ANGULAR
ARCHITECTS
INSIDE KNOWLEDGE

Reactive Extensions for JS
Basics

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Outline

- Motivation
  - History of design pattern
  - Pull vs Push & Concurrency
  - Why reactive programming?
- Observable
- Observer
- Subscription
- Subjects
- Managing Subscriptions
- Hot Observables

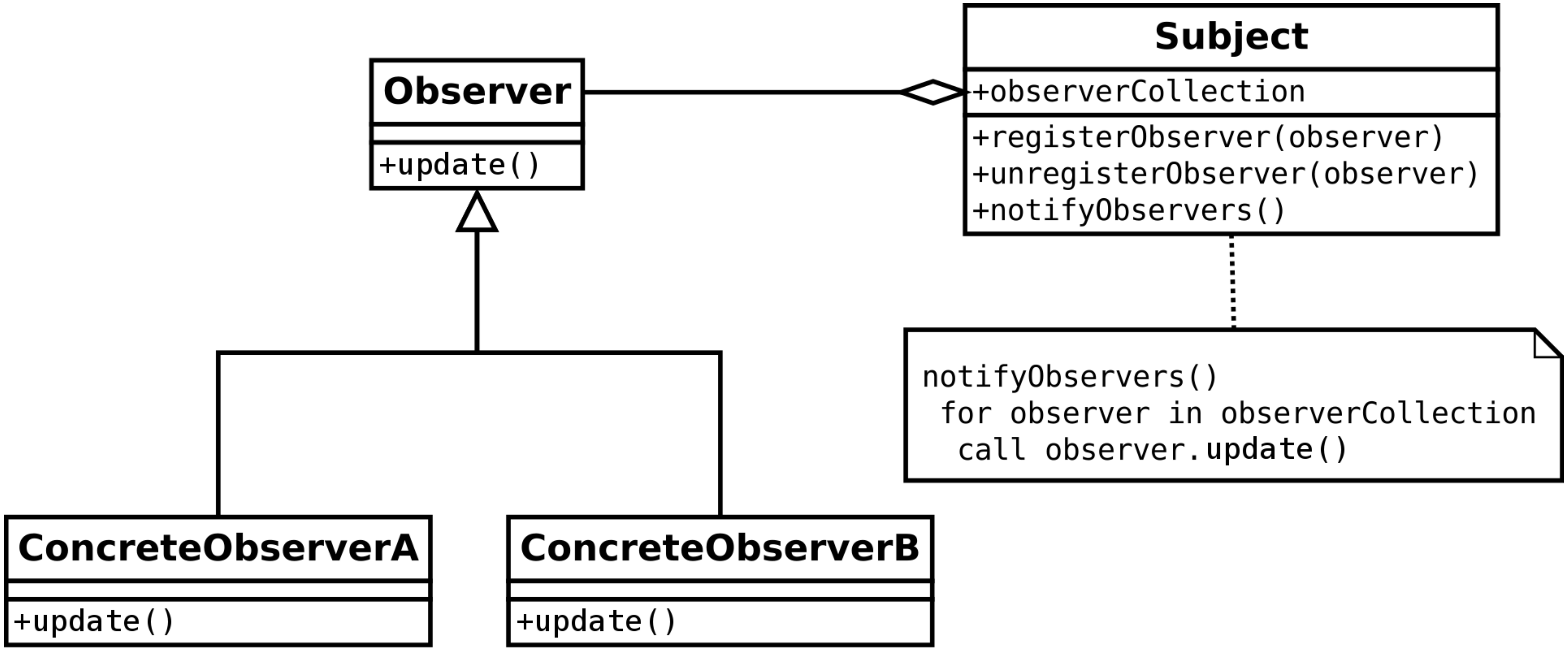
Motivation

Once upon a time

- Design Patterns (1994 - Gang Of Four)
  - Iterator Pattern (Behavioral Design Pattern)
    - Decouble data from alogrithms

```
class Iterable {
 [Symbol.iterator]() {
   …
    }
}

const iterable = new Iterable();
for (const item of iterable) {
  …
}
```

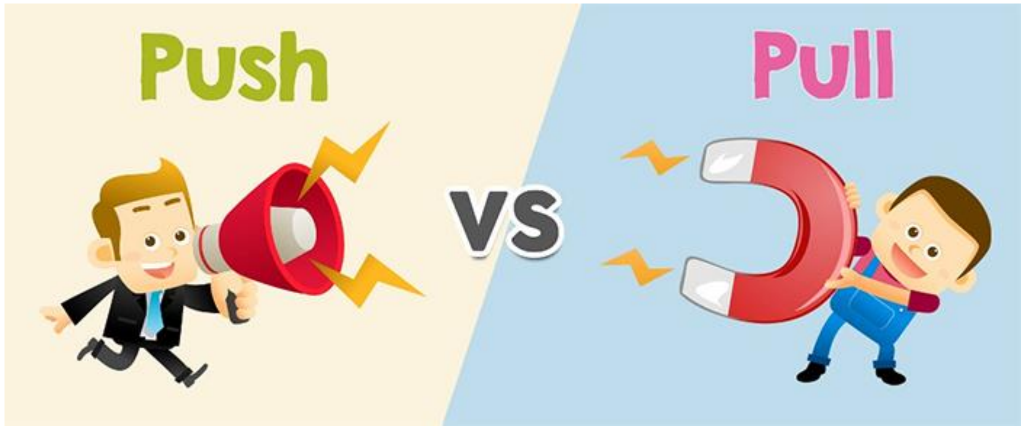
Observer pattern (Behavioral DP)



```
notifyObservers()
 for observer in observerCollection
  call observer.update()
```

Pull vs Push Architecure (I)

- Pull-based
  - Consumer decide when data is pulled
  - Producer unaware when
  - Every function is a producer



- Push-based
  - Get notified when changes happen
  - E.g. Mobile App Push Notifications

Pull vs Push Architecure (II)

	Producer	Consumer
Pull	**Passive:** produces data when requested.	**Active:** decides when data is requested.
Push	**Active:** produces data at its own pace.	**Passive:** reacts to received data.

Why asynchronicity?

Asynchronous operations (API requests)

Interactive behavior (user input)

Websockets

Server Send Events (Push)

Concurrency (I)

- Synchronous vs. asynchronous computing
  - Latency → wait time

- Non-blocking code with callbacks
  - Often used in JavaScript

Concurrency (II)

	Single item	Mulitple items
synchronous / Pull	Function	Iterable (Array)
asynchronous / Push	Promise / async|await	?

Concurrency (II)

	Single item	**Mulitple items**
synchronous / Pull	Function	Iterable (Array)
asynchronous / Push	Promise / async|await	**Observable (or Signal)**

Why reactive programming?

- Enhances the user experience to be more fluid and responsive

- Simpler to manage by developer (believe it or not ☺)
  - avoid "callback hell" → instead cleaner, readable code base
  - simpler to compose / combine streams of data
  - simpler than traditional threading

- Powerful RxJS Operators (reactive best practices)

- But **difficult to learn** and can cause **memory leaks**

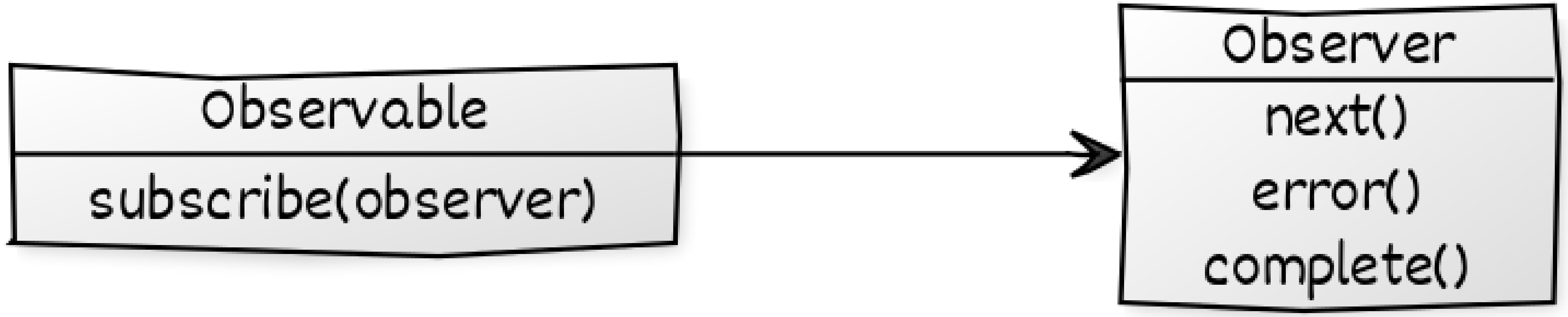
Observables & Observer

What are observables?

- Represents (asynchronous) data that is published over time
- A collection of values over any amount of time
  - 0..N values could be emitted
- Cancellable
- Lazy
- RxJS Operators support
  - Ton of functionality ☺

Observable „Source“
Operator (z. B. map)
Observer „Destination“

Observable and Observer



Subscribing an Observer

Observer

```
myObservable.subscribe(
   (nextValue) => { … }
);
```

next

Observer

```
myObservable.subscribe({
    next: (nextValue) => { … },
    error: (err) => { … },
    complete: () => { … }
});
```

next

Observer

DEMO: Observable

Creating Observables

Creating an Observable (rarely done this way)

```
const observable$ = new Observable((sender) => {

    sender.next(4711);
    sender.next(815);

    // sender.error("err!");

    sender.complete();
});
```

Sync/Async, Event-driven

```
let subscription = observable$.subscribe(…);
```

```
subscription.unsubscribe();
```

Creation Operators (Factories)

[https://www.learnrxjs.io]

fromEvent

of

throwError

interval

timer

Hot Observables

Cold vs. Hot Observables

Cold	Hot
• Point to point • Lazy: Only starts at subscription	• Multicast • Lazy or eager: Sender starts without subscriptions

Default

Create Hot Observable (lazy)

```
let o = this.find(from, to)
            .pipe(publish()) as ConnectableObservable<Flight[]>;

o.subscribe(…);

o.connect();

o.subscribe(…);
```

Create Hot Observable (eager)

```
let o = this.find(from, to).pipe(share());

o.subscribe(…);

o.subscribe(…);
```

Sender starts with first subscription

Sender stops after all receiver have been unsubscribed

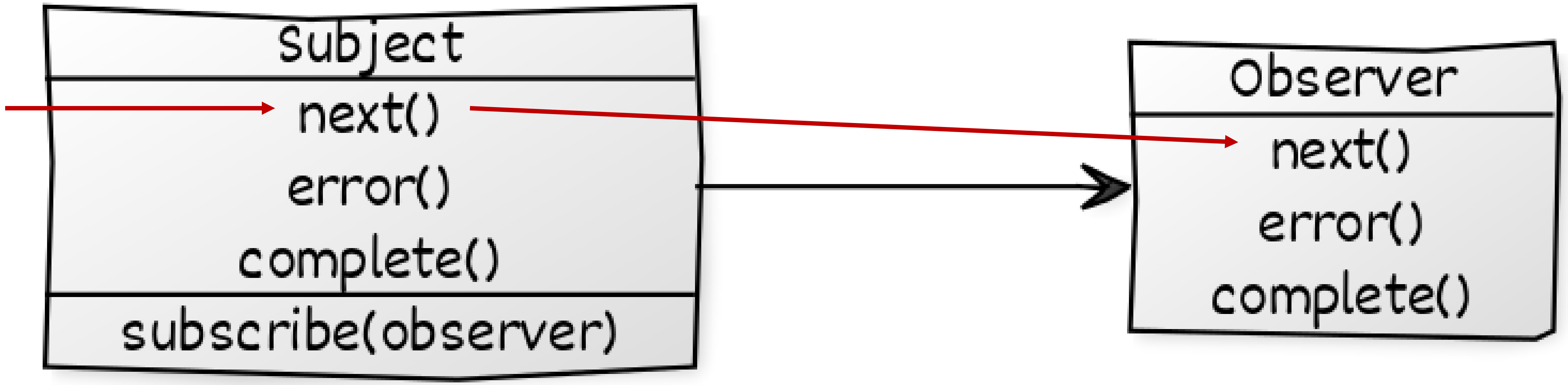
Create Hot Observable (eager + cache)

```
let o = this.find(from, to)
            .pipe(shareReplay(1));

o.subscribe(…);

o.subscribe(…);
```

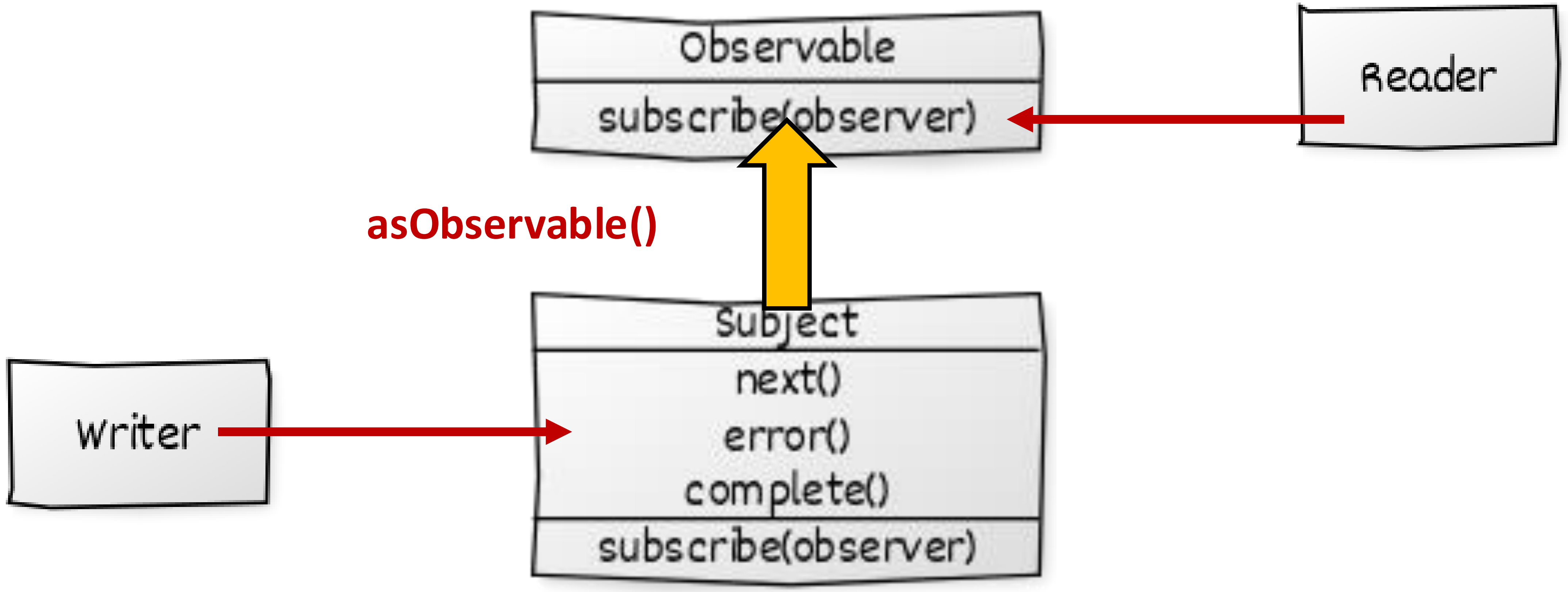
DEMO: Hot Observable

Subjects

Subjects: Special Observables



Convert Subject into Observable



asObservable

```
private readonly subject = new Subject<Flight>();
readonly observable$ = this.subject.asObservable();

[…]
this.observable$.subscribe(…)

[…]
this.subject.next(…)
```

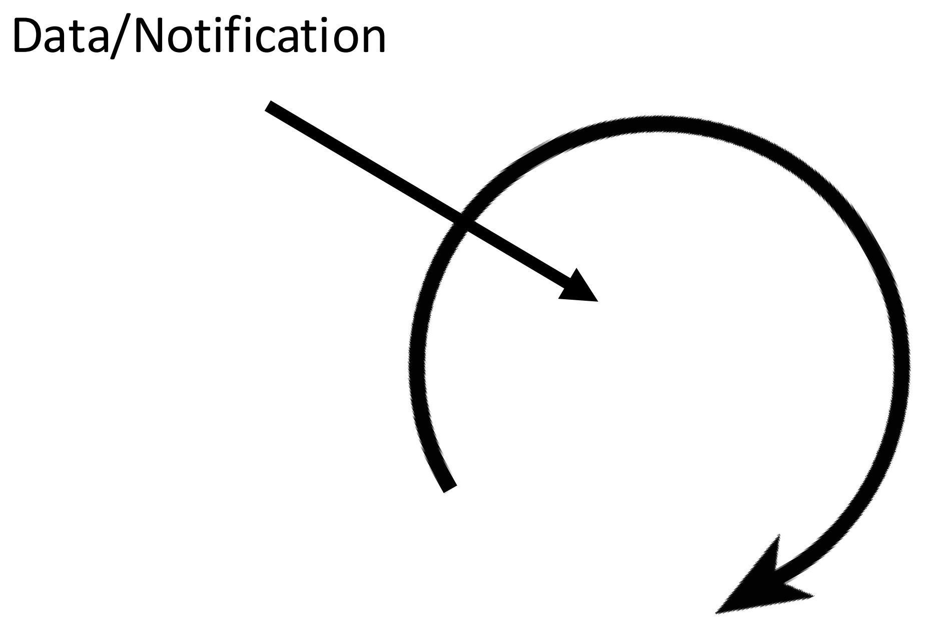
Subjects

Subject	Hot & distributes data
BehaviorSubject(iV) *(or signal)*	Saves last value, has initial value
ReplaySubject(n)	Saves (caches) last n values

Eventing with Subject

```
const sub = new Subject<Flight>();

sub.subscribe((flight) => console.debug(flight));

sub.next({ id: 1, ...})
```

Subjects



```
.subscribe({
    (result) => { … },
    (error) => { … },
    () => { … }
});
```

Subject

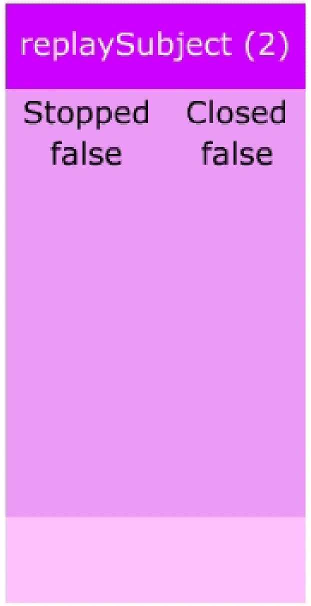
Observer

State with BehaviorSubject (or signal)

```
const temperature = new BehaviorSubject<number>(0);

temperature.next(-1);

temperature.subscribe((temp) => console.debug(temp));

temperature.next(-2);
```

Diff with ReplaySubject

```
const diff = new ReplaySubject<number>(2);
```



Managing Subscriptions

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Why do we need to cancel subscription?

Avoid side effects (bugs)

Avoid memory leaks

Also for HttpClient‘s get / post ...

How are subscriptions cancelled?

Observables

complete()
error()

Observer

unsubscribe()

How to unsubscribe()???

- Explicitly

  const subscription = my$.subscribe(…);
  // subscription.add(other$.subscribe(…)); // also possible since V6
  subscription?.**unsubscribe()**;

- Implicitly
  - ~~observable$.pipe(**takeUntil(terminator$)**).subscribe(…);~~
  - observable$.pipe(**takeUntilDestroyed()**).subscribe(…);

  $\}$ **last operator!**

- Implicitly with async-Pipe in Angular

  {{ my$ | **async** }} $\longrightarrow$ **also triggers a cdr.markForCheck for OnPush**

- Automatic by Angular
  - Angular Router (automatically completes onDestroy)

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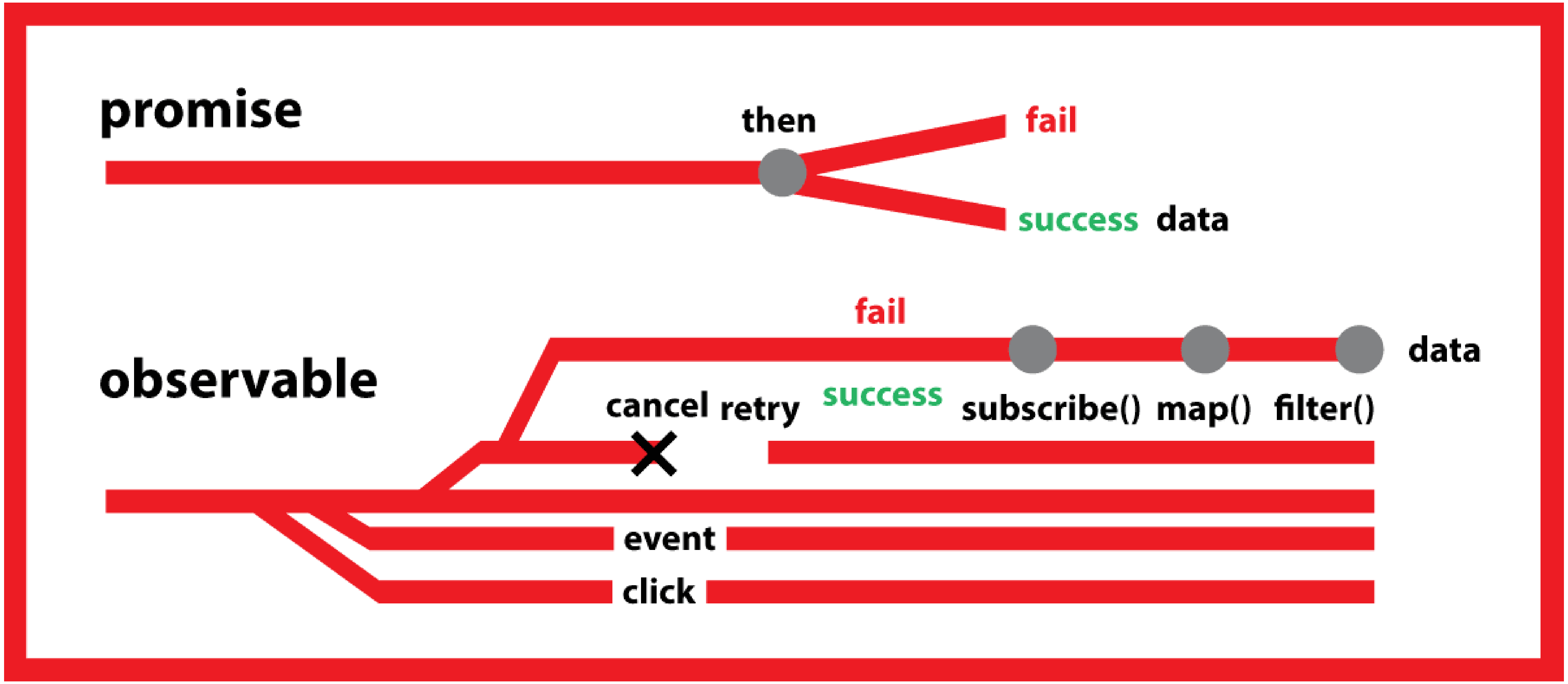
DEMO: Cancelling Subscriptions

Lab

RxJS Basics

Observables vs Promises

Observables vs Promises – Overview



https://stackoverflow.com/questions/37364973/what-is-the-difference-between-promises-and-observables

Observables vs Promises – Details

Observables (Streams)	**Promises (Single Event)**
More features	Less powerful
Can emit zero, **one or multiple** values over time.	Emit a **single** value at a time.
Lazy: they're not executed until we subscribe using the subscribe() method.	**Eager**: execute immediately after creation.
Subscriptions are **cancellable** using the unsubscribe() method, which stops the listener from receiving further values.	Are **not cancellable**.
RxJS provides a **ton of functionality** to operate on observables like the map, forEach, filter, reduce, retry, and retryWhen operators.	Don't provide any operations.
Deliver errors to the subscribers.	Push errors to the child promises.
Used by HTTP Client, Reactive Forms & Route Params	Used by Angular in Router.navigate

Recap