aarixa
> ict and business optimization

Angular Advanced - RxJS Observables

Writing an Observable from scratch – using Angular

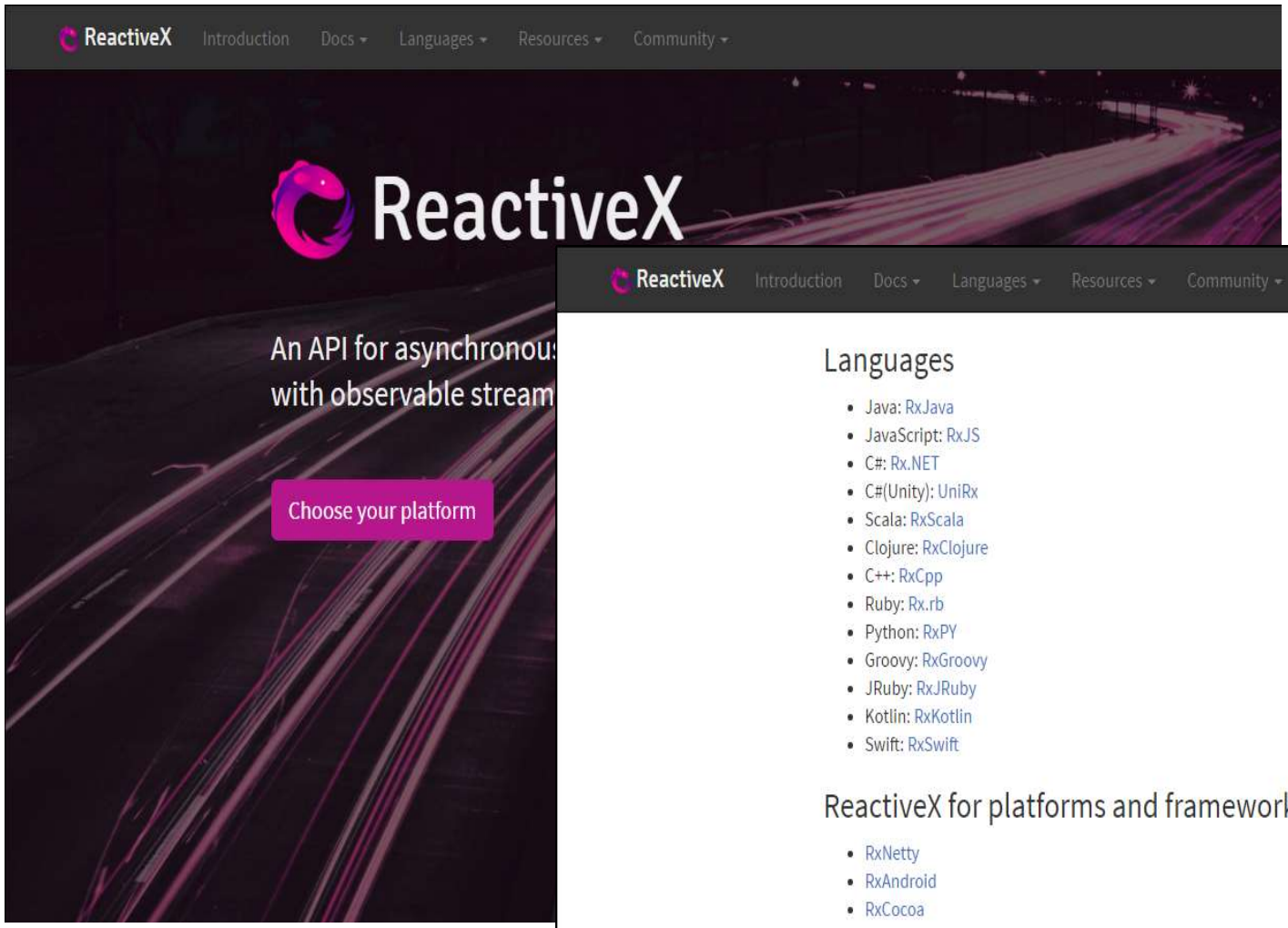
In this module:

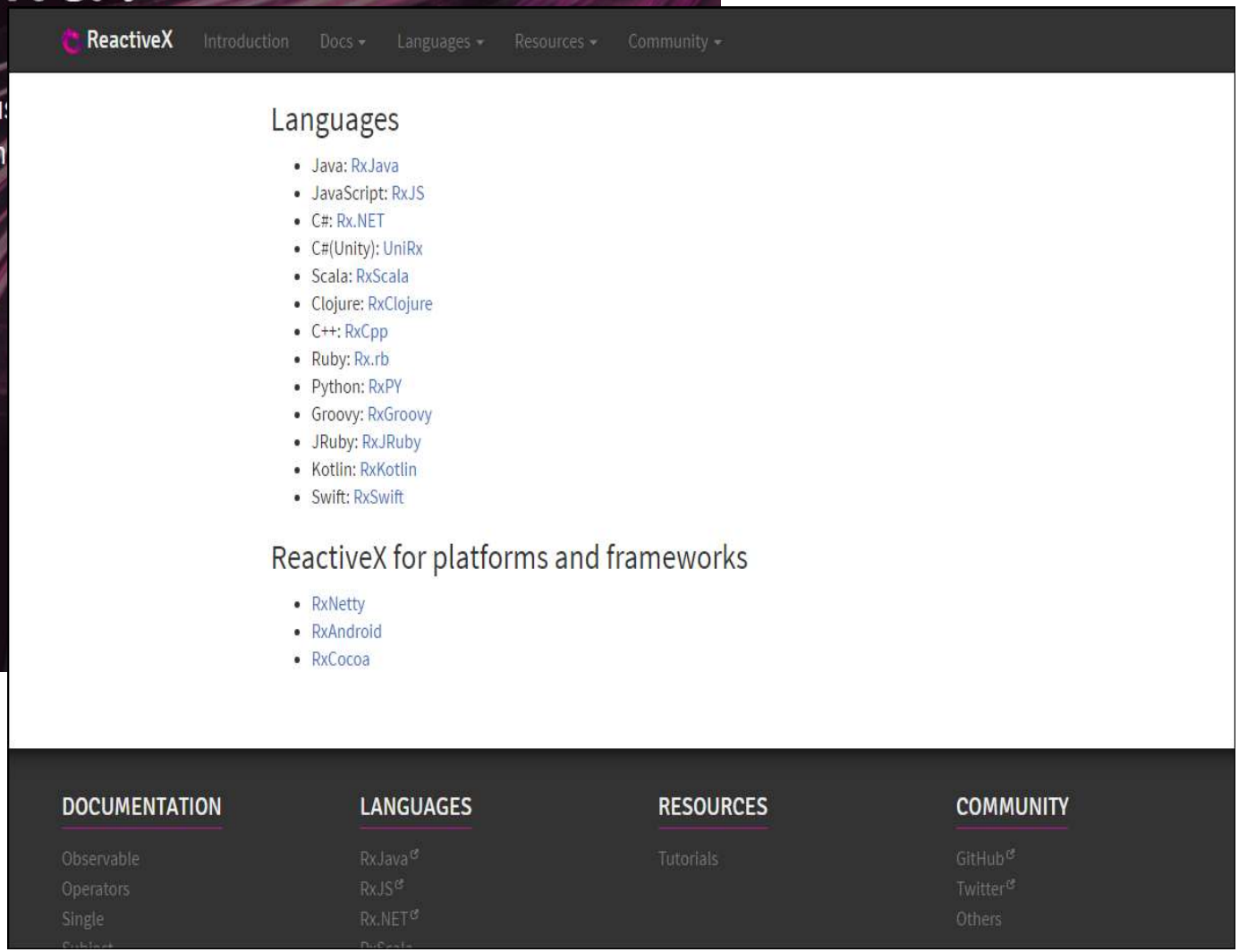
- Introduction to the observable design pattern
- Creating observables from scratch
- Using observables for Http communication
- The async pipe
- Communicating with live API's
- More on RxJS Operators

What is RxJS?

- Lots of actions now work asynchrounous
- Other frameworks – Promises, $.ajax()
- Angular – Observables

"Programming with observable streams"





http://reactivex.io/

Why Observables?

"We can do much more with observables than with promises.

With observables, we have a whole bunch of operators to pull from, which let us customize our streams in nearly any way we want."

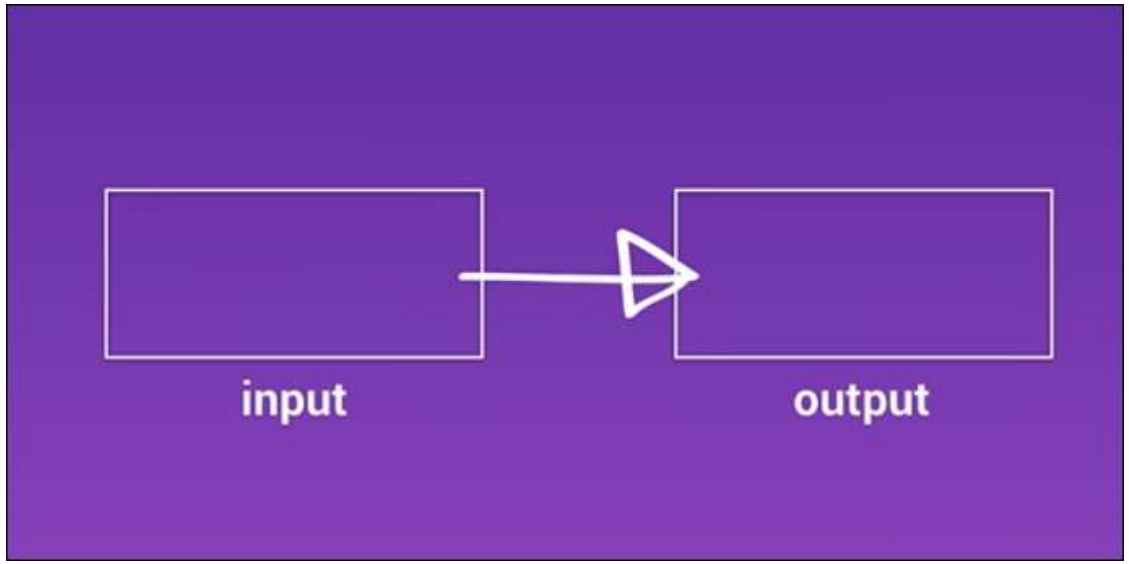
https://auth0.com/blog/2015/10/15/angular-2-series-part-3-using-http/

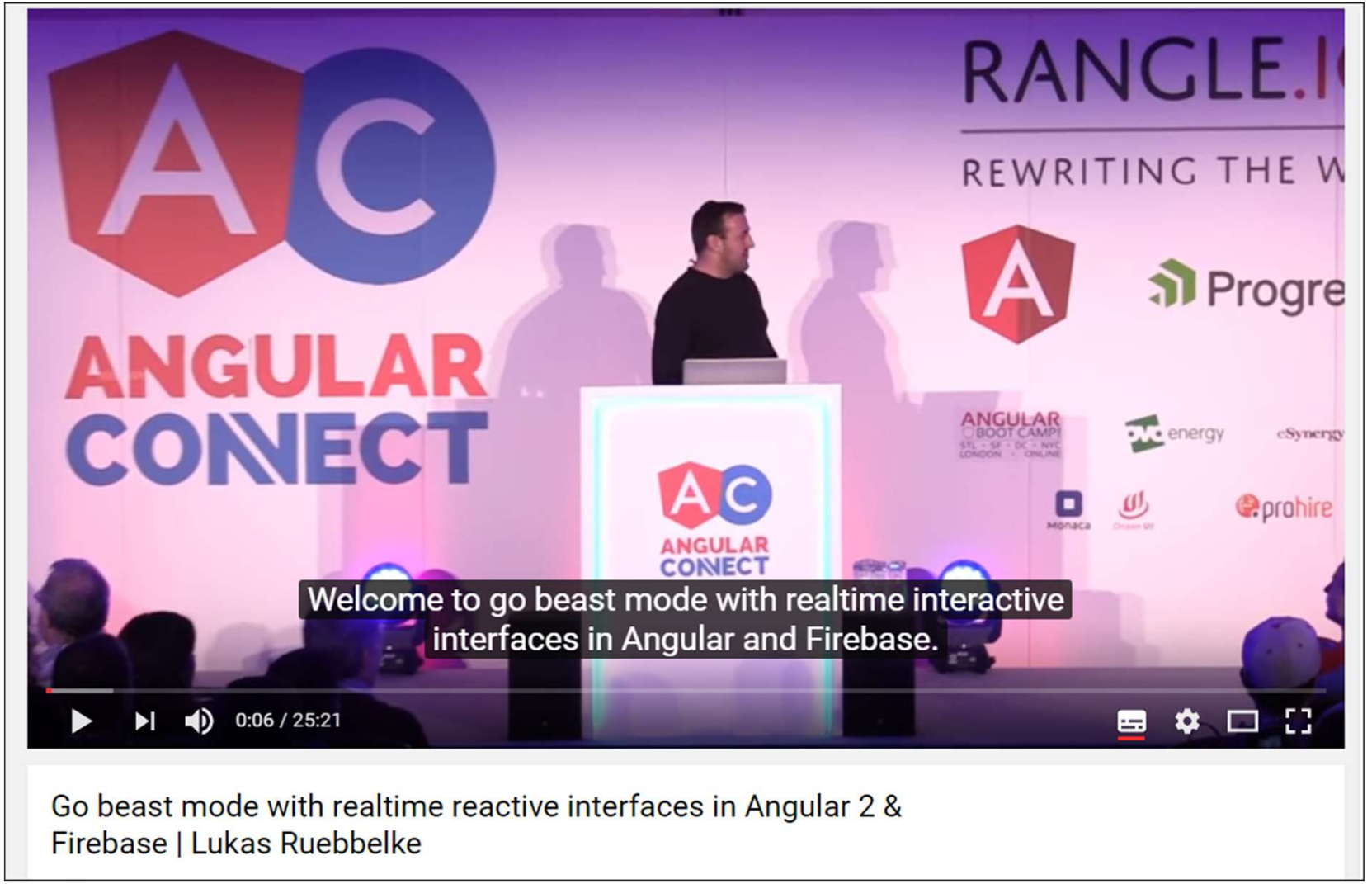
Observables en RxJs

- "Reactive Programming"
  - *"Reactive programming is programming with asynchronous data streams."*
  - https://gist.github.com/staltz/868e7e9bc2a7b8c1f754
- Observables provide extra options, as opposed to Promises
  - Mapping
  - Filtering
  - Combining
  - Cancel
  - Retry
  - …
- Therefore: no more `.success()`, `.error()` and `.then()` chaining!

How do observables work

- First - *The Observable Stream*
- Later - all 10.000 operators…
- Traditionally:

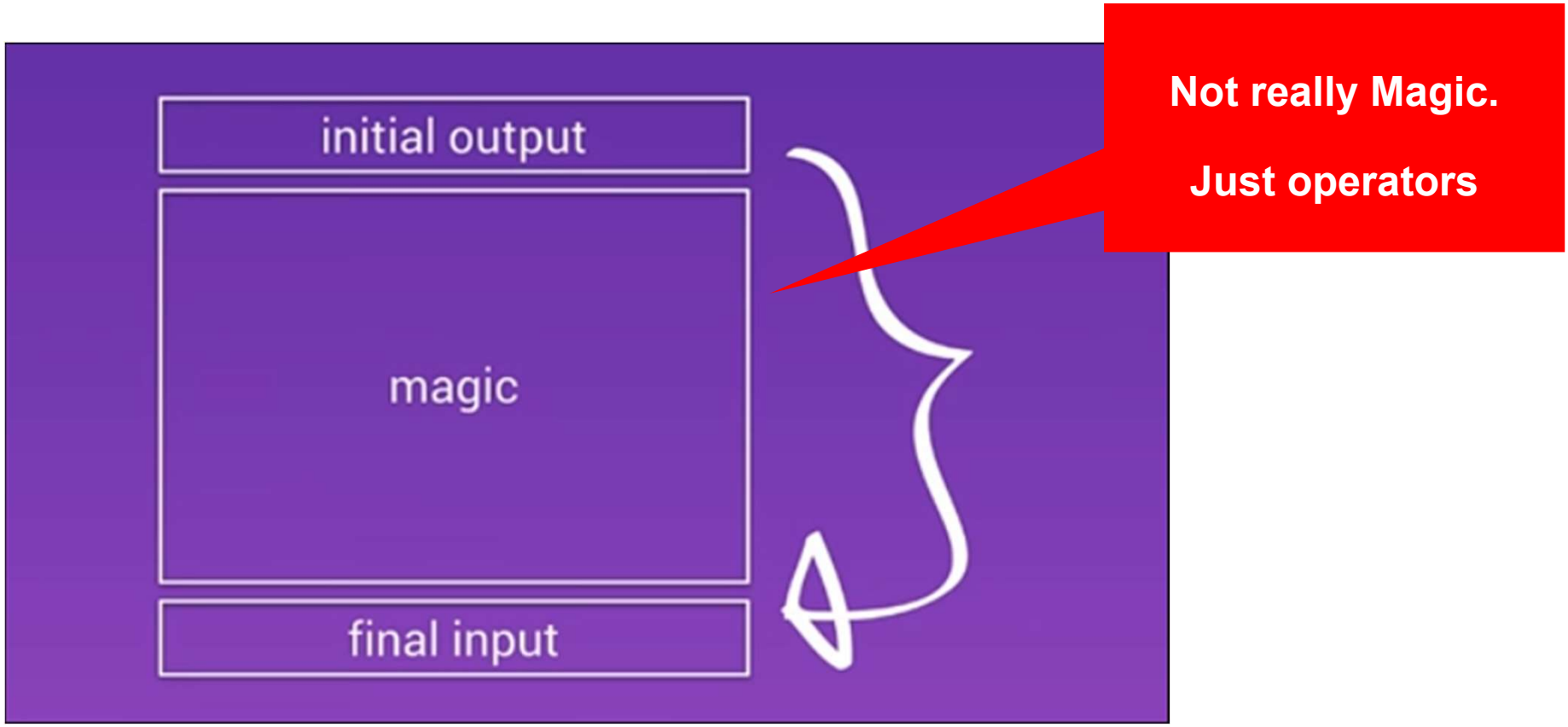




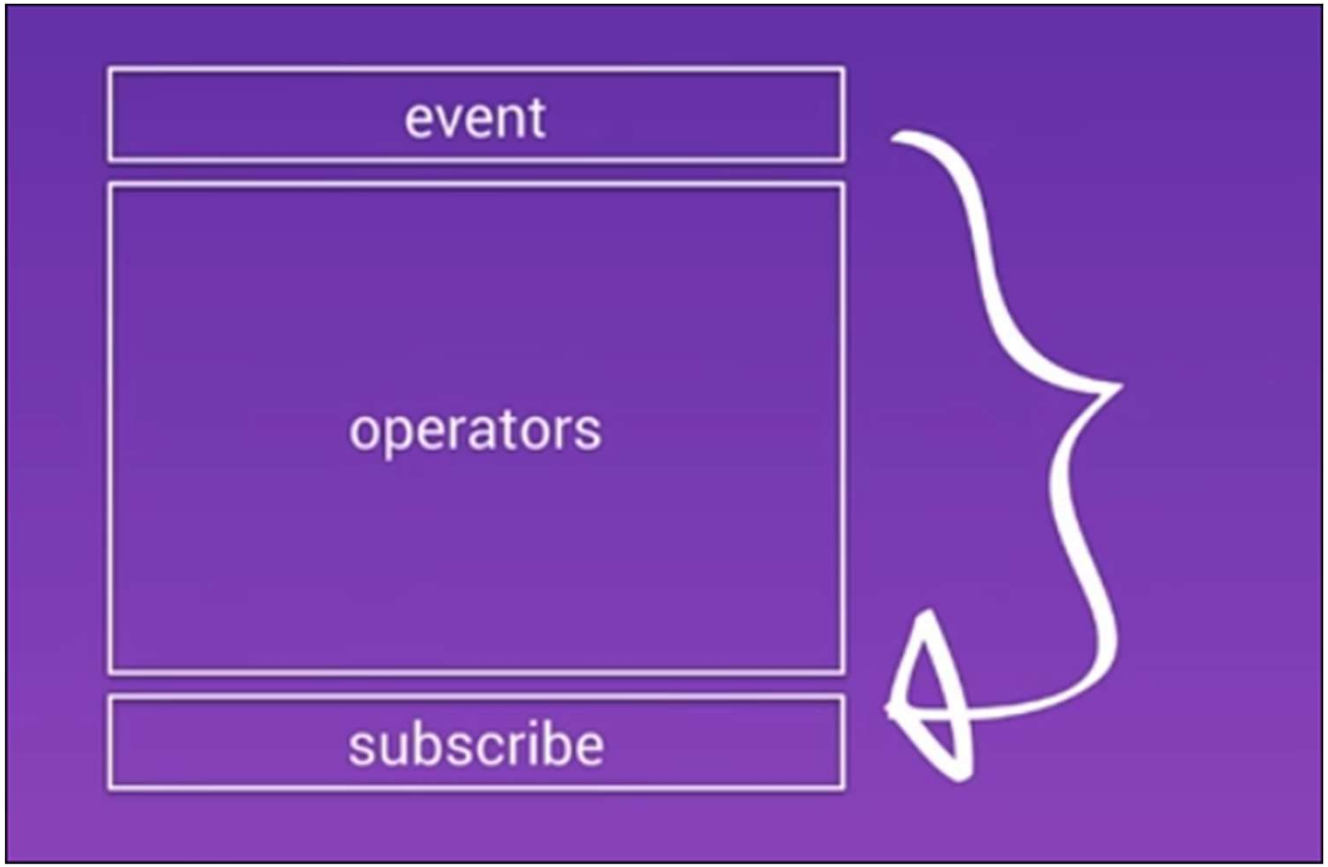
https://www.youtube.com/watch?v=5CTL7aqSvJU

https://youtu.be/5CTL7aqSvJU?t=4m31s

"The observable sandwich"



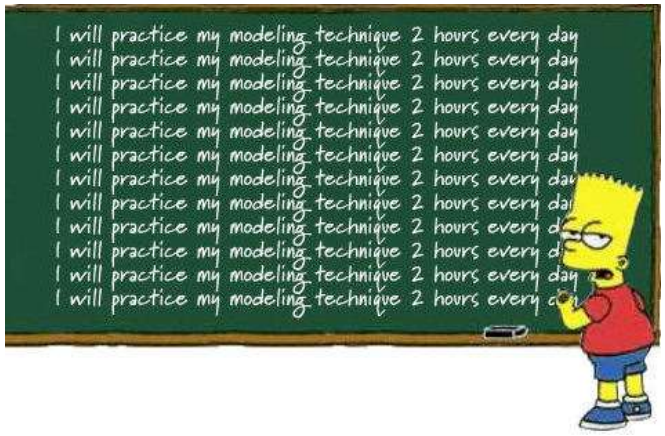
Subscribe to events



Project: ../180-observables-from-scratch

Workshop

- Create your own Angular app
- Give it some UI, add for example a textbox and a button
- Create observables, based on the DOM-elements
  - Tekst that is typed in the textbox is shown in the UI on Enter-press
  - For example – handle button clicks, handle text input
- Subscribe to the observables, updating the UI on changes
- Generic example `../180-observable-from-scratch`.
  - In the \advanced repo

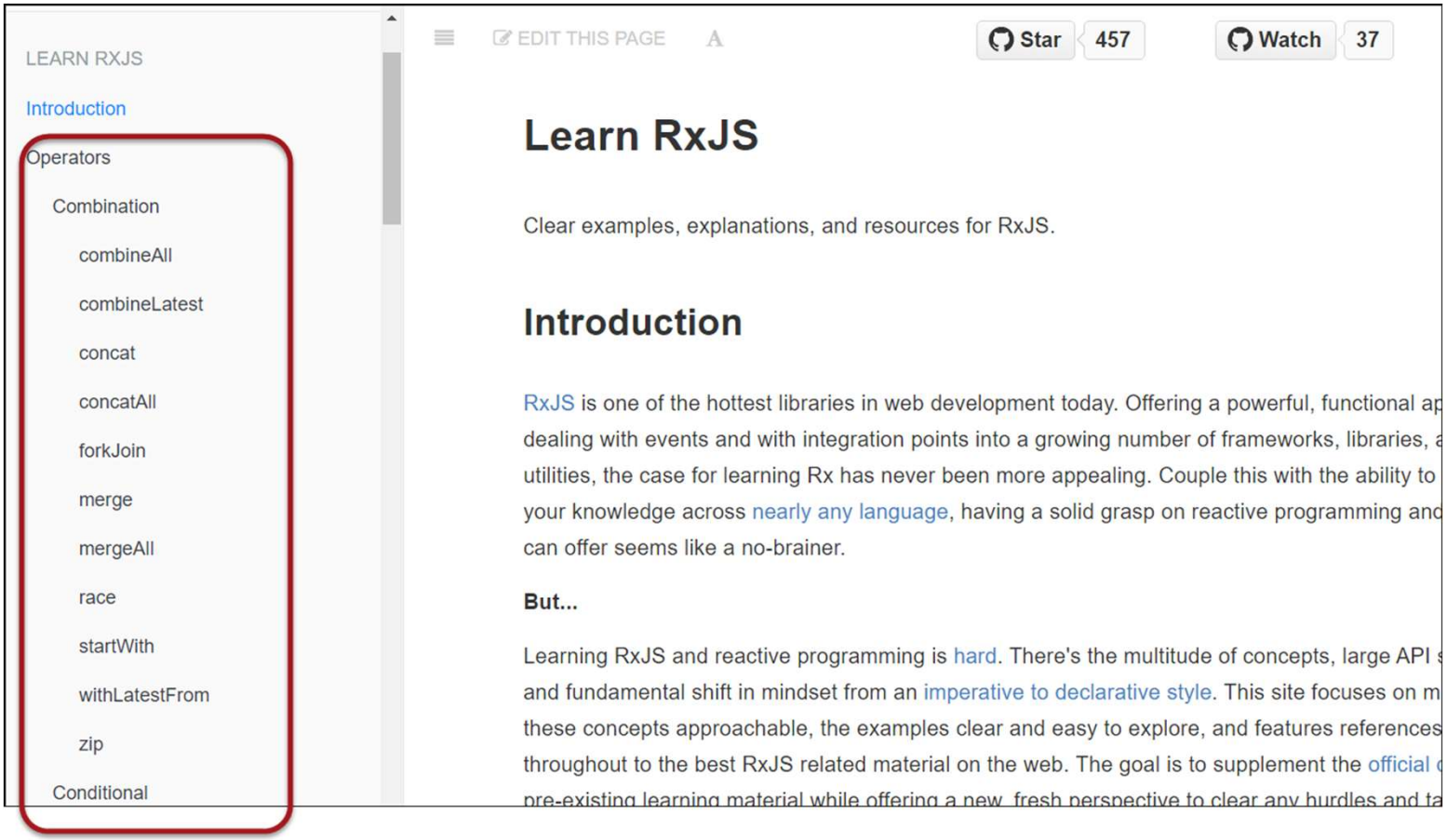


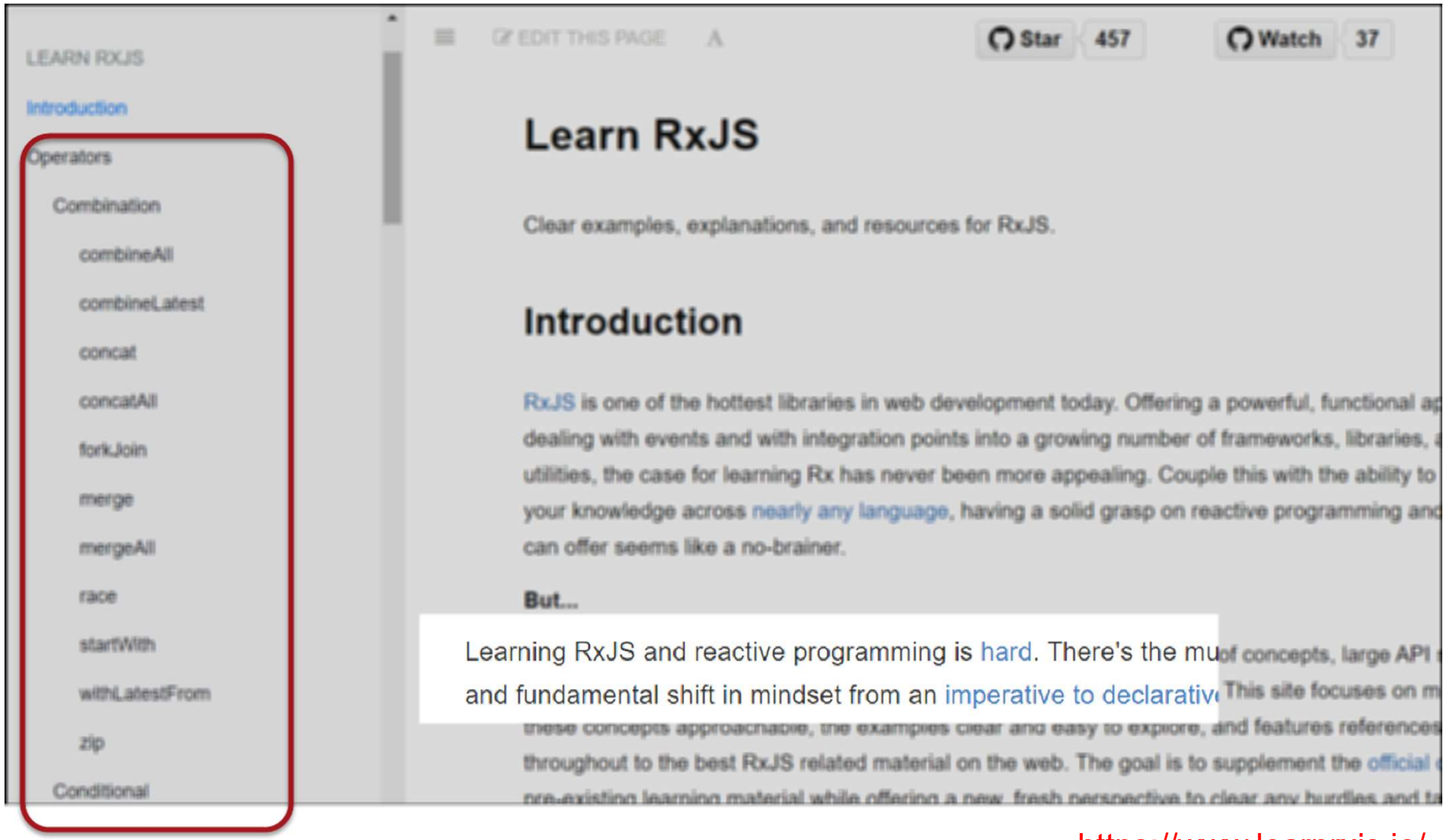
More on operators

Transforming your stream in the `.pipe()` function

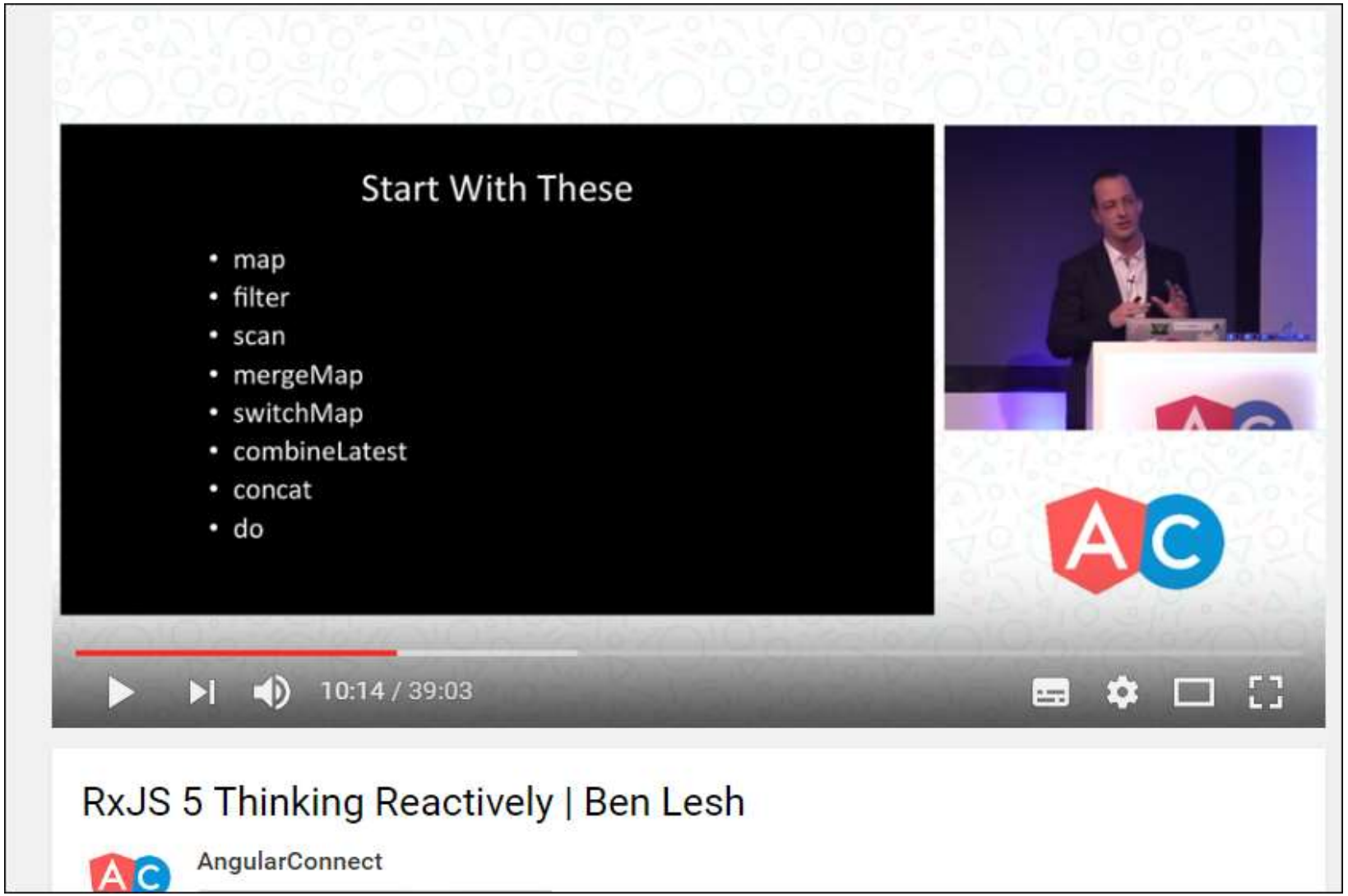
The Problem with RxJS Operators...

- There are so many of them...





https://www.learnrxjs.io/

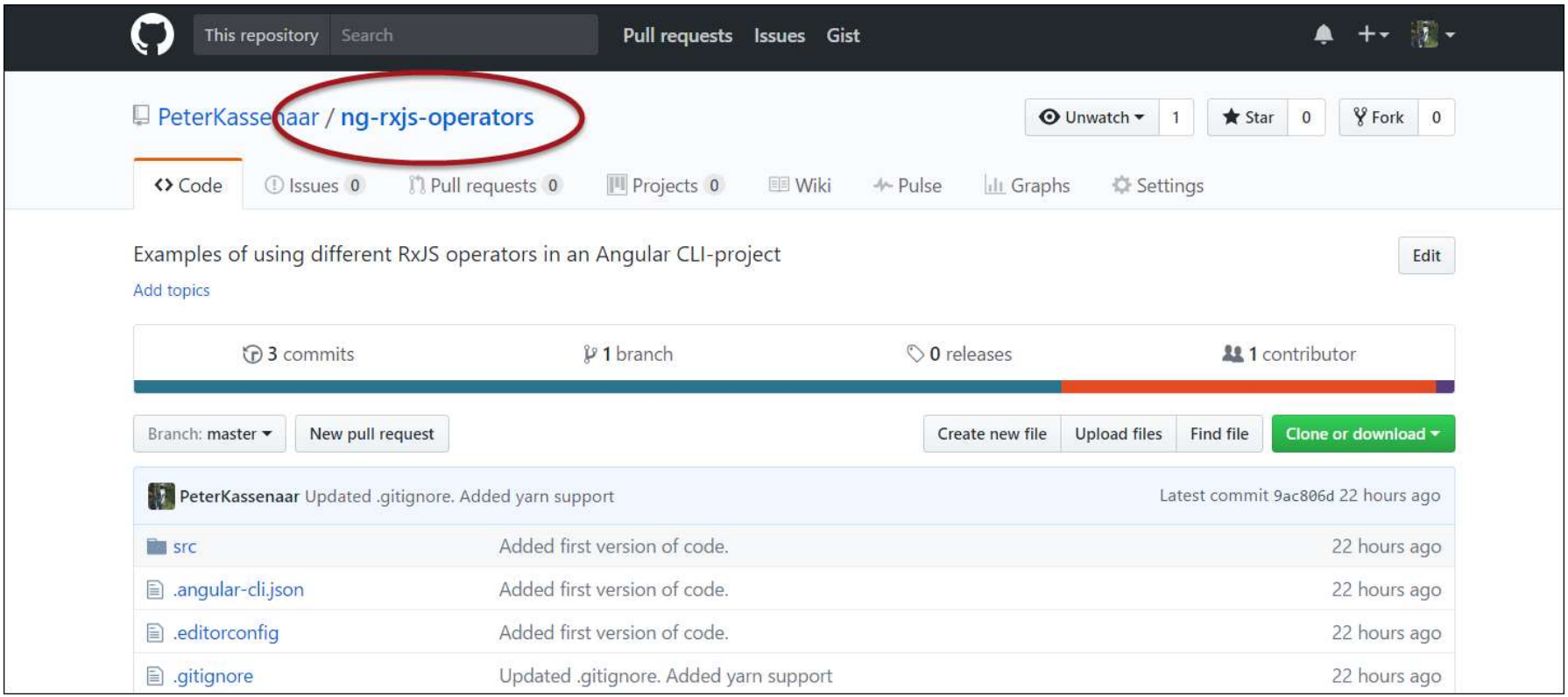


https://www.youtube.com/watch?v=3LKMwkuK0ZE

"Don't try to "Rx everything". Start with the operators you know, and go imperatively from there. There's nothing wrong with that."

- Ben Lesh

Example code



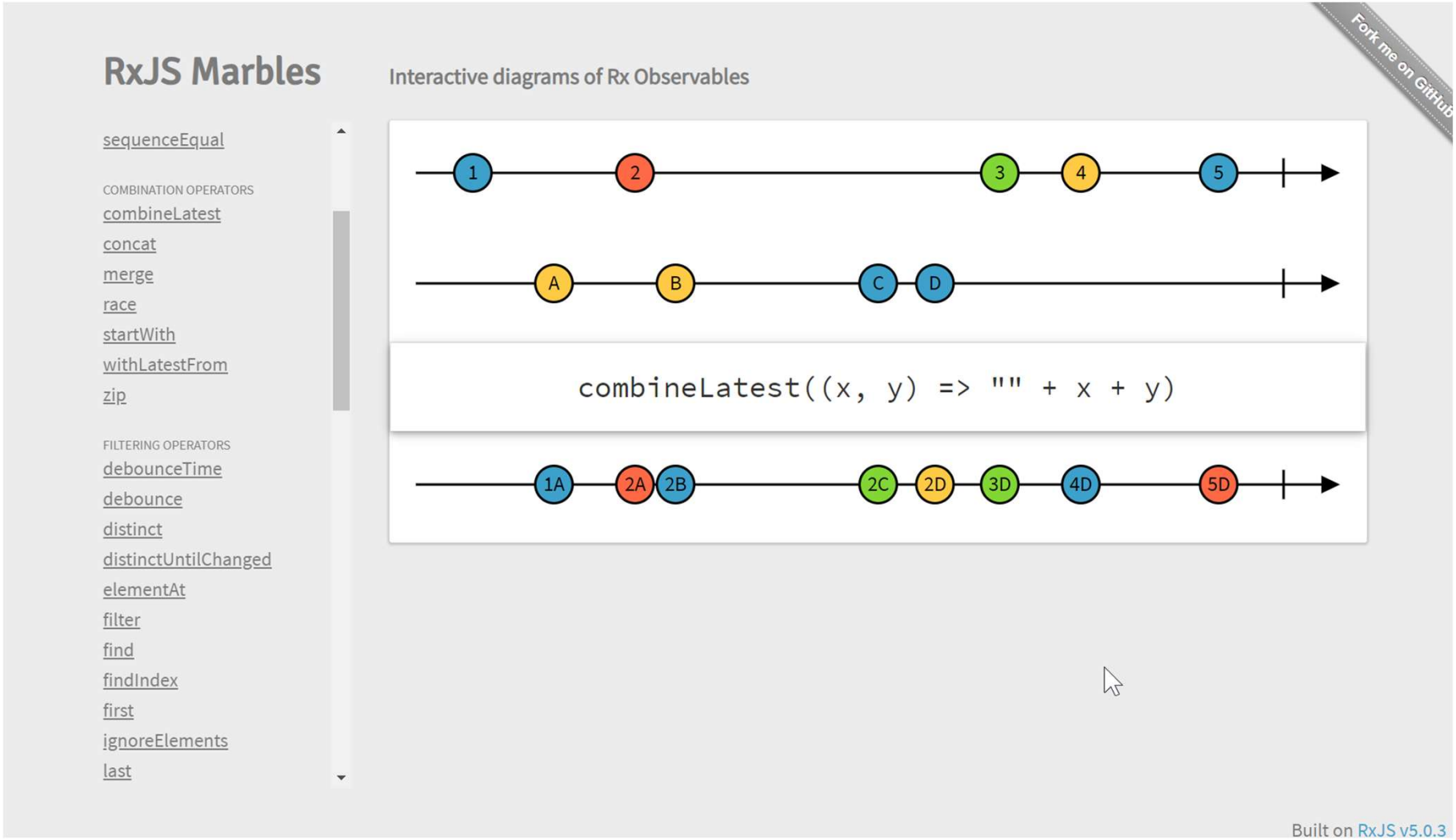
https://github.com/PeterKassenaar/ng-rxjs-operators

This presentation - 2 sections

1. Basic Streams
   - Create a stream, or multiple streams from scratch, based on a UI-element
   - Subscribe to that stream(s) and do something
2. Operators

   Demo the purpose and inner workings of some often used operators

Helpful resource - rxMarbles



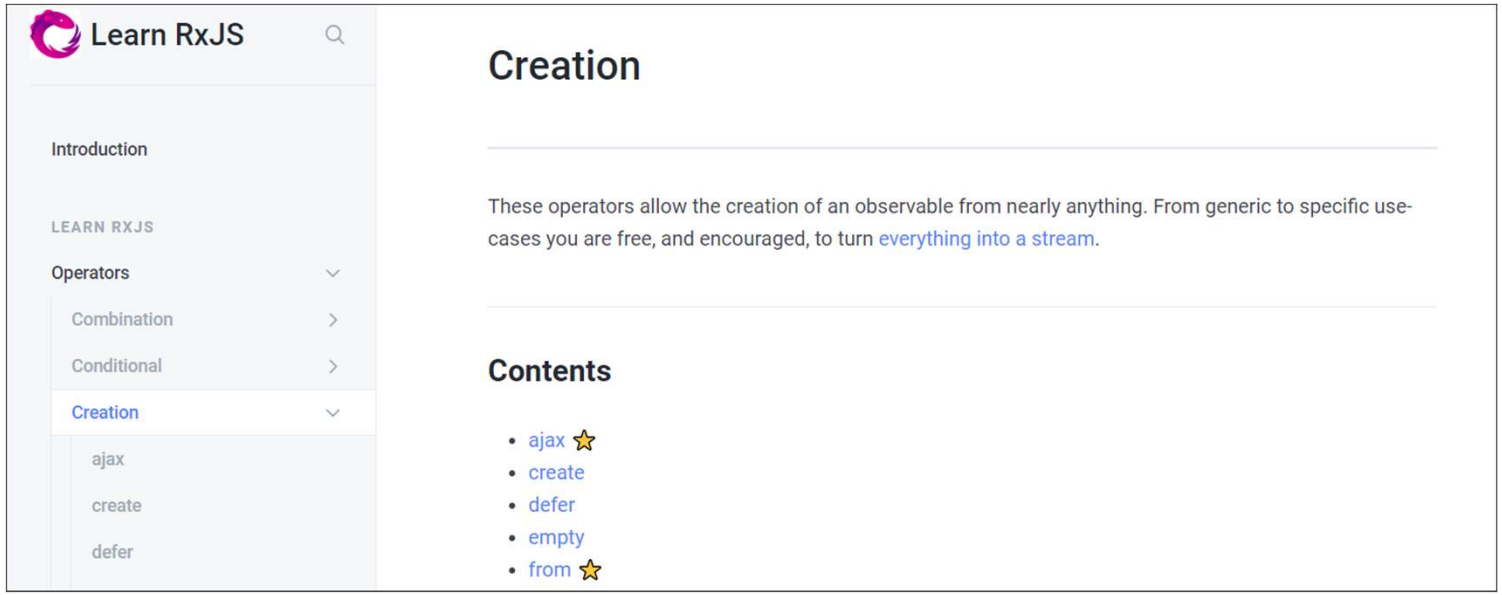
https://rxmarbles.com/

Basic streams

Creating observables from scratch

Turn something into an observable

- Basic creation operators
  - `create ()` – create an observable manually
  - `from()` – turn an array, promise or iterable into an observable
  - `fromEvent()` – turn an event into an observable
  - `of()` – turn a variable into an observable, emit it's value('s) and complete
- https://www.learnrxjs.io/learn-rxjs/operators/creation

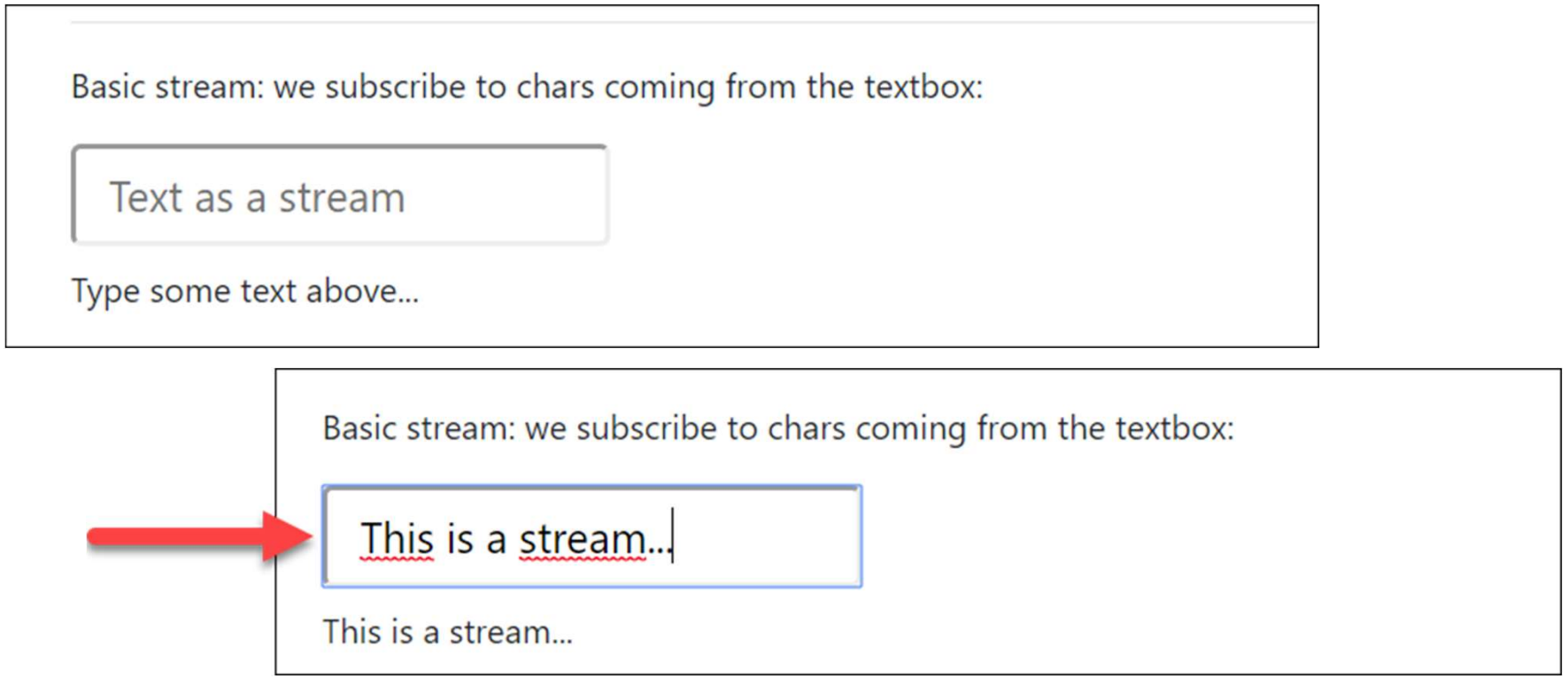


Creating an observable from a textbox

```
<input class="form-control-lg" type="text" #text1
         id="text1" placeholder="Text as a stream">
<p>{{ textStream1 }}</p>
```

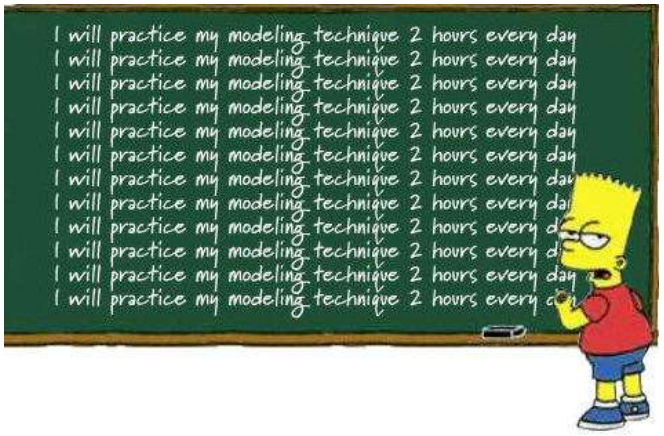
```
textStream1 = 'Type some text above...';
@ViewChild('text1', {static: true}) text1; // two parameters for @ViewChild()

// Suggestion: break the onInit() up in smaller functions
ngOnInit(): void {
  this.onTextStream1();
}

onTextStream1() {
  fromEvent(this.text1.nativeElement, 'keyup')
    .subscribe((event: any) => this.textStream1 = event.target.value);
}
```

Result


Basic stream: we subscribe to chars coming from the textbox:
Text as a stream
Type some text above...
Basic stream: we subscribe to chars coming from the textbox:
This is a stream...
This is a stream...

Workshop

- Create a textbox.
  - Add items that are typed in, to a Todo-list
  - Use an observable to subscribe to keyup-events.
- Capture key events, test if the key pressed is the Enter-key
  - If it's Enter, Add the current value of the textbox to a static array `todoItems[]`
- Example `../basic-stream/basic-stream.component.ts`
  - Start from scratch or expand this component



Using the pipe()

- We can transform the stream by adding operators to the pipeline
- Inside the pipeline we calculate new values and bind them to the UI, using generic attribute binding […]

```
<button #btnRight class="btn btn-secondary">Right</button>
Mario is moved by observable streams from the button click.
<div>
  <img id="mario" #mario
       [style.left]="position.x + 'px'"
       [style.right]="position.y + 'px'"
       src="../assets/img/mario-1.png" alt="Mario">
</div>
```

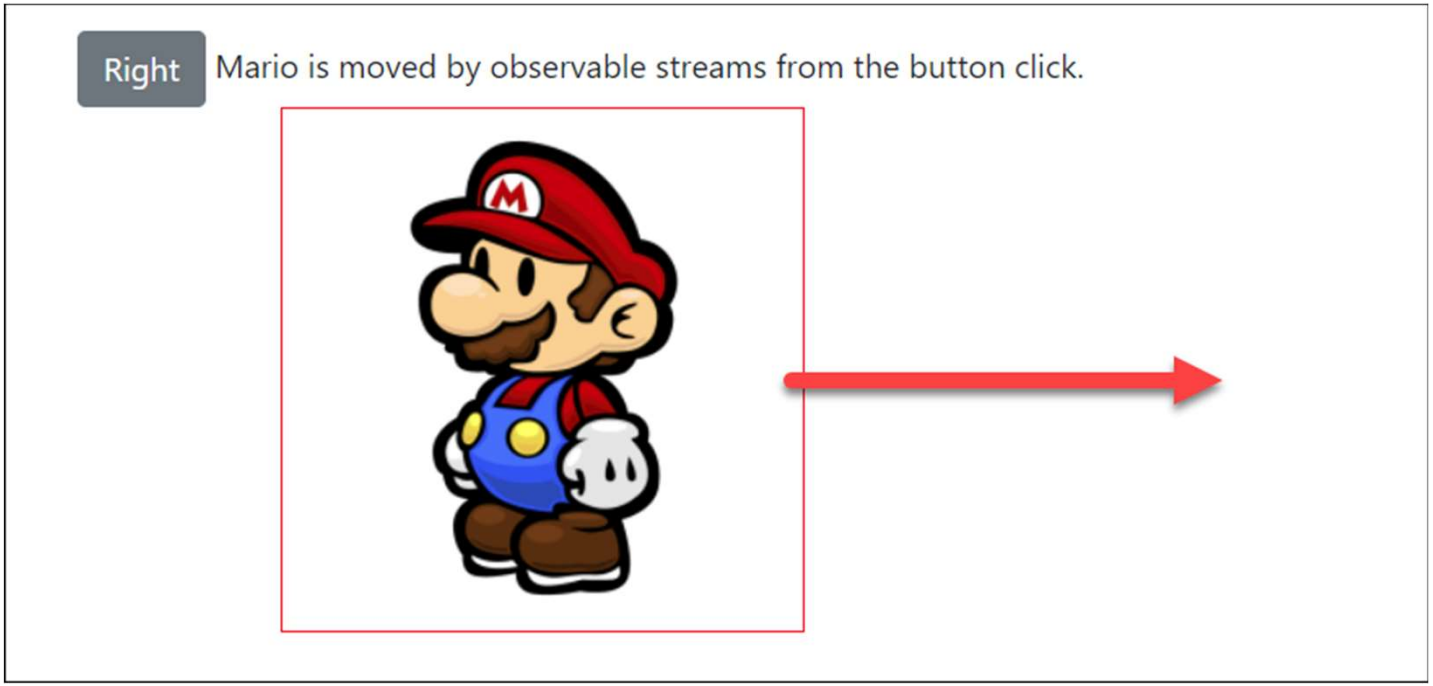
Inside our class

```
// mario
position: any;
@ViewChild('btnRight', {static: true}) btnRight;
```

```
fromEvent(this.btnRight.nativeElement, 'click')
  .pipe(
    map(event => 10), // 1. map the event to a useful value, in this case 10px
    startWith({x: 100, y: 100}), // 2. start with an object of { 100, 100}.
    scan((acc: any, current: number) => { // 3, use the scan operator as reducer function.
      return {
        x: acc.x + current,
        y: acc.y
      };
    })
  )
  .subscribe(result => {
    this.position = result;
  });
```

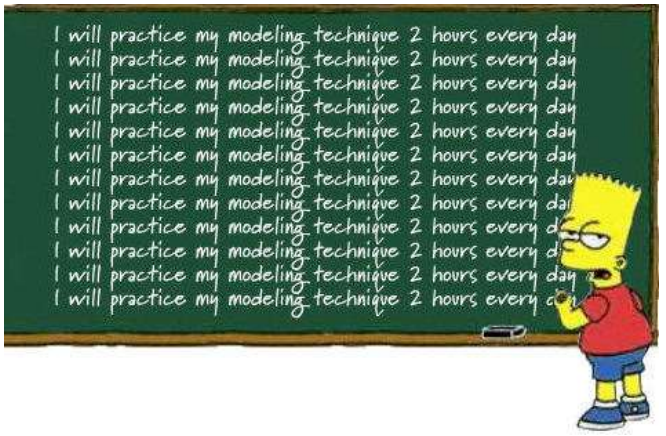
The result of the previous operator is the input of the next operator in the pipeline

Result


Right
Mario is moved by observable streams from the button click.

Workshop

- Create button that moves Mario to the left.
- Example `../basic-stream/basic-stream.component.ts`
  - Start from scratch or expand this component

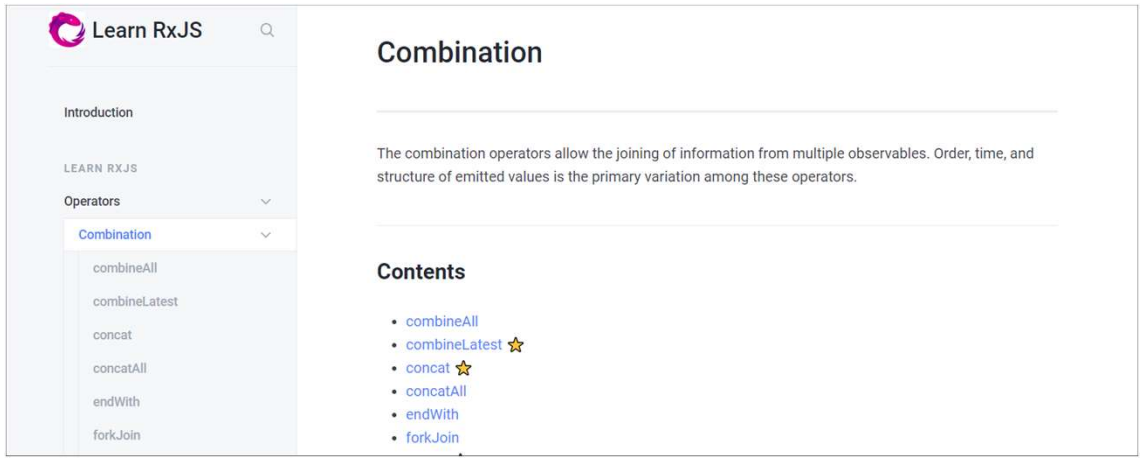


Combining streams

There are **a *lot*** of options to combine multiple streams into one stream

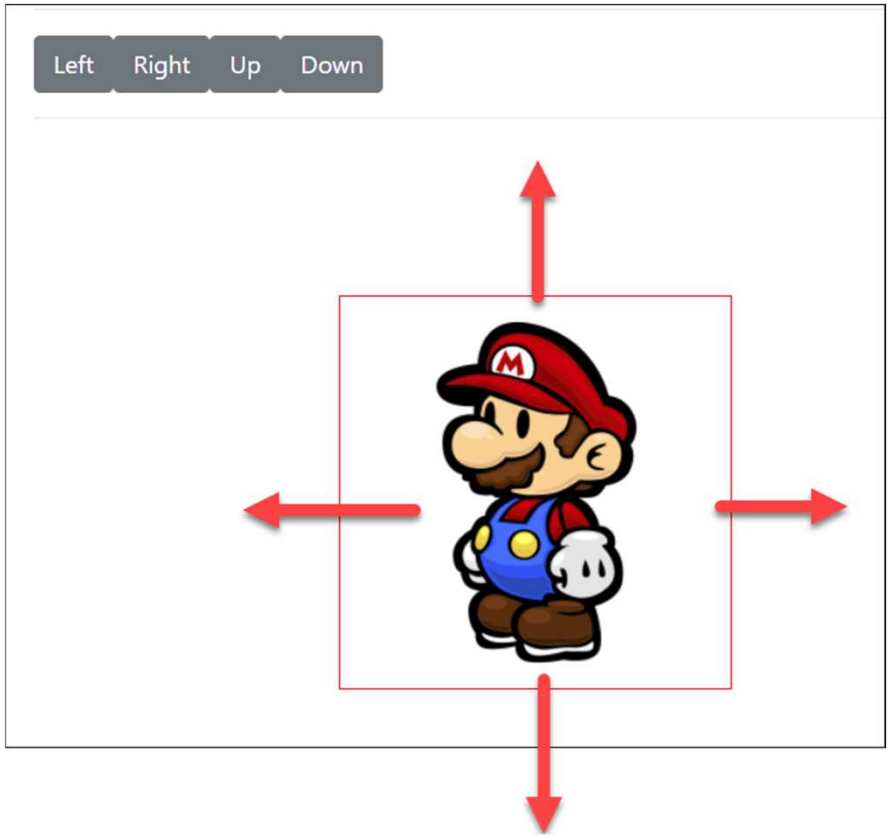
Options for combining streams

- `combineLatest()` - When any observable emits a value, emit the last emitted value from each
- `concat()` - Subscribe to observables in order as previous completes
- `forkJoin()` - When all observables complete, emit the last emitted value from each
- `merge()` - Turn multiple observables into a single observable
- `startWith()` - Emit given value first
- https://www.learnrxjs.io/learn-rxjs/operators/combination



Use case: move Mario

- Create four buttons to move Mario in different directions
  - all combined in one stream and one subscription



Template

```
<button #btnLeft> Left </button>
<button #btnRight> Right </button>
<button #btnUp> Up </button>
<button #btnDown> Down </button>
<hr>

<img id="mario" #mario
     [style.left]="position.x + 'px'"
     [style.top]="position.y + 'px'"
     src="../assets/img/mario-1.png" alt="Mario">
```

```
position: any;
@ViewChild('btnLeft', {static: true}) btnLeft;
@ViewChild('btnRight', {static: true}) btnRight;
@ViewChild('btnUp', {static: true}) btnUp;
@ViewChild('btnDown', {static: true}) btnDown;

ngOnInit(): void {
  // Create multiple streams
  const right$ = fromEvent(this.btnRight.nativeElement, 'click')
    .pipe(
      map(event => {
        return {direction: 'horizontal', value: 10};
      }) // 10 px to the right
    );
  const left$ = fromEvent(this.btnLeft.nativeElement, 'click')
    .pipe(
      map(event => {
        return {direction: 'horizontal', value: -10};
      }) // -10 px to the left
    );
  …
  // combine our streams
  merge(right$, left$, up$, down$)
   .pipe(
    startWith({x: 200, y: 100}),
    scan((acc: any, current: any) => {
    return {
        x: acc.x + (current.direction === 'horizontal' ? current.value : 0),
        y: acc.y + (current.direction === 'vertical' ? current.value : 0)
      };
    })
  ).subscribe(result => {
    this.position = result;
  });
```

Create 4 different streams

Merge the streams

One subscriber

Sequencing streams

Use streams to start other streams so you can use the combined behavior

Use case: drag & drop

- We want to move Mario around with the mouse: drag-n-drop
- We compose different streams for that:
  - `down$`, when the mouse is pressed
  - `move$`, when the mouse is moved, return the current mouse position
  - `up$`, when the mouse is released
- Again, we have only one (1) subscription
  - Subscribe to the `down$`. This is the initiator
  - After the initial event, switch to the `move$`: using the `switchMap()` operator
  - But only until the `up$` event occurs!
  - Then complete the observable an release Mario
- This translates to the following code:

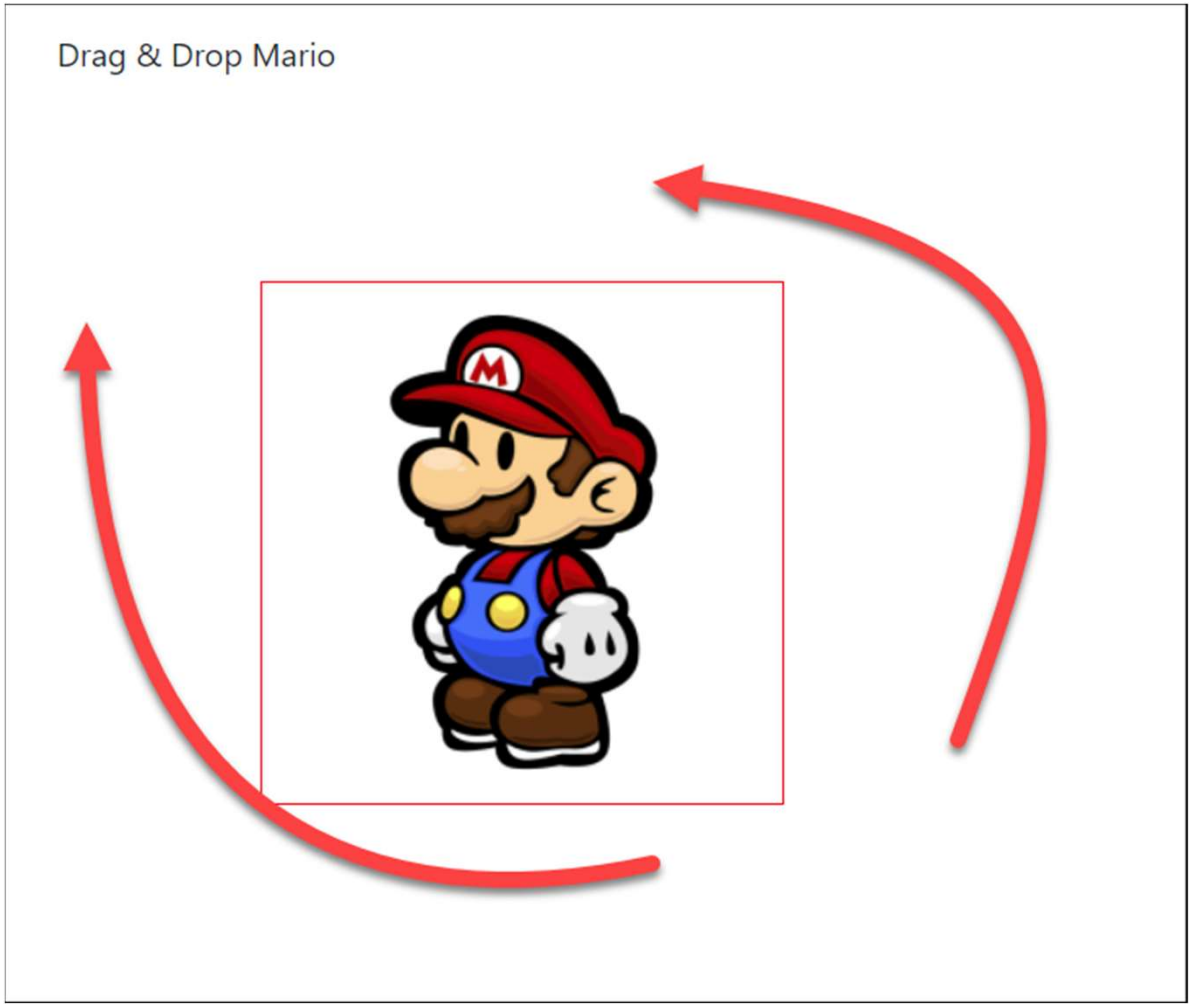
```
// correction factor for image and current page. Your mileage may vary!
  const OFFSET_X = 180;
  const OFFSET_Y = 280;

  // 1. With Drag and drop, first you capture the mousedown event
  const down$ = fromEvent(document, 'mousedown');

  // 2. What to do when the mouse moves
  const move$ = fromEvent(document, 'mousemove')
    .pipe(
      map((event: any) => {
        return {x: event.pageX - OFFSET_X, y: event.pageY - OFFSET_Y}; // OFFSET as correction factor
      })
    );

  // 3. Capture the mouseup event
  const up$ = fromEvent(document, 'mouseup');

  // 4. extend the down$ stream and subscribe
  down$
    .pipe(
      // IF the down$-event happens, we ar no longer interested in it. Instead,
      // we switch the focus to the move$ event.
      // BUT: we are only interested in the move until the mouse is released again.
      // So we add *another* pipe and use the takeUntil() operator.
      switchMap(event => move$.pipe(
        takeUntil(up$)
      )),
      startWith(this.position)
    )
    .subscribe(result => this.position = result);
}
```

Compose streams

Switch execution to another observable

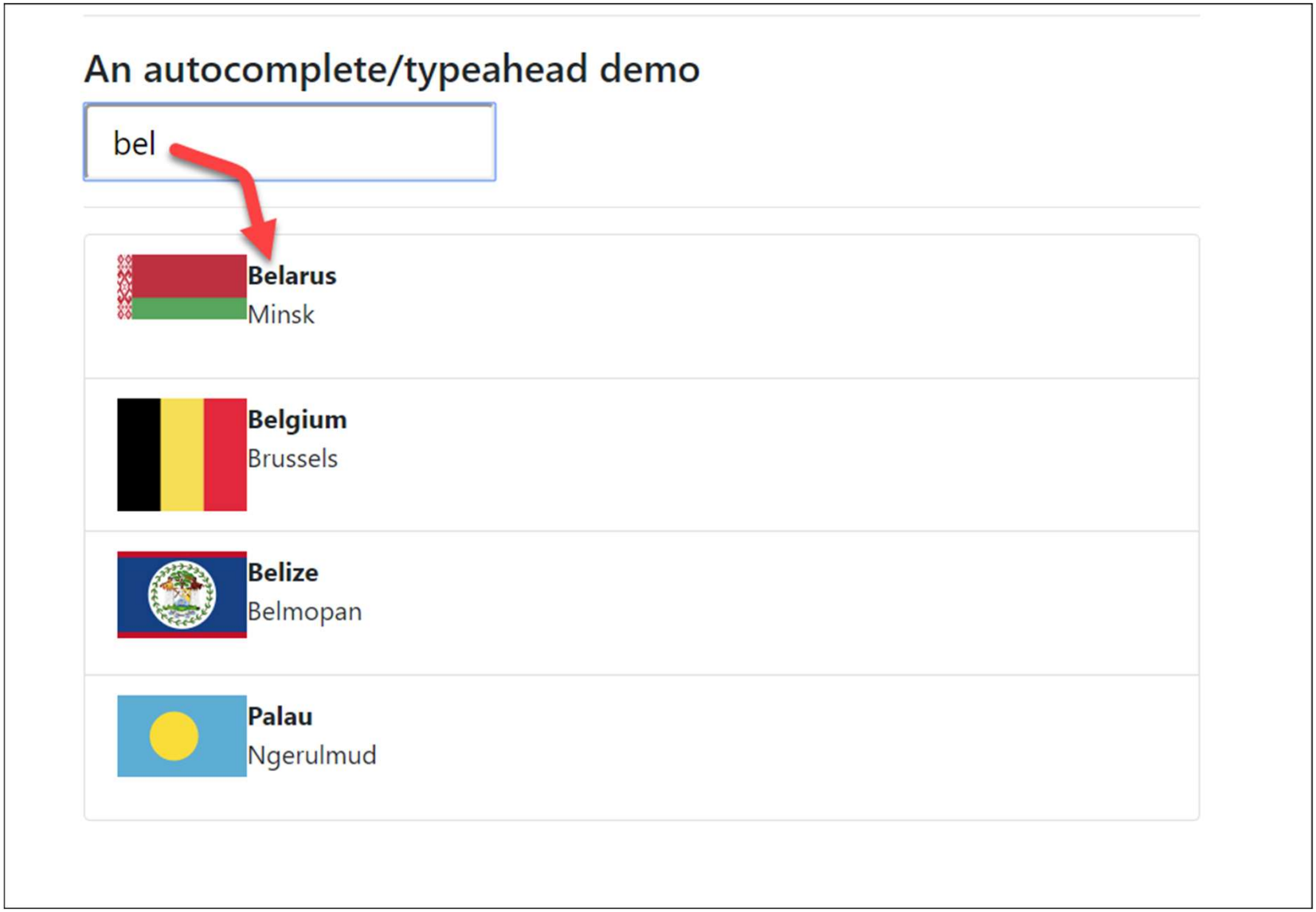
Subscribe and update position

Result



`../streams/drag-drop-stream.component.html|ts`

An autocomplete/typeahead demo



Template

As per usual – little HTML

```
<h4>An autocomplete/typeahead demo</h4>
<!--Get the keyword, the class is subscribed to this inputbox-->
<input type="text" placeholder="Country name..."
       #typeahead class="form-control-lg">
<hr/>
<!--Results-->
<ul class="list-group">
  <li class="list-group-item" *ngFor="let country of countries$ | async ">
    <img src="{{ country.flag }}" alt="" width="80" style="float: left">
    <p>
      <strong>{{ country.name}}</strong><br>
      {{ country.capital }}
    </p>
  </li>
</ul>
```

This time: using the `async` pipe

Code

```
interface ICountry {
  name: string;
  capital: string;
  flag: string;
}

const errorCountry: ICountry = {
  name: 'Error',
  capital: 'Not found',
  flag: ''
};
```

Creating interface and simple error message

```
@ViewChild('typeahead', {static: true}) typeahead;
countries$: Observable<ICountry[]>;

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

Inside the component class

```
ngOnInit(): void {
  this.countries$ = fromEvent(this.typeahead.nativeElement, 'keyup')
    .pipe(
      filter((e: any) => e.target.value.length >= 2),
      debounceTime(400),
      map((e: any) => e.target.value),
      distinctUntilChanged(),
      switchMap(keyword => this.getCountries(keyword))
    );
}
```

Main method. See example code for comments

../streams/typeahead-stream.component.html|ts

Fetching the countries

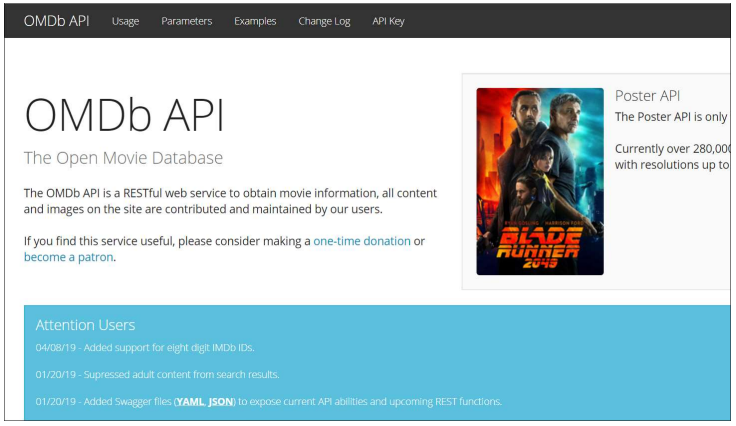
```
getCountries(keyword): Observable<ICountry[]> {
  // 7. Create the actual http-call.
   return this.http
    .get<ICountry[]>(`https://restcountries.eu/rest/v2/name/${keyword}?fields=name;capital;flag`)
    .pipe(
      // 8. catch http-errors and return a 'not found' country
      catchError(err => {
        console.log(err);
        return of([errorCountry]);
      })
    );
}
```

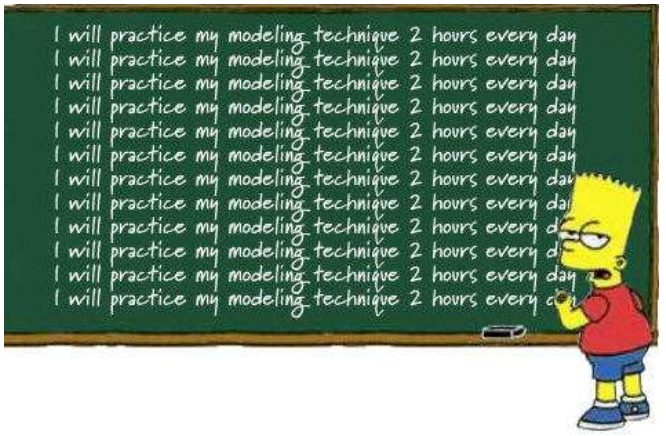
Documentation:

- filter: https://www.learnrxjs.io/learn-rxjs/operators/filtering/filter
- debounceTime: https://www.learnrxjs.io/learn-rxjs/operators/filtering/debouncetime
- distinctUntilChanged: https://www.learnrxjs.io/learn-rxjs/operators/filtering/distinctuntilchanged
- switchMap: https://www.learnrxjs.io/learn-rxjs/operators/transformation/switchmap
- catchError: https://www.learnrxjs.io/learn-rxjs/operators/error_handling/catch

Workshop

- Search movies in the Open Movie Database.
  - `https://www.omdbapi.com/?apikey=f1f56c8e&s=[keyword]`
  - Create an AutoComplete inputfield for movie titels.
  - For instance, if you type `'ava…'` it should show movies like `Avatar`, and more
- Example `../basic-stream/typeahead.component.ts`
  - Start from scratch or expand this component





More operators

Getting familiar with some of the more used operators

map() and mapTo()

```
const source = from([1, 2, 3, 4, 5, 6, 7, 8, 9, 10]);

// .map() - apply a function every emitted output.
source.pipe(
  map((val: number) => val = val * 10)
)
  .subscribe(result => this.mapData.push(result));


// .mapTo() - map the emission to a constant value
source.pipe(
  mapTo('Hello World')
)

  .subscribe(result => this.mapToData.push(result));
```

https://rxjs-dev.firebaseapp.com/api/operators/map

filter()

```
const source       = Observable.from([1, 2, 3, 4, 5, 6, 7, 8, 9, 10]);
const sourceCities = Observable.from([
   'Haarlem',
   'Breda',
   'Amsterdam',
   'Groningen',
   'Hengelo',
   …
]);
```

```
// filter() - only emit values that pass the provided condition.
// In this case: only even numbers are passed through.
source.pipe(
  filter(val => val % 2 === 0)
)
  .subscribe(result => this.filterData.push(result));

// Emit only the cities that starts with an 'H'.
sourceCities.pipe(filter(city => city.startsWith('H')))
  .subscribe(result => this.cityData.push(result));
```

https://rxjs-dev.firebaseapp.com/api/operators/filter

scan()

```
const source        = Observable.from([1, 2, 3, 4, 5, 6, 7, 8, 9, 10]);
```

```
// .scan() acts as the classic .reduce() function on array's. It takes an
// accumulator and the current value. The accumulator is persisted over time.
source
  .pipe(
    startWith(0),
    scan((acc, curr) => acc + curr)
  )
  .subscribe(result => this.scanData.push(result));
```

https://rxjs-dev.firebaseapp.com/api/operators/scan

concat()

- Concat subscribes to observables *in order*.
- “Only when the first one completes, let me know.”
- Then move on to the next one.

- Use `concat()` when the order of your observables matters.

- Example code: simulated delay.
  - The second observable (which is finished first) only emits when the first observable completes.

app/shared/services/data.service.ts

```
// constants that are used as pointers to some json-data
const BOOKS: string   = 'assets/data/books.json';
const AUTHORS: string = 'assets/data/authors.json';
```

```
getConcatData(): Observable<any> {
  // First call. Simulate delay of 1 second
  const authors = this.http.get(AUTHORS)
    .pipe(
      delay(2000)
    );
  // Second call. Simulate delay of 2 seconds
  const books = this.http.get(BOOKS)
    .pipe(
      delay(1000)
    );

  // return the concatenated observable. It will always deliver
  // FIRST the results of the first call. No matter how long the delay.
  return concat(authors, books);
}
```

https://rxjs-dev.firebaseapp.com/api/operators/concat

merge()

- Merge combines multiple observables into one single observable.

- It emits *as soon as* it gets a result.

- Use `merge()` when order of observables is not important.

```
getMergeData(): Observable<any> {
  // First call. Simulate delay of 3 seconds, so this observable will emit last.
  const authors = this.http.get(AUTHORS)
    .pipe(
      delay(3000)
    );


  // Second call. Simulate delay of 1 seconds, so this observable will emit first.
  const books = this.http.get(BOOKS)
    .pipe(
      delay(1000)
    );


  // return the merged observable. BOOKS will be delivered first
  return merge(authors, books);
}
```

https://rxjs-dev.firebaseapp.com/api/index/function/merge

mergeMap()

- Merges the value of an inner observable into an outer observable.
- Need only the *last* value emitted? Use `.switchMap()`.
- Use this for example to retrieve results in a second observable, based on the output of a first observable

```
getMergeMapData(authorID: number = 0): Observable<any> {
  // first http-call, outer observable.
  return this.http.get(AUTHORS)
    .pipe(
      tap(response => console.log(response)),
      map((authors: any[]) => {
        console.log(authors);
        // find the correct author, using the array .find() method
        return authors.find((author: any) => author.id === authorID);
      }),
      mergeMap((author: any) => {
        if (author) {
          // second http-call, inner observable
          return this.http.get(BOOKS)
            .pipe(map((books: any[]) => {
              // filter books, bases on authorname we found earlier.
              return books.filter((book: any) => book.author === author.name);
            }));
        } else {
          // nothing found. Return empty array
          return of([]);
        }
      })
    );
}
```

https://rxjs-dev.firebaseapp.com/api/operators/mergeMap

.forkJoin()

- Make multiple (http) requests and return one combined response *once all observables are completed*.

- `.forkJoin()` returns an array with the last emitted value from each observable.

- Compose results as per your needs

`forkJoin()` **vs** `combineLatest()`

In general, they are pretty similar:

`forkJoin()`

When all observables complete, emit the last emitted value from each.

`combineLatest` *( )*

When any observable emits a value, emit the latest value from each.

"Not only does `forkJoin` require all input observables to be completed, but it also returns an observable that produces a single value that is an array of the last values produced by the input observables. In other words, it waits until the last input observable completes, and then produces a single value and completes."

…which means you don't have to unsubscribe from a `forkjoin()`

In contrast, `combineLatest` returns an Observable that produces a new value every time the input observables do, once all input observables have produced at least one value. This means it could have infinite values and may not complete. It also means that the input observables don't have to complete before producing a value"

…which means you have to unsubscribe from `combineLatest()`

https://stackoverflow.com/questions/41797439/rxjs-observable-combinelatest-vs-observable-forkjoin

```
getForkJoinData(): Observable<any> {
  return forkJoin(
    // first call
    this.http.get(AUTHORS)
      .pipe(
        delay(3000)
      ),
    // second call
    this.http.get(BOOKS)
  )
    .pipe(
      map((data: any[]) => {
        // data is now an array with 2 objects, b/c we did 2 http-calls.
        // First result, from the http-call to AUTHORS
        const author: any = data[0][0]; // Get just first author from file.
        // Second result, from the http-call to BOOKS
        const books: any[] = data[1];
        // Compose result, in this case adding the books to the extracted author.
        author.books = books.filter(book => book.author === author.name);
        return author;
      })
    );
}
```

https://rxjs-dev.firebaseapp.com/api/index/function/forkJoin

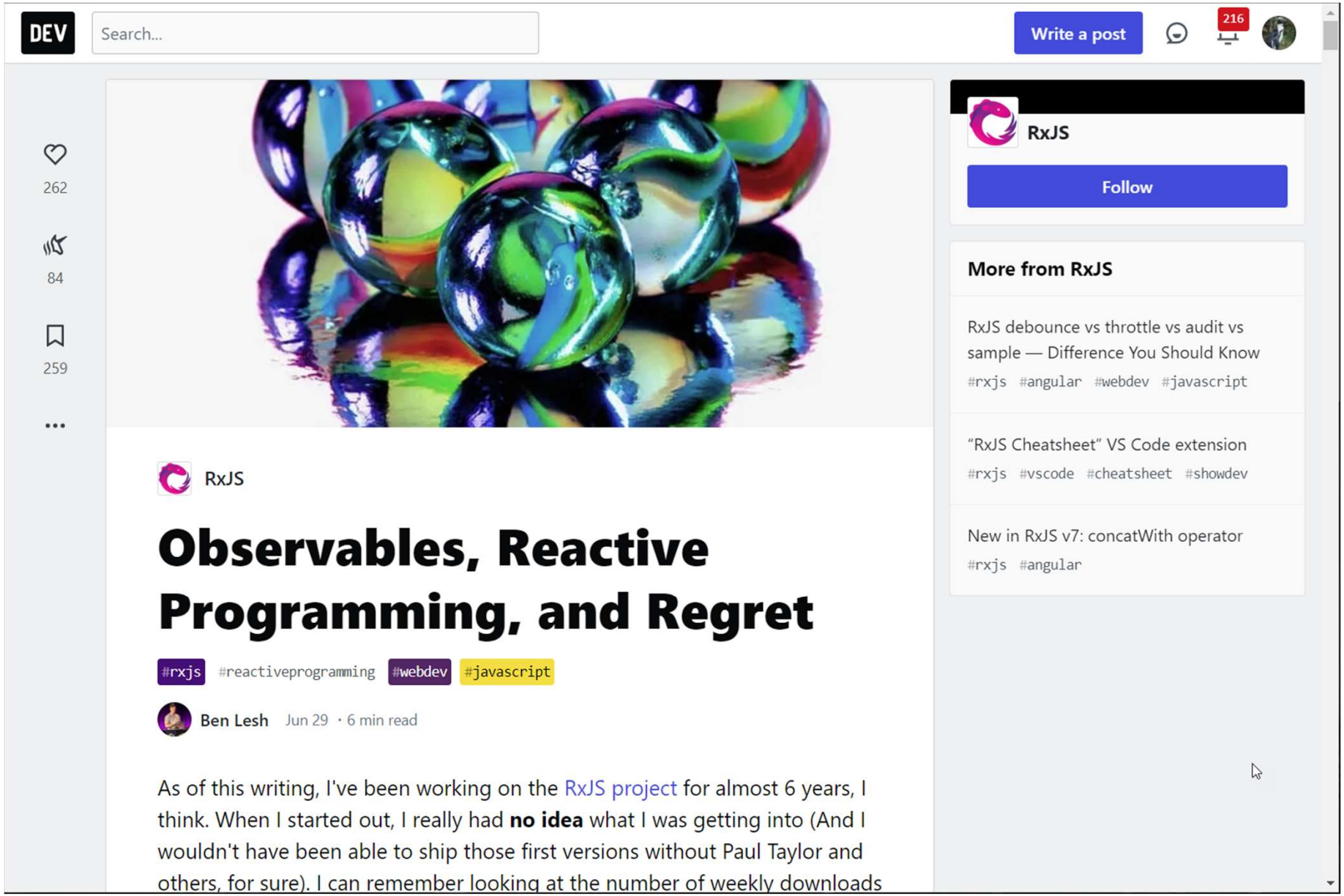
Other interesting / often used Operators

- `from()`, `of()` - create observables from almost everything
- `fromEvent()` - create observable from a DOM-event.
- `debounce()`, `debounceTime()` - Discard emitted values that take less than the specified time between output
- `tap()` - utility operator - transform side-effects, such as logging
- …and much more… See http://www.learnrxjs.io
- See also https://rxjs-dev.firebaseapp.com/

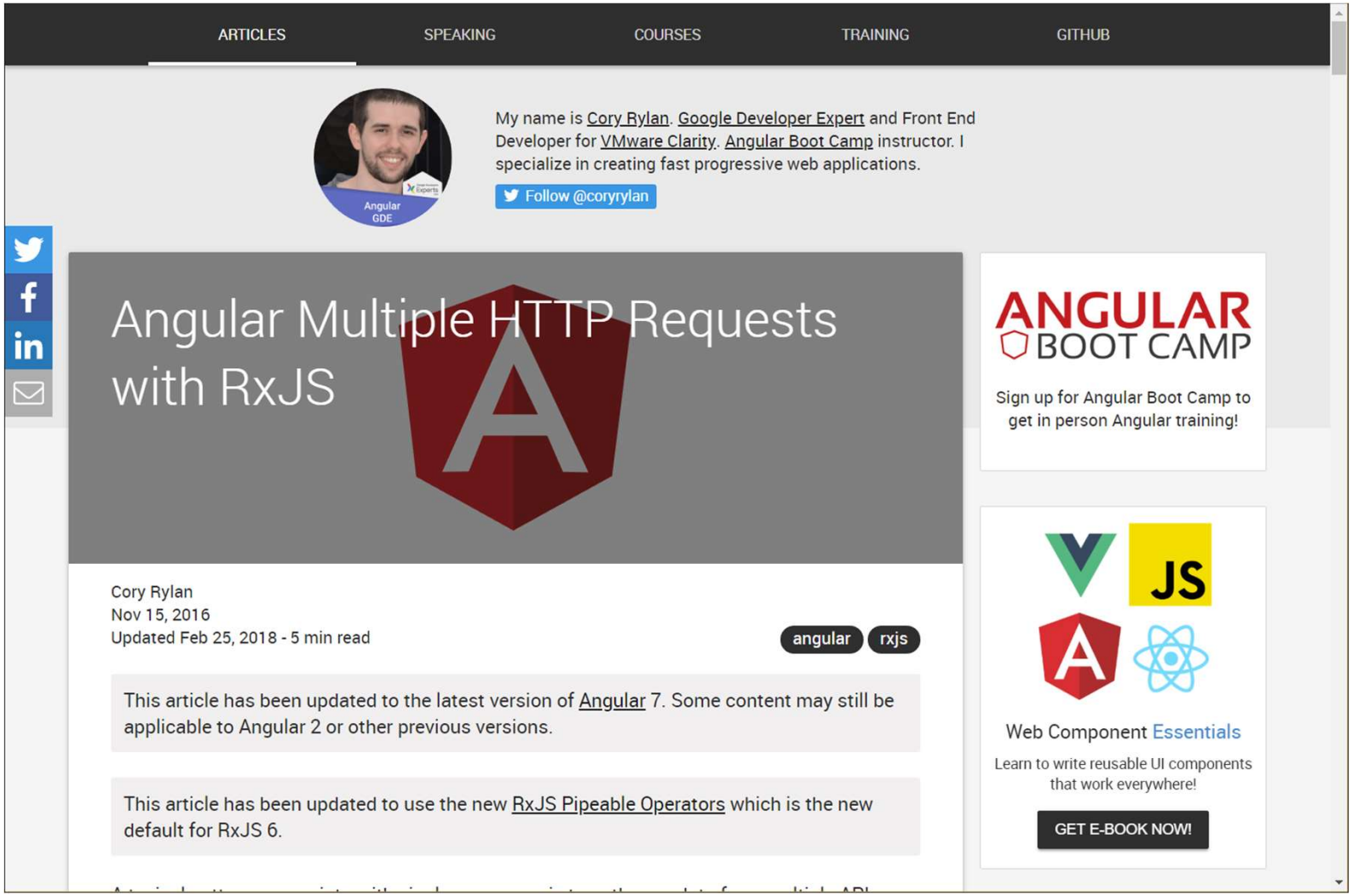
Extra information

Some background info on RxJS and Operators

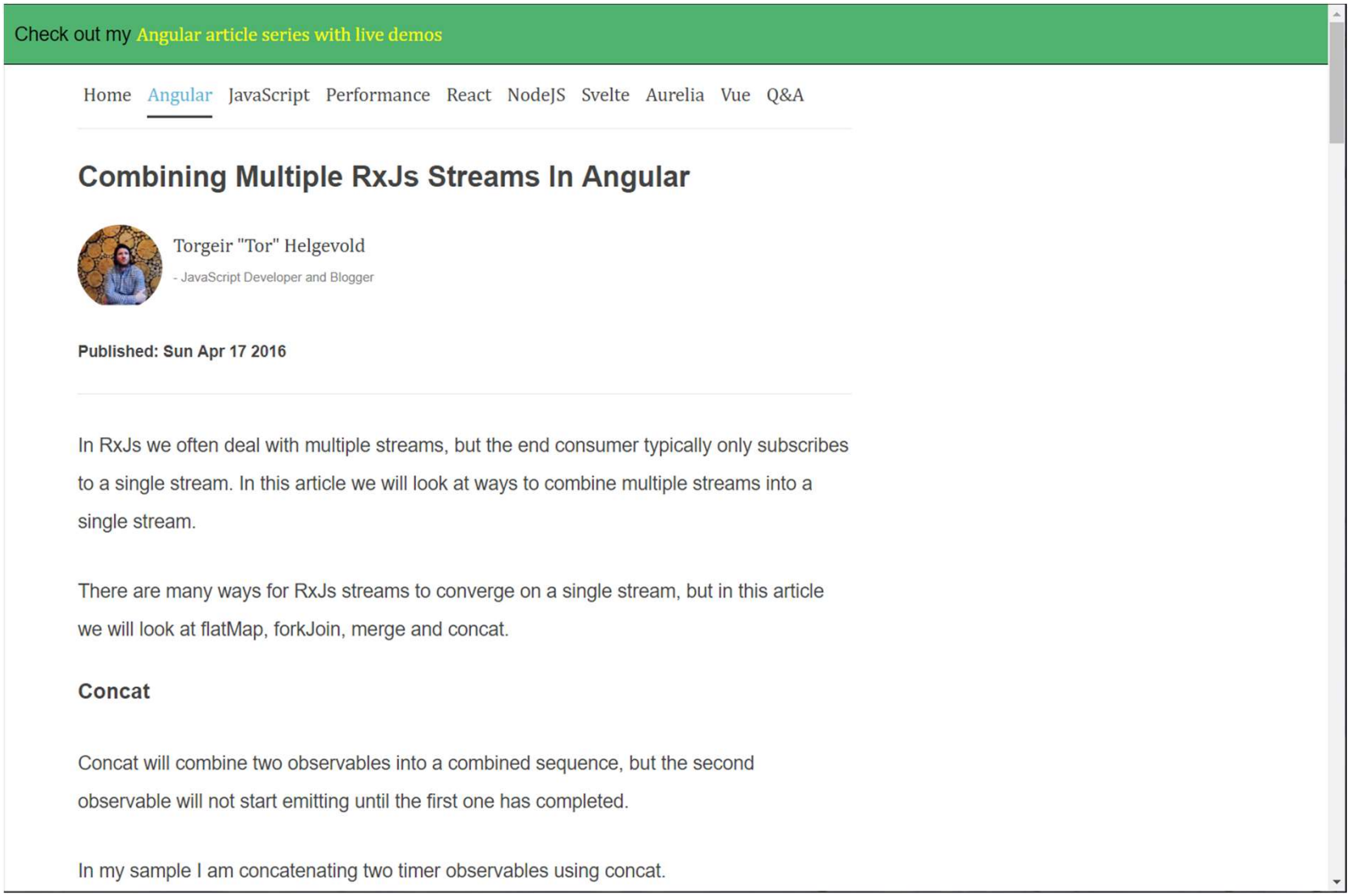
https://dev.to/rxjs/observables-reactive-programming-and-regret-4jm6



More info on operators (good articles)

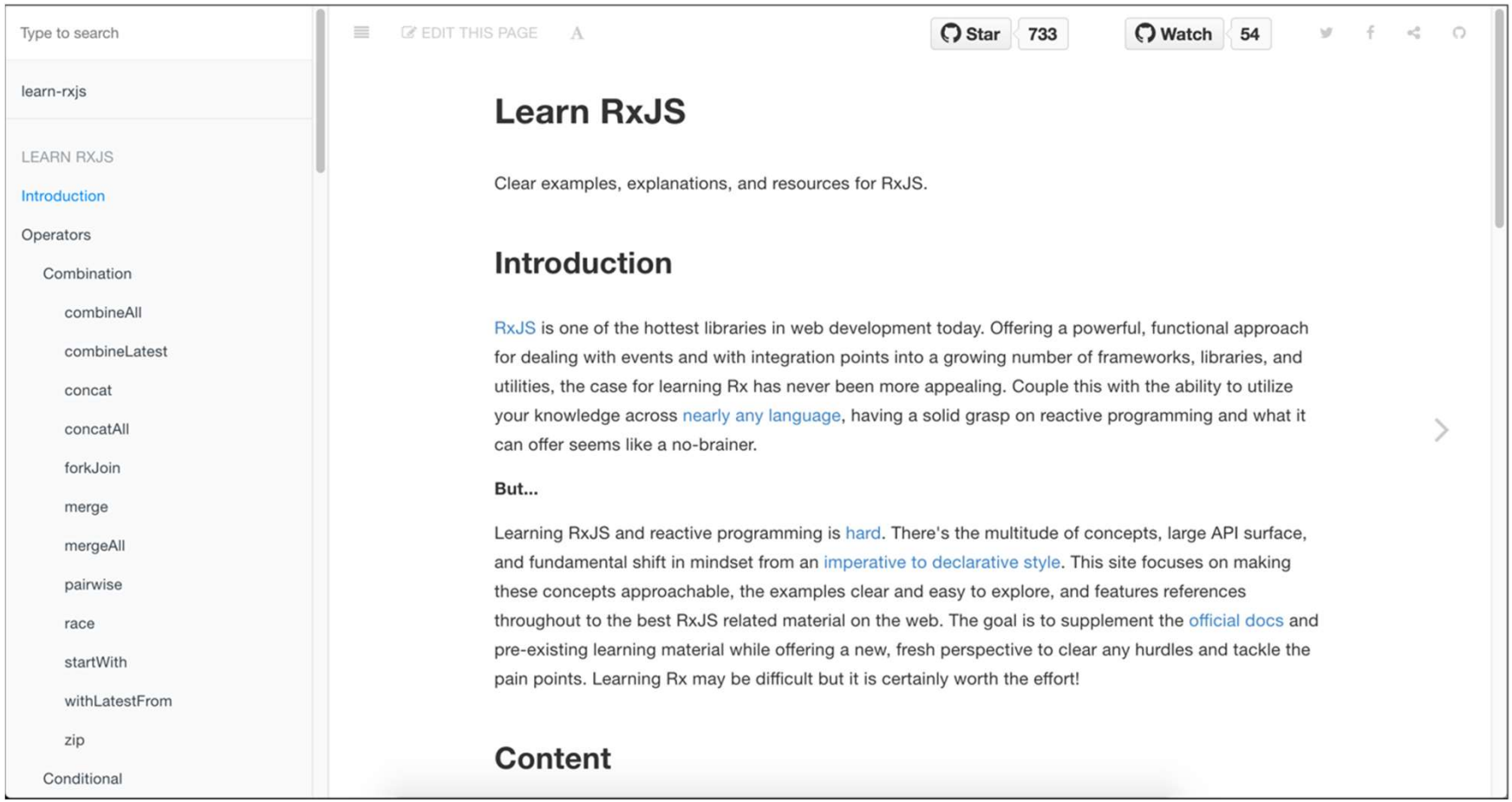


https://coryrylan.com/blog/angular-multiple-http-requests-with-rxjs

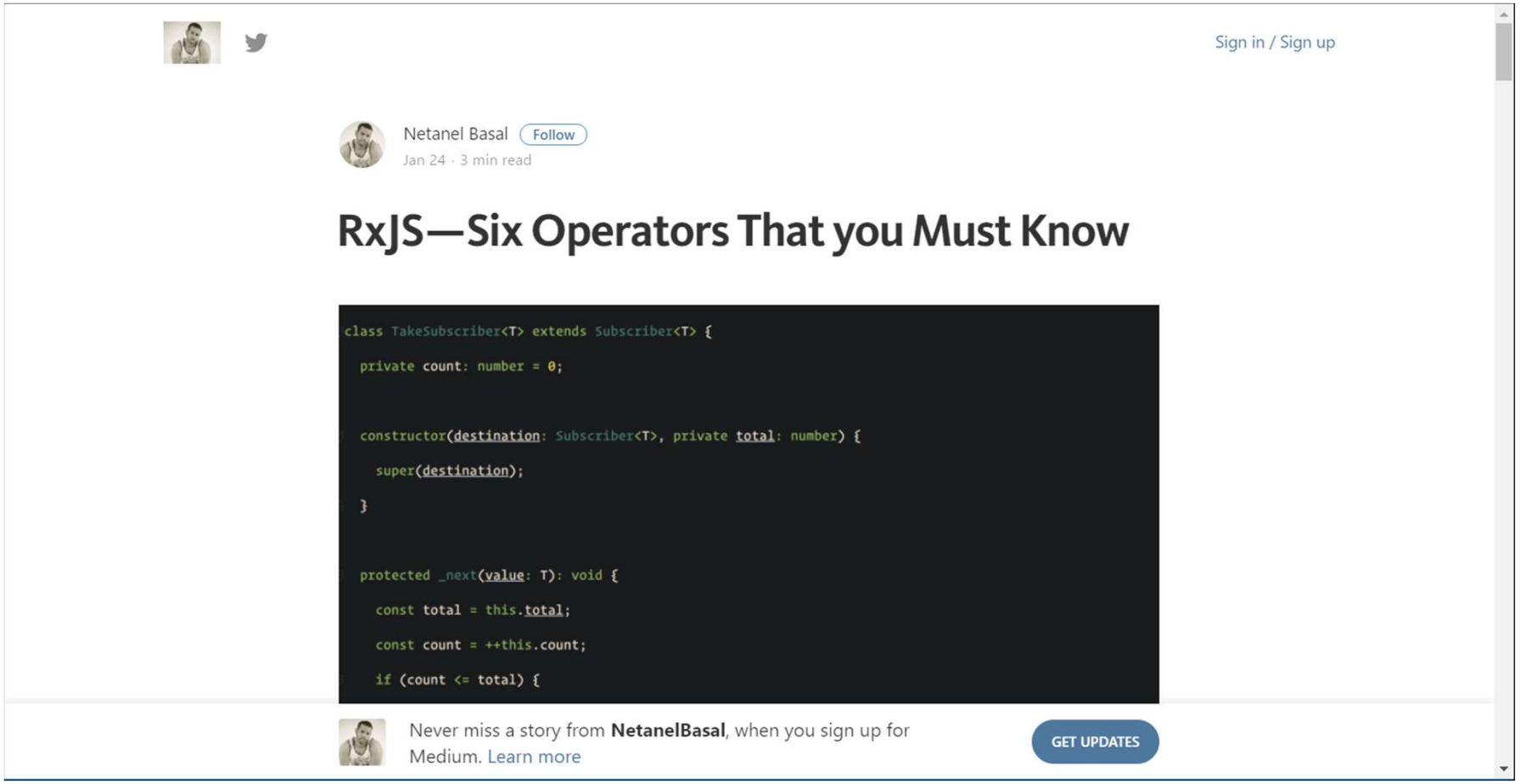


http://www.syntaxsuccess.com/viewarticle/combining-multiple-rxjs-streams-in-angular-2.0

https://www.learnrxjs.io/

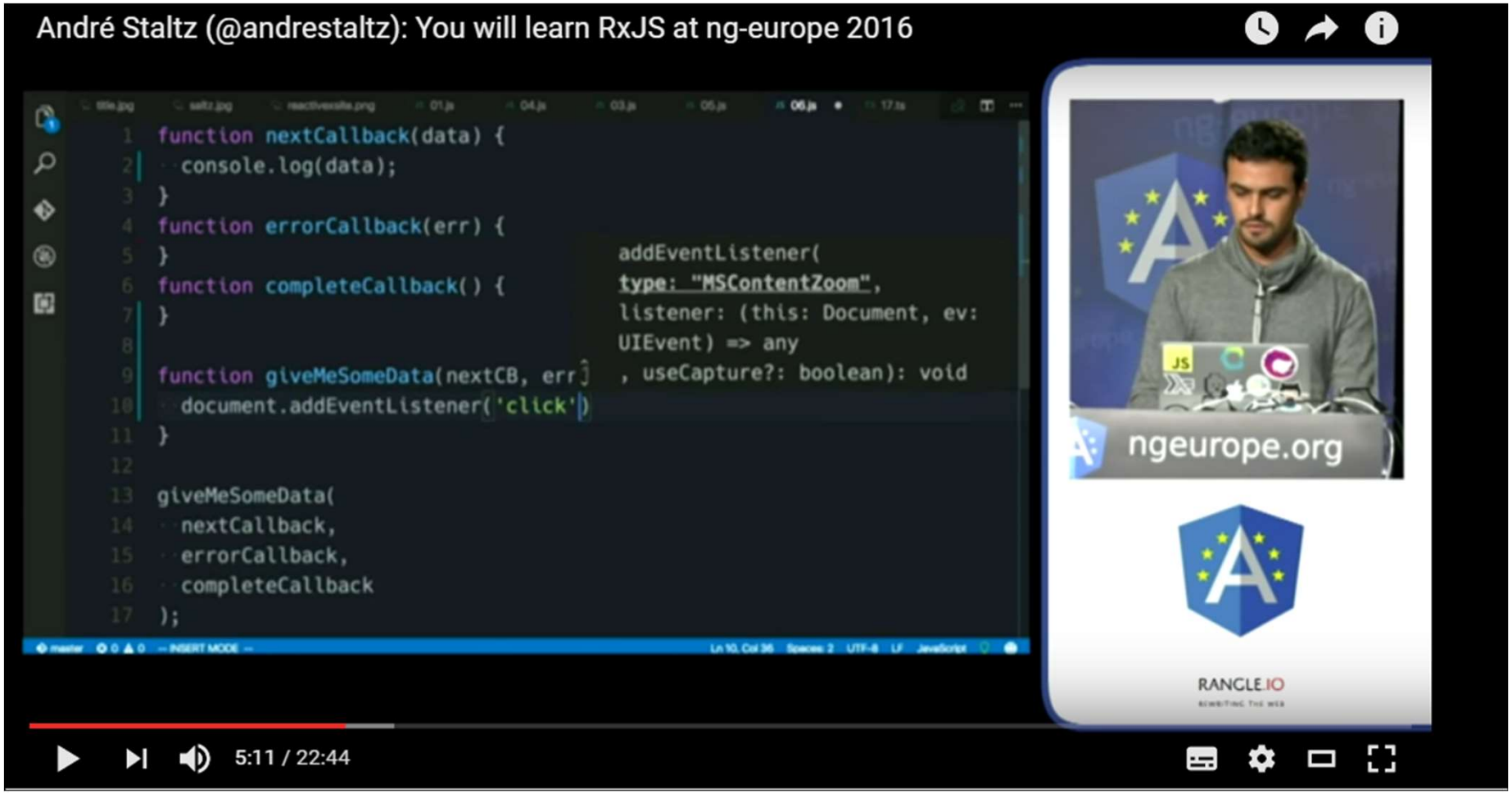


Article - 6 Operators you must know

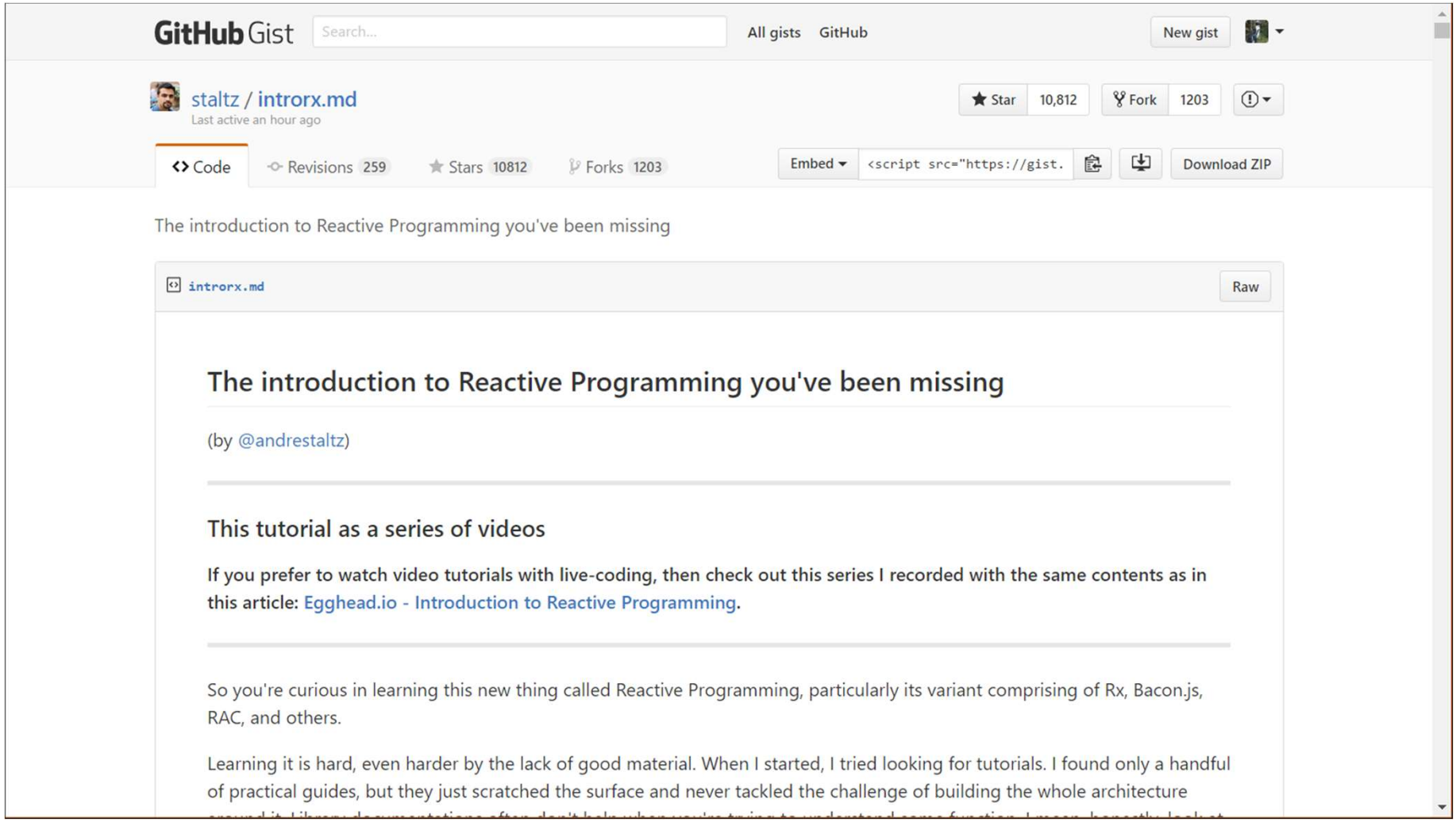


https://netbasal.com/rxjs-six-operators-that-you-must-know-5ed3b6e238a0#.11of73aox

Creating Observables from scratch - André Staltz

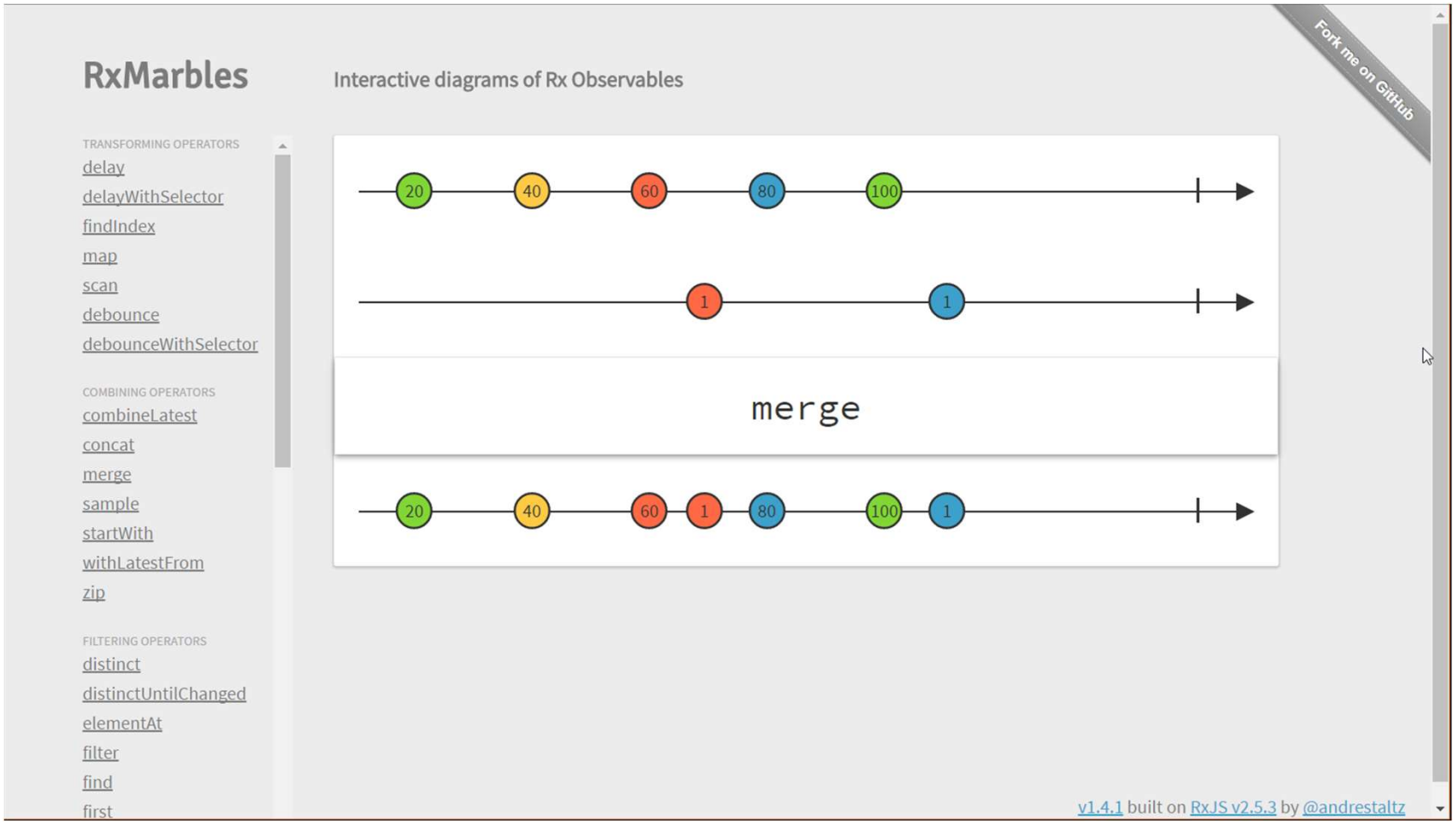


https://www.youtube.com/watch?v=uQ1zhJHclvs



https://gist.github.com/staltz/868e7e9bc2a7b8c1f754

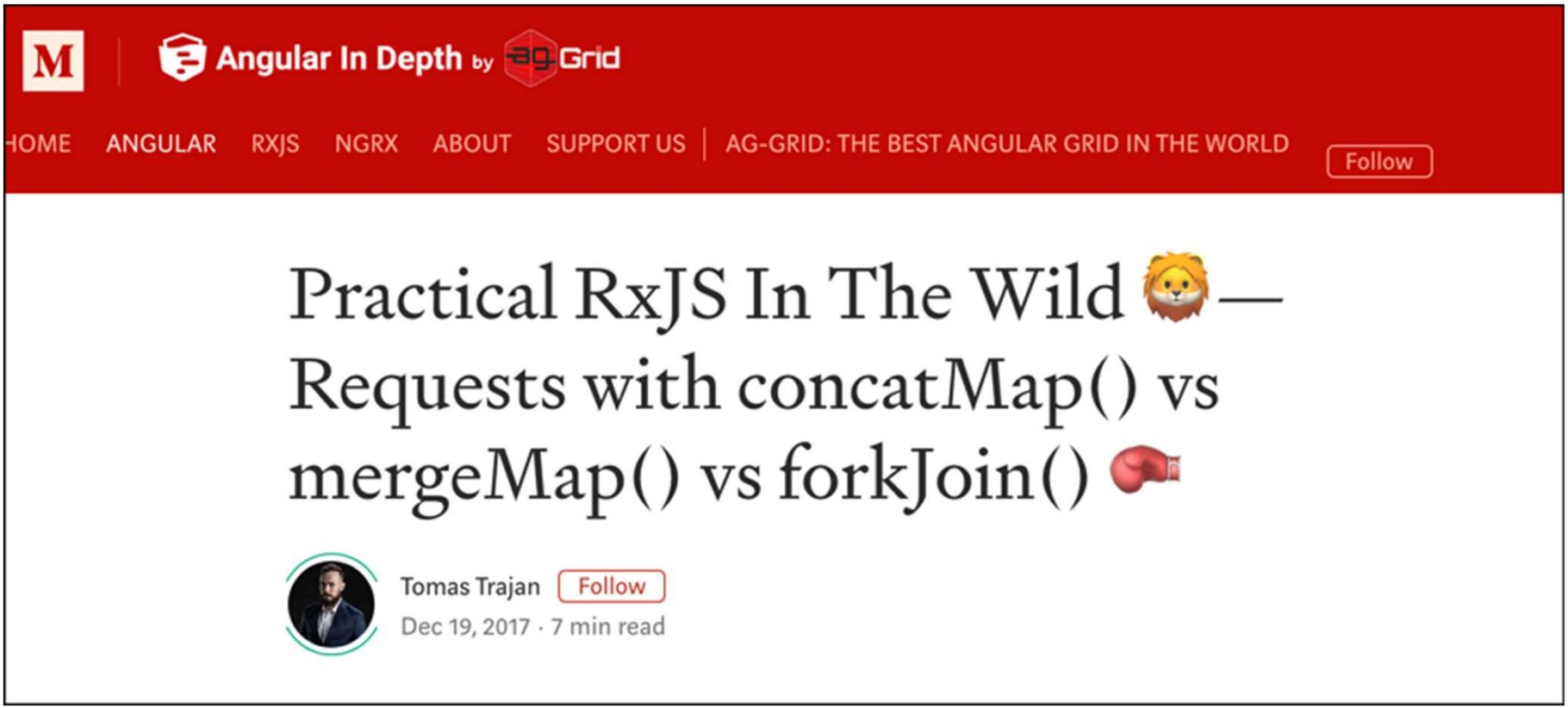
Also by Andre Stalz - RxMarbles



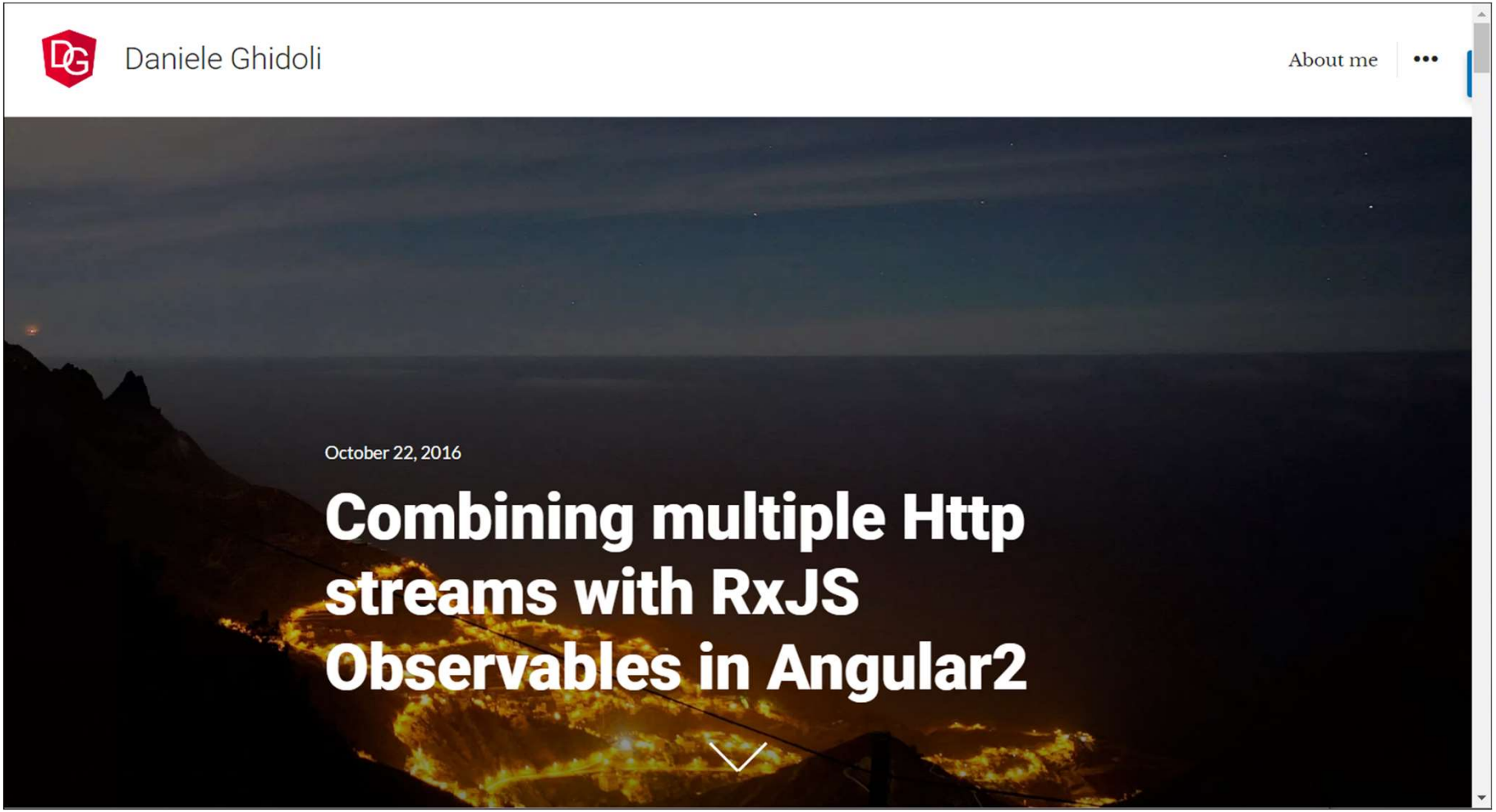
http://rxmarbles.com/

Fetching a collection of observables

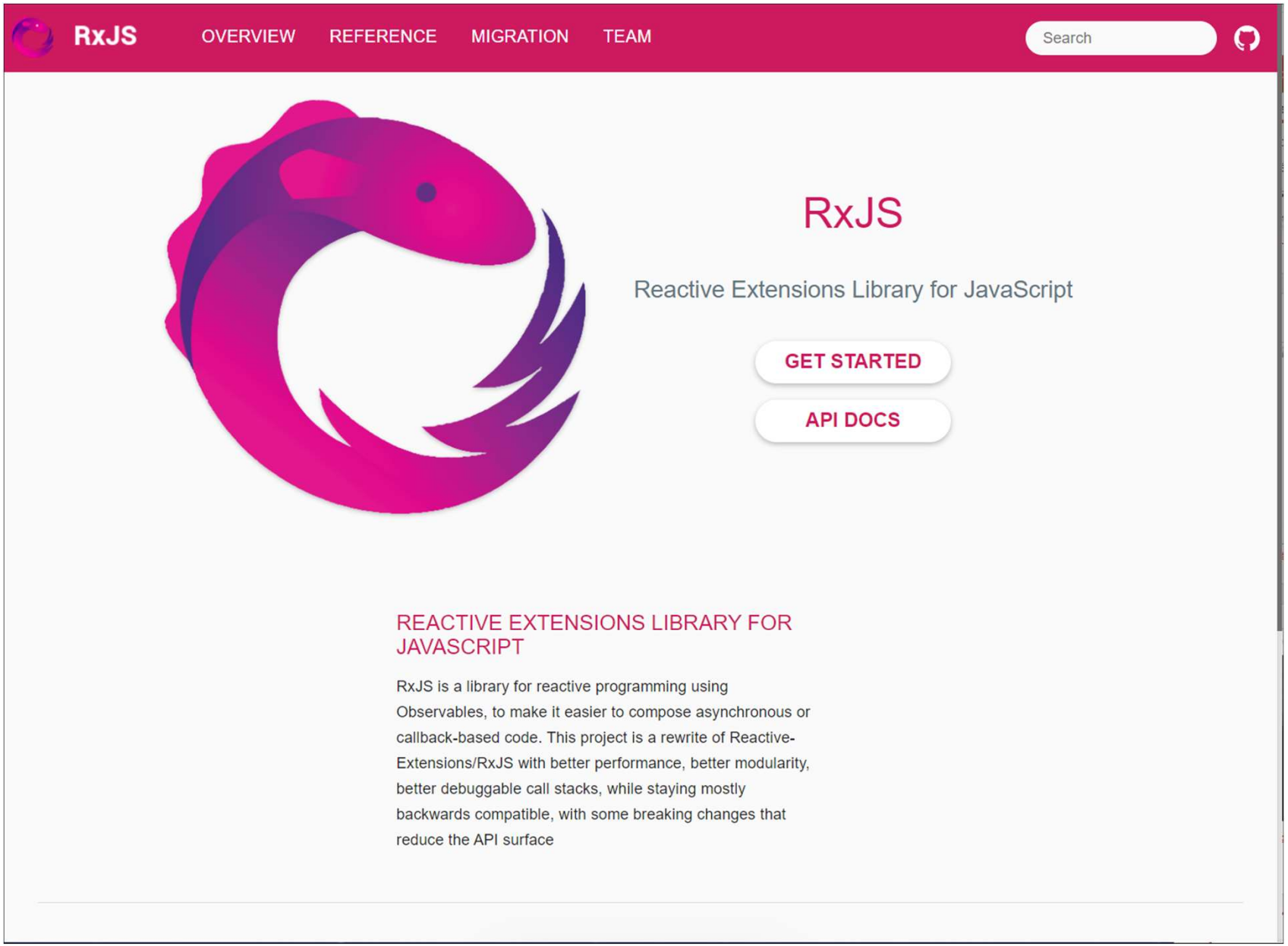
https://blog.angularindepth.com/practical-rxjs-in-the-wild-requests-with-concatmap-vs-mergemap-vs-forkjoin-11e5b2efe293



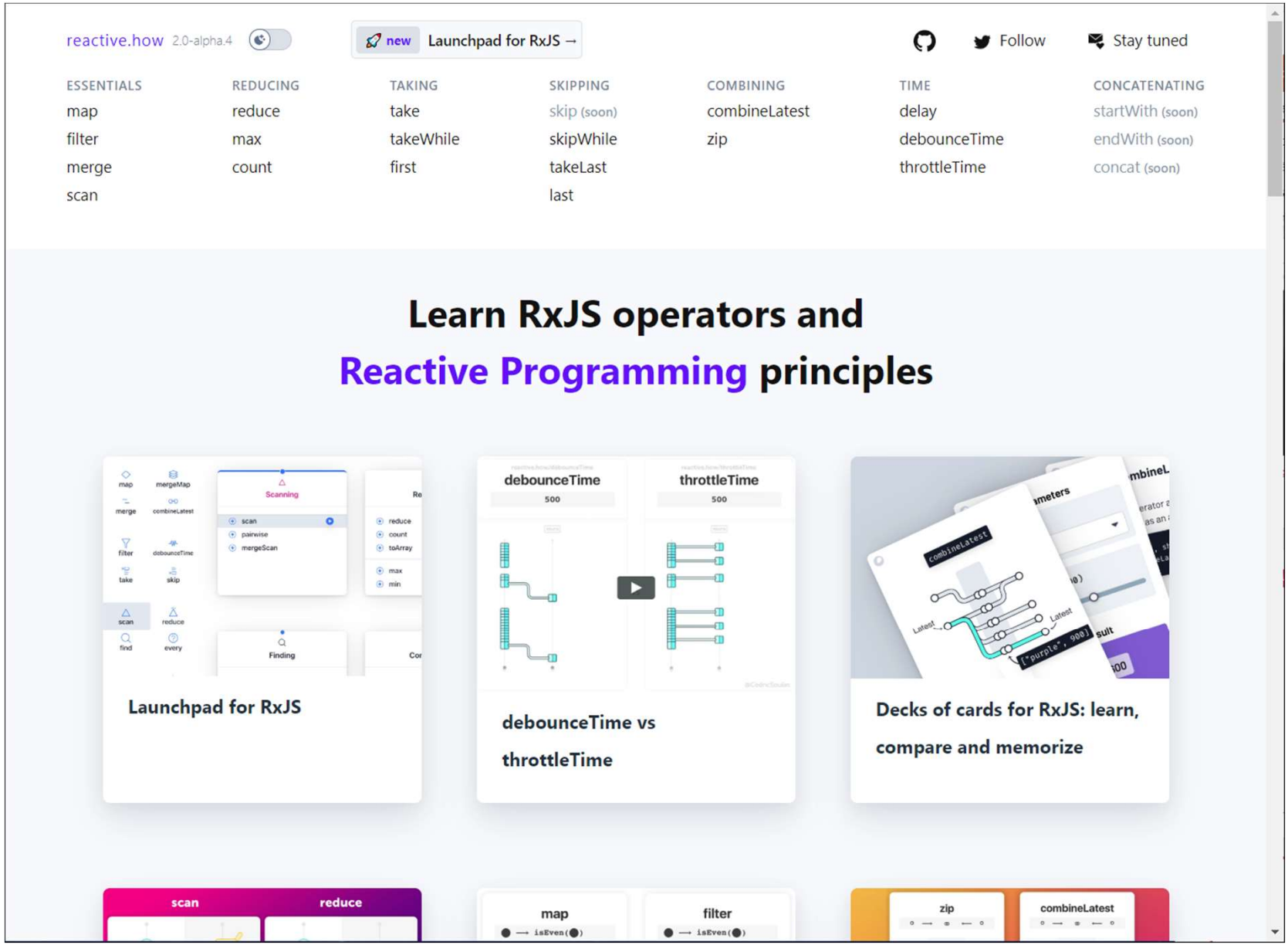
https://github.com/tomastrajan/ngx-model-hacker-news-example



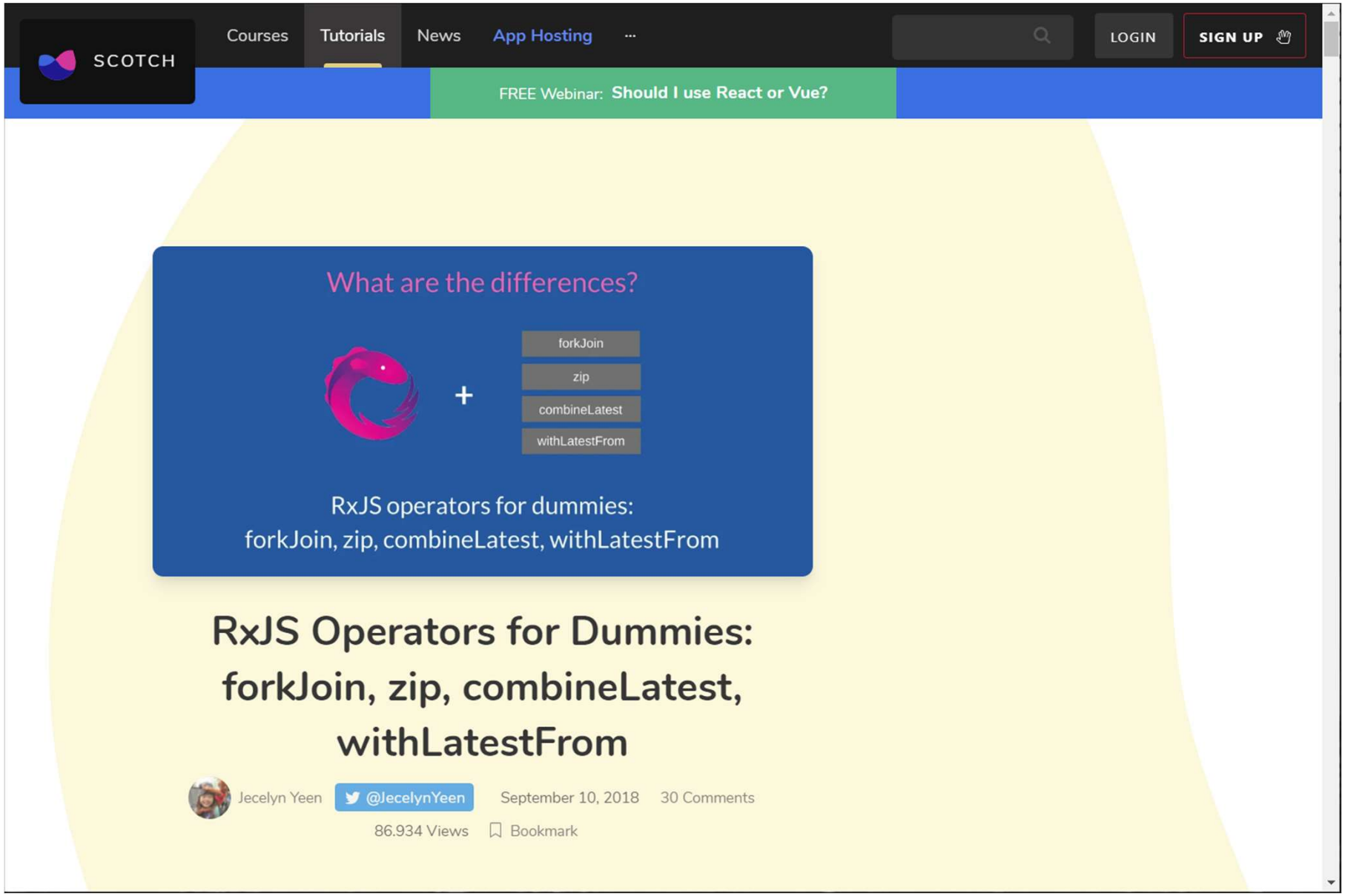
http://blog.danieleghidoli.it/2016/10/22/http-rxjs-observables-angular/



https://rxjs-dev.firebaseapp.com/



https://reactive.how/



https://scotch.io/tutorials/rxjs-operators-for-dummies-forkjoin-zip-combinelatest-withlatestfrom

Workshop

- Create a call to the Open Movie Database API, using a keyword to search for 10 movies
  - http://www.omdbapi.com/?apikey=f1f56c8e&s=<keyword>
- Create an additional call to get details for every movie returned. Use the `imdbID` property for that
  - http://www.omdbapi.com/?apikey=f1f56c8e&i=<imdbID>
- Display results in the UI, first a list of movies, then details per movie as soon as they come available.
- What is your best solution? Multiple ways of doing this!