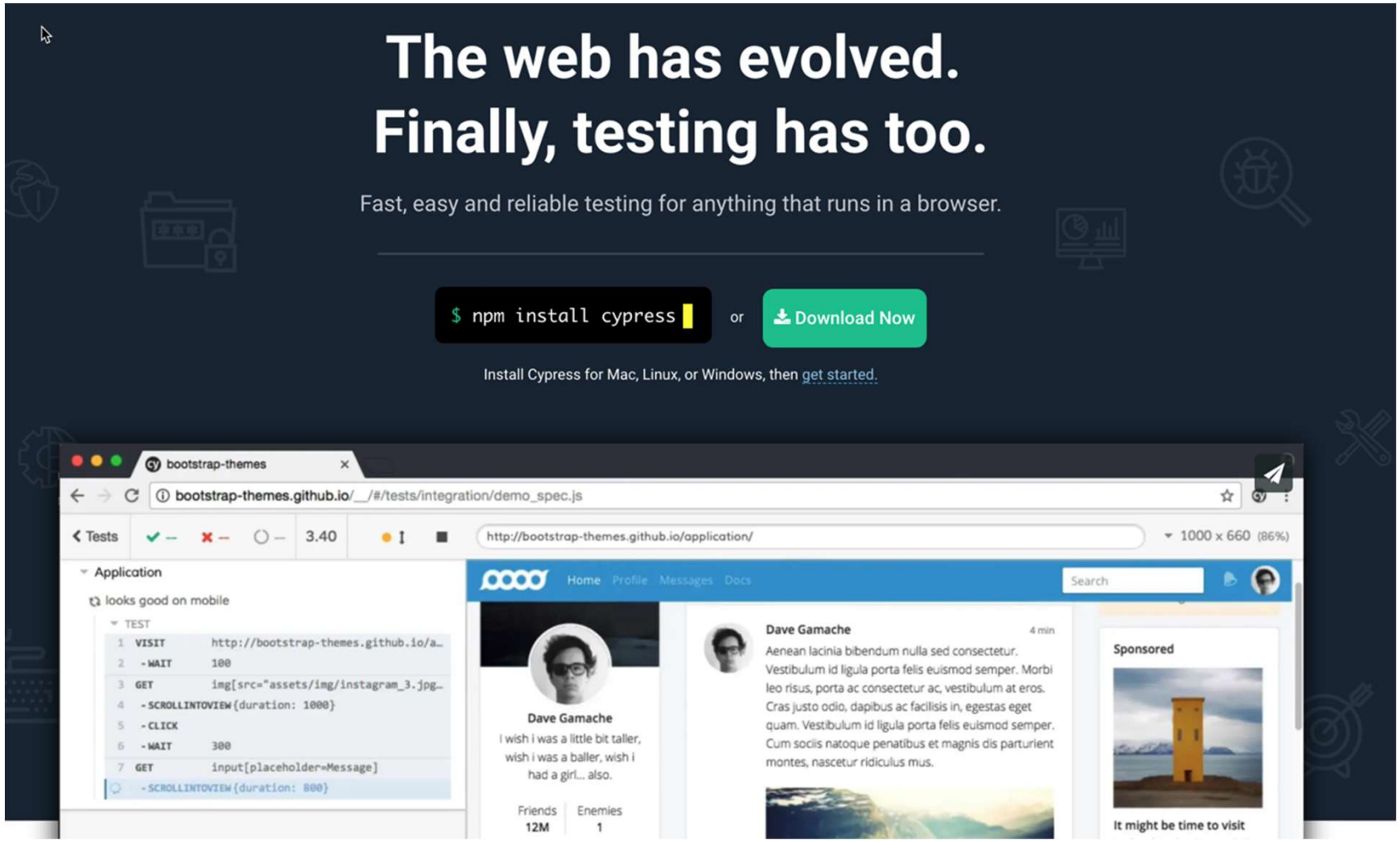
End to end testing

https://jasmine.github.io/

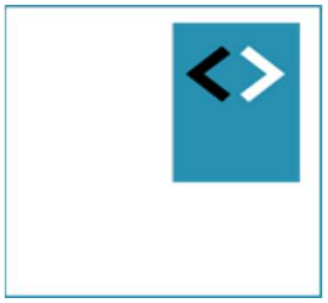
https://karma-runner.github.io/1.0/index.html

http://www.protractortest.org/#/

An alternative to E2E-testing - Cypress



https://www.cypress.io/



General Testing

General Jasmine syntax for testing classes and models

General testing pattern/syntax

Just a simple class and its usage:
import {Person} **from "./person.model"**;

```
// Person.model.ts
export class Person {
    constructor(public name?: string,
                public email?: string) {
    }

    sayHello(): string {
        return `Hi, ${this.name}`;
    }
}
```

General unit test pattern

```
// Generic testing pattern

// 1. Describe block for every test suite
describe('The Person', () => {

   // 2. Variables used by this test suite
   let aPerson;

   // 3. Setup block, run before every individual test
   beforeEach(() => {
      aPerson = new Person('Peter');
   });

   // 4. Clean up after every individual test
   afterEach(() => {
      aPerson = null;
   });

   // 5. Perform each test in an it()-block
   it('should say Hello', () => {
      let msg = aPerson.sayHello();
      expect(msg).toBe('Hi, Peter');
   });

   // 6. More it()-blocks…
});
```

So a `*.spec.ts` file typically contains:

One or more `describe()` blocks

One or more `beforeEach()` blocks

One or (typically) more `it()` blocks, using `expect()` statements and Jasmine *matchers*

We're using `@angular/cli` here

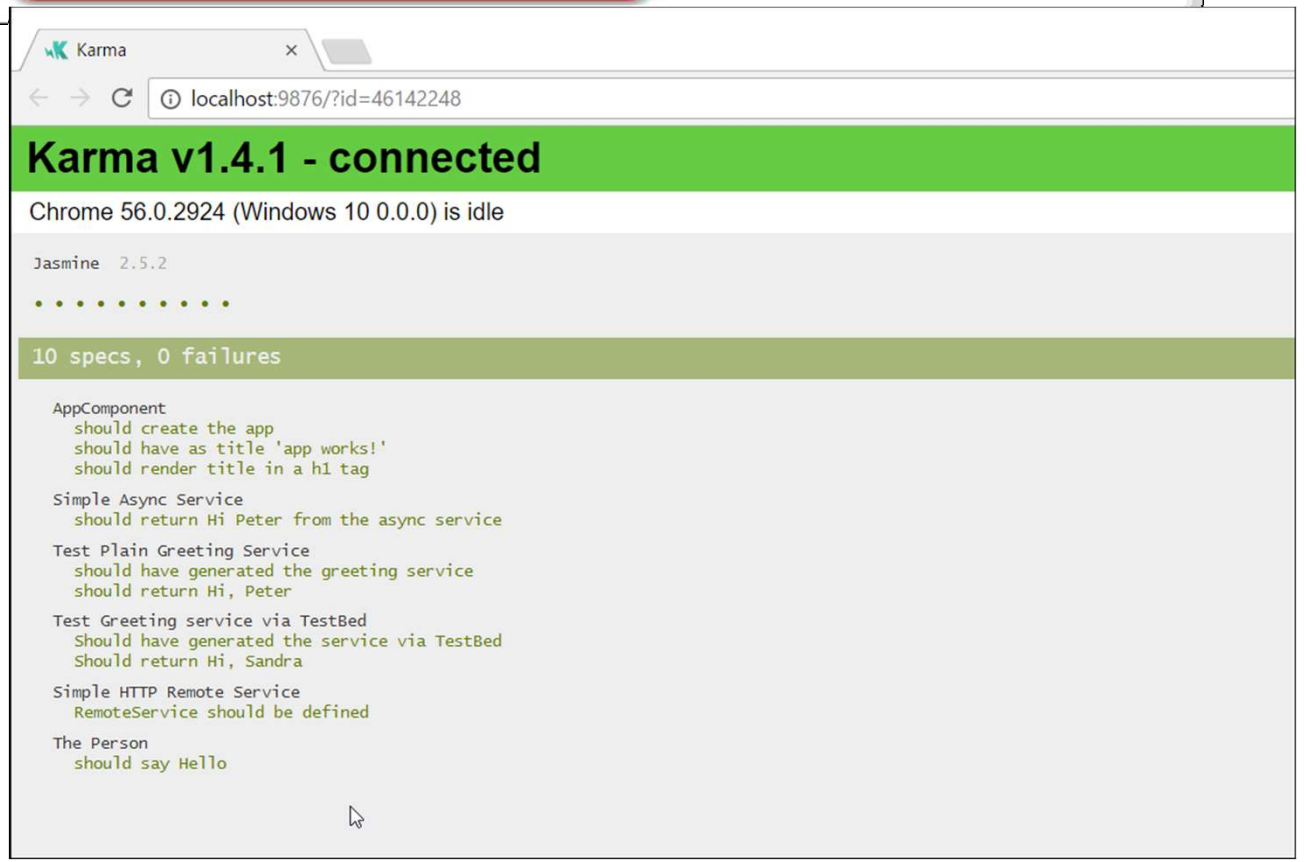
- Angular-cli: all dependencies already installed and configured.
  - Command: `ng test`

- Manual project? Install & setup karma and jasmine yourself
  - Create and adapt `karma.conf.js`
  - `karma --init`
  - Install and setup jasmine reporters
  - *We're not doing that here*.
  - See documentation

```
…
},
"devDependencies": {
   …
  "@types/jasmine": "2.5.38",
  "@types/node": "~6.0.60",
  "codelyzer": "~2.0.0",
  "jasmine-core": "~2.5.2",
  "jasmine-spec-reporter": "~3.2.0",
  "karma": "~1.4.1",
  "karma-chrome-launcher": "~2.0.0",
  "karma-cli": "~1.0.1",
  "karma-jasmine": "~1.1.0",
  "karma-jasmine-html-reporter": "^0.2.2",
  "karma-coverage-istanbul-reporter": "^0.2.0",
  "protractor": "~5.1.0",
   …
}
…
```

Browser like...

```
C:\Users\Peter Kassenaar\Desktop\ng-testing>ng test
10 03 2017 16:50:40.157:WARN [karma]: No captured browser, open http://localhost:9876/
10 03 2017 16:50:40.170:INFO [karma]: Karma v1.4.1 server started at http://0.0.0.0:9876/
10 03 2017 16:50:40.171:INFO [launcher]: Launching browser Chrome with unlimited concurrency
10 03 2017 16:50:40.310:INFO [launcher]: Starting browser Chrome
10 03 2017 16:50:42.220:INFO [Chrome 56.0.2924 (Windows 10 0.0.0)]: Connected on socket 3Ox3NIH4ohFYk
MAuAAAA with id 46142248
Chrome 56.0.2924 (Windows 10 0.0.0): Executed 10 of 10 SUCCESS (0.461 secs / 0.439 secs)
```



On Angular-specific terms

- TestBed
- inject
- async
- fakeAsync
- ComponentFixture
- DebugElement
- configureTestingModule

Basic component test included

```
1  import { TestBed, async } from '@angular/core/testing';
2  import { AppComponent } from './app.component';
3
4  describe('AppComponent', () => {
5    beforeEach(async(() => {
6      TestBed.configureTestingModule({
7        declarations: [
8          AppComponent
9        ],
10     }).compileComponents();
11   }));
12
13   it('should create the app', () => {
14     const fixture = TestBed.createComponent(AppComponent);
15     const app = fixture.debugElement.componentInstance;
16     expect(app).toBeTruthy();
17   });
18
19   it(`should have as title 'oceTestApp'`, () =>{
20     const fixture = TestBed.createComponent(AppComponent);
21     const app = fixture.debugElement.componentInstance;
22     expect(app.title).toEqual('oceTestApp');
23   });
24
25   it('should render title in a h1 tag', () => {
```

Breaking the .spec file down:

- `TestBed` – the Angular Testing implementation of a Module
- `.configureTestingModule()` – configure only the parts of the module you want to test
- `.compileComponents()` – we're testing a component here. Not necessary for services, models, etc.
- `fixture` – is of type `ComponentFixture`, acts as a wrapper around the actual component
- `debugElement.nativeElement` - access to the DOM of the actual component instance
- `detectChanges` – run change detection manually

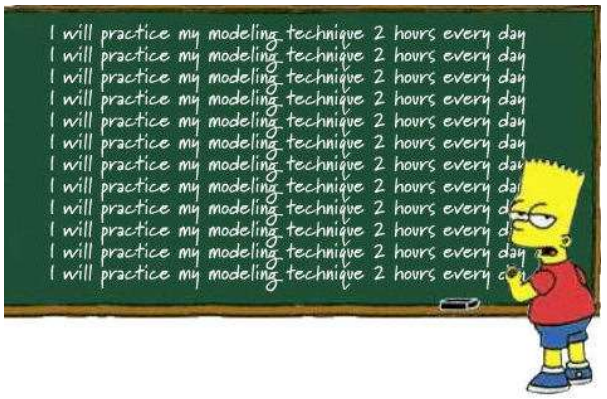
Running the tests

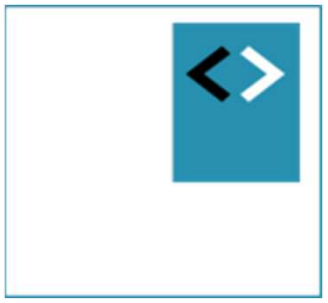
- `ng test`
  - Run all the tests in the .spec-files in the project
  - You can keep this running in the background!
    - It might slow down development
- `fit` - run this test only
- `xit` - run all tests except this one

Workshop

- Create a new, empty Angular Project
- Run `ng test` – identify what tests are run
- Try to make some simple changes to the tests. See if they still run

- Add a new component and run its tests
- Add an array of Cities and functionality for adding and deleting a city
- Write tests for the new component.
  - Add a test for the `counter` property
- https://github.com/PeterKassenaar/ng-testing
- Example: `../spy/spy.component.spec.ts`





Testing Services

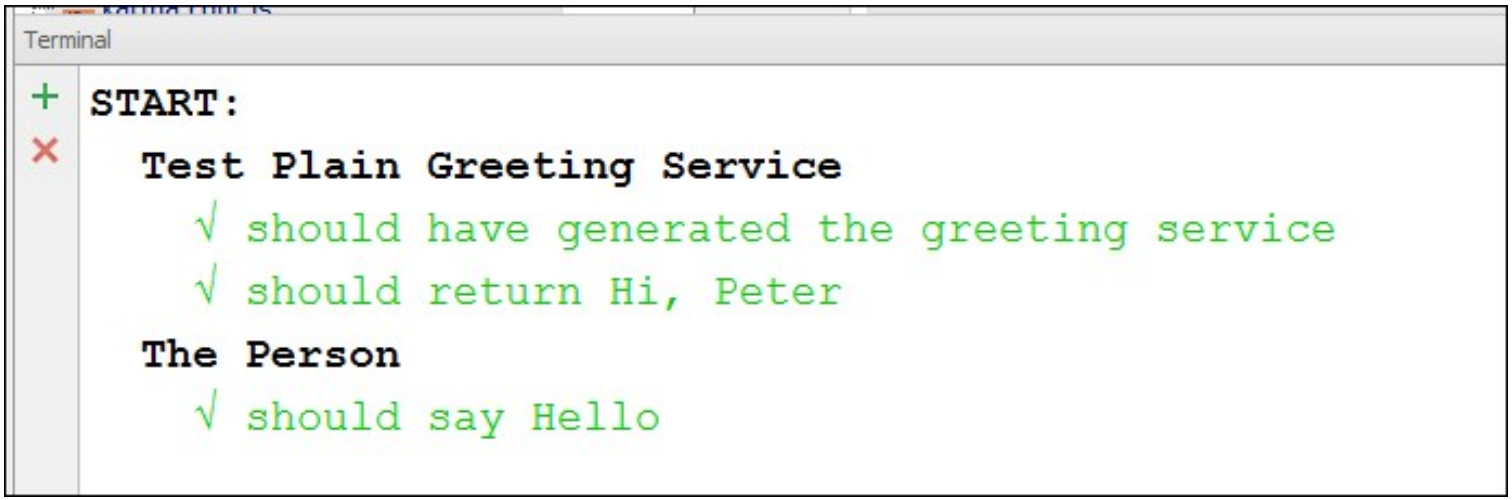
Testing a single service

One of the more easier concepts to test. So let's start there.

```
// greeting.service.ts
import {Injectable} from '@angular/core';

@Injectable()
export class GreetingService {

   constructor() {
   }

   greet(name: string): string {
      return `Hi, ${name}`;
   }
}
```

```
// greeting.service.spec.ts
import {GreetingService}from './greeting.service';
describe('Test Plain Greeting Service', () => {
    let greetingService;
    beforeEach(() => {
        greetingService = new GreetingService();
    });

    it('should have generated the greeting service', () => {
        expect(greetingService).toBeTruthy()
    });

    it('should return Hi, Peter', () => {
        let msg = greetingService.greet('Peter');
        expect(msg).toEqual('Hi, Peter');
    });
});
```

Output


Terminal
START:
Test Plain Greeting Service
√ should have generated the greeting service
√ should return Hi, Peter
The Person
√ should say Hello

But what about DI?

- Most of the time we don’t have a simple , single service
- We use it in the context of an `ngModule()`

```
…
import {GreetingService} from './shared/services/01-greeting.service';

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

Using TestBed

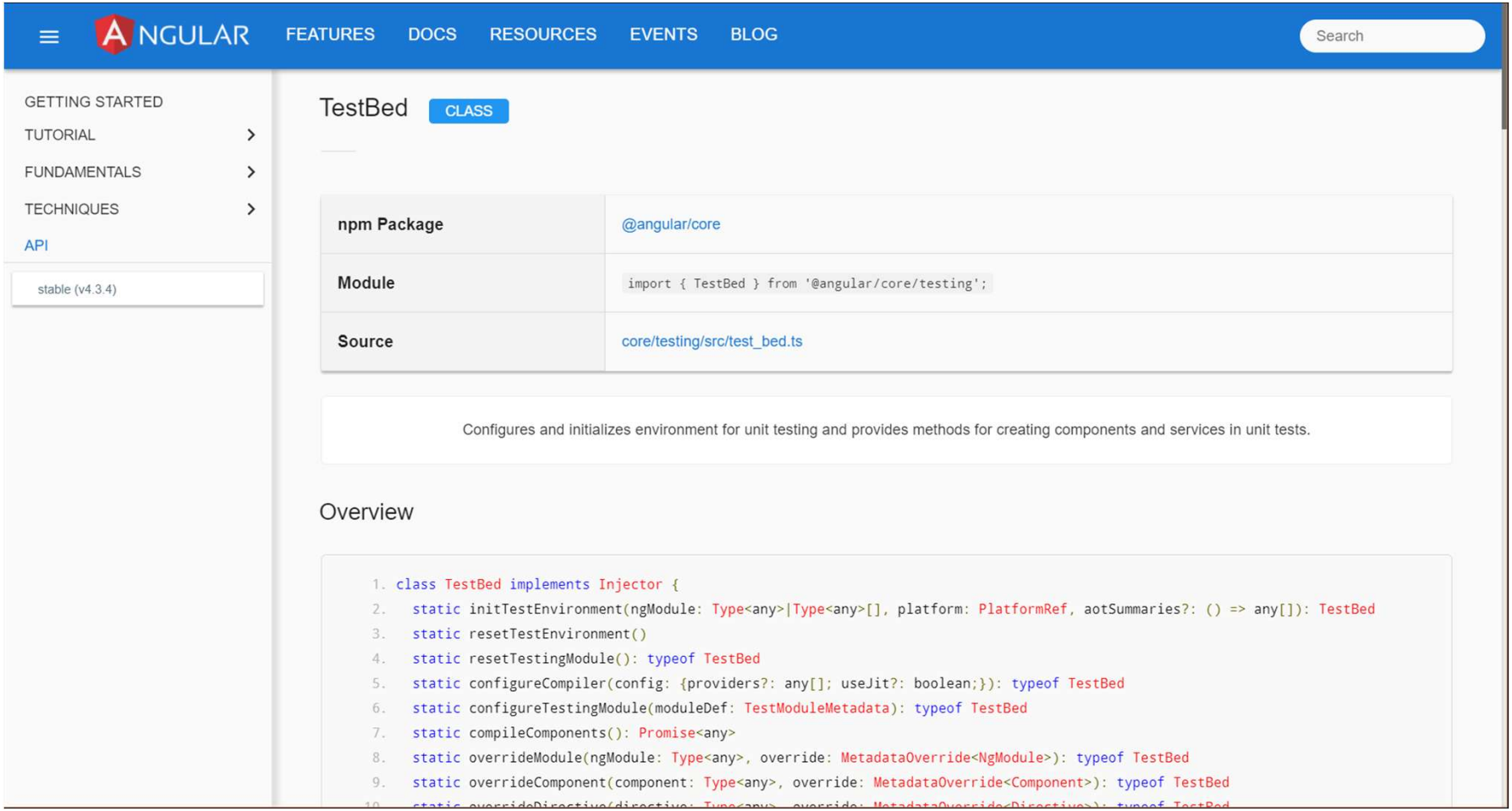
- In testing we have the same concept of modules, using `TestBed`
- TestBed has a method `.configureTestingModule()` to mimic an `ngModule`.
- You only specify the stuff you need!
  - No need to build the complete module, importing all dependencies

```
let service;
beforeEach(() => {
    TestBed.configureTestingModule({
        providers: [GreetingService]
    });
    service = TestBed.get(GreetingService);
});
```

Dependencies

Get instance of the service via TestBed.get()

“TestBed is the primary api for writing unit tests for Angular applications and libraries.”



https://angular.io/api/core/testing/TestBed

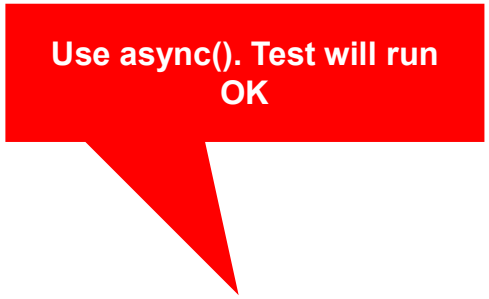
Async behavior

- If the services uses async calls, for instance Promises or Observables
- The spec-file will always returns true, because the `expect`-statement is not run in the `.then()`-clause
- So this wil NOT work:

```
it('should return Hi Peter from the async service', ()=>{
   service.greetAsync('Peter')
      .then(result =>{
         expect(result).toEqual('Hi, Petertest');
      })
});
```

Using Angular `async` and `fakeAsync`

- Solution: import and use Angular `async()` or `fakeAsync()` construct and wrap the expect statement in this function
- Jasmine will wait for the `async()` function to return and *then* perform the test




```
it('should return Hi Peter from the async service', async(()=>{
     service.greetAsync('Peter’)
        .then((result)=>{
           expect(result).toEqual('Hi, Peter');
     })
 }))
```

Async vs. fakeAsync

- Mostly interchangeable
- `fakeAsync` offers more configuration/control, but is used less often
- Use `fakeAsync` if you need manual control of zones `tick()` function

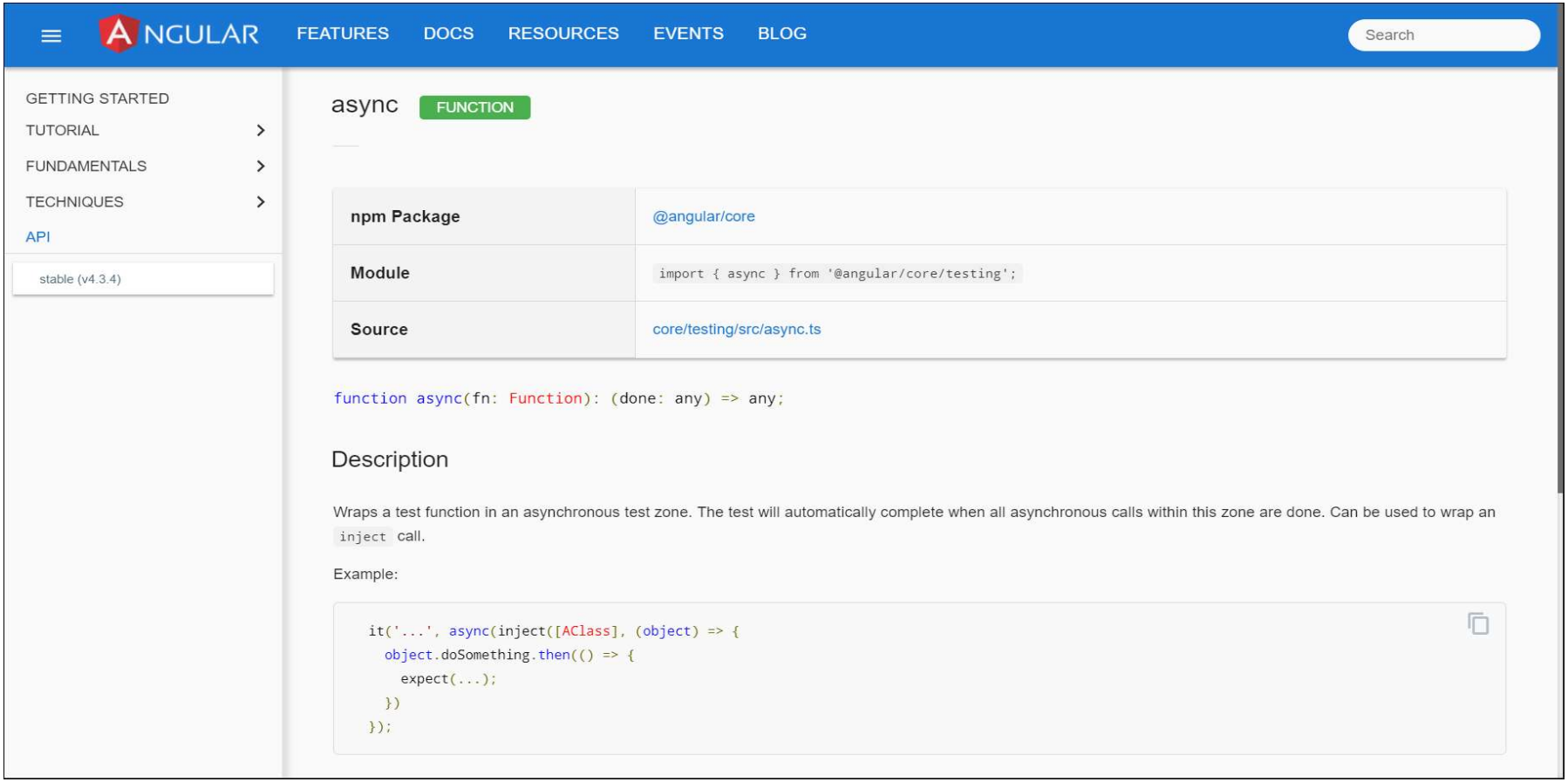
Google

```
it('should work with fakeAsync', fakeAsync(() => {
 let value;
 service.simpleAsync().then((result) => {
  value = result;
 });
 expect(value).not.toBeDefined();

 tick(50);
 expect(value).not.toBeDefined();

 tick(50);
 expect(value).toBeDefined();
}));
```

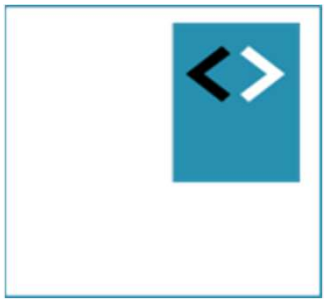
“fakeAsync() makes your async code synchronous”

https://stackoverflow.com/questions/42971537/what-is-the-difference-between-fakeasync-and-async-in-angular2-testing

Async documentation



https://angular.io/api/core/testing/async



Mocking backend

Testing asynchrounous XHR-calls

Like any external dependency, the HTTP backend needs to be mocked so your tests can simulate interaction with a remote server.

The @angular/common/http/testing library makes setting up such mocking straightforward.

https://angular.io/guide/http#testing-http-requests

Testing XHR calls

Setup (dummy) remote service to fetch some data over HTTP

```
constructor(private http: HttpClient) {
}
// Get fake people
public getPeople(): Observable<Person[]> {
   return this.http
      .get('someEndPoint/somePeople.json')
      .map(result => result.json());
}
```

Using `HttpClientTestingModule` and `HttpTestingController`

- Don’t perform the tests to a ‘real’ API with `HttpClientModule`
  - Import `HttpClientTestingModule` in your `.spec`-file
- Mock your backend by giving the test fake data

“A test expects that certain requests have or have not been made, performs assertions against those requests, and finally provide responses by "flushing" each expected request.”

Import the correct modules

```
import {HttpClientTestingModule,
        HttpTestingController} from '@angular/common/http/testing';
```

Then, add the `HttpClientTestingModule` to the TestBed and write the tests

```
// 2. Setup in the beforeEach() block
beforeEach(() => {
  TestBed.configureTestingModule({
    imports: [HttpClientTestingModule],
    providers: [RemoteService]
  });
  // 2a. Assign variables.
  injector = getTestBed();
  remoteService = injector.get(RemoteService);
  httpMock = injector.get(HttpTestingController);
  // 2b. Our mocked response
  mockUsers = [{
    name: 'Peter',
    email: 'info@kassenaar.com'
  }, {
    name: 'Sandra',
    email: 'sandra@kassenaar.nl'
  }]
});
```

HttpClientTestingModule

Mocked (fake) data

Now requests made in the tests will hit the testing backend instead of the normal backend.

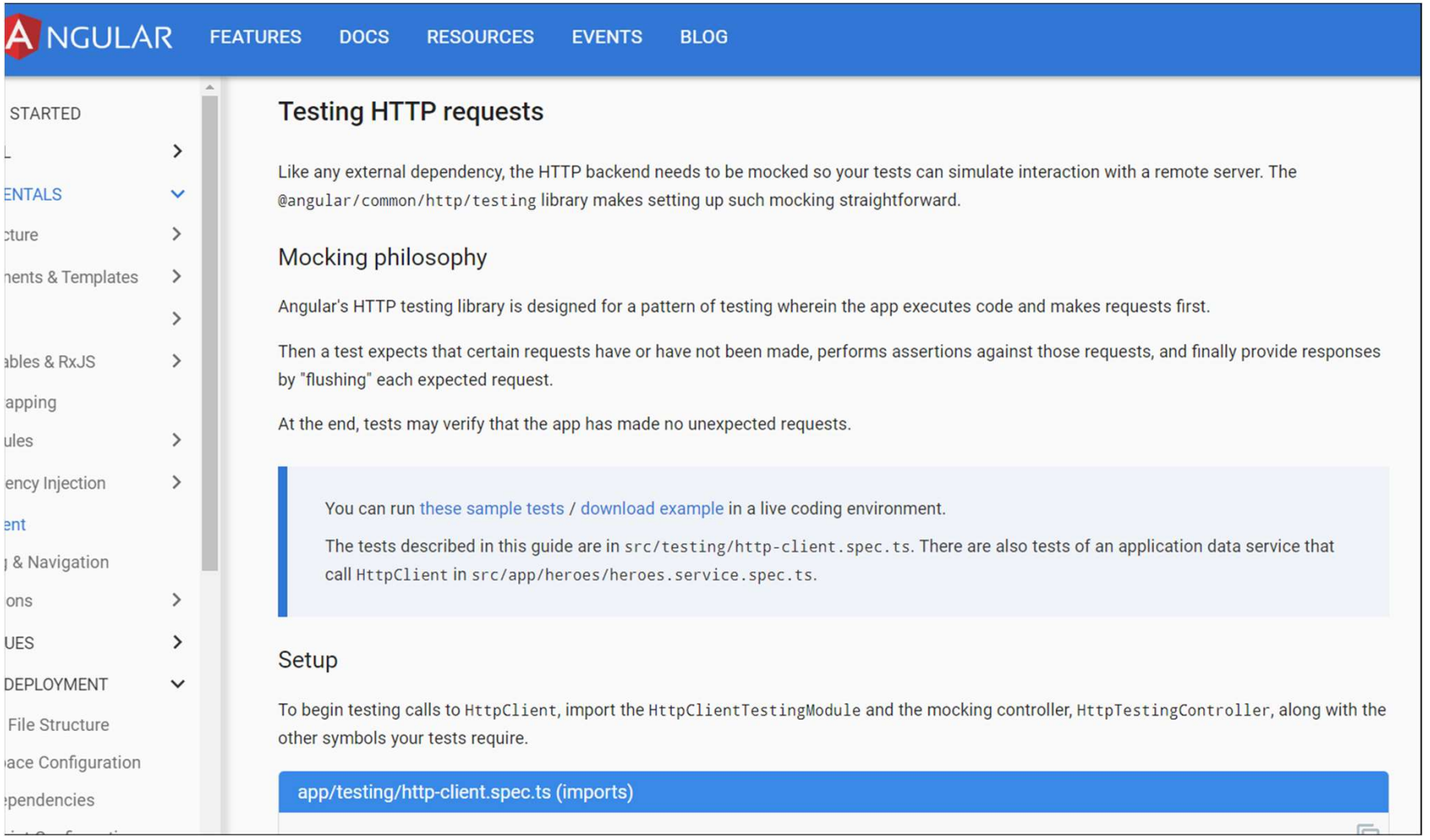
Write test for mocked backend

```
it('should return an Observable<User[]>', () => {
  // Make an HTTP GET request
  remoteService.getPeople()
    .subscribe(users => {
      expect(users.length).toBe(2);
      expect(users).toEqual(mockUsers);
    });
  // verify and flush our request
  const req = httpMock.expectOne(remoteService.url);
  expect(req.request.method).toBe("GET"); // just to be safe. Not mandatory.

  // Only after a flush() the .subscribe expecations are evaluated and available!
  req.flush(mockUsers);

  // Finally, verify if there are no outstanding requests.
 // httpMock.verify()
});
```

Subscriber. Results are only available after a Flush

Provide the subscriber with our (fake) data by calling .flush()

Documentation on HttpTestingModule



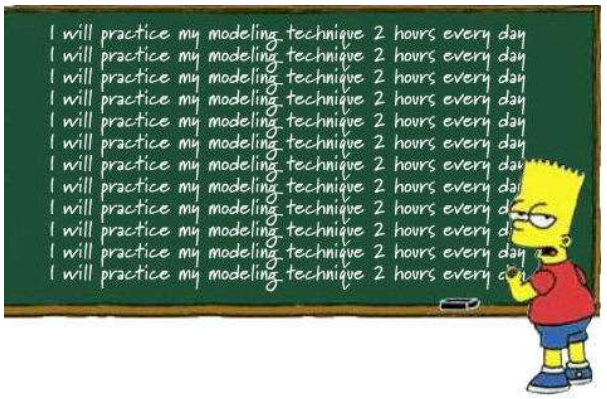
https://angular.io/guide/http#testing-http-requests

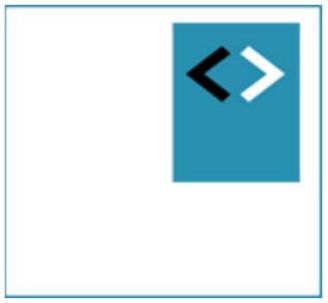
Summary

- What have we learned?
  - Jasmine Syntax: `describe()`, `beforeEach()`, `it()`, `expect()`
  - `TestBed.configureTestingModule()`
  - `TestBed.get()`
  - Testing Classes
  - Testing Services
- Mocking backend
  - `HttpClientTestingModule`, `HttpTestingController`
  - flush()

Workshop

- Study the example `../ng-testing`.
- Study `shared/model/10-car.model.ts` and create a test suite for it
- Study `10-car.service.ts` and create a test suite for it, using `TestBed.configureTestingModule()`
- Study `11-car.remote.service.ts` and create a test suite for it, using `HttpClientTestingModule`
  - The service is fetching Cars from a dummy backend.
  - Also write a test for the second method, fetching cars from a specific year.





Testing components

Building blocks of every application

Testing components

- Less often tested than services, routes, etc.
- Test View components only for their `@Input()` en `@Output()'s`
- Test Smart components as simple as possible

- New concepts:
  - `.compileComponents()`
  - `Fixture`
  - `.detectChanges()`
  - `componentInstance`
  - `DebugElement`
  - `NativeElement`

Simple Component testing

- Generate a simple component, using `{{ … }}` data binding for instance
- Create a TestBed, with instance of the component
  - Now using the `declarations` array
- Compile the component using `.compileComponents()`.

```
beforeEach(async(() => {
      TestBed.configureTestingModule({
         declarations: [CityComponent]
      })
      .compileComponents();
   })
);
```

"Do not configure the TestBed after calling compileComponents. Make compileComponents the last step before calling TestBed.createComponent to instantiate the component-under-test."

https://angular.io/guide/testing#the-first-asynchronous-beforeeach

Component Instance

- Component is now compiled for testing purposes (and added to the TestBed), but is not instantiated yet
- Use variables `component` and `fixture` for that.

```
let component: CityComponent;
let fixture: ComponentFixture<CityComponent>;

beforeEach(async(() => {
      …
      fixture   = TestBed.createComponent(CityComponent);
      component = fixture.componentInstance;
      fixture.detectChanges();
   })
);
```

"The fixture provides access to the component instance itself and to the DebugElement, which is a handle on the component's DOM element."

Complete test

```
import {async, ComponentFixture, TestBed} from '@angular/core/testing';

import {CityComponent} from './city.component';

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

   beforeEach(async(() => {
         TestBed.configureTestingModule({
            declarations: [CityComponent]
         })
            .compileComponents();

         fixture   = TestBed.createComponent(CityComponent);
         component = fixture.componentInstance;
         fixture.detectChanges();
      })
   );

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

Testing a method on a component

Suppose the component has a `setCity(name)` method like so:

```
setCity(name: string) {
   this.city = name;
}
```

Usage in a test

```
it('city should have the name Amsterdam', ()=>{
   component.setCity('Amsterdam');
   expect(component.city).toEqual('Amsterdam');
});
```

Accessing DOM-elements

Handy Helper library: `By`

- Provides querying the DOM like jQuery and `.querySelector[All]`

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

Use debugElement and NativeElement.

Don’t forget to trigger change detection on the fixture!

```
it('should have rendered Amsterdam on the page', ()=>{
    const de = fixture.debugElement.query(By.css('h1'));
    const element = de.nativeElement;
    component.setCity('Amsterdam');
    fixture.detectChanges();
    expect(element.textContent).toContain('Amsterdam');
});
```

Testing @Input() and @Output

Testing component attributes and events, using Jasmine spies

Testing @Input() parameters

- An `Input()`-parameter is just a property on the class.
- So treat it as such…

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

@Component({
   selector   : 'app-input',
   templateUrl: './input.component.html',
   styles     : []
})
export class InputComponent {
   @Input() msg: string;
}
```

With the template just: "{{ msg }}"

Writing the @Input test

```
import {async, ComponentFixture, TestBed} from '@angular/core/testing';

import {InputComponent} from './input.component';

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

   beforeEach(async(() => {
     …
   }));

   it('should have the message defined', ()=>{
      expect(fixture.debugElement.nativeElement.innerHTML).toEqual('');

      // now let's set the message
      component.msg = 'Hi, there';

      fixture.detectChanges();

      expect(fixture.debugElement.nativeElement.innerHTML).toEqual('Hi, there');

   })
});
```

Different ways to access the underlying DOM

- Access DOM-element via `debugElement` and `By`:
  - `fixture.debugElement.query(By.css('h1'));`
  - Recommended. DOM is abstracted by Angular. Works also in Non-DOM environments (like server-apps)
- Access native element directly:
  - Not recommended, but certainly possible (if you *know*, you app will never run outside a browser environment)
  - `fixture.nativeElement.querySelector('h1');`

Testing @Output() events

- Simple class, outputting a `msg` event, submitting a message.

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

@Component({
   selector   : 'app-output',
   templateUrl: './output.component.html'
})
export class OutputComponent {

   @Output() msg: EventEmitter<string> = new EventEmitter<string>();

   sendMsg(msg: string) {
      this.msg.emit(msg);
   }
}
```

```
 <p>
  <button (click)="sendMsg('Hi, there')">Send Message</button>
</p>
```

Different strategies for testing events

1st strategy:
simply subscribe to the event and call the method that fires the event

```
it('should fire the msg event', ()=>{
   // 1st strategy : subscribe to the msg event
   component.msg.subscribe(msg =>{
      expect(msg).toBe('Hi, there');
   });
   // emit the actual event with a value
   component.sendMsg('Hi, there');
})
```

Creating a Jasmine Spy

- Spies are Jasmine 'watchers'
- You can query the spy and expect that
  - it has been called,
  - It has not been called
  - It has been called with a specific value,
  - It has been called a specific number of times,
  - …
- Documentation: https://jasmine.github.io/api/2.7/global.html#spyOn
- Cheat sheet: https://daveceddia.com/jasmine-2-spy-cheat-sheet/
- Tutorial: http://www.htmlgoodies.com/html5/javascript/spy-on-javascript-methods-using-the-jasmine-testing-framework.html

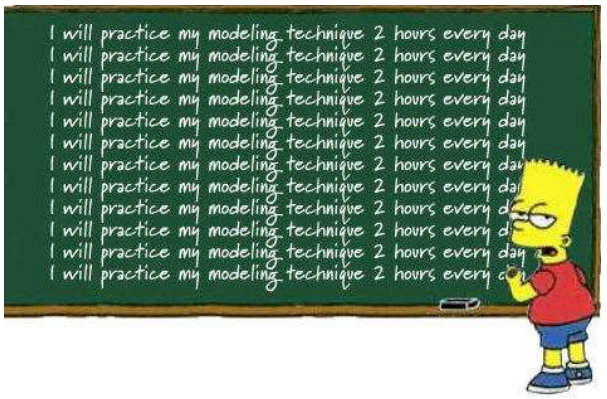
Jasmine spyOn()

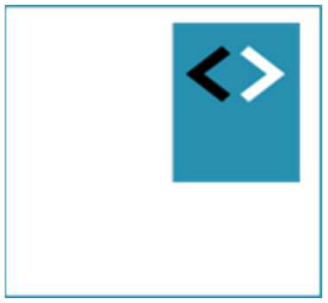
`spyOn(Object, 'method')`

```
it('should spy on the msg event', ()=>{
   // 2nd strategy : create a Jasmine Spy, watch the 'emit' event.
   spyOn(component.msg, 'emit');
   const button = fixture.debugElement.nativeElement.querySelector('button');
   button.click();

   expect(component.msg.emit).toHaveBeenCalledWith('Hi, there');
})
```

Workshop

- Study `car.component.ts` and create a test suite for it
- Test wether the component is correctly created
- Test if `this.cars[]` is constructed after initialisation. Expect the length of the array to be `2`.
- Test wether the `@Output()` event is called when clicked on a car
- Create an `@Input` property for the component yourself and test it





Mocking components

Strategies for minimizing the dependency chain of components

Multiple components

- What if an a component has multiple, nested components?
- Different possible strategies
  - Include all your components
  - Override your components at test time
  - Ignore errors and continue, using `NO_ERRORS_SCHEMA`

```
<!--card.component.html|ts|spec.ts-->
<card-header>
   Some Title
</card-header>
<card-content>
   Some content
</card-content>
<card-footer>
   Copyright (C) - 2017
</card-footer>
```

#1 Include all components

- Import all components and reference them in `declarations : […]` section
- *Pro* – complete test coverage, compile the component as it would run in the live app
- *Con* – more overhead, slower, tests for nested components are possibly elsewhere, overkill

```
import {CardComponent, CardContent, CardFooter, CardHeader} from './card.component';

describe('CardComponent', () => {
   …
   beforeEach(async(() => {
      TestBed.configureTestingModule({
         declarations: [CardComponent, CardHeader, CardContent, CardFooter],
      })
         .compileComponents();
   }));
   …
});
```

#2 – Override components at test time

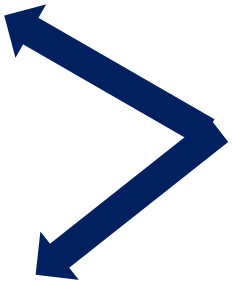
- Simply provide empty components to the testsuite
- *Pro* – Component would compile as at run time
- *Con* – duplicate code, not a nice view, more overhead.

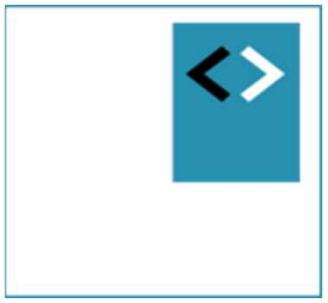
```
@Component({
   selector: 'card-header',
   template:''
})
export class CardHeader{}

@Component({
   selector: 'card-content',
   template:''
})
export class CardContent{}
…
```

#3 Using NO_ERRORS_SCHEMA

- Provide a schema to the testing module, ignoring all errors and always continu the test
- *Pro* – flexible setup, no dependencies, faster compiling
- *Con* – you might not catch other errors

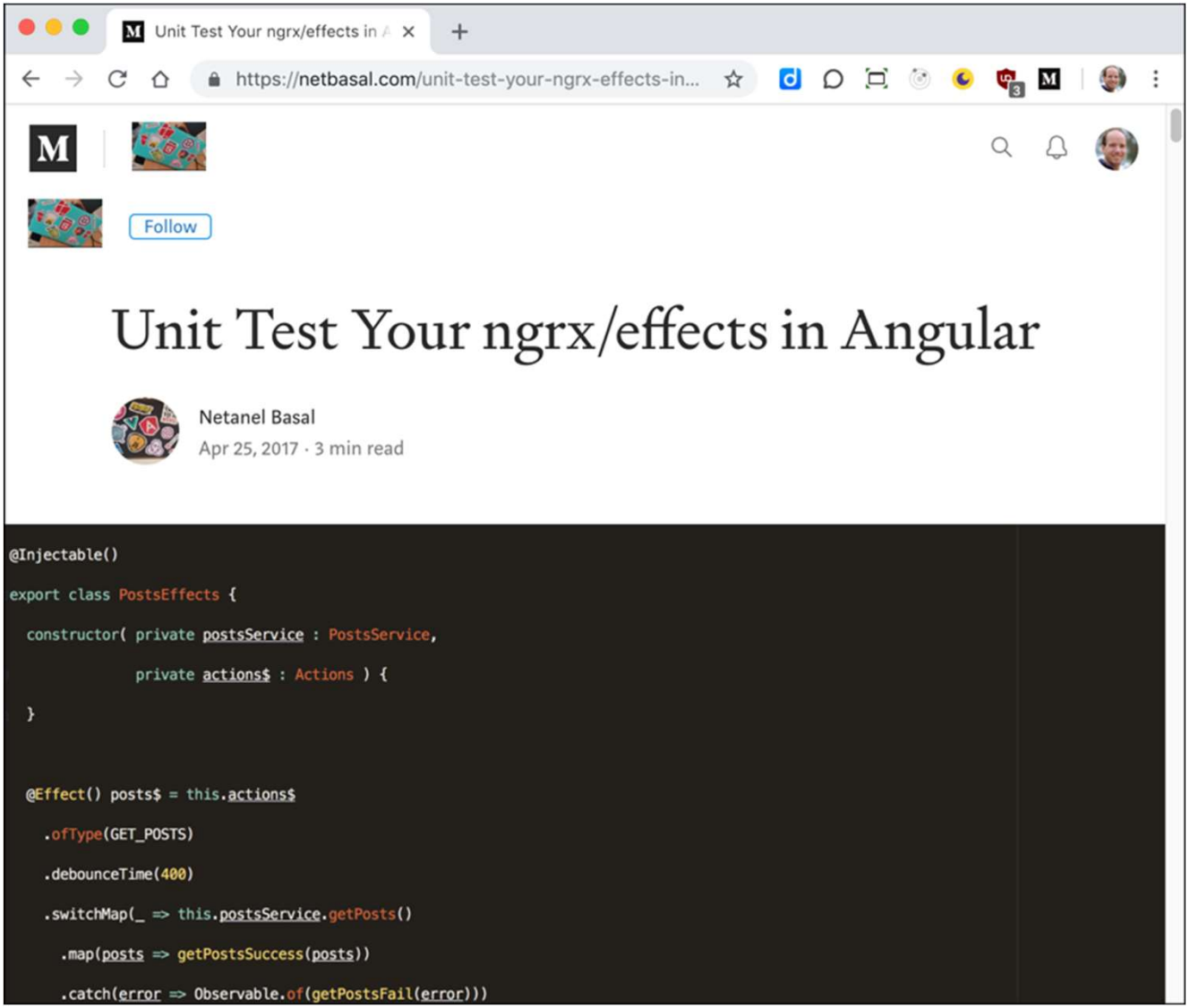
```
import {NO_ERRORS_SCHEMA} from '@angular/core';

describe('CardComponent', () => {
   …
   beforeEach(async(() => {
      TestBed.configureTestingModule({
         declarations: [CardComponent],
         schemas     : [NO_ERRORS_SCHEMA] // ignore alle errors, just go on.
      })
      .compileComponents();
      …
   }));
   …
});
```



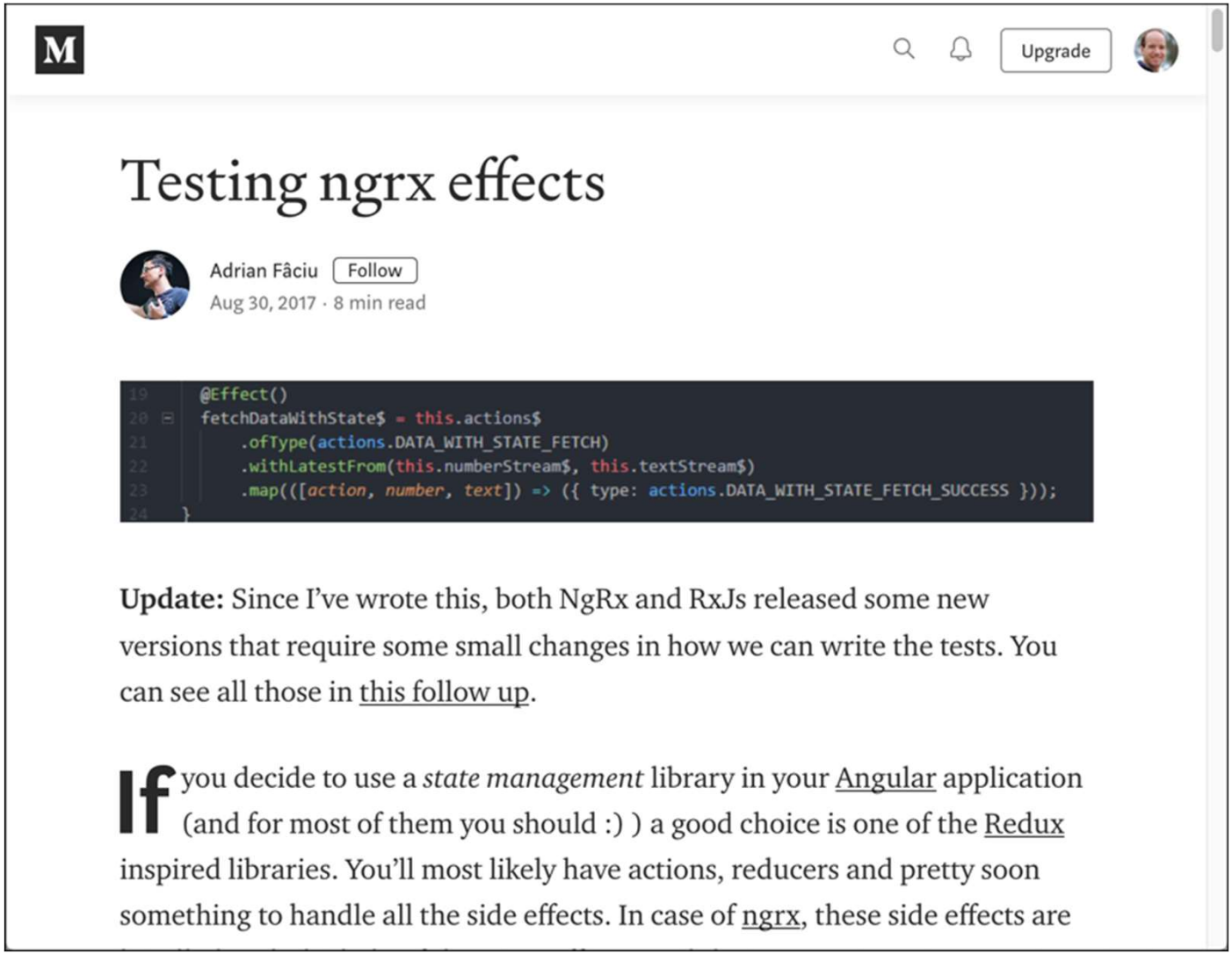


Testing @Effects

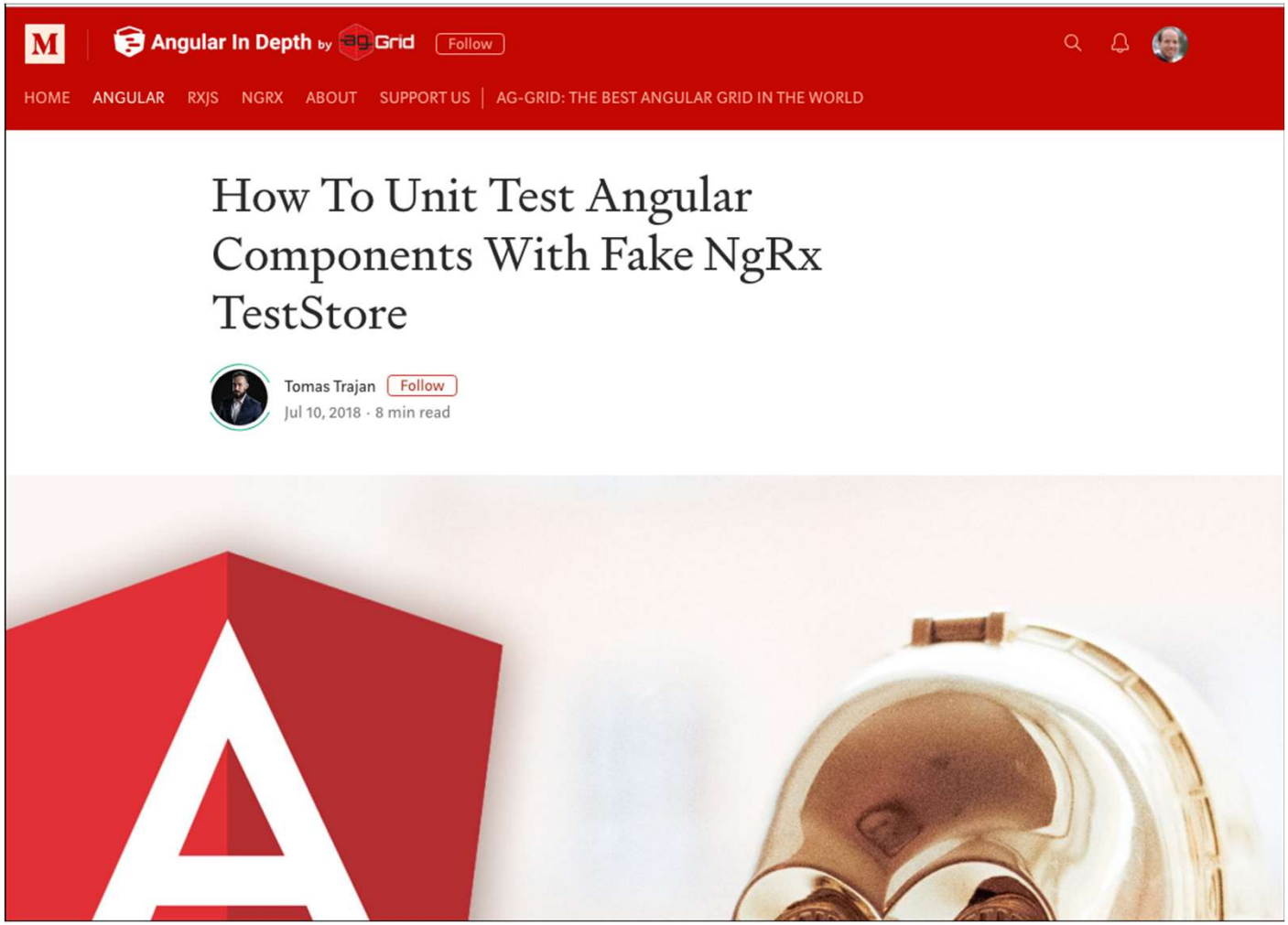
Writing unit tests for Store-enhanced applications



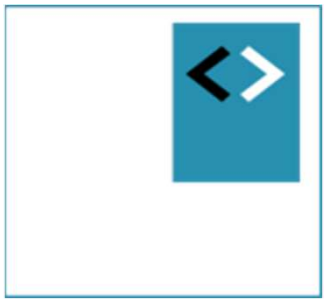
https://netbasal.com/unit-test-your-ngrx-effects-in-angular-1bf2142dd459



https://medium.com/@adrianfaciu/testing-ngrx-effects-3682cb5d760e



https://blog.angularindepth.com/how-to-unit-test-angular-components-with-fake-ngrx-teststore-f0500cc5fc26



End-2-End testing

Testing complete scenario’s

What is End 2 End testing

- Test complete processes, not single units
- Test in real environments, with the whole application
- Test real live situations
- Know if most important (tested) features work with the application
- Does *not* test edge cases
- Does *not* necessarily improve code quality

E2e test Tooling

Automate browsers to perform scenario's

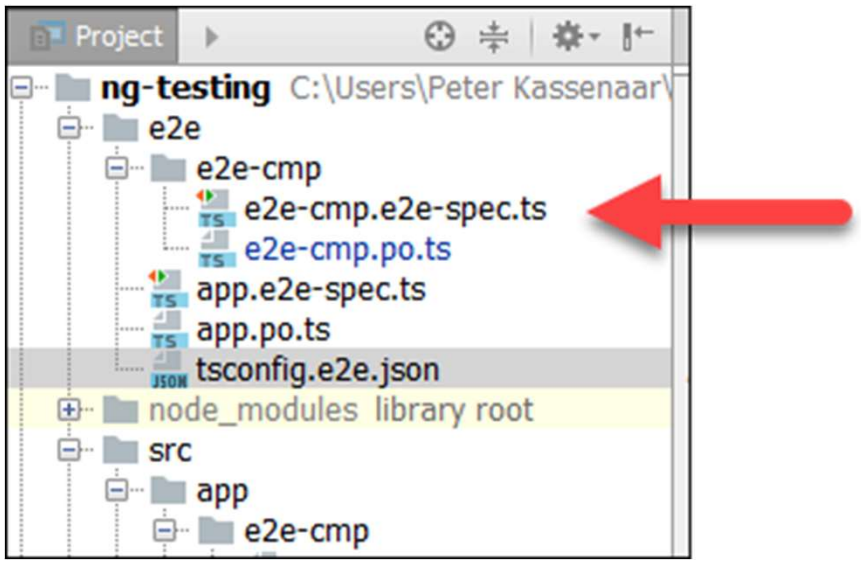
Developed by Team Angular – wrapper around selenium

Parts of e2e tests

- Folder: `/e2e`
- Page Objects – describe the scenario in a `*.po.ts`-file
  - Export a class with a `navigateTo()` function,
  - Plus functions for all the elements you want to retrieve/test
- Test files – write tests as usual
  - They load the Page Object class
  - Write a `beforeEach()` block to instantiate the Page Object
  - Write tests to invoke and test the elements on the page

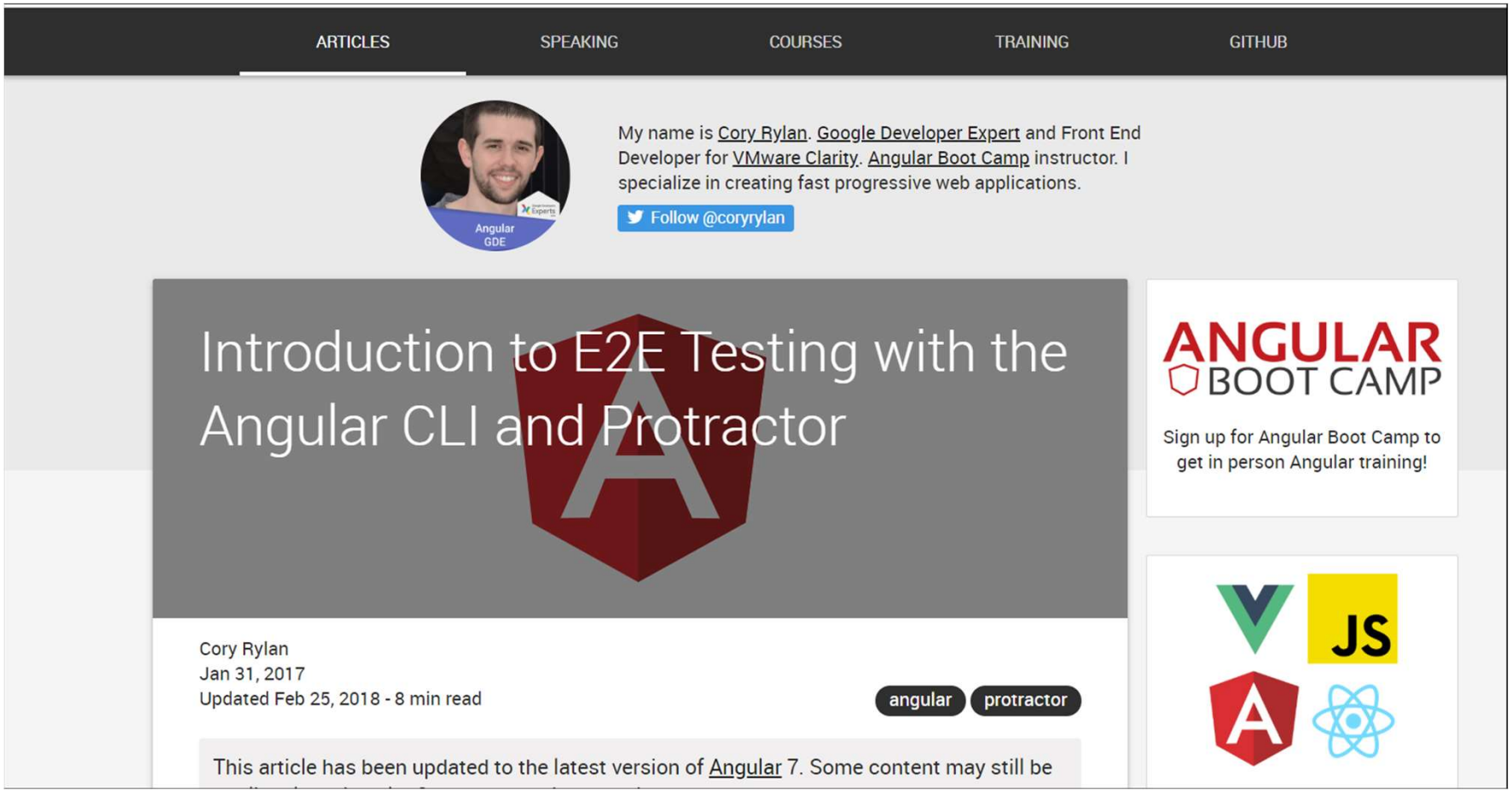
Executing e2e tests

- Generic command: `ng e2e`
- Examples: `\e2e-cmp`

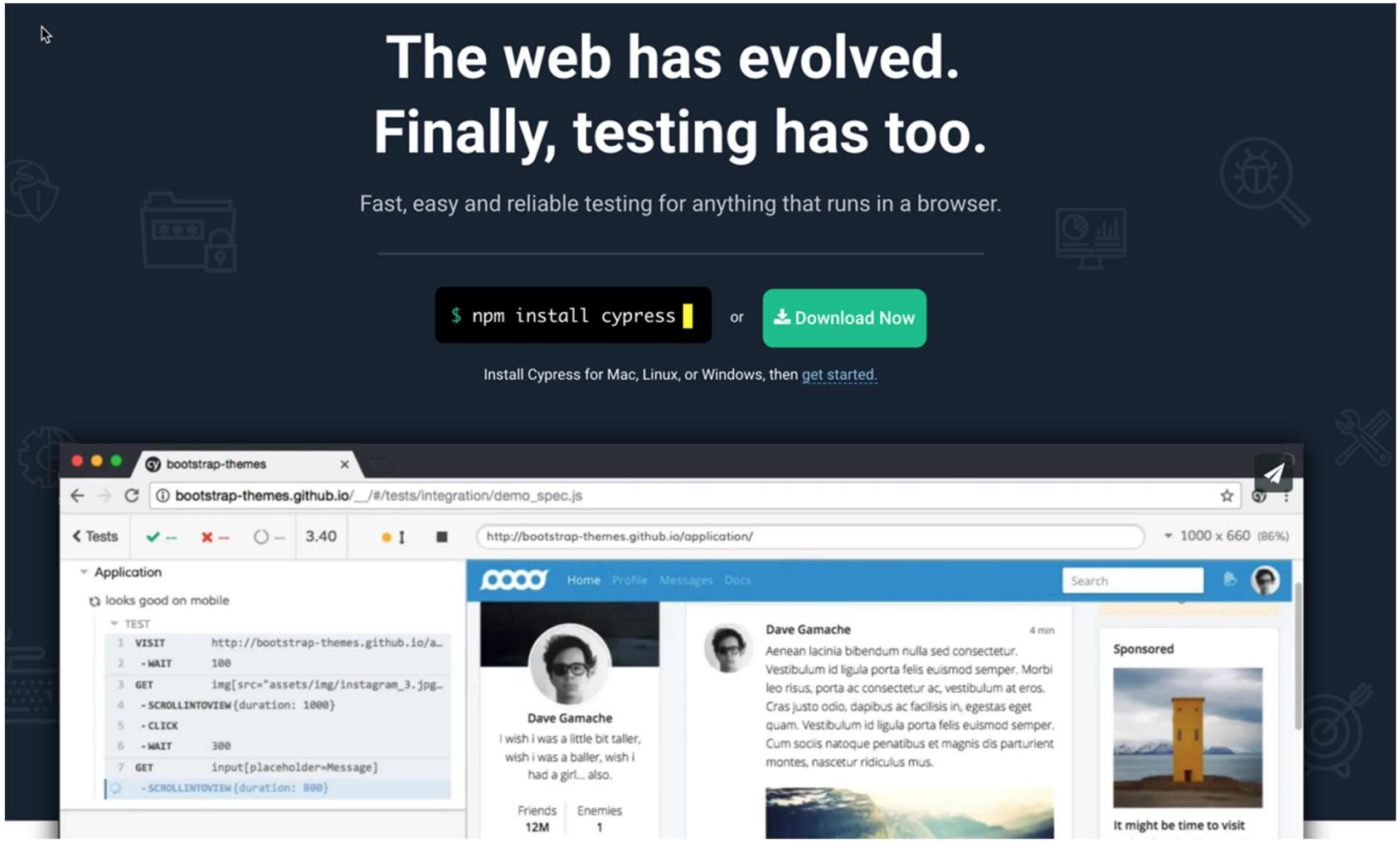


More information on e2e testing

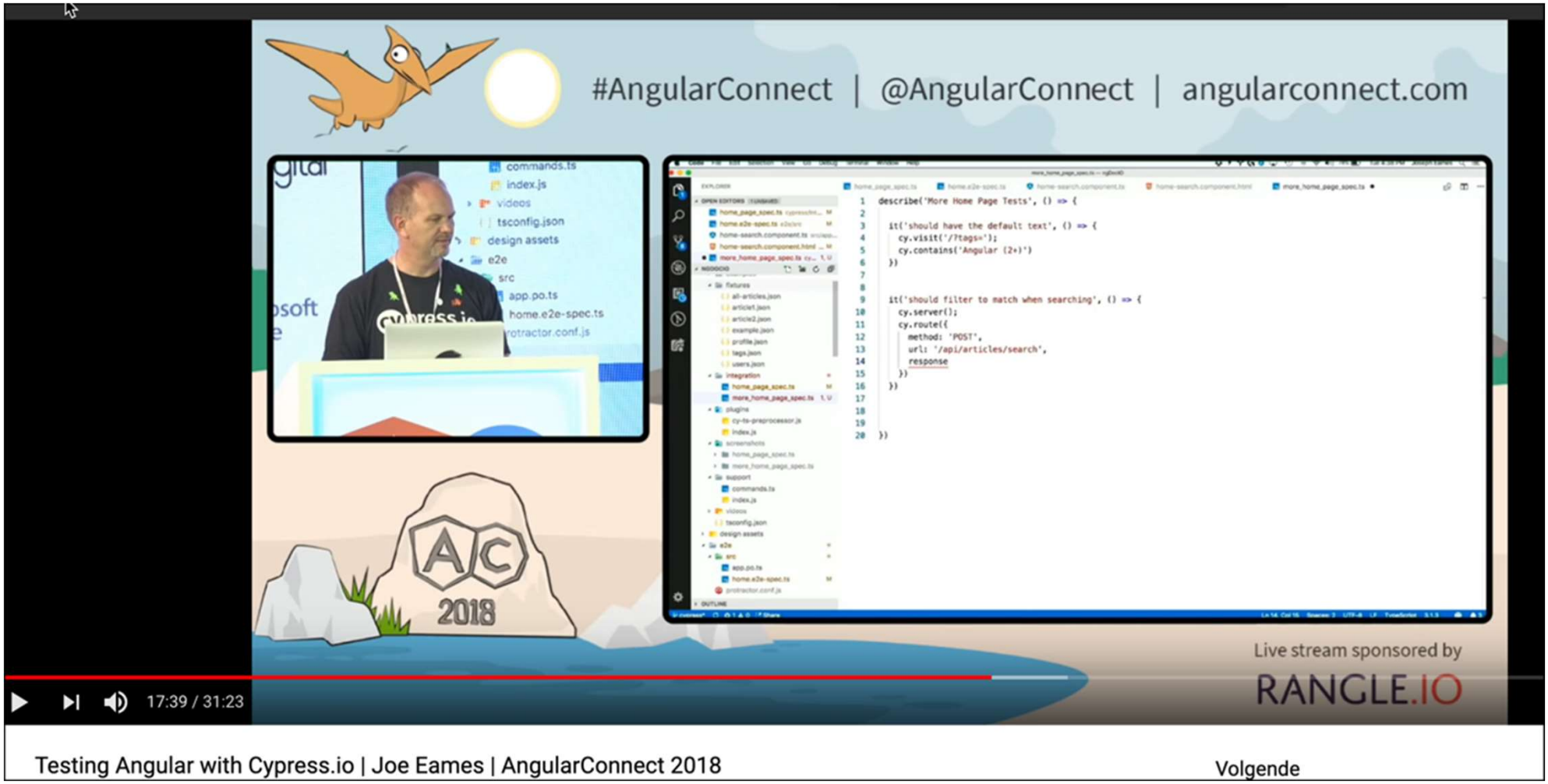
- https://coryrylan.com/blog/introduction-to-e2e-testing-with-the-angular-cli-and-protractor



An alternative to E2E-testing - Cypress



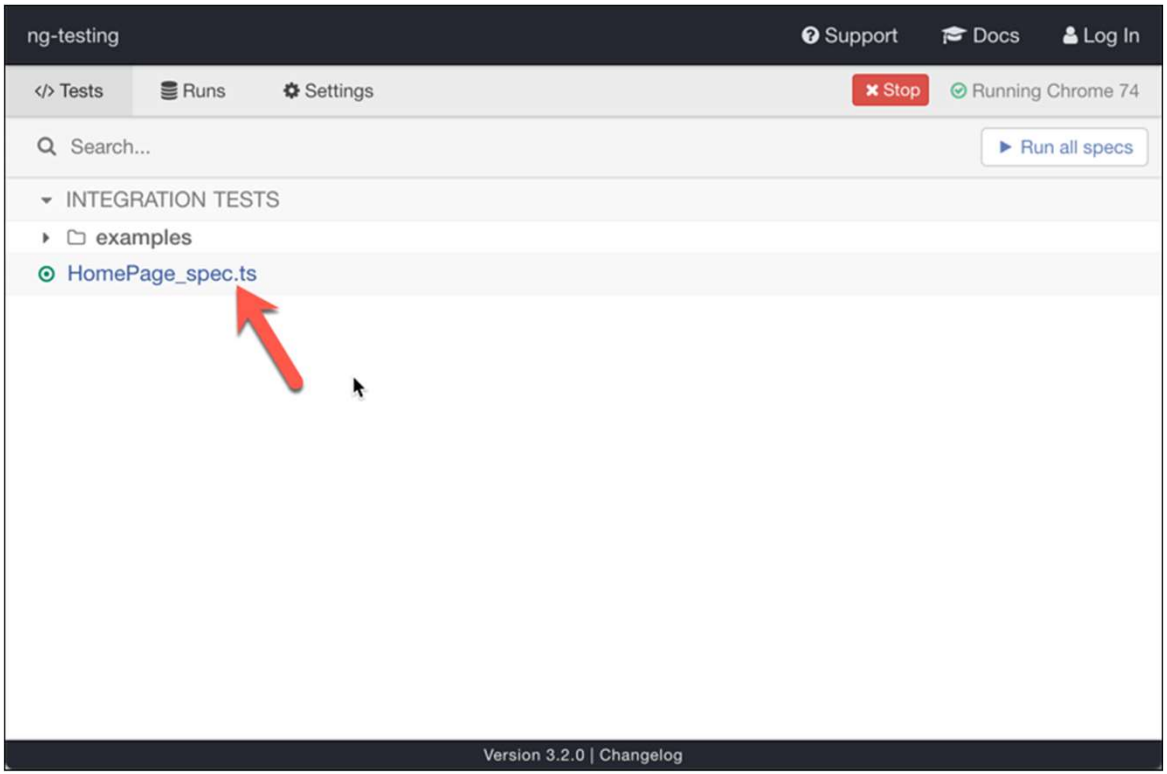
https://www.cypress.io/

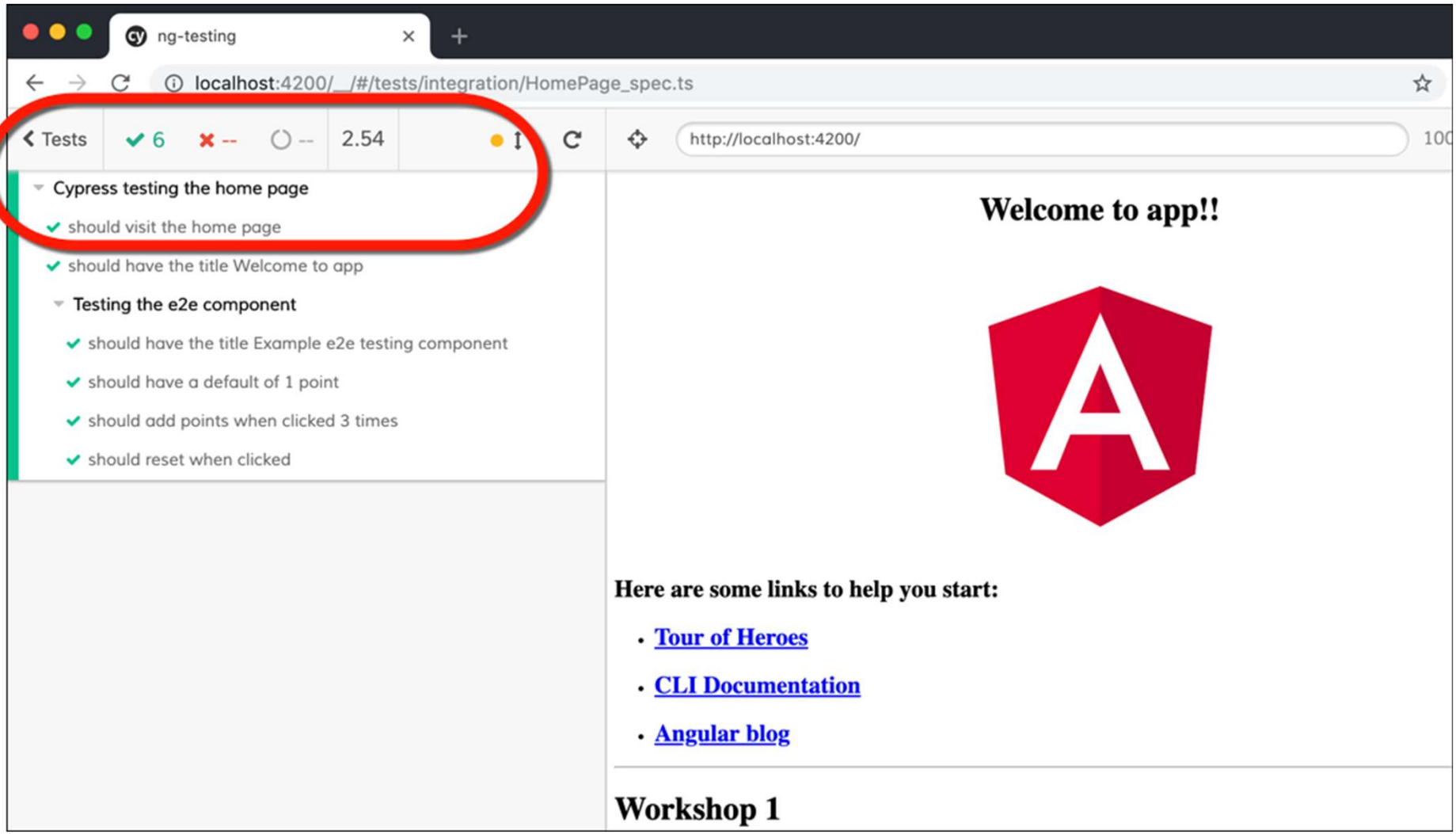


https://www.youtube.com/watch?v=eZyD-8qglWY

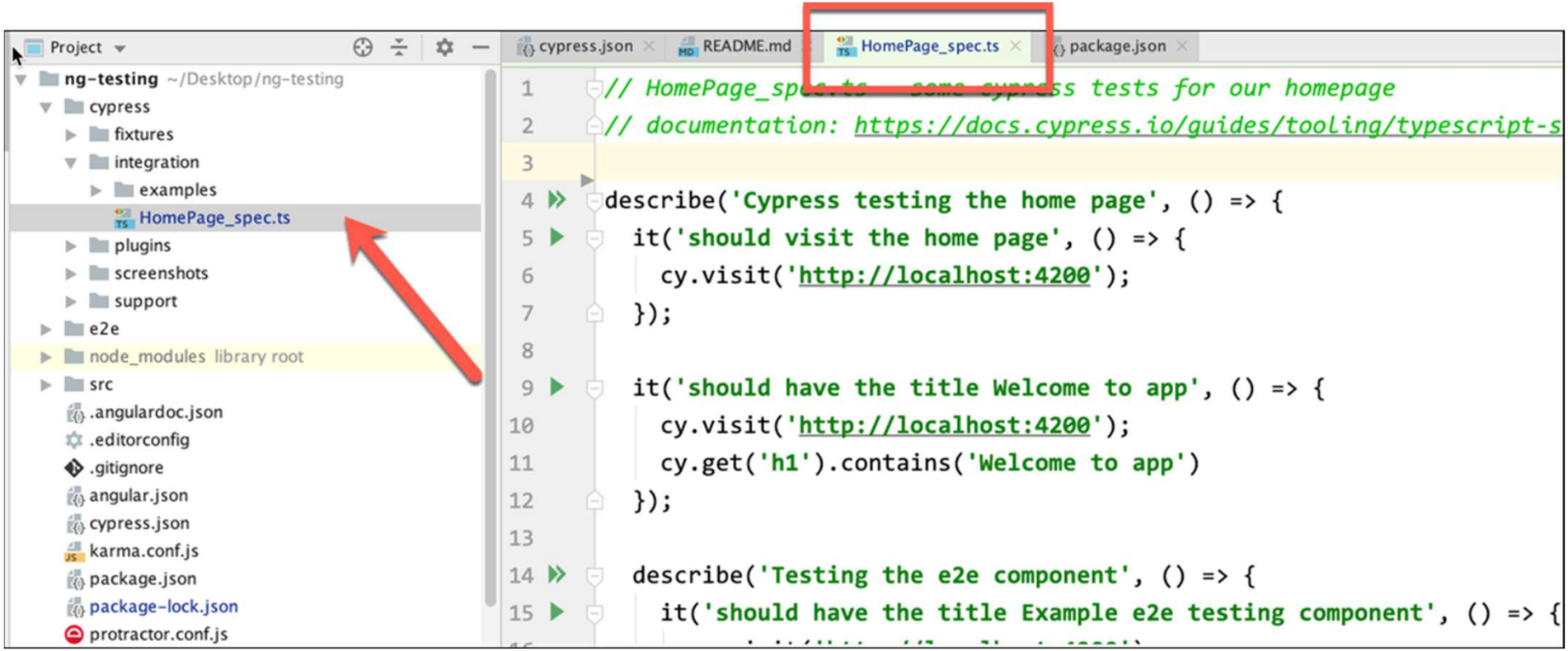
In testing repo

- A small test for the homepage
  - Start project on `localhost:4200`
  - `npm run cypress:open`



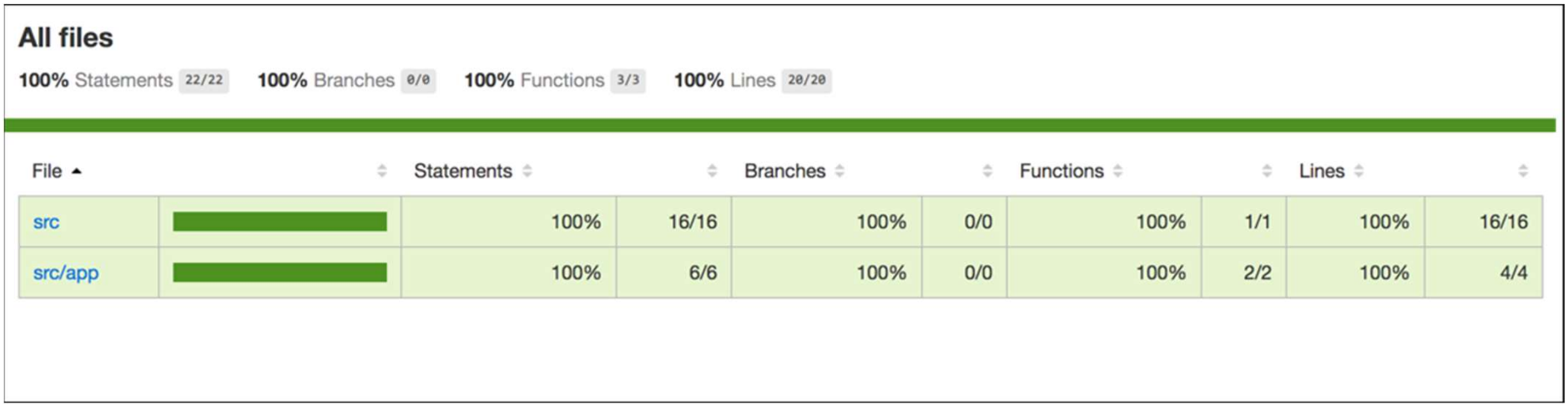

ng-testing
localhost:4200/__/#/tests/integration/HomePage_spec.ts
Tests
6
--
--
2.54
http://localhost:4200/
Cypress testing the home page
should visit the home page
should have the title Welcome to app
Testing the e2e component
should have the title Example e2e testing component
should have a default of 1 point
should add points when clicked 3 times
should reset when clicked
Welcome to app!!
Here are some links to help you start:
Tour of Heroes
CLI Documentation
Angular blog
Workshop 1

Check the code

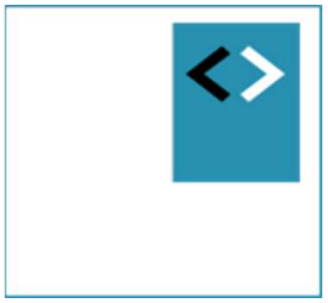


Code Coverage

- "How much of my code is covered by tests?"
- 100% would be ideal, but many teams are OK with 80-90%.
  - To be discussed
- Built in in CLI as a flag:
  - `ng test --code-coverage`



File	Statements		Branches		Functions		Lines	
src	100%	16/16	100%	0/0	100%	1/1	100%	16/16
src/app	100%	6/6	100%	0/0	100%	2/2	100%	4/4

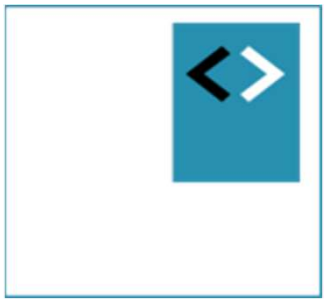


Summary

What have we learned

Summary

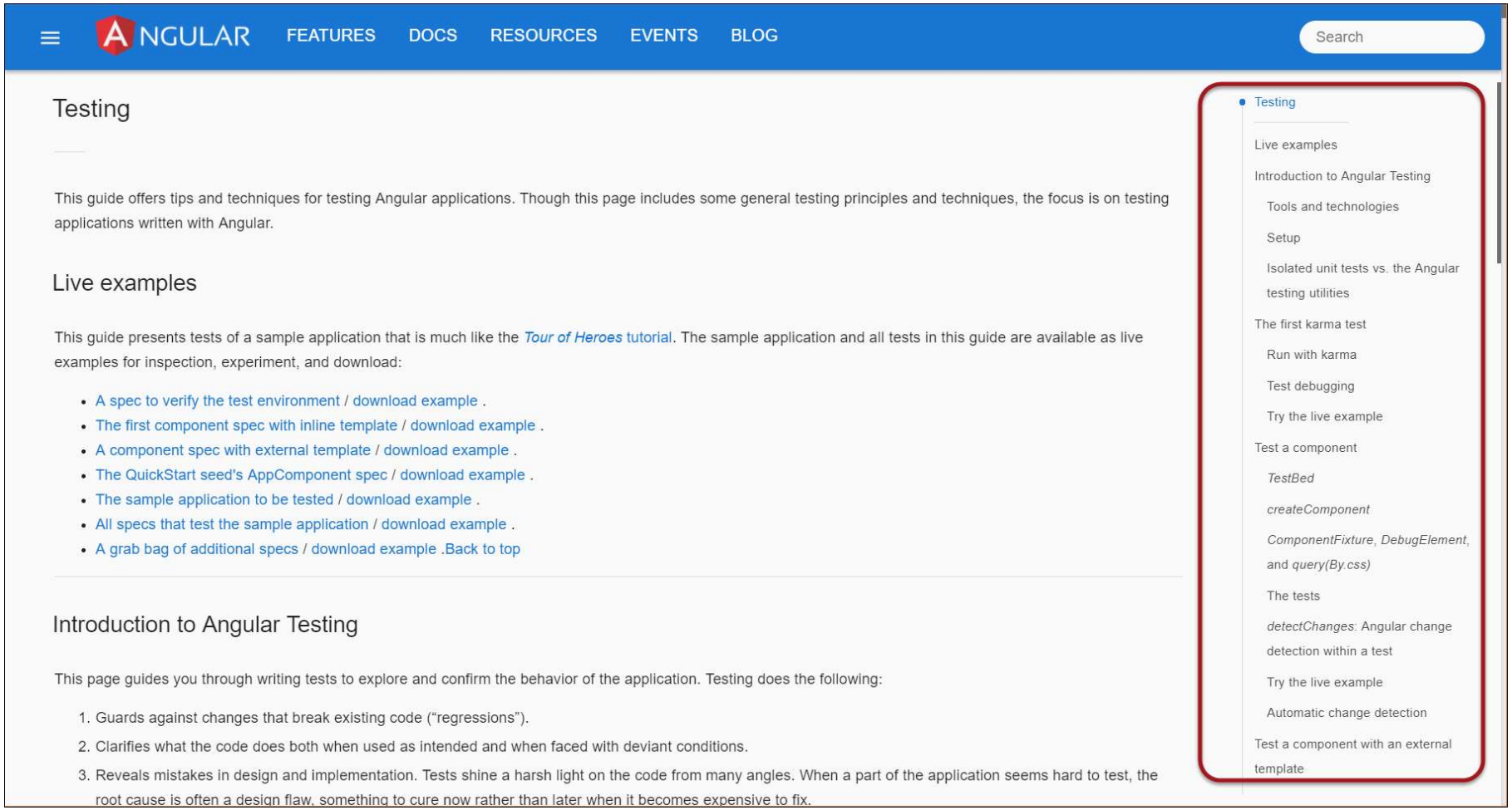
- We learned about:
  - ComponentFixture
  - .compileComponents()
  - .detectChanges()
  - .componentIntstance
  - .debugElement
  - .nativeElement
  - By (helper class)
  - NO_ERROR_SCHEMA
  - Mocking strategies
  - End to End testing with Cypress or Protractor



More info

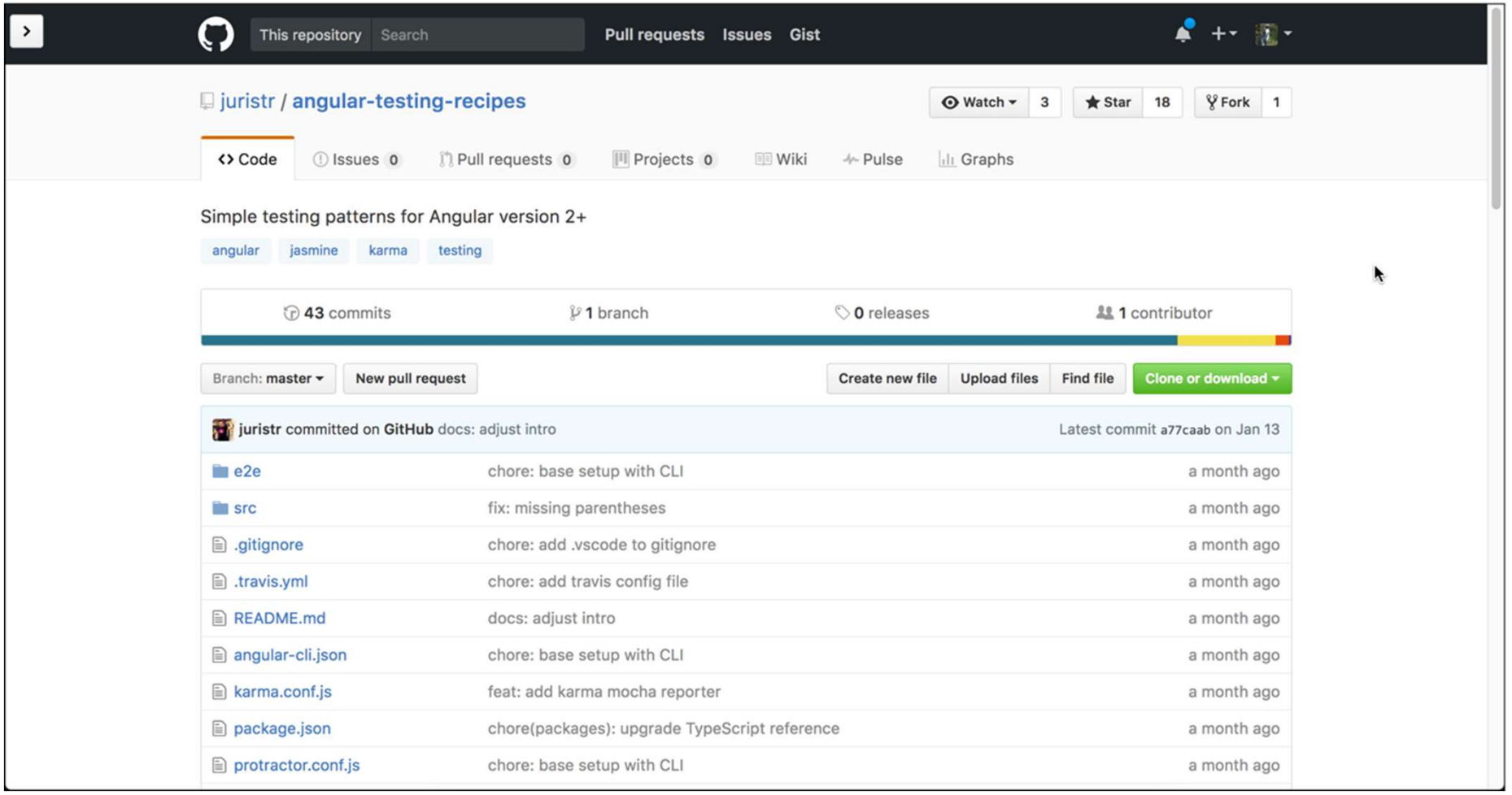
Elsewhere on the interwebz…

Testing documentation



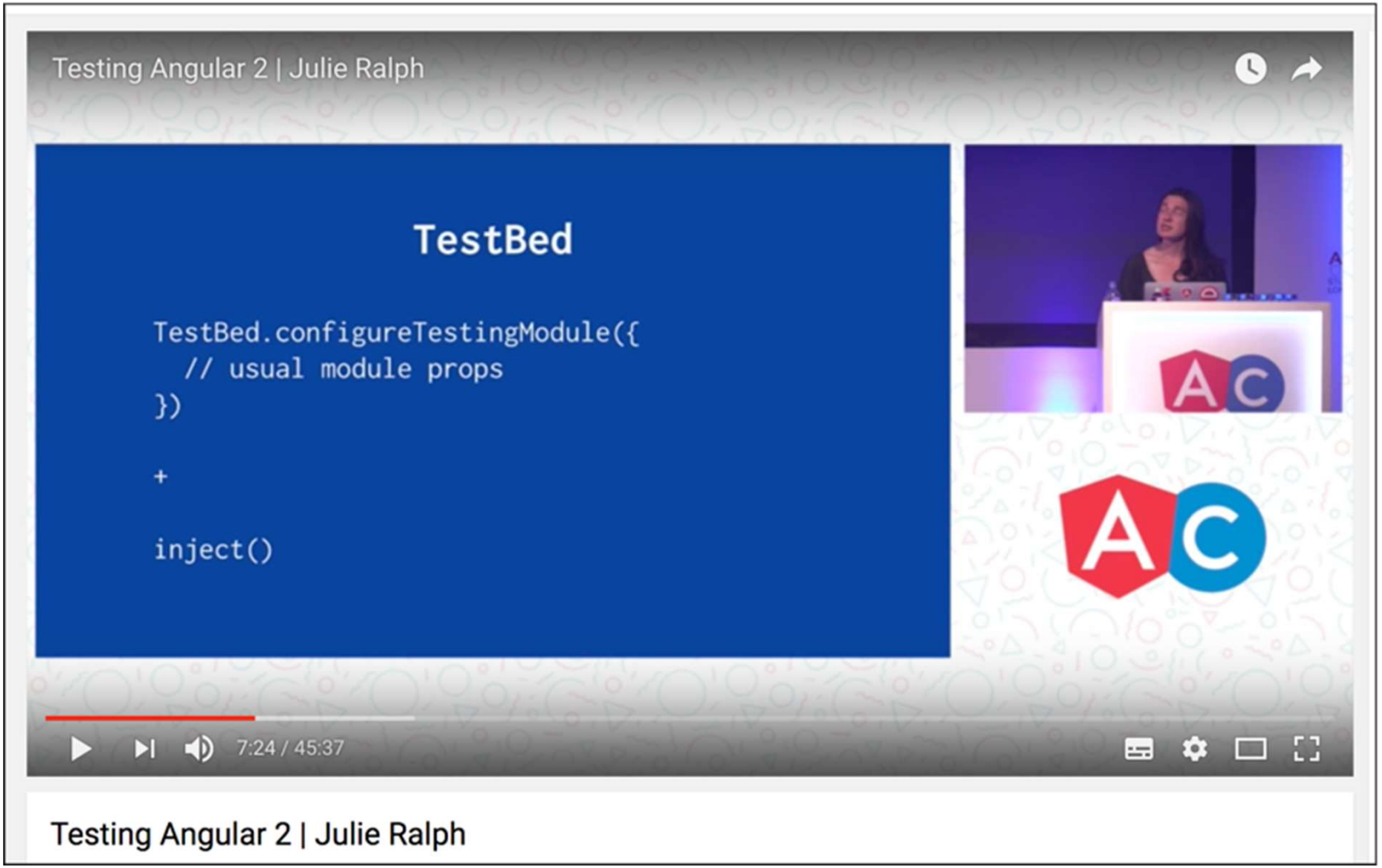
https://angular.io/guide/testing

Repo – Angular Testing recipes



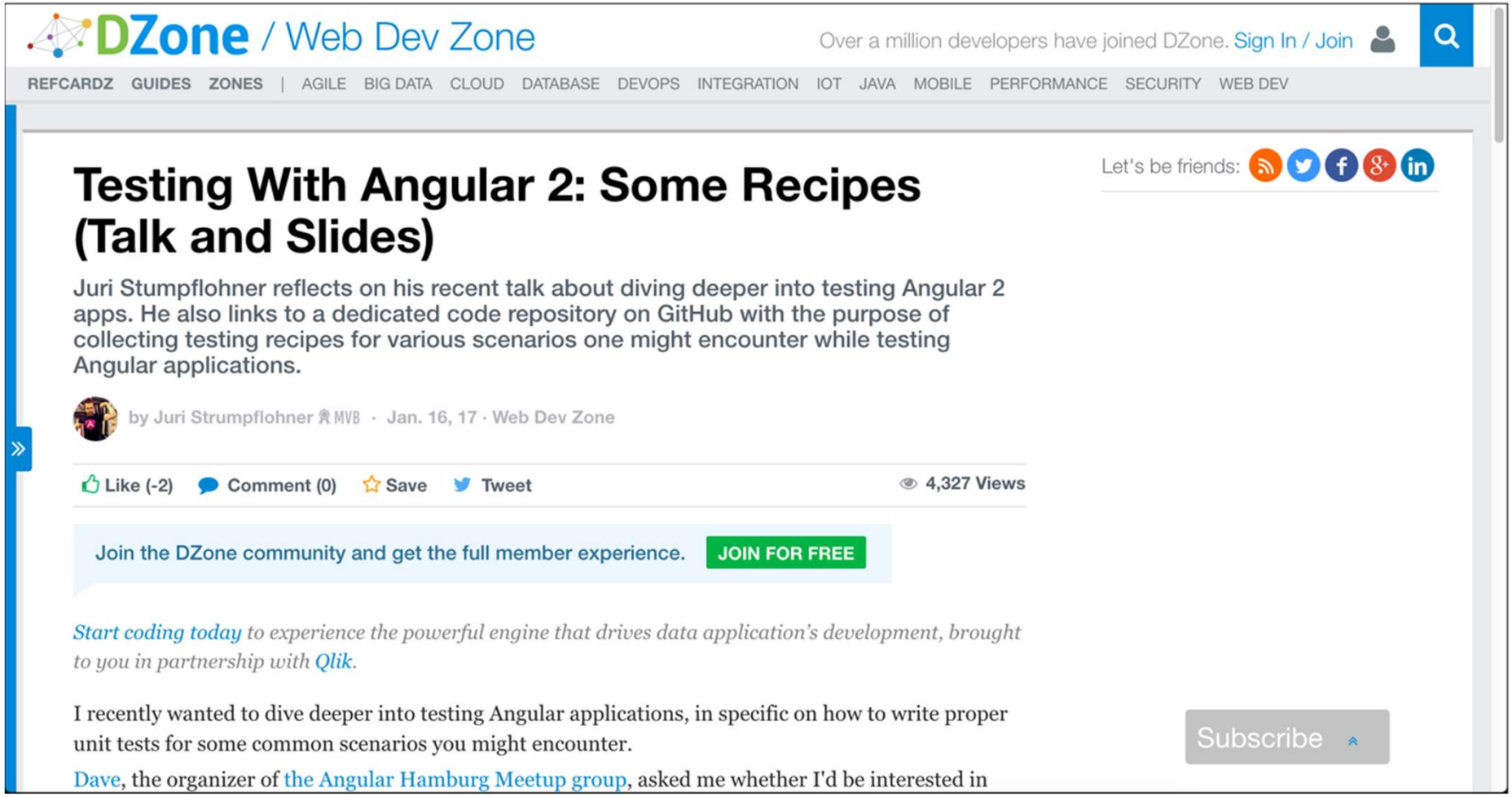
https://github.com/juristr/angular-testing-recipes

Videos on testing



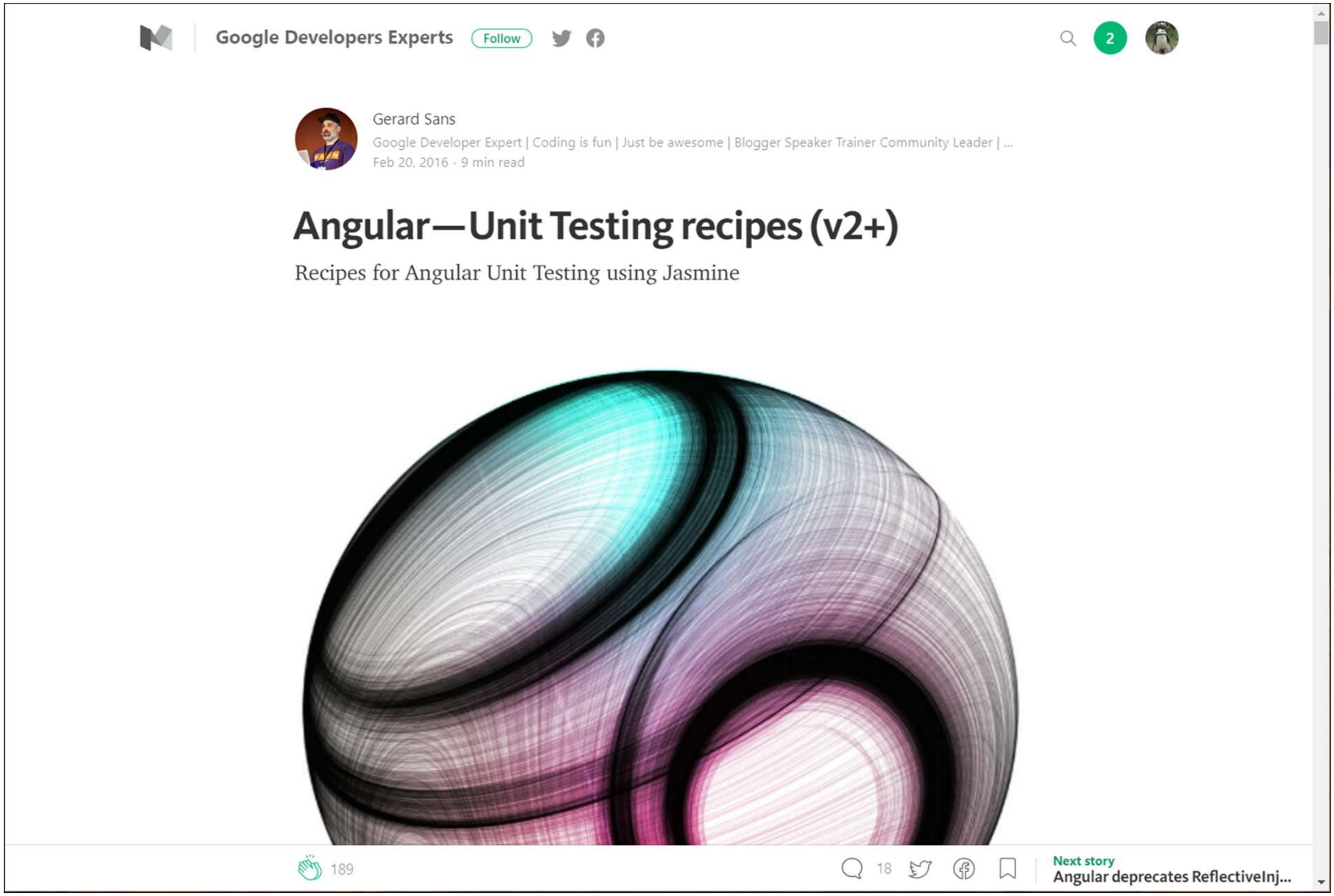
https://www.youtube.com/watch?v=f493Xf0F2yU

Good introductory article + video



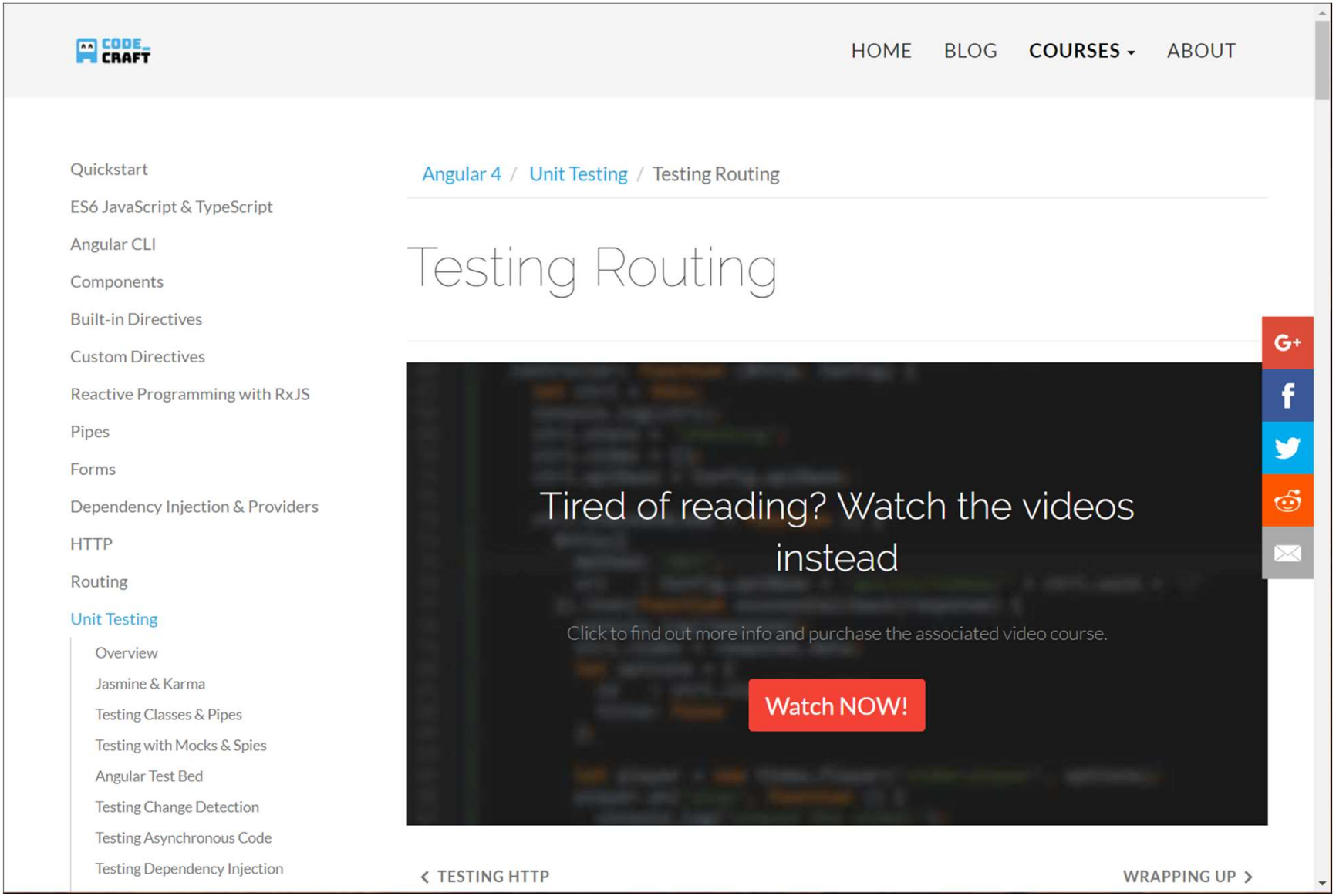
https://dzone.com/articles/talk-testing-with-angular-some-recipes

Gerard Sans on testing



https://medium.com/google-developer-experts/angular-2-unit-testing-with-jasmine-defe20421584

Testing Routing



https://codecraft.tv/courses/angular/unit-testing/routing/