Taming asynchronous workflows with Functional Reactive Programming

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about:me

- Thoughtworker
- Functional Programming enthusiast
- Clojure Evangelist
- Founder & Organiser of the Sydney Clojure User Group (clj-syd)
- World traveller
- Fan of Murray’s Beers :)

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Functional programmers like programming with values:

`a, b, c...`

and pure functions:

`f, g, h...`

We get new values by applying functions to it

```
(f a) ;;=> b
```

But that’s hardly useful when we have multiple values

```
(def vals [a b c])
```

So we use Higher Order Functions

```
(map f vals)
```

And compose them as we see fit

```
(-> vals
    (filter f)
    (map g)
    (reduce h))
```

But what if the value isn’t known...yet?

We make promises

```
;; thread#1
(def a (promise))
```

```
;; ...later in the program
(f @a) ;;<= blocks thread

;; thread#2
(deliver a 10) ;; now thread#1 continues
```

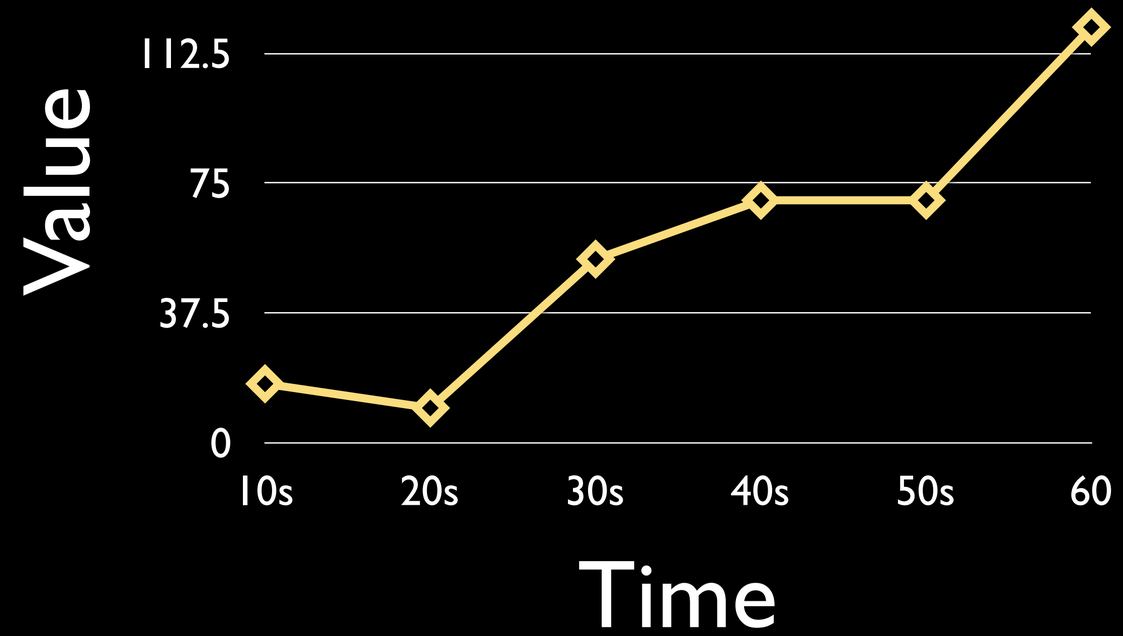
Not great if we want to ‘react’

to a new value

What about a list of - as of yet unknown - values?

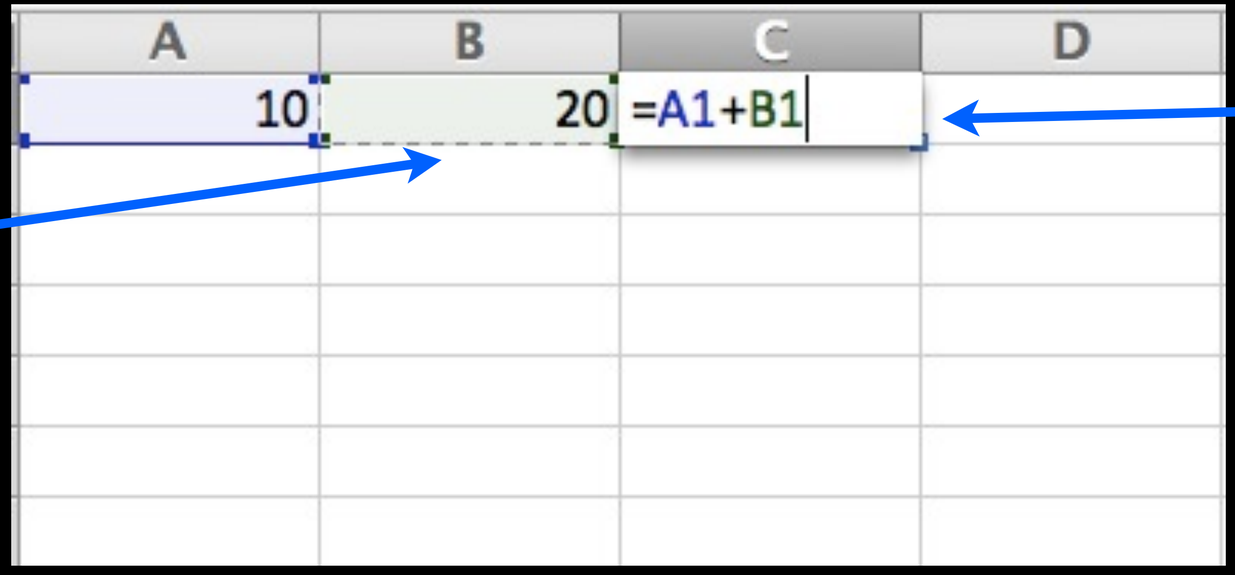
[?, ?, ?]

Or better yet, a value that changes over time?



Does this sound familiar?

Spreadsheets: a poor man's reactive programming model



Values

Function

Spreadsheets: a poor man's reactive programming model

As we change a value

A	B	C	D
10	47.5	57.5	

Our function cell reacts to the change

‘Changing a value’ is an event

Several events over time form an event stream

“Functional Reactive Programming is about effectively processing event streams without explicitly managing state”

- me

“FRP is about handling time-varying values like they were regular values.”

- Haskell wiki

We'll use Reactive Extensions (Rx) - but there are many implementations

In Rx, event streams are called

Observable sequences

Rx 101

```
(-> (.returnValue js/Rx.Observable 42)
    (.map #(* % 2))
    (.subscribe #(.log js/console %)))
;; 84
```

Rx 101

```
(-> (.fromArray js/Rx.Observable
                (clj->js [10 20 30]))
    (.map #(* % 2))
    (.reduce +)
    (.subscribe #(.log js/console %)))

;; 120
```

Rx 101

```clojure
(defn project-range [n]
  (.returnValue js/Rx.Observable (range n)))

(-> (.fromArray js/Rx.Observable
                (clj->js [1 2 3]))
    (.selectMany project-range)
    (.subscribe #(.log js/console (clj->js %))))

;; [0]
;; [0 1]
;; [0 1 2]
```

Observables are Monads

The Monad Type Class

```
class Monad m where
    return :: a -> m a
    (>>=)  :: m a -> (a -> m b) -> m b
```

Monad functions: return

```
return :: a -> m a
```

```
returnValue :: a -> Observable a
```

Monad functions: >>= (bind)

```
(>>=) :: m a -> (a -> m b) -> m b
```

```
selectMany :: Observable a -> (a -> Observable b) -> Observable b
```

Demo: Simple polling app

Server exposes poll questions and results

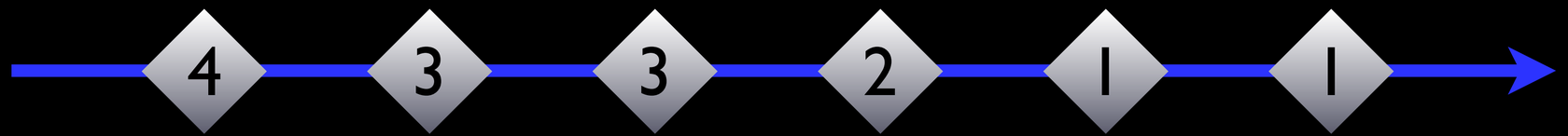
```
e.g.:
{:id 7
 :question "Which is the best music style?"
 :results {:a 10
           :b 47
           :c 17}}
```

What we want

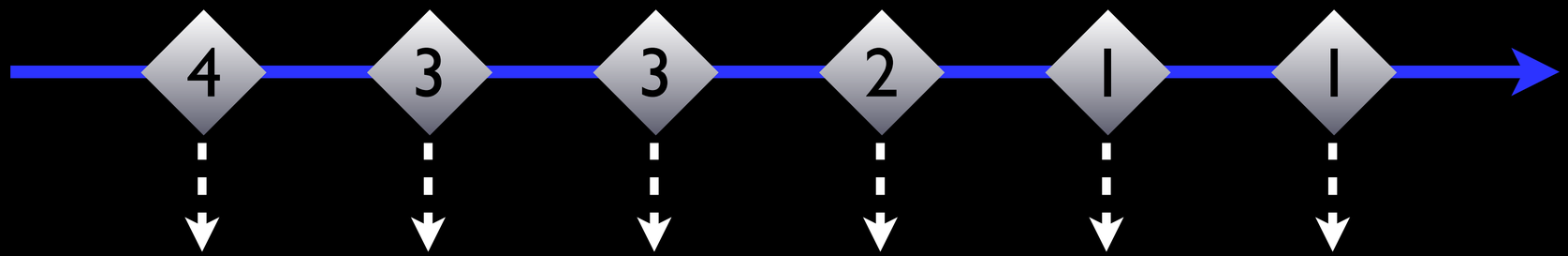
- Render results
- Continuously poll server every 2 secs
- If current question is the same as the previous one update results;
  - Otherwise:
    - Stop polling;
    - Display countdown message;
    - Render new question and results;
    - Restart polling;

The core idea

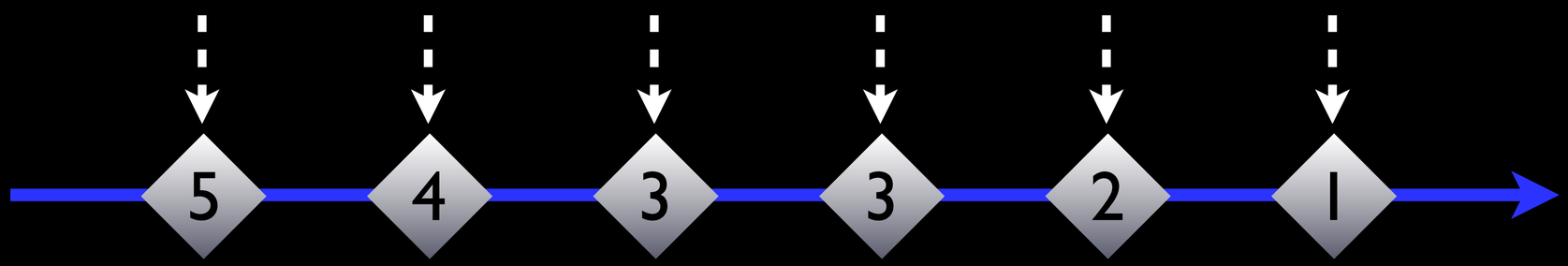
Turn server results into an event stream



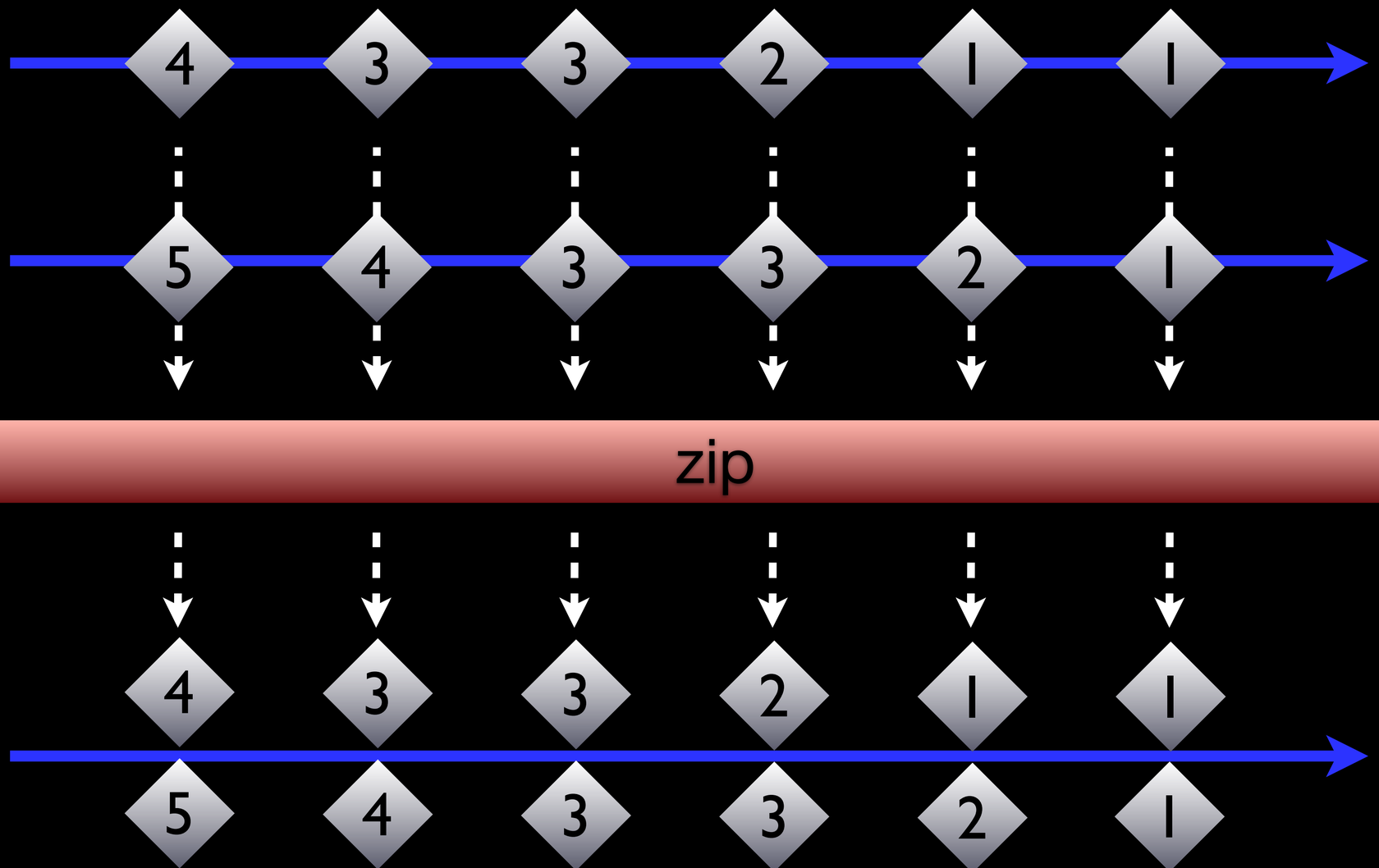
Duplicate stream, skipping one



skip 1



Zip them together



Now we have access to both the previous and current results, with no local variables

Show me the code!

https://github.com/leonardoborges/frp-code

The core idea

```
(def results-connectable
  (let [obs (-> js/Rx.Observable
                (.interval 2000)
                (.selectMany results-observable)
                (.publish)
                (.refCount))
        obs-1 (.skip obs 1)]
    (.zip obs obs-1 (fn [prev curr]
                      {:prev prev
                       :curr curr}))))
```

Turn server results into an event stream

Clone stream, skip one

Zip them together

“FRP is about handling time-varying values like they were regular values.”

- Haskell wiki

Questions?

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References

Code - https://github.com/leonardoborges/frp-code

RxJS - https://github.com/Reactive-Extensions/RxJS
RxJava - https://github.com/Netflix/RxJava

Other FRP implementations:
Reactive-banana - http://www.haskell.org/haskellwiki/Reactive-banana
Javelin (Clojurescript) - https://github.com/tailrecursion/javelin
Bacon.js - https://github.com/raimohanska/bacon.js