Angular and The Case for RxJS

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PRX

Observable (not a spicy Promise)

- Multiple values over time
- Cancellable with unsubscribe
- Synchronous or asynchronous
- Declarative: what, not how or when
- Nothing happens without an observer
- Separate chaining and subscription
- Can be reused or retried

	Observable (lazy)	Promise (eager)
Create:	`new Observable((observer) => observer.next(123));`	`new Promise((resolve, reject) => resolve(123));`
Transform:	`obs$.pipe(map((value) => value * 2));`	`promise.then((value) => value * 2);`
Subscribe:	`sub = obs$.subscribe((value) => console.log(value));`	`promise.then((value) => console.log(value));`
Unsubscribe:	`sub.unsubscribe();`	`// implied by promise resolution`

https://angular.io/guide/comparing-observables#cheat-sheet

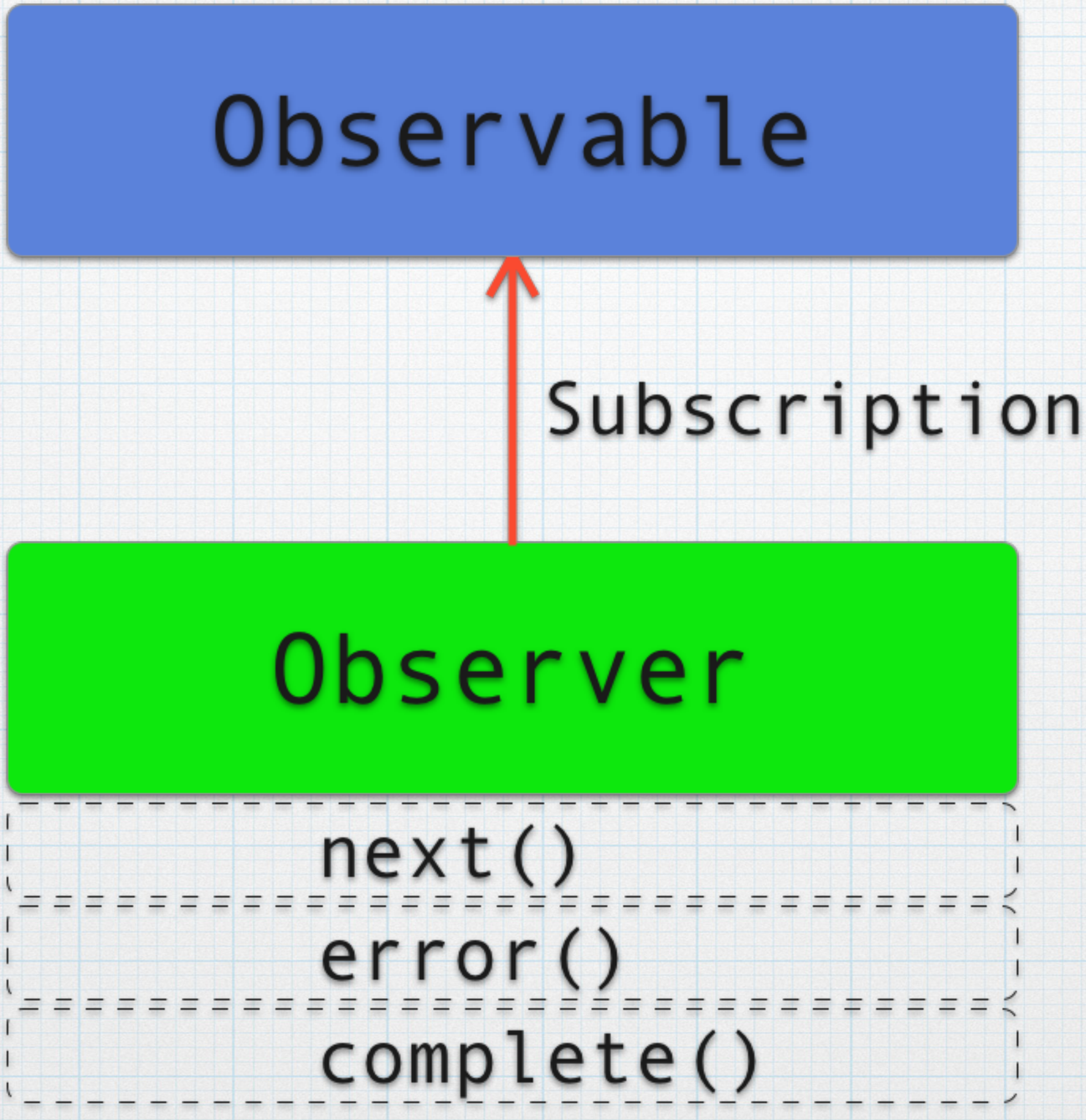
Observable

```
const clicks$ = fromEvent(button, 'click');
const subscription = clicks$.subscribe(event => console.log('Clicked', event));
subscription.unsubscribe();
```

Event

```
button.addEventListener('click', e => console.log('Clicked', e));
button.removeEventListener('click');
```

https://angular.io/guide/comparing-observables#observables-compared-to-events-api


Observable
Subscription
Observer
next()
error()
complete()

Observable

a function that takes an observer

```
const subscription = observable.subscribe(observer);

subscription.unsubscribe();
```

Observer

an object with `next`, `error`, and `complete` methods

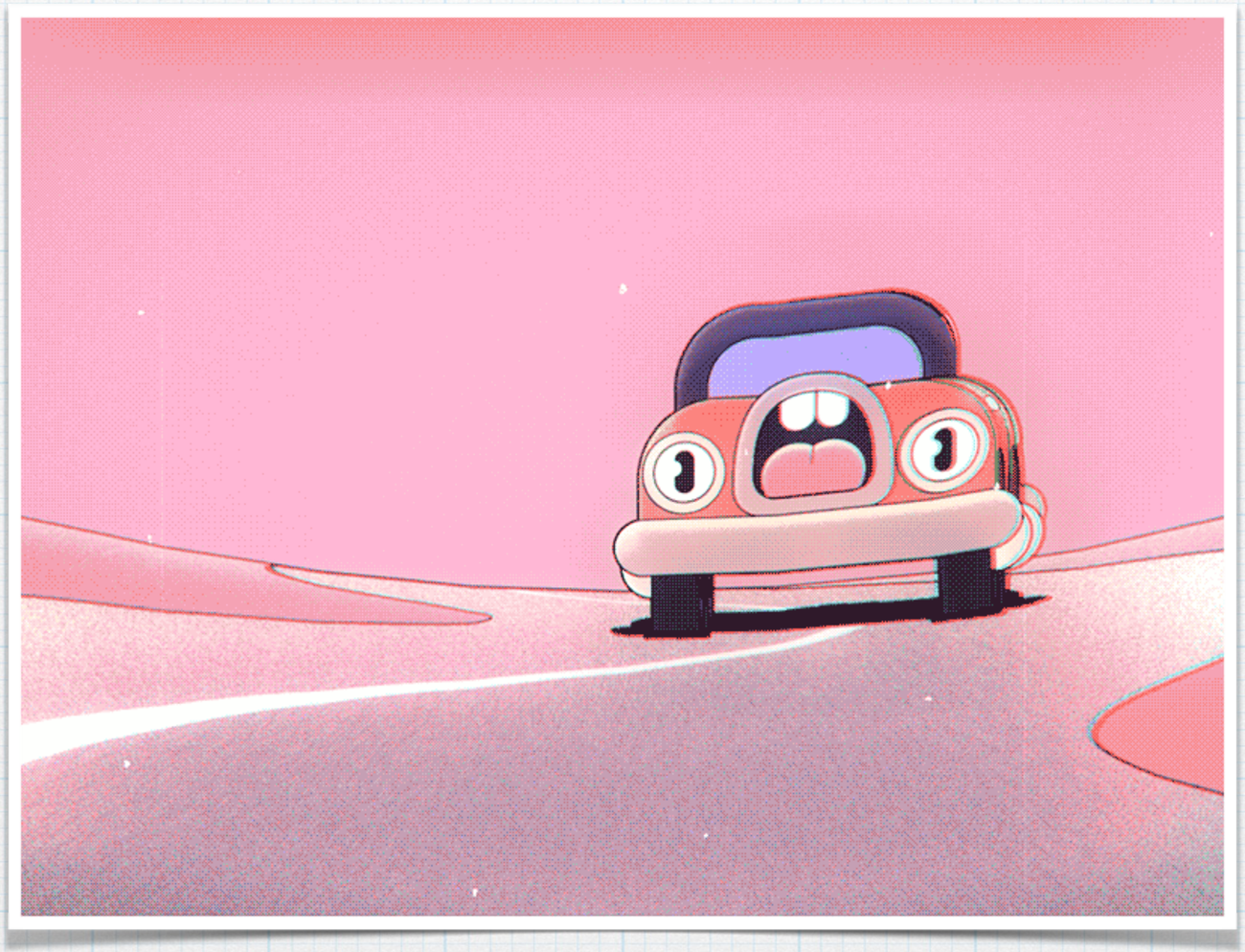
```
const observer = {
  next: value => console.log('Next value:', value),
  error: err => console.error('Error:', err),
  complete: () => console.log('Complete')
};

const subscription = observable.subscribe(observer);
```

Subscription

an Observable only produces values on `subscribe()`

A long time ago,
We used to be friends,
But I haven't thought of
you lately at all...



TERMINATION IS NOT GUARANTEED

Ben Lesh Follow
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COLD is when your observable creates the producer

```
// COLD
var cold = new Observable((observer) => {
  var producer = new Producer();
  // have observer listen to producer here
});
```

HOT is when your observable closes over the producer

```
// HOT
var producer = new Producer();
var hot = new Observable((observer) => {
  // have observer listen to producer here
});
```

https://medium.com/@benlesh/hot-vs-cold-observables-f8094ed53339

Ben Lesh Follow

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...

```
const source = new Observable((observer) => {
  const socket = new WebSocket('ws://someurl');
  socket.addEventListener('message', (e) => observer.next(e));
  return () => socket.close();
});
```

https://medium.com/@benlesh/hot-vs-cold-observables-f8094ed53339

COLD OBSERVABLES

The producer is created during the subscription

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...

```
const socket = new WebSocket('ws://someurl');

const source = new Observable((observer) => {
  socket.addEventListener('message', (e) => observer.next(e));
});
```

https://medium.com/@benlesh/hot-vs-cold-observables-f8094ed53339

HOT OBSERVABLES

The producer is created outside the subscription

Ben Lesh Follow

Mar 28, 2016 · 6 min read

...

```
function makeHot(cold) {
  const subject = new Subject();
  cold.subscribe(subject);
  return new Observable((observer) => subject.subscribe(observer));
}
```

https://medium.com/@benlesh/hot-vs-cold-observables-f8094ed53339

SUBJECT: both an observable and an observer

Make a cold Observable hot

be [bee; *unstressed* bee, bi] SHOW IPA

WORD ORIGIN

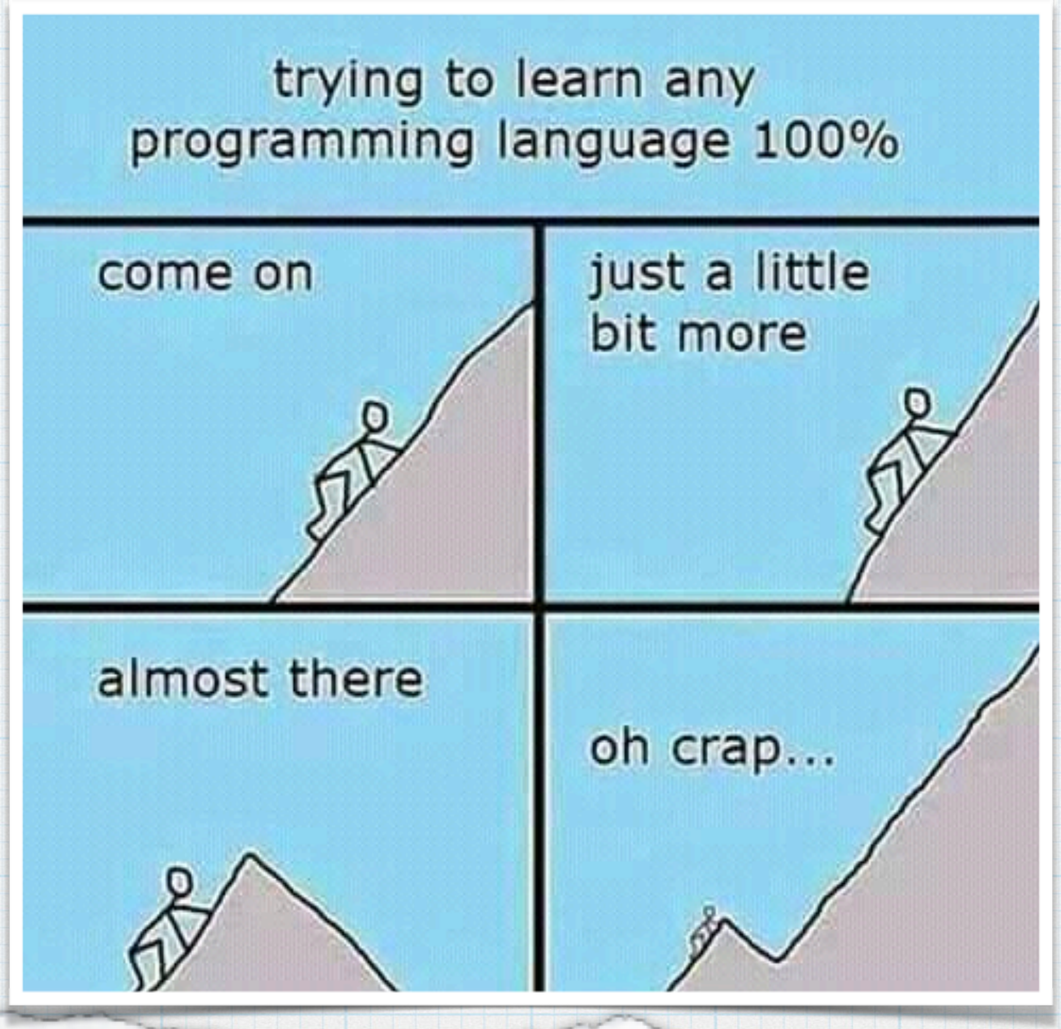
SEE MORE SYNONYMS FOR *be* ON THESAURUS.COM

verb (used without object), present singular 1st person **am,** *2nd* **are** or (*Archaic*) **art,** *3rd* **is,** *present plural* **are;** *past singular 1st person* **was,** *2nd* **were** or (*Archaic*) **wast** or **wert,** *3rd* **was,** *past plural* **were;** *present subjunctive* **be;** *past subjunctive singular 1st person* **were,** *2nd* **were** or (*Archaic*) **wert,** *3rd* **were;** *past subjunctive plural* **were;** *past participle* **been;** *present participle* **be·ing.**

1. to exist or live:
   Shakespeare's "To be or not to be" is the ultimate question.
2. to take place; happen; occur:
   The wedding was last week.
3. to occupy a place or position:
   The book is on the table.
4. to continue or remain as before:
   Let things be.

SUBJECT HAS STATE

Keeps a list of observers and sometimes also a number of the values that have been emitted



RxJS

STEEP LEARNING CURVE

```
@Injectable()
export class TodoStoreService {

  private _todos: BehaviorSubject<Todo[]> = new BehaviorSubject([]);

  constructor(private todoHTTP: TodoHttpService) {
    this.loadData();
  }

  get todos(): Observable<Todo[]> {
    return this._todos.asObservable();
  }

  loadData() {
    this.todoAPI.getTodos()
      .subscribe(
          todos => this._todos.next(todos),
          err => console.log('Error retrieving Todos’)
      );
  }
}
```

https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/store/todo-store.service.ts

STORE: OBSERVABLE DATA SERVICE

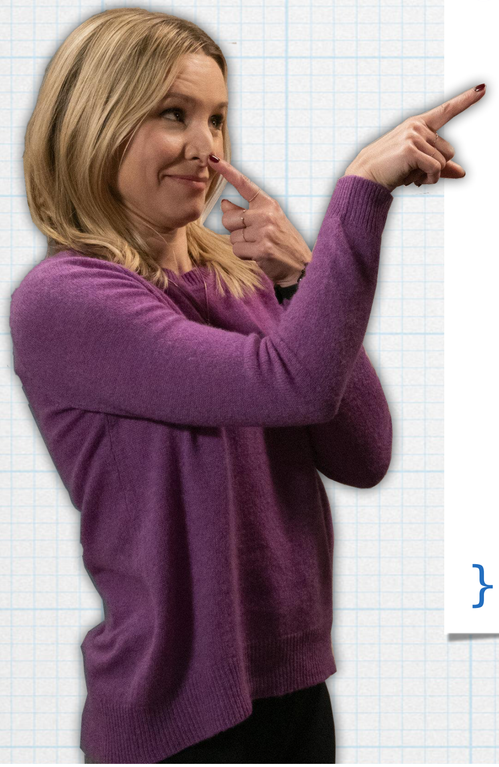
Provide data to multiple parts of an application

```
const subject = new BehaviorSubject(initialValue);

// some time later…

const value = subject.getValue();
```

https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-behavior-subject-getvalue-ts

BehaviorSubject

Just because you can access the value directly...



```
@Injectable()
export class TodoStoreService {

  private _todo: BehaviorSubject<Todo[]> = new BehaviorSubject([]);

  constructor(private todoAPI: TodoHttpService) {
    this.loadData();
  }

  get todos(): Observable<Todo[]> {
    return this._todos.asObservable();
  }
}
```

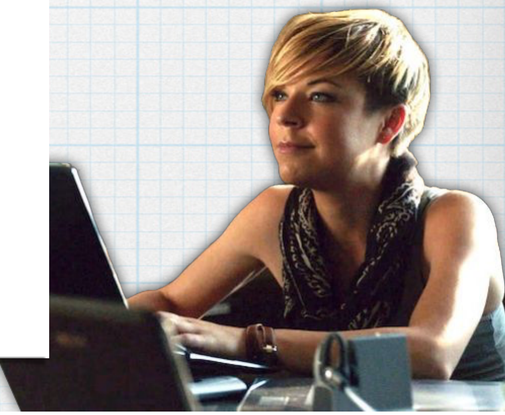
https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/store/todo-store.service.ts

PROTECT THE BehaviorSubject WITH asObservable()

Components can subscribe after the data arrives

```
@Component({
  selector: 'app-todo-list',
  template: `
    <ul>
      <app-todo-list-item
        *ngFor="let todo of todos"
        [todo]="todo">
      </app-todo-list-item>
    </ul>
  `
})
export class TodoListComponent implements OnInit, OnDestroy {
  todos: Todo[];
  todosSub: Subscription;

  constructor (private todoStore: TodoStoreService) {}

  ngOnInit() {
    this.todosSub = this.todoStore.todos.subscribe(todos => {
      this.todos = todos;
    });
  }

  ngOnDestroy() {
    this.todosSub.unsubscribe();
  }
}
```

```
@Component({
  selector: 'app-todo-list',
  template: `
    <ul>
      <app-todo-list-item
        *ngFor="let todo of todos$ | async"
        [todo]="todo">
      </app-todo-list-item>
    </ul>
  `
})
export class TodoListComponent {
  todos$: Observable<Todo[]> = this.todoStore.todos;

  constructor (private todoStore: TodoStoreService) {}
}
```



https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/components/todo-list.component.ts

USE THE ASYNC PIPE TO AVOID MEMORY LEAKS

Subscriptions live until a stream is completed or until they are manually unsubscribed

Dan Abramov Retweeted

Justin Falcone
@modernserf

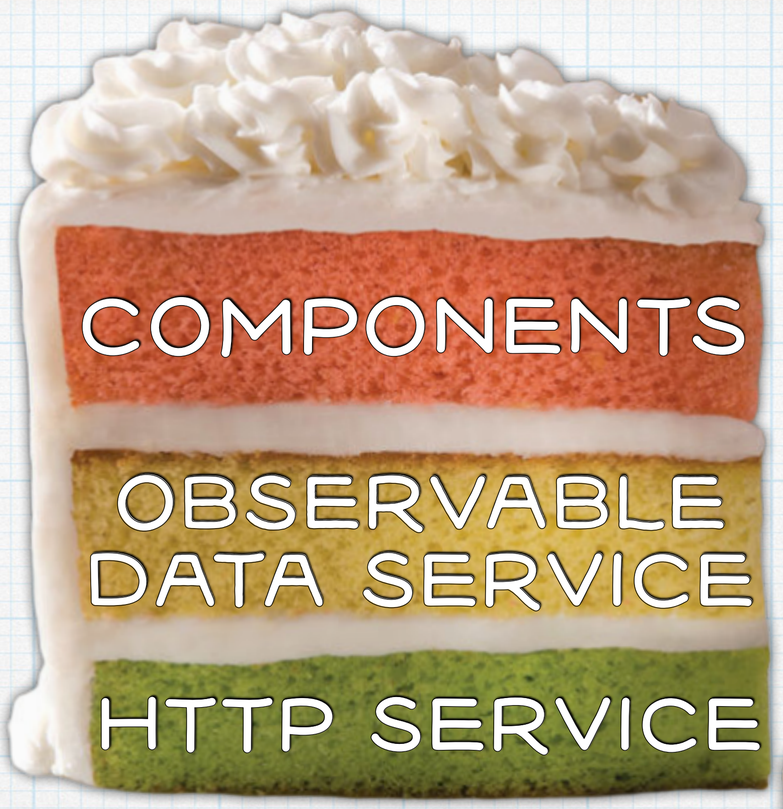
separation of concerns

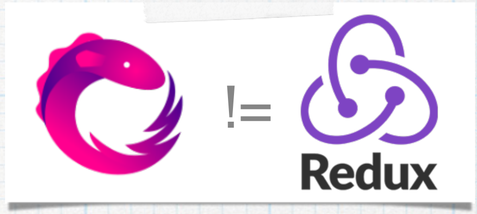
4:06 PM · 6/6/19 · Twitter for iPad

17 Retweets **124** Likes

Justin Falcone @modernserf · 6d
Replying to @modernserf

though I guess the react version of this is a little bit of meatloaf + green bean + brownie in each cell of a pillminder





* Decouple responsibilities
* Observable Data Service
  * Provide data to multiple parts of an application
  * Not the same as centralized state management

```
addTodo(newTodo: Todo): Observable<Todo> {
  const observable = this.todoAPI.saveTodo(newTodo);

  observable.pipe(
    withLatestFrom(this.todos),
  ).subscribe(( [savedTodo, todos] ) => {
    this._todos.next(todos.concat(savedTodo));
  });

  return observable;
}
```

https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/store/todo-store.service.ts

STORE: OBSERVABLE DATA SERVICE

Action method updates the store on success

```
addTodo(newTodo: Todo): Observable<Todo> {
  const observable = this.todoAPI.saveTodo(newTodo);

  observable.pipe(
    withLatestFrom(this.todos),
  ).subscribe(( [savedTodo, todos] ) => {
    this._todos.next(todos.concat(savedTodo));
  });

  return observable;
}
```

https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/store/todo-store.service.ts

HTTP OBSERVABLES ARE COLD

Avoid duplicating HTTP requests!

```
@Injectable()
export class TodoHttpService {
  base = 'http://localhost:3000/todos';

  constructor(private http: HttpClient) { }

  getTodos(): Observable<Todo[]> {
    return this.http.get<Todo[]>(this.base);
  }

  saveTodo(newTodo: Todo): Observable<Todo> {
    return this.http.post<Todo>(this.base, newTodo, {headers}).pipe(share());
  }
}
```

https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/http/todo-http.service.ts

HTTP SERVICE

`share()` makes a cold Observable hot

OPERATORS

Compose complex asynchronous code in a declarative manner

Pipeable Operators: take an input Observable and generate a resulting output Observable

Examples: `filter`, `map`, `mergeMap`

Creation Operators: standalone functions to create a new Observable

Examples: `interval`, `of`, `fromEvent`, `concat`

```
@Injectable()
export class TodoHttpService {
  base = 'http://localhost:3000/todos';

  constructor(private http: HttpClient) { }

  getTodos(): Observable<Todo[]> {
    return this.http.get<Todo[]>(this.base);
  }

  saveTodo(newTodo: Todo): Observable<Todo> {
    return this.http.post<Todo>(this.base, newTodo, {headers}).pipe(share());
  }
}
```

https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/http/todo-http.service.ts

share() : refCount

share() also makes Observables retry-able

🔥 HOT: SHARE THE EXECUTION

⛄ COLD: INVOKE THE EXECUTION

```
@Component({
  selector: 'app-todo',
  template: `
    Total #: {{ total$ | async }}
    <app-todo-list [todos]="todos$ | async"></app-todo-list>
  `
})
export class DuplicateHttpTodoComponent {
  todos$ = this.http.get<Todo[]>('http://localhost:3000/todos');
  total$ = this.todos$.pipe(map(todos => todos.length));

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

https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-duplicate-http-component-ts

async : Unsubscribes automatically

But still be sure to avoid duplicating HTTP requests!

```
@Component({
  selector: 'app-todo',
  template: `
    <ng-container *ngIf="todos$ | async as todos">
      Total #: {{ todos.length }}
      <app-todo-list [todos]="todos"></app-todo-list>
    </ng-container>
  `
})
export class TodoComponent {
  todos$ = this.http.get<Todo[]>('http://localhost:3000/todos');

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

https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-async-as-component-ts

ngIf with | async as

Assign Observable values to a local variable

```
@Component({
  selector: 'app-todo',
  template: `
    <ng-container *ngIf="todos$ | async as todos; else loading">
      Total #: {{ todos.length }}
      <app-todo-list [todos]="todos"></app-todo-list>
    </ng-container>
    <ng-template #loading><p>Loading...</p></ng-template>
  `
})
export class TodoComponent {
  todos$ = this.http.get<Todo[]>('http://localhost:3000/todos');

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

https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-async-as-else-component-ts

ngIf with | async as with ;ngElse

Show alternate block when Observable has no value

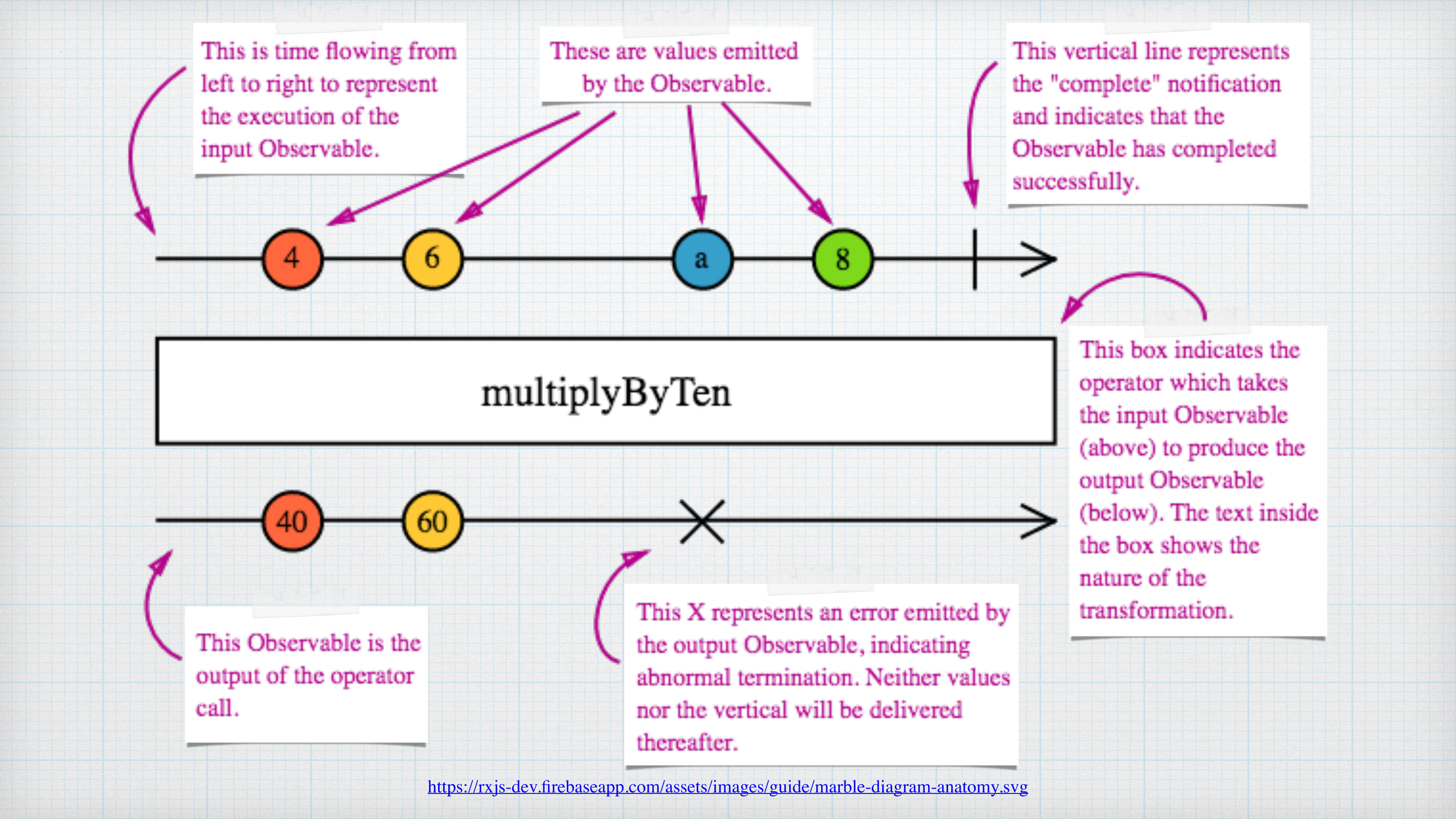
🤘 REACTIVE TEMPLATES 🤘

```
import { map, filter, scan } from 'rxjs/operators';
import { range } from 'rxjs';

const source$ = range(0, 10);

source$.pipe(
  filter(x => x % 2 === 0),
  map(x => x + x),
  scan((acc, x) => acc + x, 0)
).subscribe(x => console.log(x));
```

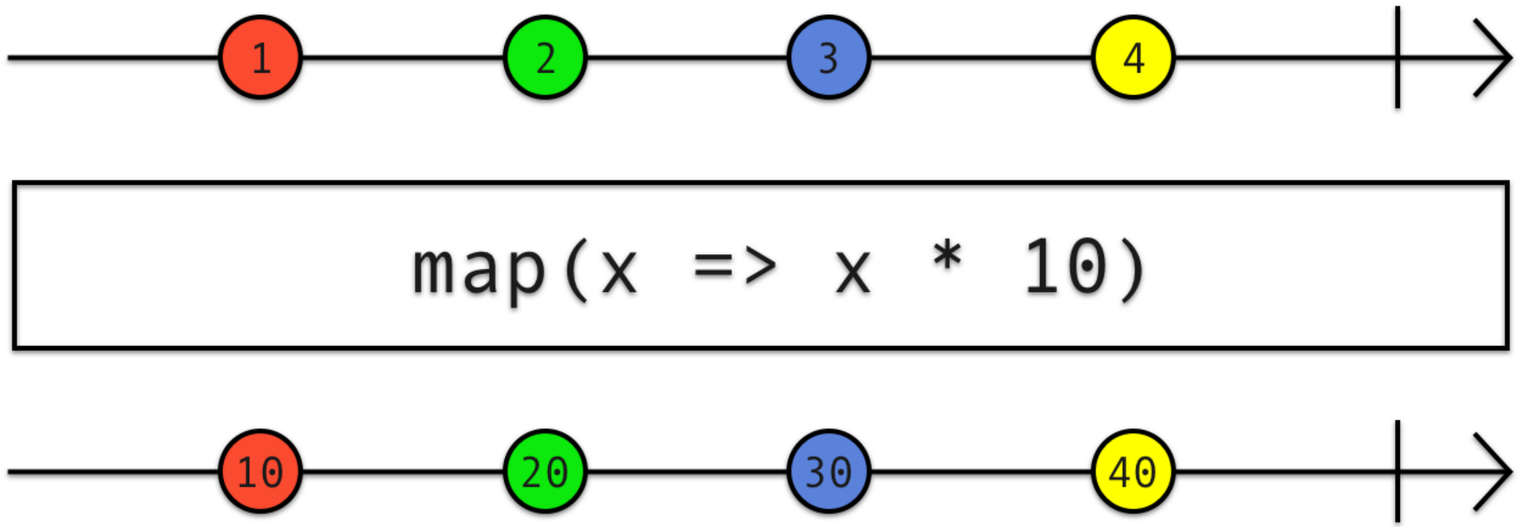
https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-pipe-ts

Observable.prototype.pipe()

Compose a series of operators



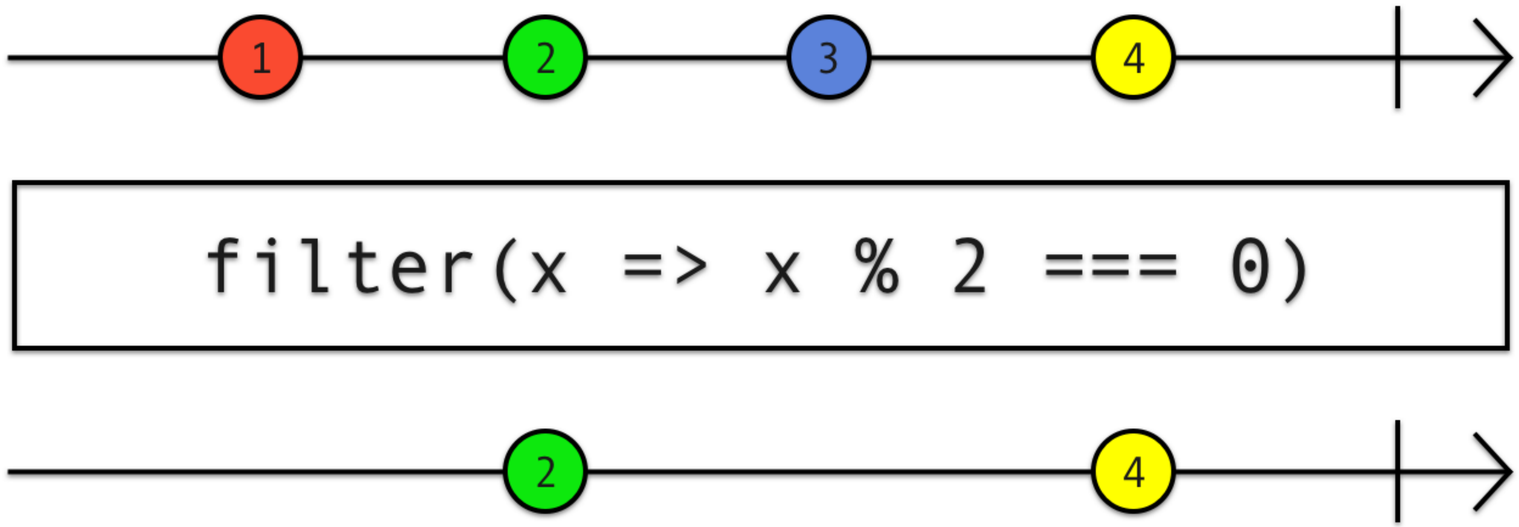
https://rxjs-dev.firebaseapp.com/assets/images/guide/marble-diagram-anatomy.svg



map()

A TRANSFORMATIONAL OPERATOR

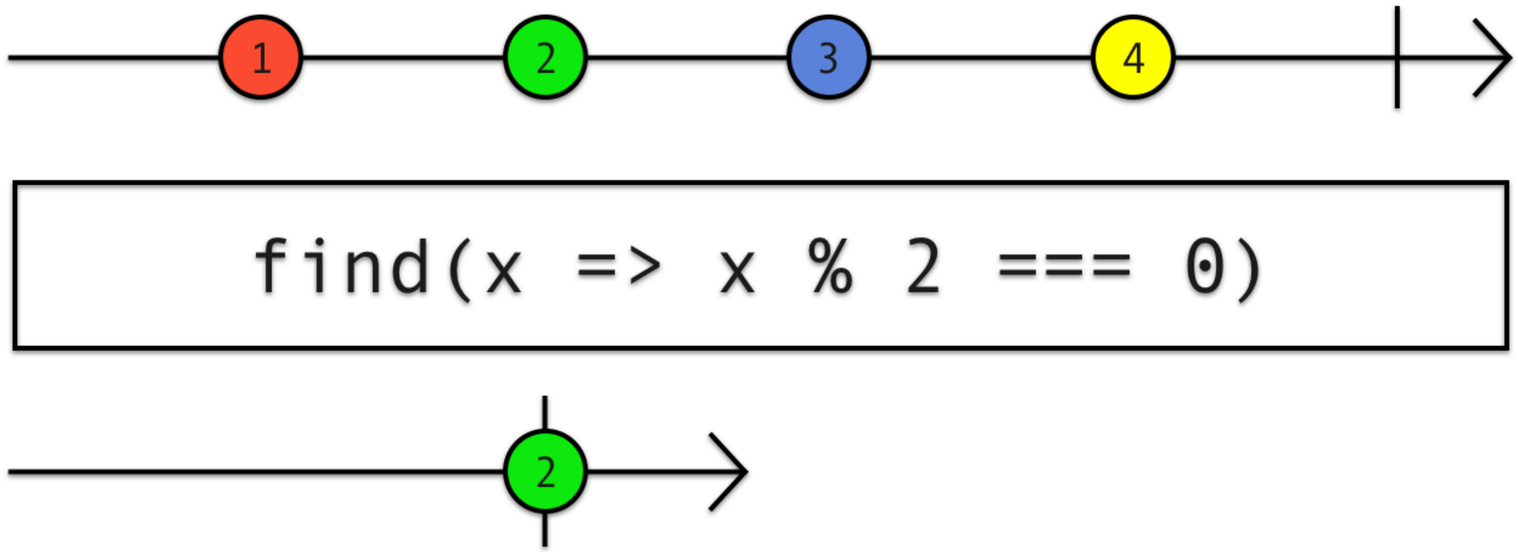
Applies a projection to each value



filter()

ONE OF MANY FILTERING OPERATORS

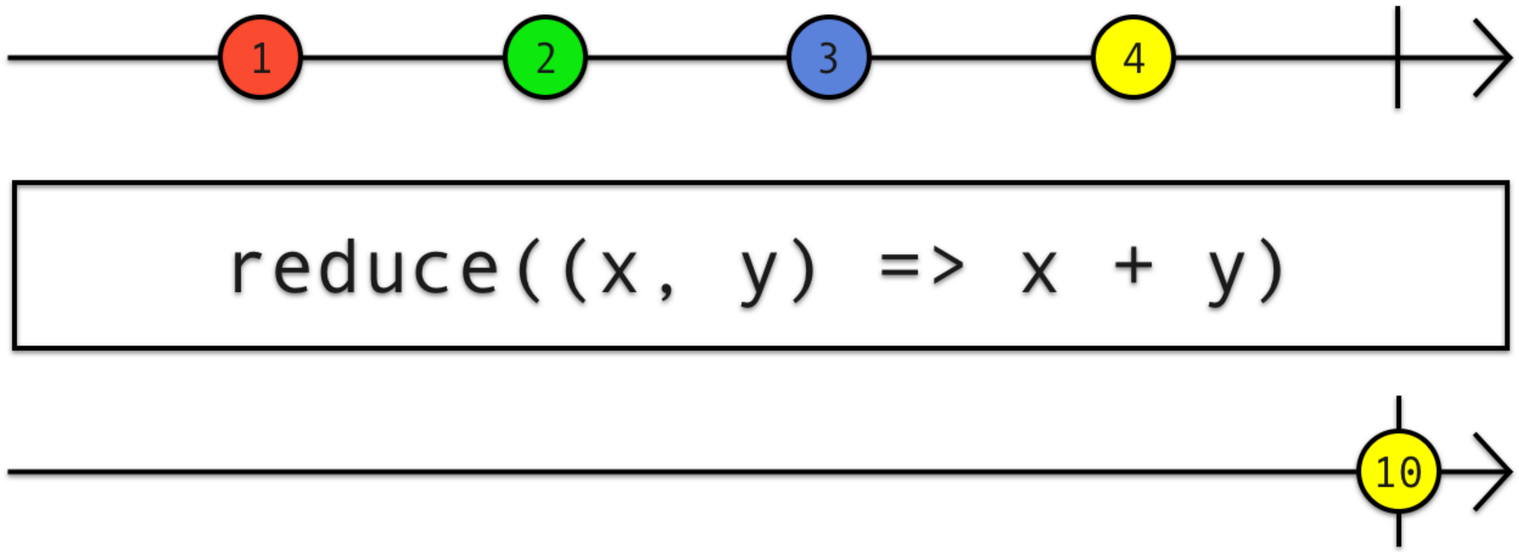
Filters items emitted from source



find()

A CONDITIONAL OPERATOR

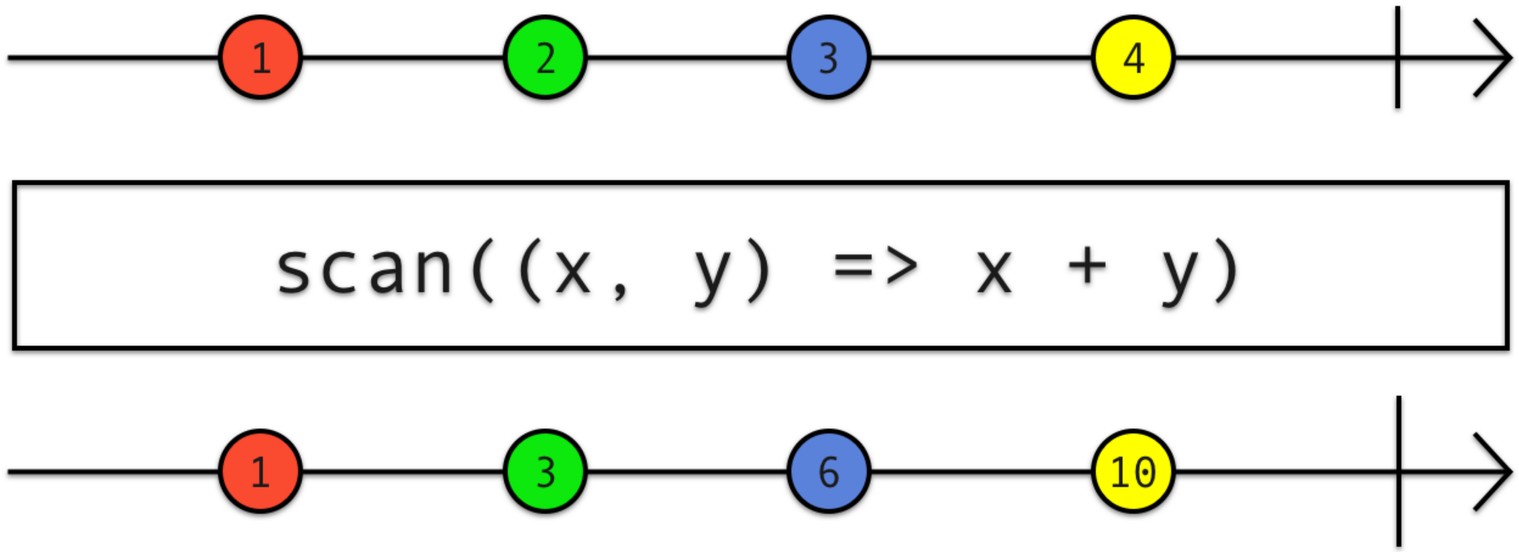
Finds the first match then completes



reduce()

AN AGGREGATE OPERATOR

Emits aggregate result on completion



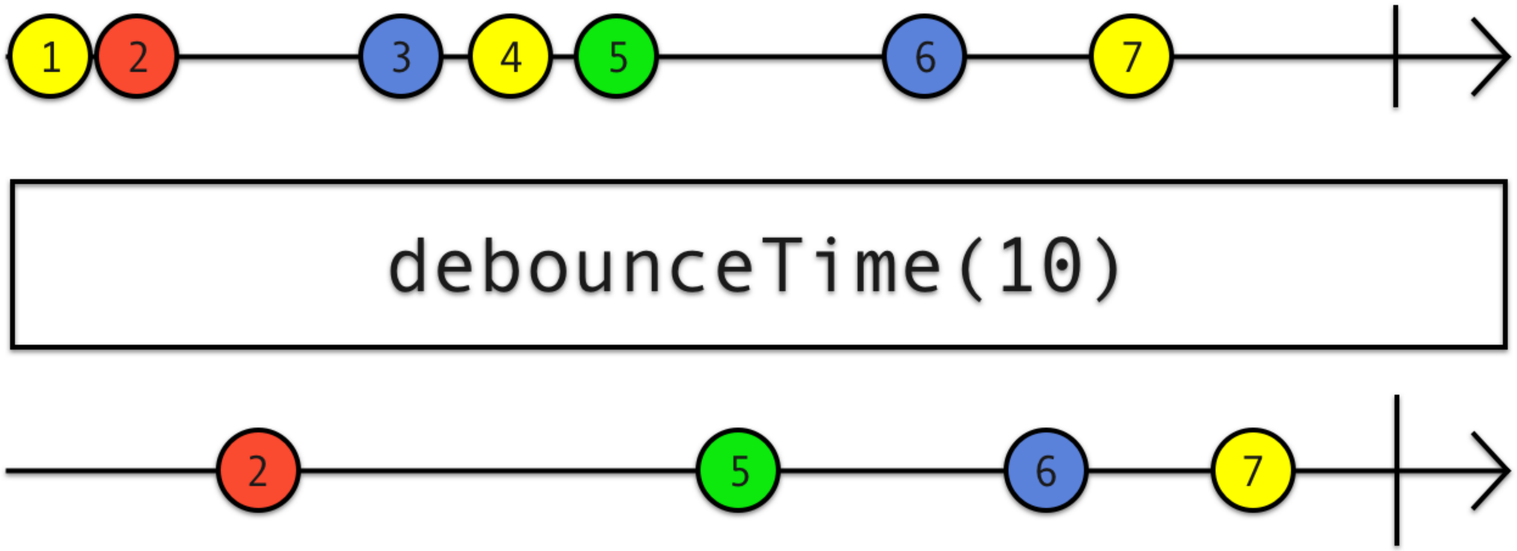
scan()

A TRANSFORMATIONAL OPERATOR

Emits accumulated result at each interval

```
@Component({
  selector: 'app-todo-search',
  template: `
    <label for="search">Search: </label>
    <input id="search" (keyup)="onSearch($event.target.value)"/>
  `
})
export class TodoSearchComponent implements OnInit, OnDestroy {
  @Output() search = new EventEmitter<string>();

  changeSub: Subscription;
  searchStream = new Subject<string>();

  ngOnInit() {
    this.changeSub = this.searchStream.pipe(
      filter(searchText => searchText.length > 2), // min length
      debounceTime(300), // wait for break in keystrokes
      distinctUntilChanged() // only if value changes
    ).subscribe(searchText => this.search.emit(searchText));
  }

  ngOnDestroy() {
    if (this.changeSub) { this.changeSub.unsubscribe(); }
  }

  onSearch(searchText: string) {
    this.searchStream.next(searchText);
  }
}
```

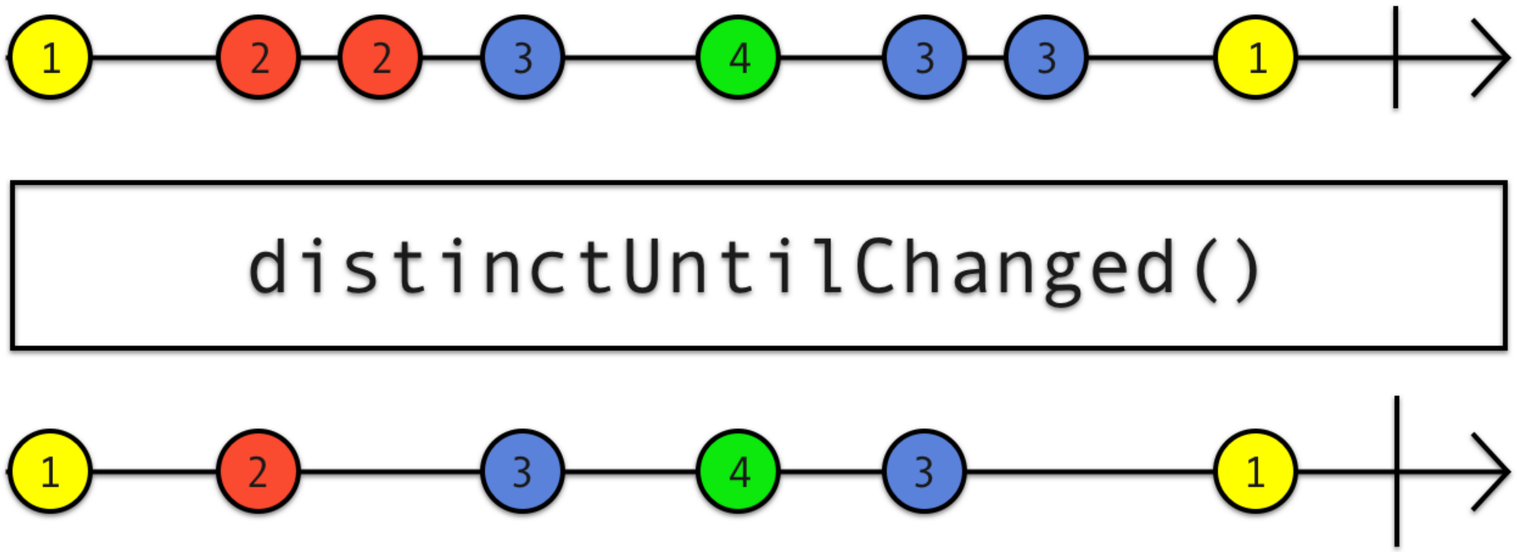
https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/components/todo-search.component.ts



debounceTime()

A FILTERING OPERATOR

Rate-limit the input and delay the output



distinctUntilChanged()

A FILTERING OPERATOR

Emits values that are distinct from the previous value

```
export class TodoEditComponent implements OnInit {
  todo: Todo;

  constructor(private todoStore: TodoStoreService,
              private route: ActivatedRoute,
              private router: Router) {}

  ngOnInit() {
    this.route.params.subscribe(params => {
      const id = +params['id'];
      this.todoStore.todos.subscribe((todos: Todo[]) => {
        this.todo = todos.find(todo => todo.id === id);
      });
    });
  }
}
```

AVOID NESTED SUBSCRIPTIONS

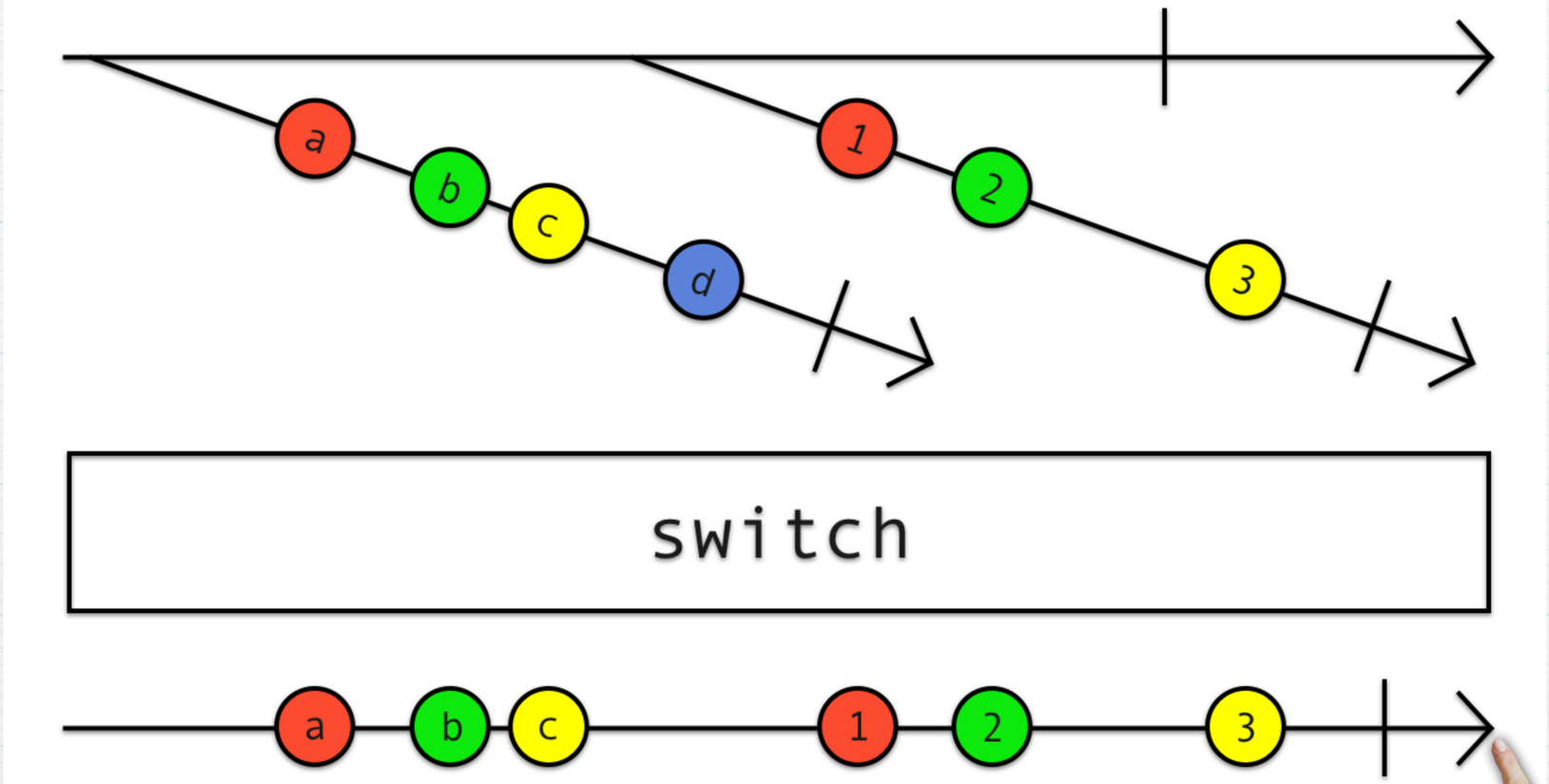
pyramid shaped callback hell

```
export class TodoEditComponent {
  todo$: Observable<Todo> = this.route.params.pipe(
    map(params => +params['id']),
    switchMap(id => this.todoStore.getTodoById(id))
  );

  constructor(private todoStore: TodoStoreService,
              private route: ActivatedRoute,
              private router: Router) {}
}
```

https://github.com/sandikbarr/rxjs-todo/blob/master/src/app/todo/components/edit/todo-edit.component.ts

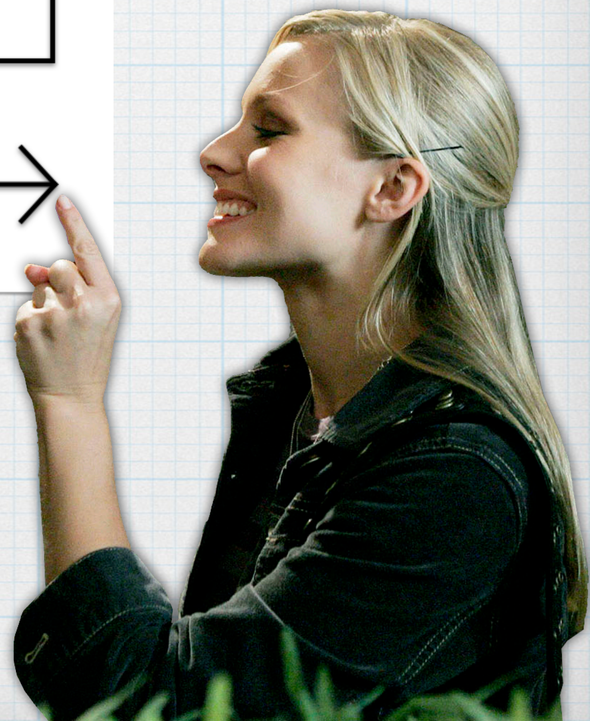
HIGHER-ORDER OBSERVABLES

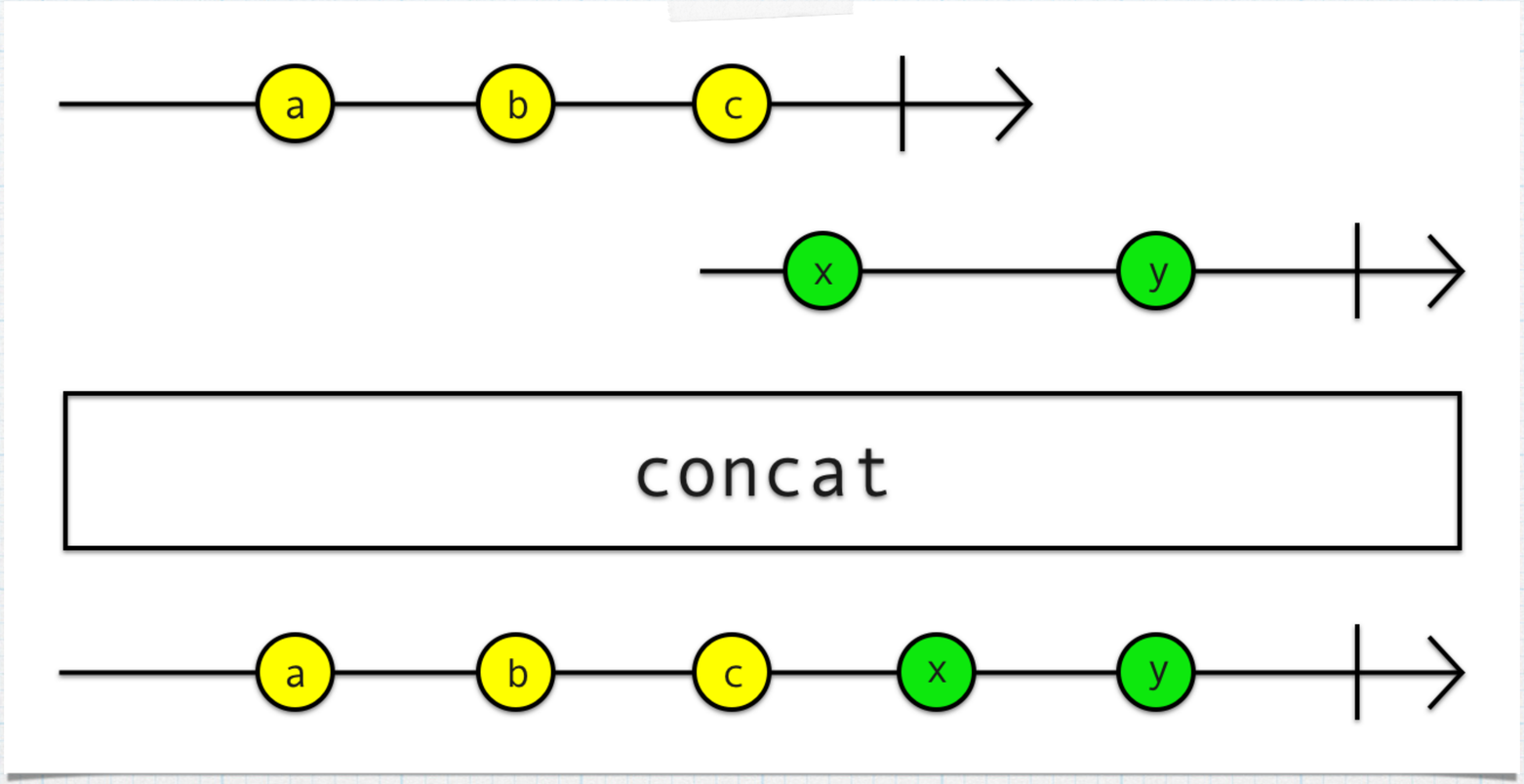
Observables that emit other Observables



SWITCH

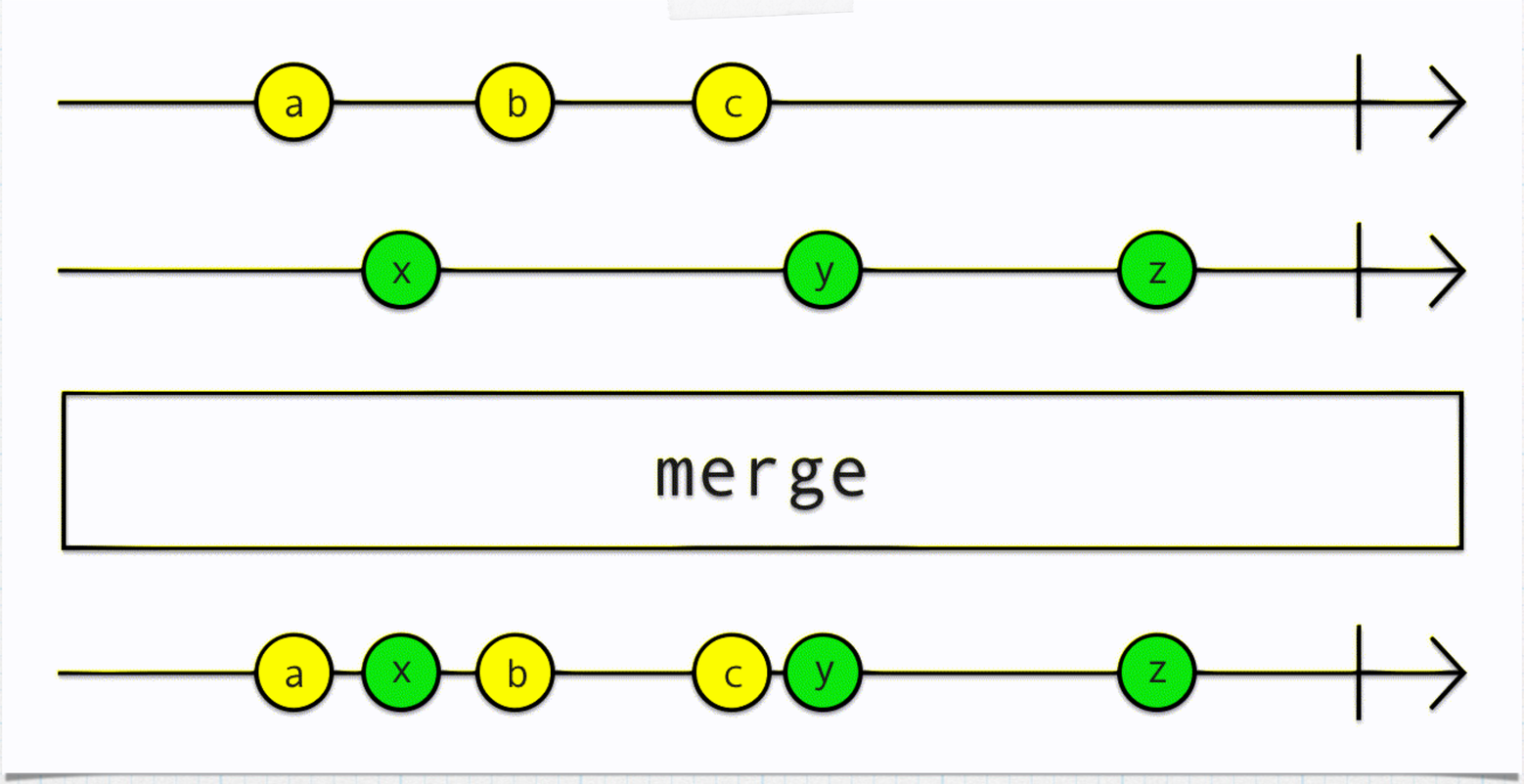
Cancels inner Observables





CONCAT

Waits for inner Observables to complete



MERGE

Subscribe to multiple inner Observables at a time

```
// using map with nested subscribe
from([1, 2, 3, 4]).pipe(
  map(param => getData(param))
).subscribe(val => val.subscribe(data => console.log(data)));

// using map and mergeAll
from([1, 2, 3, 4]).pipe(
  map(param => getData(param)),
  mergeAll()
).subscribe(val => console.log(val));

// using mergeMap
from([1, 2, 3, 4]).pipe(
  mergeMap(param => getData(param))
).subscribe(val => console.log(val));
```

https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-map-mergeall-mergemap-ts

mergeMap()

HIGHER-ORDER TRANSFORMATION OPERATOR

Projects each source value into an Observable that is merged into the output Observable

```
combineLatest( [notifications$, otherPrimaryActiities$] )
  .subscribe({
    next: ( [notification, otherPrimaryActivity] ) => {
      // fires whenever notifications$ _or_ otherPrimaryActivities$ updates
    }
  });

notifications$.pipe( withLatestFrom(mostRecentUpdates$) )
  .subscribe({
    next: ( [notification, mostRecentUpdate] ) => {
      // fires only when notifications$ updates and includes latest from mostRecentUpdates$
    }
  });
```

https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-combinelatest-withlatestfrom-ts

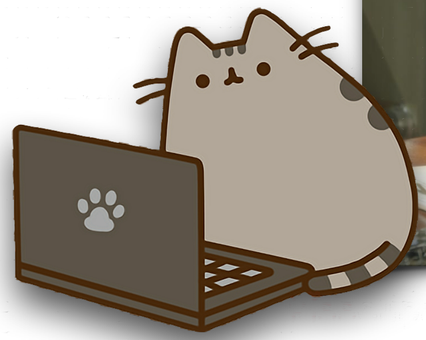
combineLatest()

Updates from the latest values of each input Observable

withLatestFrom()

Also provide the latest value from another Observable

```ts
@Component({
  selector: 'app-many-subscriptions',
  template: `<p>value 1: {{value1}}</p>
             <p>value 2: {{value2}}</p>
             <p>value 3: {{value3}}</p>`
})
export class SubscriberComponent implements OnInit, OnDestroy {
  value1: number;
  value2: number;
  value3: number;

  destroySubject$: Subject<void> = new Subject();

  constructor(private service: MyService) {}

  ngOnInit() {
    this.service.value1.pipe(
      takeUntil(this.destroySubject$)
    ).subscribe(value => {
      this.value1 = value;
    });
    this.service.value2.pipe(
      takeUntil(this.destroySubject$)
    ).subscribe(value => {
      this.value2 = value;
    });
    this.service.value3.pipe(
      takeUntil(this.destroySubject$)
    ).subscribe(value => {
      this.value3 = value;
    });
  }

  ngOnDestroy() {
    this.destroySubject$.next();
  }
}
```

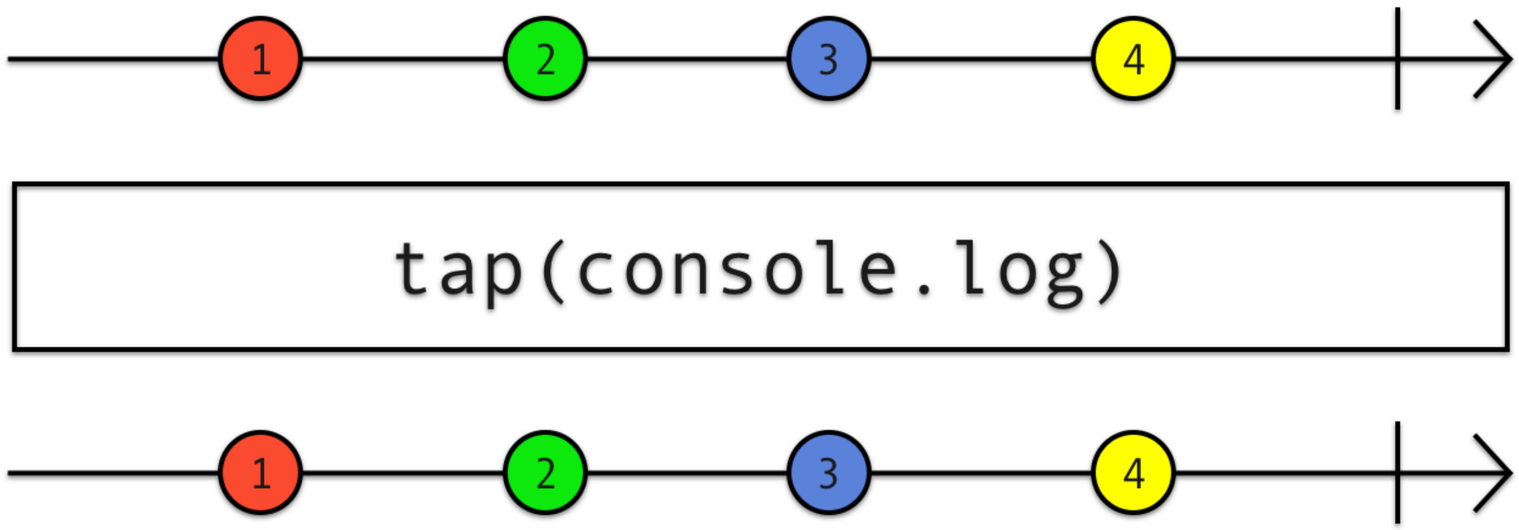


USE A SUBJECT TO COMPLETE STREAMS

with this one weird trick

Always Bring Backup

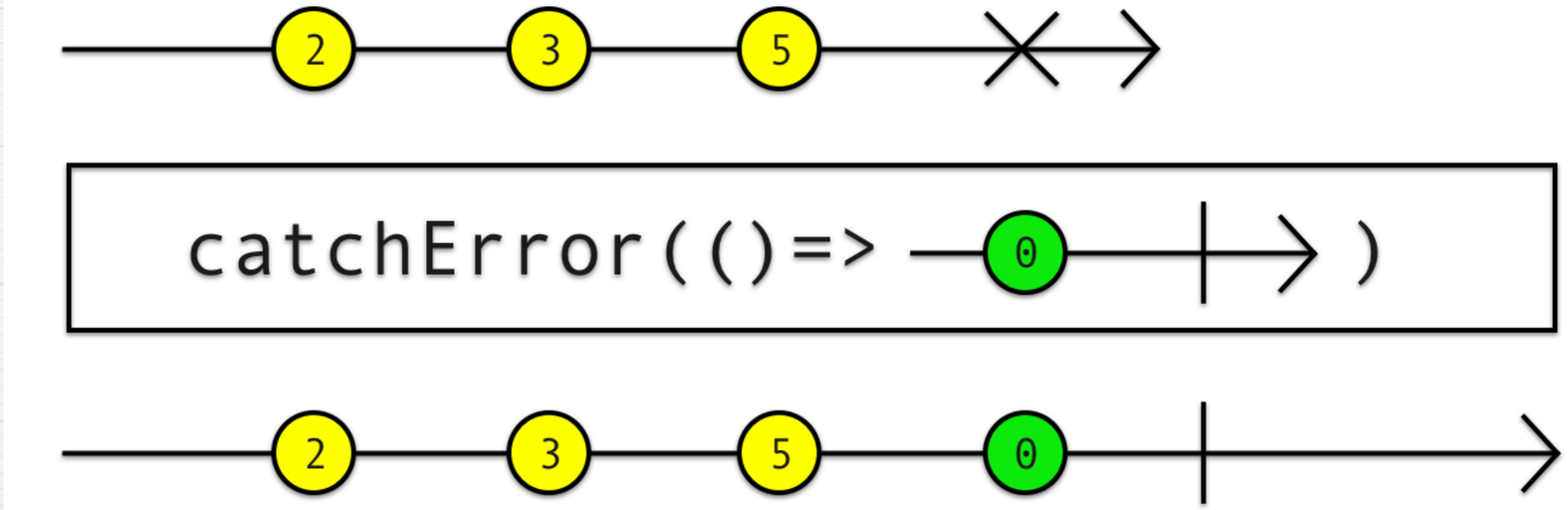
https://gist.github.com/sandikbarr/36bb0bf0b99a82a74be92aba1b1d0482#file-weird-trick-takeuntil-ts-L1



tap()

A UTILITY OPERATOR

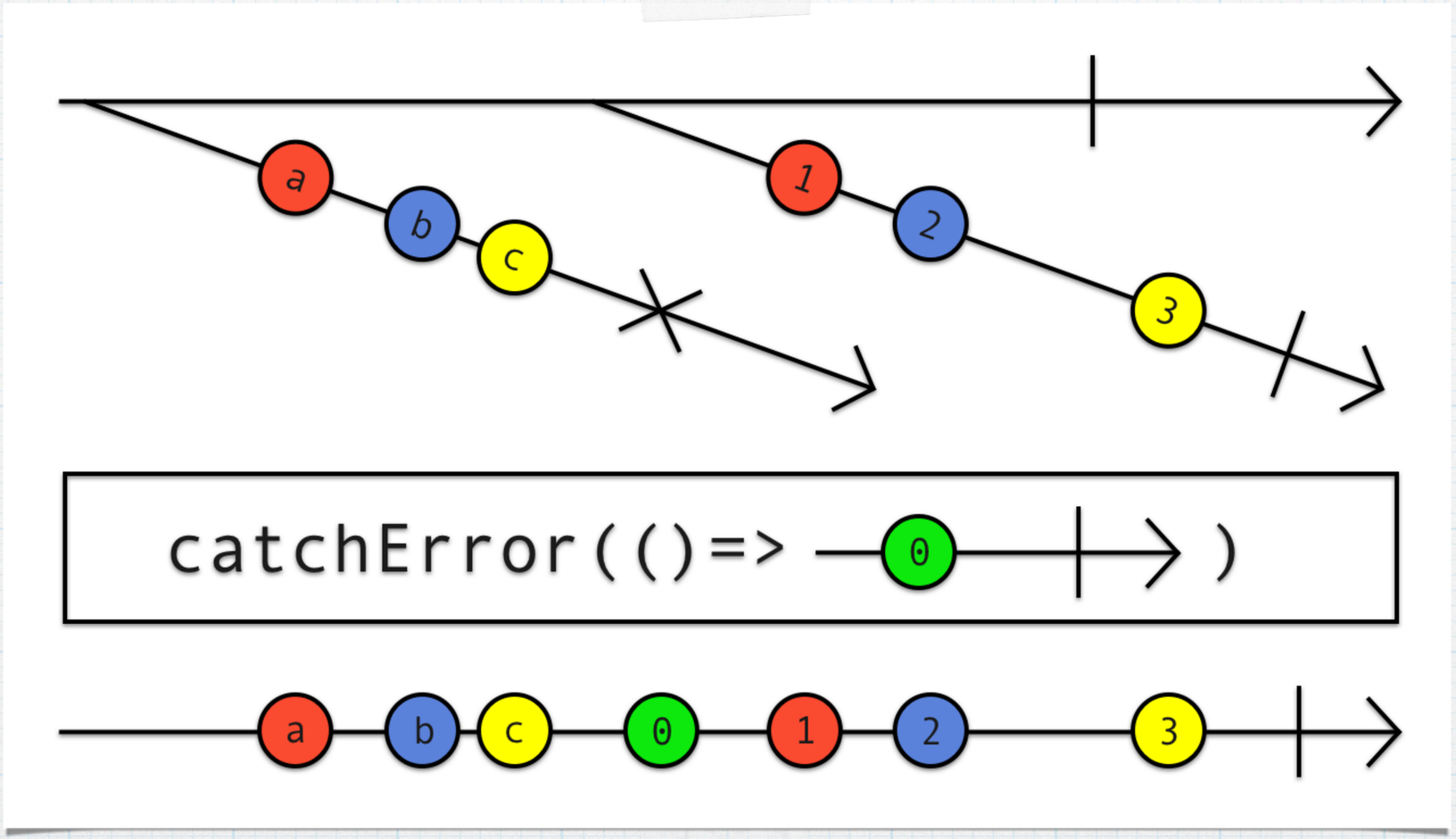
Perform side effects and return the stream unchanged



catchError()

AN ERROR HANDLING OPERATOR

Catch errors in the stream and return a new Observable



catchError()

An error can terminate a stream and send the error to the `error()` callback, or the stream can be allowed to continue if piped through `catchError()`.

CREATION

- fromEvent
- interval
- of

JOIN CREATION

- merge
- concat
- combineLatest

TRANSFORMATION

- map
- mergeMap
- scan

FILTERING

- filter
- debounceTime
- distinctUntilChanged

JOIN

- mergeAll
- withLatestFrom

MULTICASTING

- share
- publish
- publishReplay

ERROR HANDLING

- catchError
- retry

UTILITY

- tap
- delay
- toArray

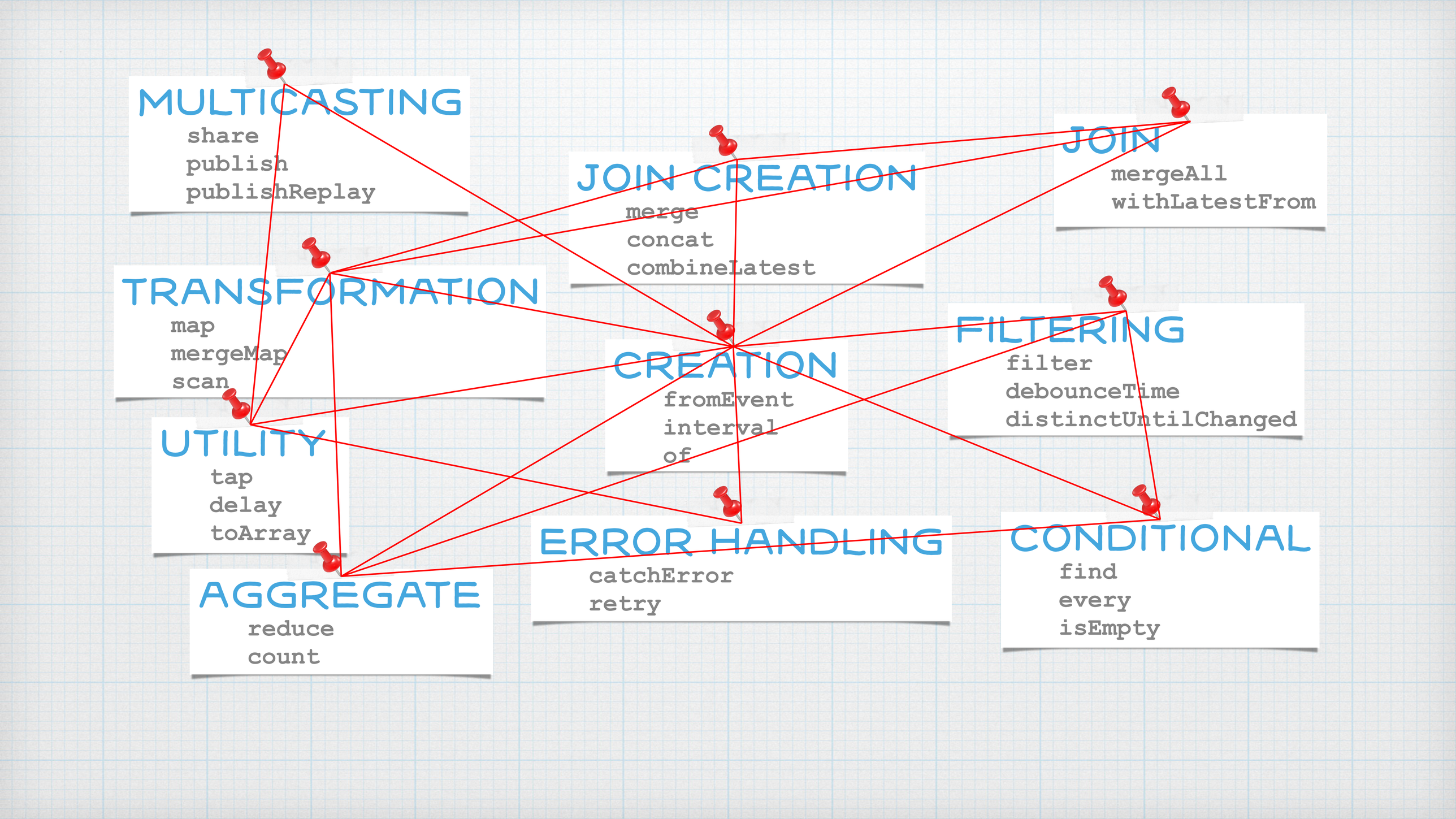
CONDITIONAL

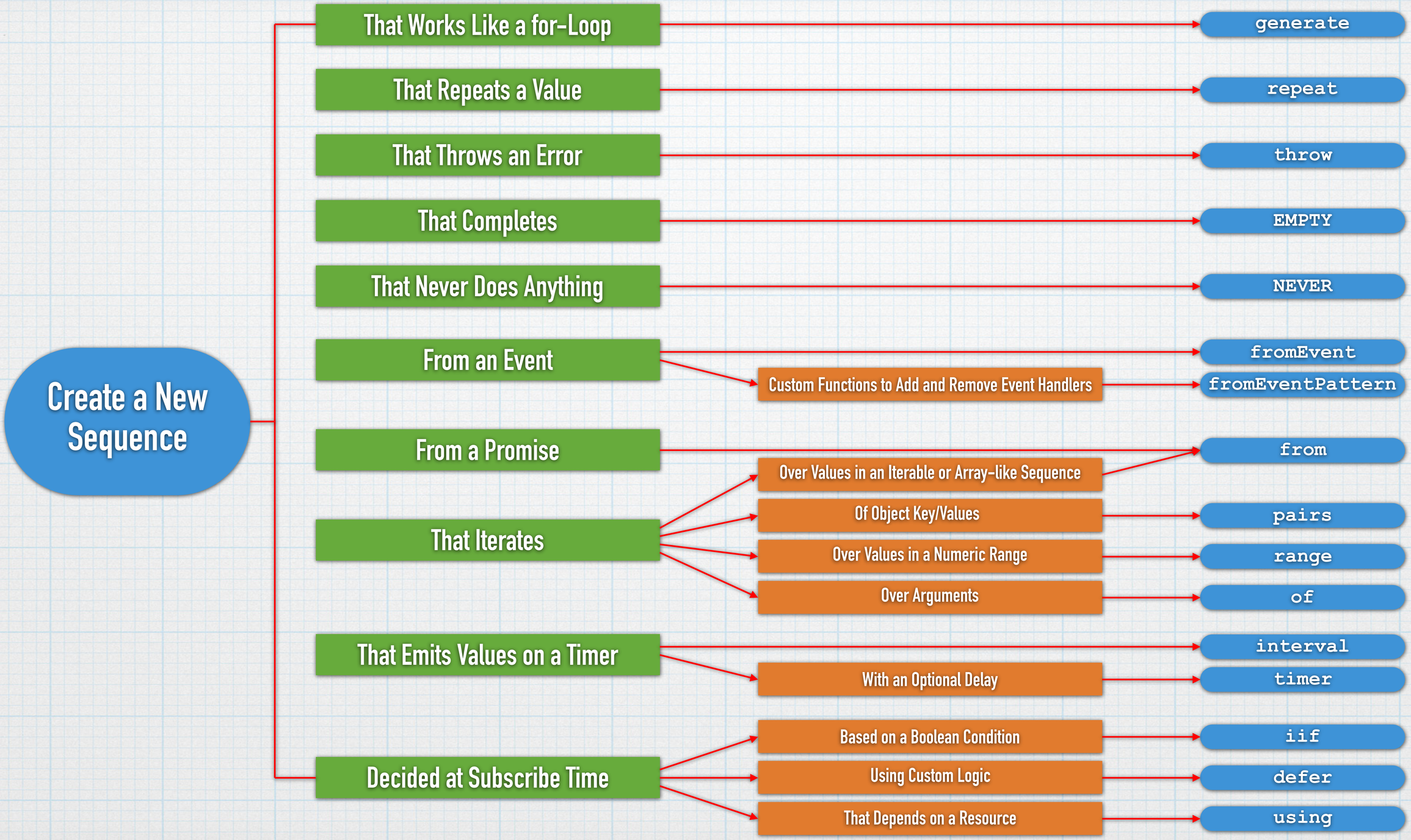
- find
- every
- isEmpty

AGGREGATE

- reduce
- count

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


MULTICASTING
share
publish
publishReplay
JOIN CREATION
merge
concat
combineLatest
JOIN
mergeAll
withLatestFrom
TRANSFORMATION
map
mergeMap
scan
CREATION
fromEvent
interval
of
FILTERING
filter
debounceTime
distinctUntilChanged
UTILITY
tap
delay
toArray
ERROR HANDLING
catchError
retry
CONDITIONAL
find
every
isEmpty
AGGREGATE
reduce
count


Create a New Sequence
That Works Like a for-Loop
generate
That Repeats a Value
repeat
That Throws an Error
throw
That Completes
EMPTY
That Never Does Anything
NEVER
From an Event
fromEvent
Custom Functions to Add and Remove Event Handlers
fromEventPattern
From a Promise
from
That Iterates
Over Values in an Iterable or Array-like Sequence
Of Object Key/Values
pairs
Over Values in a Numeric Range
range
Over Arguments
of
That Emits Values on a Timer
interval
With an Optional Delay
timer
Decided at Subscribe Time
Based on a Boolean Condition
iif
Using Custom Logic
defer
That Depends on a Resource
using

TROUBLESHOOTING

* Has this Observable been subscribed to?
* How many Subscriptions does this Observable have?
* When does this Observable complete? Does it complete?
* Do I need to unsubscribe from this Observable?

THANKS!

example code: https://github.com/sandikbarr/rxjs-todo