RXJS

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RxJS

- “RxJS is a library for reactive programming using Observables, to make it easier to compose asynchronous or callback-based code” http://reactivex.io/rxjs
- There is a formal proposal at https://github.com/tc39/proposal-observable
  - Currently at Stage 1

RxJS – Core Ingredients

- Observable
- Observer
- Subscription

Observable

- Observable is basically a wrapper around a data source/stream

```
const observable = Rx.Observable.create(
    obs => {
        obs.next('a value');
        obs.next('a second value');
        obs.complete();
});
```

Observable which wraps a function

Observer

- The observer’s role is to execute code when the observable receives a new value

Creating the observer

```
let observer = {
    next: value => {console.log(value)},
    error: error => {console.log(error)},
    complete: () => {console.log('completed')}
};

Rx.Observable.create(
    obs => {...}
).subscribe(observer);
```

Executing the observer’s functions

subscribe

- subscribe calls are not shared among multiple observers
- Each subscribe invocation causes a new "run"

Invoking subscribe again causes the observable to "run" again

```
const obs = Rx.Observable.create(observer => {
   observer.next(1);
   observer.next(2);
   observer.complete();
});

obs.subscribe(val => {console.log(val);});
obs.subscribe(val => {console.log(val);});
```

Subscription

- □ An observable might never complete
- □ In that case the client (observer) must unsubscribe manually
- □ Else, its lifetime is bound to the lifetime of the observable → Memory leak

```
let observer = {...};

let subscription = Rx.Observable.create(...).subscribe(observer);

setTimeout(() => {
    subscription.unsubscribe();
},2000);
```

Observables are Synchronous

- Unlike Promises, observables are synchronous by default

```
const obs = Rx.Observable.create(obs => {
   obs.next(1);
   obs.next(2);
   obs.complete();
});

console.log("Before");

obs.subscribe(val => {
   console.log(val);
});

console.log("After");
```

The output is:
Before
1
2
After

Observables may be Asynchronous

```
const obs = Rx.Observable.create(obs => {
   obs.next(1);

   setTimeout(function () {
      obs.next(2);
      obs.complete();
   }, 0);
});

console.log("Before");
obs.subscribe(val => {
   console.log(val);
});
console.log("After");
```

The output is now:

```
Before
1
After
2
```

Cold Observable

- This is the default
- Each subscribe get its own stream of data

Invoking subscribe again causes the observable to "run" again

```
const obs = Rx.Observable.create(observer => {
   observer.next(1);
   observer.next(2);
   observer.complete();
});

obs.subscribe(val => {console.log(val);});
obs.subscribe(val => {console.log(val);});
```

Hot Observable

- □ Each subscriber is registered to a live stream of data
- □ New subscriber sees only new data

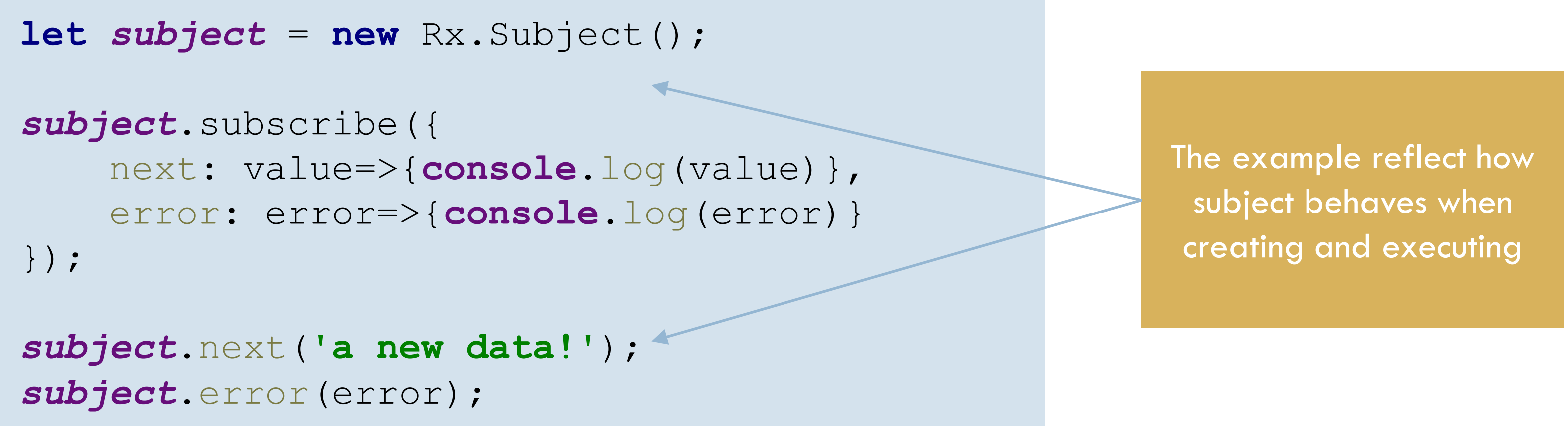
```
const producer = new Producer();
producer.run();

const obs = Observable.create(observer => {
    producer.listeners.push(function(val) {
        observer.next(val);
    });
});
```

Subject

- Observable.subscribe creates a new stream of data each time is executed
- Subject allows you to share the same stream with different clients
- A client can subscribe in the middle of a stream
- Resembles an event emitter

Subject



```
let subject = new Rx.Subject();

subject.subscribe({
    next: value=>{console.log(value)},
    error: error=>{console.log(error)}
});

subject.next('a new data!');
subject.error(error);
```

The example reflect how subject behaves when creating and executing

- □ Executing subject.next after subject.complete yields nothing since the observable is considered completed

Subject & unsubscribe

- Subject is often used as an event emitter
- A client registers
- The subject is never completed → The client is bound to the lifetime of the subject
- It is important to remember to call the unsubscribe method once a client is "inactive" or "dead"
  - Else, you risk a memory leak

BehaviorSubject

- □ Allows you to specify an initial value
- □ When subscribing, the behavioral subject notifies the observer with last passed value immediately
- □ Grants the ability to retrieve the last value passed down the subject
- □ Useful for interaction between a service and a component where any new component must re-render upon subscribing

BehaviorSubject

```
let subject = new Rx.BehaviorSubject("a");

subject.subscribe(value => {
    console.log("Subscription 1", value)
});

subject.next("b");

subject.subscribe((value) => {
    console.log("Subscription 2", value)
});

subject.next("c");
subject.next("d");

console.log(subject.getValue());
```

It is mandatory to set an initial value .

Retrieving the last value

AsyncSubject

- □ AsyncSubject emits the data only when the subject.complete is invoked
- □ Is often used when heavy computations are streaming through the observable
- □ It remembers only the final result of the heavy computation

AsyncSubject

```
let subject = new Rx.AsyncSubject();

let obs = {
    next: value => {console.log(value)},
    error: error => {console.log(error)},
    complete: () => {console.log('complete')}
};

subject.subscribe(obs);

asyncSubject.next('1');
asyncSubject.next('2');
asyncSubject.complete();
```

next method is invoked only once when the subject completes

Operators

- Operators allows you to create new observable from an existing one
- Resembles the concept of promise chaining/transformation
- For example, given an observable that produces the values [1,2,3] you can use the map method to create a new observable that produces the values [2,4,6]

Operators

□ What will be printed during runtime?

```
let observable = Rx.Observable.interval(1000);

observable
    .throttleTime(2000)
    .map(x => x*2)
    .subscribe(value => {console.log(value);});
```

throttleTime emits latest value when specified duration has passed

Observable.from

- Method that turns an iterable object into an observable

```
const obj = {
    [Symbol.iterator]: function() {
        let num = 0;
        return {
            next: function() {
                return {value: num, done: num++==100};
            }
        };
    }
};
```

Observable.from does not cache values. Once subscribing it iterates through obj and notifies observer of each value

```
const arraySource = Rx.Observable.from([1,2,3,4,5]);
const subscribe = arraySource.subscribe(val => console.log(val));
```

Observable.of

□ Turn an amount of values into a sequenced observable

```
const source = Rx.Observable.of(1,2,3,4,5);
source.subscribe(val => {console.log(val);});
```

filter

- □ A method which is chained to the observable and will filter all data according to the manipulated code

```
let observable = Rx.Observable.interval(1000);

observable.filter(value => {
    return value % 2 == 0;
})
.subscribe(value => {console.log(value));
```

The example reflects a simple use case for the filter method chained to the observable before the subscription

do

- Perform actions without transformation

```
Rx.Observable.interval(500)
    .do(x => {
        console.log(x);

        return x * 2;
    })
    .subscribe(x => {
        console.log(x);
    });
```

Return value is ignored. Use map for transforming values

debounceTime

- □ “blocks” the stream until inactivity is detected
- □ Once inactivity detected, it emits latest values

```
Rx.Observable.interval(500)
    .do(x => {
        console.log(x);
    })
    .debounceTime(501)
    .subscribe(x => {
        console.log("never happens");
    });
```

distinctUntilChanged

- “blocks” the stream until a new value is detected

```
let input = document.querySelector('input');

Rx.Observable.fromEvent(input,'input')
     .map(event => event.target.value)
     .debounceTime(2000)
     .distinctUntilChanged()
     .subscribe({
         next: value => {console.log(value);}
     });
```

reduce

- □ Reduces a stream of values into a single value
- □ Waits for the completion of the source and only then emits the accumulated single value

```
let observable = Rx.Observable.of(1,2,3,4);

observable
    .reduce((total,currentValue) => {
            return total + currentValue;
    },0)
    .subscribe(value => {
        console.log(value);
    });
```

Observer will be invoked only once and will emit the value 10

scan

- □ Unlink reduce scan doesn’t wait for source completeness
- □ It emits the accumulated value immediately

```
Rx.Observable.interval(500)
    .reduce((total,currentValue) => {
        return total + currentValue;
    },0)
    .subscribe(value => {
        console.log(value);
    });
```

pluck

- □ Returns a “deep” property
- □ Returns undefined if path is broken

```
Rx.Observable.from([
    {name: "Ori", address: {city: "Rehovot"}},
    {name: "Roni"},
])
.pluck("address", "city")
.subscribe(x => {
    console.log(x);
});
```

“Rehovot”
undefined

concat

- □ Concatenates all observables, but only after the former has been completed

```
const obs1 = Rx.Observable.of(1,2,3);
const obs2 = Rx.Observable.of(4,5,6);
const obs3 = obs1.concat(obs2);

obs3.subscribe(val => console.log(val));
```

Prints: 1,2,3,4,5,6

merge

- □ Creates new observables that emits all sources values
- □ First come first served …

```
const obs1 = Rx.Observable.interval(1000).mapTo("1000");
const obs2 = Rx.Observable.interval(2000).mapTo("2000");

obs1.merge(obs2).subscribe(x => {
   console.log(x);
});
```

mapTo method simply set the emitted value to a fixed value

partition

- Given a criteria it returns two observables
- First observable matches the criteria, the other one doesn’t match

```
const [even, odd] =
Rx.Observable.from([1,2,3,4,5,6]).partition(x=>x%2==0);

even.subscribe(x=>{console.log(x);});
odd.subscribe(x=>{console.log(x);});
```

Example will result in:
2,4,6,1,3,5

groupBy

- □ Transforms single stream into a stream of groups
- □ Each group is a stream and has a unique key

```
1: 1
2: 2
0: 3
1: 4
2: 5
0: 6
```

```
Rx.Observable.from([1,2,3,4,5,6])
    .groupBy(num => num%3)
    .subscribe(group => {
        group.subscribe(num => {
            console.log(group.key + ": " + num);
        });
    });
```

A group has key and can be used as observable

zip

- Transforms two streams (or more) into one
- The 1st emitted value is an array of the 1st values from the source streams
- The 2nd emitted value is an array of the 2nd values from the source streams
- And so on …

The new stream emits value every 3 seconds

The emitted value is in the form of [obs1[n], obs2[n]]

```
const obs1 = Rx.Observable.interval(500).map(i => "X" + i);
const obs2 = Rx.Observable.interval(3000).map(i => "Y" + i);

Rx.Observable.zip(obs1,obs2)
  .subscribe(x => {
    console.log(x);
  });
```

flatMap (A.K.A mergeMap)

- □ Transforms a stream of arrays into a stream of single values (A.K.A flattening)

Instead of array you can use an observable and the result will be the same

```
const obs = Rx.Observable.from([
   Rx.Observable.from([1,10,100]),
   Rx.Observable.from([2,20,200]),
   Rx.Observable.from([3,30,300]),
]);

obs.flatMap(x=>x).subscribe(x => {
   console.log(x);
});
```

flatMap does not wait for completeness of the sources

switchMap

- □ Switch to a new observable and cancel the previous
- □ Maintain only one inner subscription

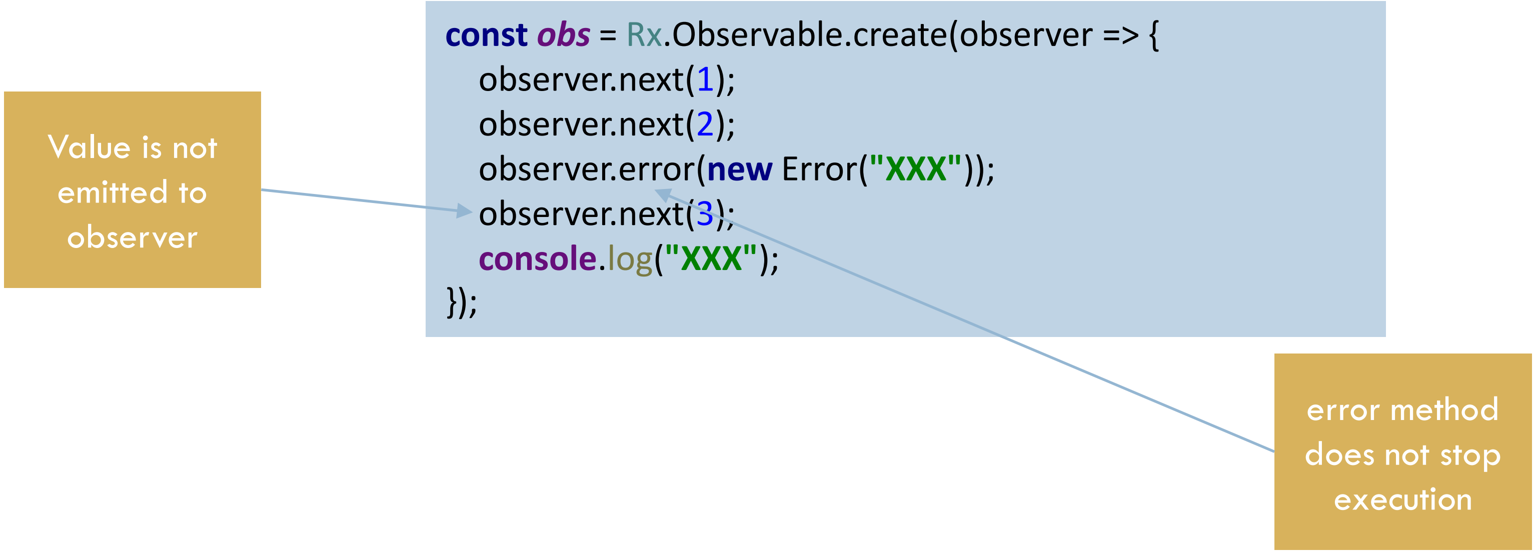
Every 1010 ms switches to the inner observable

```
const obs = Observable.interval(1010);

obs.switchMap(()=>Observable.interval(200)).subscribe(x => {
    console.log(x);
});
```

Error Handling

- □ An observable can report an error using the error method
- □ Once doing so the stream is considered faulty and future values are not emitted



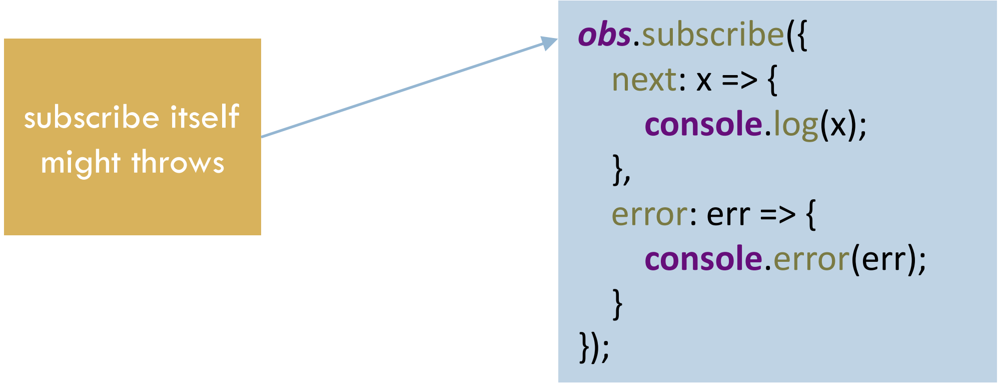
```
const obs = Rx.Observable.create(observer => {
    observer.next(1);
    observer.next(2);
    observer.error(new Error("XXX"));
    observer.next(3);
    console.log("XXX");
});
```

Value is not emitted to observer

error method does not stop execution

Throwing Error

- You should be careful when throwing error from inside an observable
- Assuming synchronous observable, the observer.error will be invoked and the subscribe method will throw



subscribe itself might throws

```
obs.subscribe({
    next: x => {
        console.log(x);
    },
    error: err => {
        console.error(err);
    }
});
```

Observable Chain

- An error inside source stream makes the “chained” stream to become faulty too

```
const obs1 = Rx.Observable.interval(500)
    .take(3)
    .do(x => {
        if (x == 2) {
            throw new Error("XXX");
        }
    });

const obs2 = obs1.map(x => x * 2);

obs2.subscribe(x => {
    console.log(x);
});
```

obs1 emits 0,1 and then fails. obs2 emits 0,2 and then fails too

catch

- Transforms a faulty stream into valid one
- Must return a new stream instead of the faulty one

```
const obs1 = Rx.Observable.interval(500).take(3)
    .do(x => {
        if (x == 2) {
            throw new Error("XXX");
        }
    });

obs1.catch(err => {
    return ["X"];
}).subscribe(x => {
    console.log(x);
});
```

Emitted values are 1, 2, X

Ngrx

- RxJS powered state management
- Inspired by Redux
- State is a single immutable data structure
- State can be accessed in an observable fasion
- Action dispatched to the store are described by an observable too

Getting Started

- □ npm install @ngrx/store
- □ Define a reducer (just like Redux)
- □ Imports Ngrx module

```
imports: [
  BrowserModule,
  StoreModule.forRoot({ counter: counterReducer })
]
```

Using the Store

□ The store is injectable

□ Can select from the store

```
export class AppComponent {
  counter: Observable<number>;

  constructor(private store: Store<AppState>) {
    this.counter = store.select('counter');
  }

  inc(){this.store.dispatch({ type: INCREMENT });}

  dec(){this.store.dispatch({ type: DECREMENT });}

  reset(){this.store.dispatch({ type: RESET });}
}
```

@ngrx/effects

- npm install @ngrx/effects
- Provides API to model actions being dispatched as a single reactive stream
- Effect listens for an action
- Initiate an activity (usually HTTP request)
- Dispatches new actions which
  - Reduce application state
  - Initiates a new activity

Actions

- An observable that represents all actions being dispatched to the store

```
@Injectable()
export class AuthEffects {
  @Effect()
  login$: Observable<any> = this.actions$.ofType('LOGIN')
    .mergeMap((action: any) =>
      this.http.post('/auth', action.payload)
        .map(data => ({type: 'LOGIN_SUCCESS', payload: data}))
        .catch(() => of({type: 'LOGIN_FAILED'}))
    );

  constructor(private http: HttpClient, private actions$: Actions) {
  }
}
```

Component side

```
export class AppComponent {
  userName: Observable<string>;

  constructor(private store: Store<AppState>) {
    this.userName = store.pluck('user', 'userName');
  }
}
```

```
dec(){
  this.store.dispatch({ type: DECREMENT });
}
```

Summary

- Reactive programming is fun to write
- Usually not so fun to read
- Using few operators you can implement a complex reactive flow that would take other wise many lines of imperative code