



# Reactive Extensions for JavaScript

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- Generating Observables
- Hot vs. Cold Observables
- Piping operators (lookahead)
- Combination Operators
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# Overview



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# What are observables?

- Represents (asynchronous) data that is published over time

Observable  
„Source“



Operator  
(z. B. map)

Observer  
„Destination“



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# Observer

Option with more than one  
parameter is now deprecated!

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

← **Observer**



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# Observer

```
myObservable.subscribe(  
  (result) => { ... }  
);
```



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# Observer

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



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Deprecated!

# Example

```
this
  .http
  .get("http://www.angular.at/api/...")
  .map(flightDateStr => new Date(flightDateStr))
  .subscribe({
    next: (date) => { ... },
    error: (err) => { console.error(err); }
  });
```



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# Example with Pipeable Operators

```
import { map } from 'rxjs/operators';

this
  .http
  .get("http://www.angular.at/api/...")
  .pipe(map(flightDateStr => new Date(flightDateStr)))
  .subscribe({
    next: (bookings) => { ... },
    error: (err) => { console.error(err); }
  });
```

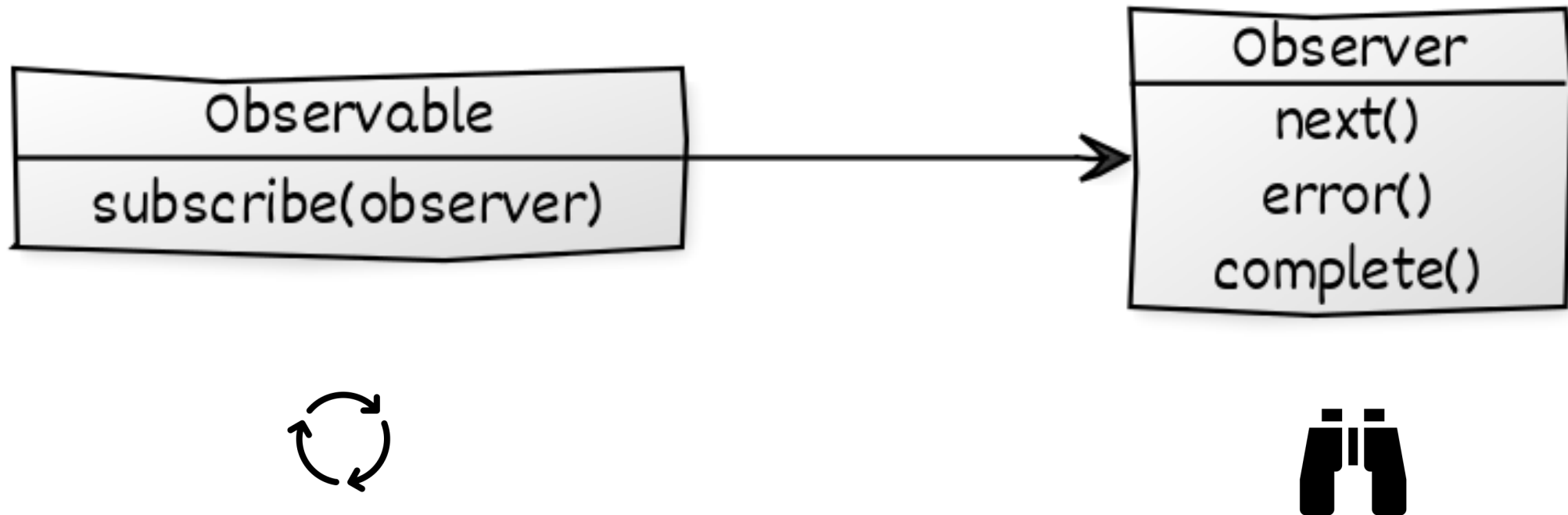


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# Observable und Observer



# Why Observables?

Asynchronous  
operations

Interactive  
(reactive)  
behavior



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# Creating Observables



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# Creating an Observable

```
let observable = new Observable((sender) => {  
    sender.next(4711);  
    sender.next(815);  
    // sender.error("err!");  
    sender.complete();  
    return () => { console.debug('Bye bye'); };  
});
```

} **Sync/Async, Event-driven**

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

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



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# Creation Operators (Factories)

[<https://www.learnrxjs.io>]

fromEvent

of

throwError

interval

timer



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# Cold vs. Hot Observables



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# Cold vs. Hot Observables

## Cold

- Default
- Point to point
- One Sender per consumer
- Lazy: Only starts at subscription

## Hot

- Multicast
- Eager: Sender starts without subscriptions



# Create Hot Observable

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

o.subscribe(...);

o.connect();

o.subscribe(...);
```



# Create Hot Observable

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

```
o.subscribe(...);
```



```
o.subscribe(...);
```

**Sender starts with first subscription**

**Sender stops after all receiver have  
been unsubscribed**



# Create Hot Observable

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

o.subscribe(...);

o.subscribe(...);
```



# Operators



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# Transformation Operators



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# Operators

[<http://rxmarbles.com/#map>]



`map(x => 10 * x)`





`pluck("a")`

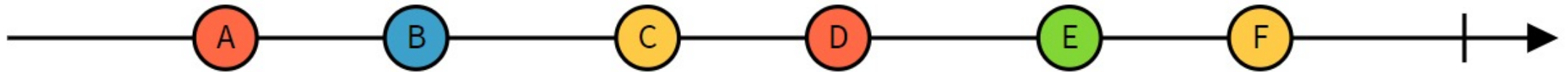


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pairwise



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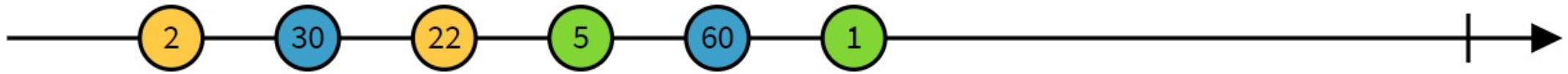
# Filtering Operators



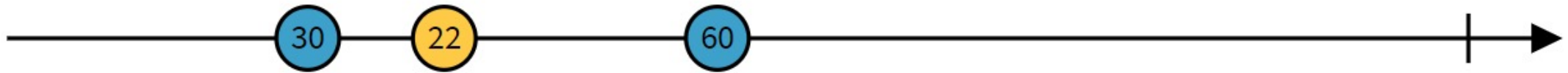
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```
filter(x => x > 10)
```



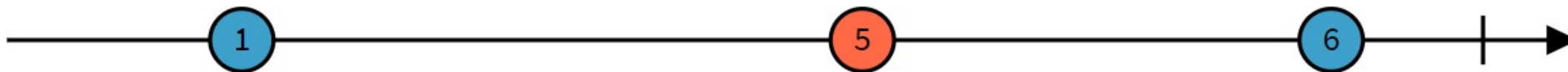
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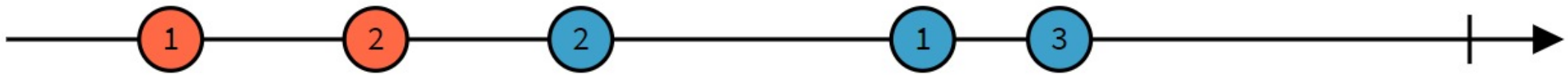
`debounceTime(10)`



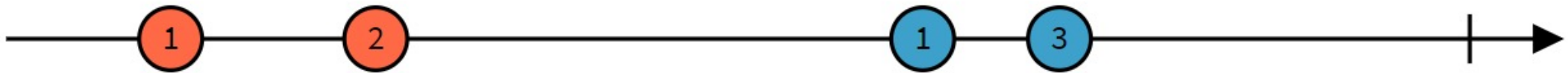
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`distinctUntilChanged`



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# Lab/Demo

Simple Lookahead



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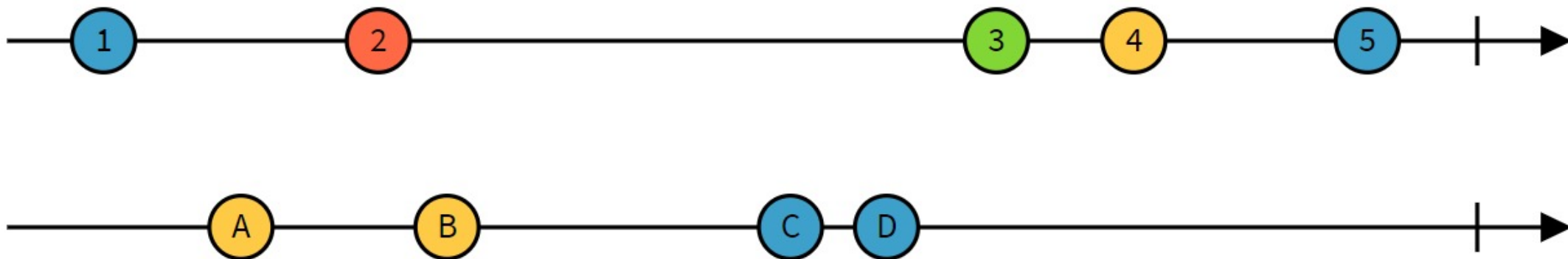
# Combination Operators



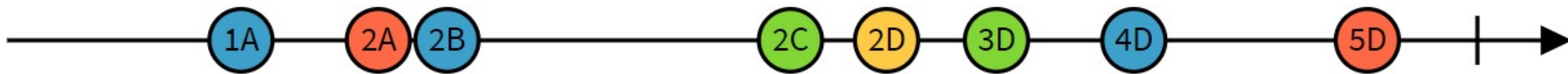
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```
combineLatest((x, y) => "" + x + y)
```

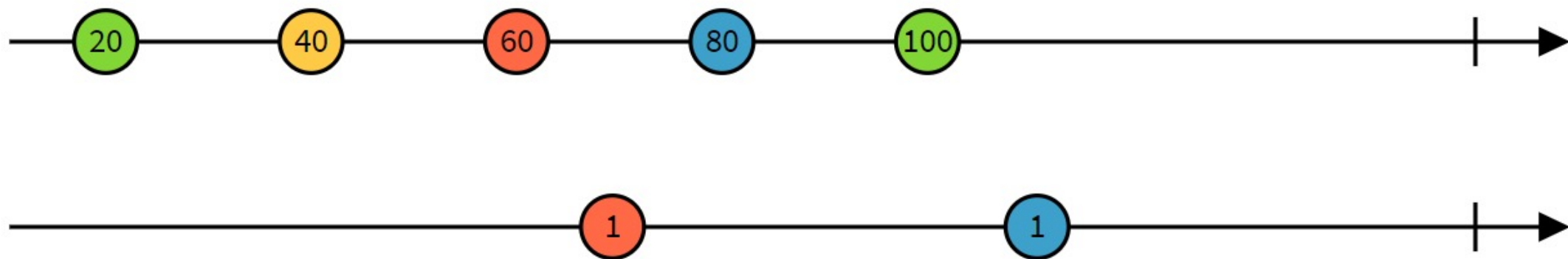


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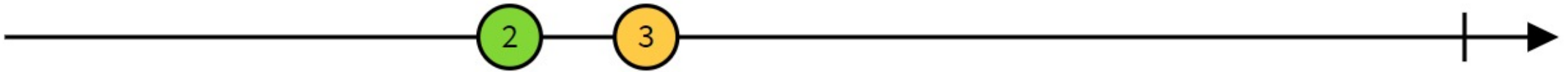
merge



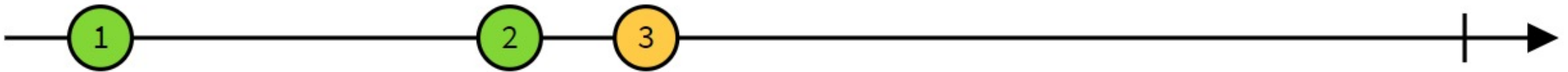
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`startWith(1)`



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# Lab/Demo

Combine Streams



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# Higher Order Observables



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# Operators for Higher Order Observables

- mergeMap
  - merges outer (source) and inner observables
- exhaustMap
  - outer is ignored until inner is finished
- switchMap
  - inner will be completed after next outer
- concatMap
  - outer will be sent after inner is finished



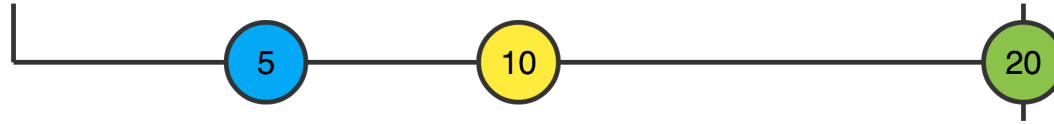
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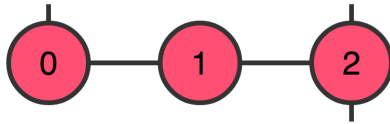
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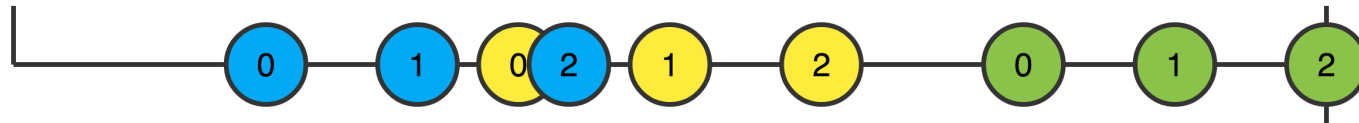
[source\$] A stream that emits at [5ms, 10ms, 20ms]



[target\$] will be mapped to a timer that emits at [N+0ms, N+3ms, N+6ms]



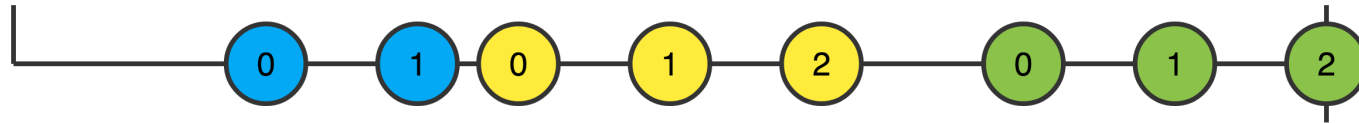
mergeMap



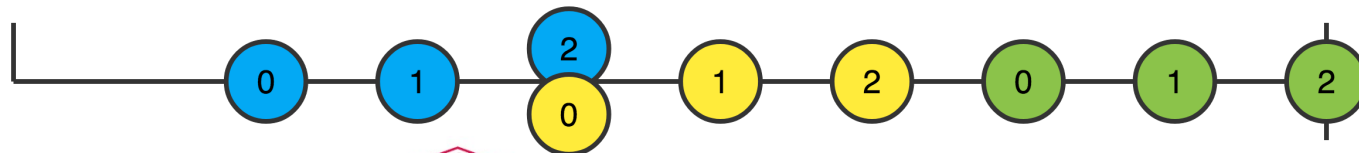
exhaustMap



switchMap



concatMap



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# Error Handling



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# Operators for Error Handling

- catchError
- retry
- retryWhen
  
- throwError

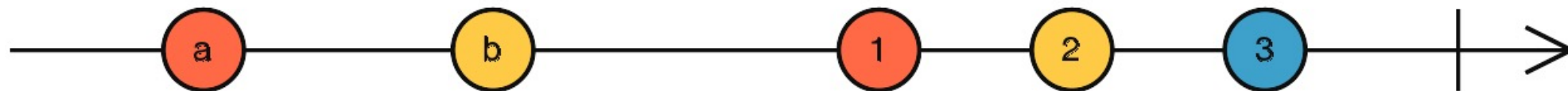
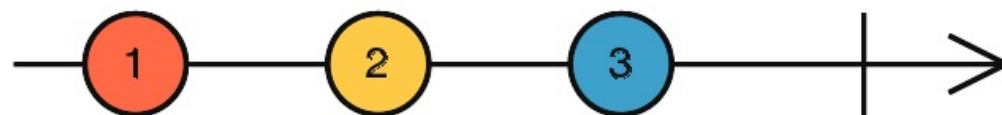


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# Lab/Demo

Error Handling



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# Subjects

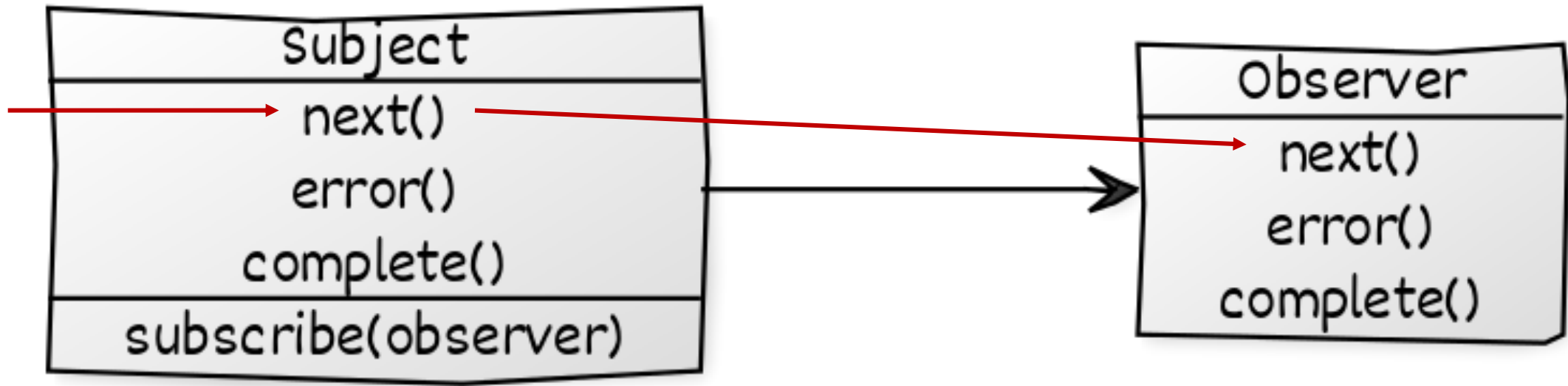


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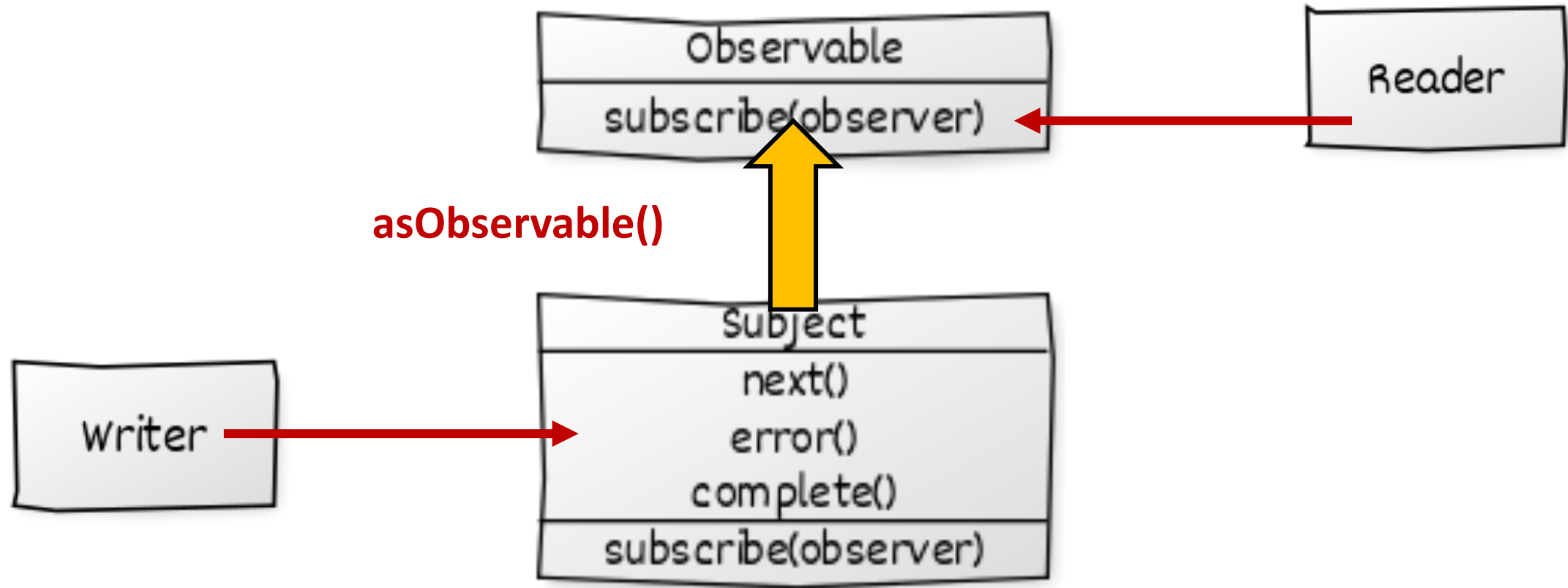


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# Subjects: Special Observables



# Convert Subject into Observable



# asObservable

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

```
[...]  
this.observable.subscribe(...)
```

```
[...]  
this.subject.next(...)
```

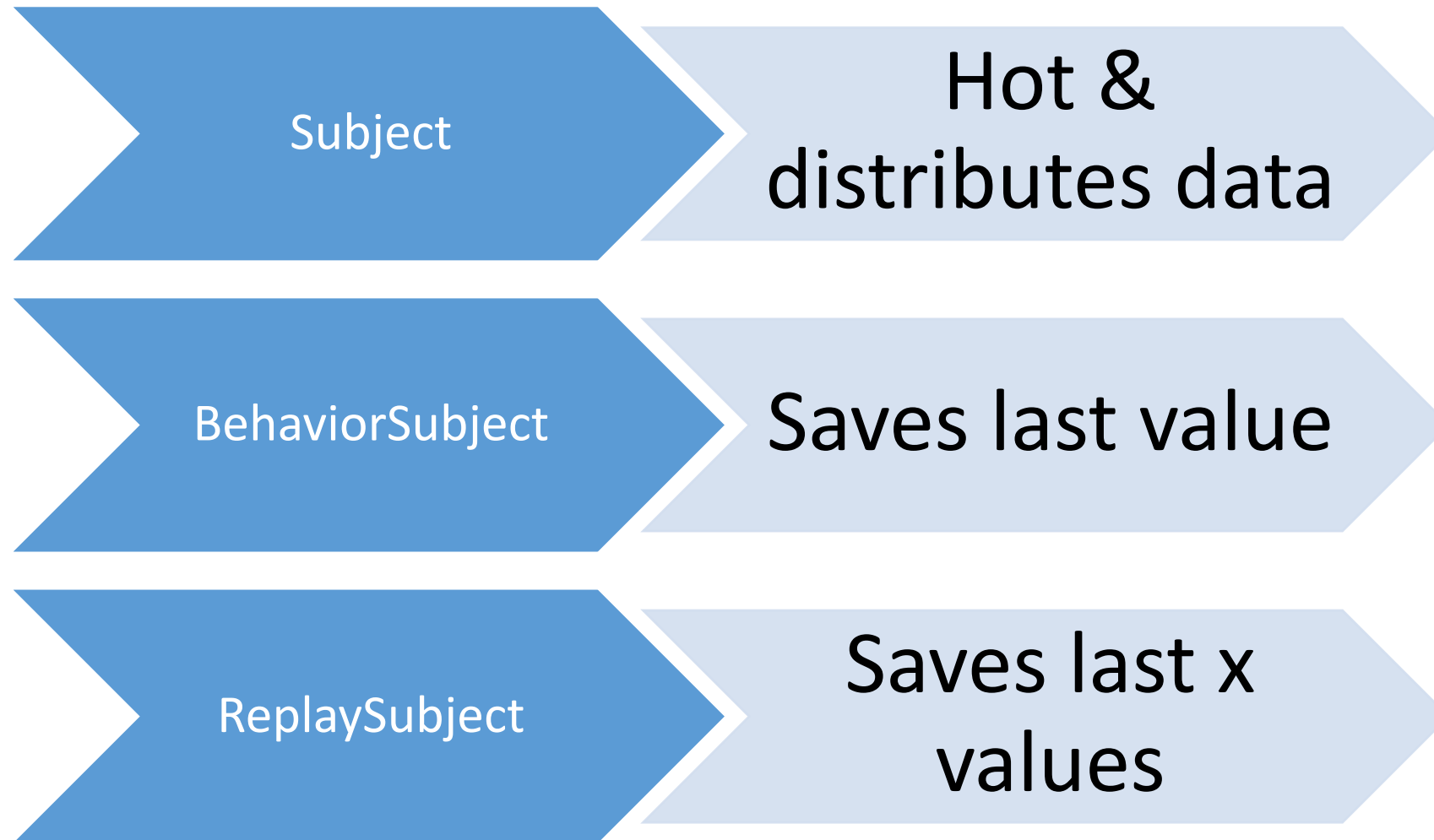


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# Subjects



# Closing Observables



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# Closing Observables

- Explicitly
  - let subscription = observable\$.subscribe(...);  
subscription.**unsubscribe()**;
- Implicitly
  - observable\$.pipe(**take(2)**).subscribe(...);
  - observable\$.pipe(**first()**).subscribe(...);
  - observable\$.pipe(**takeUntil(otherSubject)**).subscribe(...);
- Implicitly with async-Pipe in Angular
  - {{ observable\$ | **async** }}
- Automatic by Angular
  - Everything, Angular opens is also closed by it



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# Like this topic?

- Marble Diagrams
  - <http://rxmarbles.com>
- Other Links
  - <https://rxjs.dev/guide/overview>
    - <https://reactive.how/rxjs/>
  - <https://www.learnrxjs.io/>
  - <https://angular.io/guide/rx-library>
- Official documentation
  - <http://reactivex.io/rxjs/class/es6/Observable.js~Observable.html>



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