

Kyle Simpson
@getify
<http://getify.me>

- LABjs
- grips
- asynquence





<http://YouDontKnowJS.com>

Agenda

Async Patterns

- Parallel vs Async
- Callbacks
- Thunks
- Promises
- Generators/Coroutines
- Event Reactive (observables)
- CSP (channel-oriented concurrency)

Parallel vs Async

Async Patterns

Threads

Async Patterns: parallel vs async

Single Thread

Async Patterns: parallel vs async

Concurrency

Async Patterns: parallel vs async

1

2

3

4

done!

1

2

3

done!

Async Patterns: parallel vs async

Async Patterns

Callbacks

Async Patterns

```
1 setTimeout(function(){
2     console.log("callback!");
3 },1000);
```

Async Patterns: callbacks

Callbacks

==

Continuations

Async Patterns: callbacks

```
1 setTimeout(function(){
2     console.log("one");
3     setTimeout(function(){
4         console.log("two");
5         setTimeout(function(){
6             console.log("three");
7             },1000);
8         },1000);
9     },1000);
```

Async Patterns: “callback hell”

```
1 function one(cb) {  
2     console.log("one");  
3     setTimeout(cb,1000);  
4 }  
5 function two(cb) {  
6     console.log("two");  
7     setTimeout(cb,1000);  
8 }  
9 function three() {  
10    console.log("three");  
11 }  
12  
13 one(function(){  
14     two(three);  
15 }));
```

Async Patterns: “callback hell”

(exercise #1: 5min)

Two Problems

Async Patterns: “callback hell”

Inversion of Control

Async Patterns: “callback hell”

```
1 // line 1
2 setTimeout(function(){
3     // line 3
4     // line 4
5 },1000);
6 // line 2
```

Async Patterns: inversion of control

```
1 trackCheckout(  
2     purchaseInfo,  
3     function finish() {  
4         chargeCreditCard(purchaseInfo);  
5         showThankYouPage();  
6     }  
7 );
```

Async Patterns: inversion of control

```
1 var hasBeenCalled = false;  
2  
3 trackCheckout(  
4     purchaseInfo,  
5     function finish() {  
6         if (!hasBeenCalled) {  
7             hasBeenCalled = true;  
8             chargeCreditCard(purchaseInfo);  
9             showThankYouPage();  
10        }  
11    }  
12 );
```

Async Patterns: inversion of control

Trust:

1. not too early
2. not too late
3. not too many times
4. not too few times
5. no lost context
6. no swallowed errors



...

Not Reasonable

Async Patterns: callbacks

```
1 start task1:  
2     do some stuff  
3     pause  
4  
5 start task2:  
6     do some other stuff  
7     pause  
8  
9 resume task1:  
10    do more stuff  
11    pause  
12  
13 resume task2:  
14    finish stuff  
15  
16 resume task1:  
17    finish stuff
```

Async Patterns: not **reasonable**

```
1 start task1:  
2     do some stuff  
3     pause  
4  
5     resume task1:  
6         do more stuff  
7         pause  
8  
9     resume task1:  
10        finish stuff  
11  
12  
13 start task2:  
14     do some other stuff  
15     pause  
16  
17 resume task2:  
18     finish stuff
```

Async Patterns: not **reasonable**

We Write:

```
1 console.log("First half of my program");
2
3 setTimeout(function(){
4
5     console.log("Second half of my program");
6
7 },1000);
```

Async Patterns: not **reasonable**

We Think:

```
1 console.log("First half of my program");
2
3 block(1000);
4
5 console.log("Second half of my program");
6
7
```

Async Patterns: not **reasonable**

JavaScript Thinks:

```
1 console.log("First half of my program");
2
3 // do lots of other stuff
4
5 console.log("Second half of my program");
6
7
```

Async Patterns: not **reasonable**

Sync-Looking Async

Synchronous
Sequential
Blocking

Async Patterns: not **reasonable**

Non Fixes

Async Patterns: callbacks

```
1 function trySomething(ok,err) {  
2     setTimeout(function(){  
3         var num = Math.random();  
4         if (num > 0.5) ok(num);  
5         else err(num);  
6     },1000);  
7 }  
8  
9 trySomething(  
10    function(num){  
11        console.log("Success: " + num);  
12    },  
13    function(num){  
14        console.log("Sorry: " + num);  
15    }  
16 );
```

Async Patterns: separate callbacks

```
1 function trySomething(cb) {  
2     setTimeout(function(){  
3         var num = Math.random();  
4         if (num > 0.5) cb(null,num);  
5         else cb("Too low!");  
6     },1000);  
7 }  
8  
9 trySomething(function(err,num){  
10    if (err) {  
11        console.log(err);  
12    }  
13    else {  
14        console.log("Number: " + num)  
15    }  
16});
```

Async Patterns: “error-first style”

Running Example: "The Meaning Of Life"

Async Patterns: callbacks

```
1 function getData(d,cb) {  
2     setTimeout(function(){ cb(d); },1000);  
3 }  
4  
5 getData(10,function(num1){  
6     var x = 1 + num1;  
7     getData(30,function(num2){  
8         var y = 1 + num2;  
9         getData(  
10            "Meaning of life: " + (x + y),  
11            function(answer){  
12                console.log(answer);  
13                // Meaning of life: 42  
14            }  
15        );  
16    });  
17});
```

Async Patterns: nested-callback tasks

Async Patterns

Thunks

Async Patterns

```
1 function add(x,y) {  
2     return x + y;  
3 }  
4  
5 var thunk = function() {  
6     return add(10,15);  
7 };  
8  
9 thunk(); // 25
```

```
1 function addAsync(x,y,cb) {  
2     setTimeout(function(){  
3         cb( x + y );  
4     },1000);  
5 }  
6  
7 var thunk = function(cb) {  
8     addAsync(10,15,cb);  
9 };  
10  
11 thunk(function(sum){  
12     sum; // 25  
13 }));
```

```
1 function makeThunk(fn) {  
2     var args = [].slice.call(arguments,1);  
3     return function(cb) {  
4         args.push(cb);  
5         fn.apply(null,args);  
6     };  
7 }
```

```
1 function addAsync(x,y,cb) {  
2     setTimeout(function(){  
3         cb( x + y );  
4     },1000);  
5 }  
6  
7 var thunk = makeThunk(addAsync,10,15);  
8  
9 thunk(function(sum){  
10    console.log(sum); // 25  
11});
```

```
1 var get10 = makeThunk(getData,10);
2 var get30 = makeThunk(getData,30);
3
4 get10(function(num1){
5     var x = 1 + num1;
6     get30(function(num2){
7         var y = 1 + num2;
8
9         var getAnswer = makeThunk( getData,
10             "Meaning of life: " + (x + y)
11         );
12
13         getAnswer(function(answer){
14             console.log(answer);
15             // Meaning of life: 42
16         });
17     });
18});
```

Async Patterns: nested-thunk tasks

(exercise #2: 5min)

Async Patterns

Promises

Future Values

“Completion Events”

Async Patterns

```
1 function finish(){
2     chargeCreditCard(purchaseInfo);
3     showThankYouPage();
4 }
5
6 function error(err){
7     logStatsError(err);
8     finish();
9 }
10
11 var listener = trackCheckout(purchaseInfo);
12
13 listener.on("completion", finish);
14 listener.on("error", error);
```

Async Patterns: "completion event"

```
1 function trackCheckout(info) {  
2   return new Promise(  
3     function(resolve, reject){  
4       // attempt to track the checkout  
5  
6       // if successful, call resolve()  
7       // otherwise, call reject(error)  
8     }  
9   );  
10 }
```

Async Patterns: (native) promises

```
1 function finish(){
2     chargeCreditCard(purchaseInfo);
3     showThankYouPage();
4 }
5
6 function error(err){
7     logStatsError(err);
8     finish();
9 }
10
11 var promise = trackCheckout(purchaseInfo);
12
13 promise.then(
14     finish,
15     error
16 );
```

Async Patterns: (native) promises

Still callbacks?

Async Patterns: (native) promises

Promise Trust:

1. only resolved once
2. either success OR error
3. messages passed/kept
4. exceptions become errors
5. immutable once resolved



Async Patterns: (native) promises

unInversion of Control

Async Patterns: (native) promises

Flow Control

Async Patterns: (native) promises

```
1 doFirstThing
2   then doSecondThing
3   then doThirdThing
4   then complete
5 or error
```

Async Patterns: promise flow control

Chaining Promises

Async Patterns: promise flow control

```
1 doFirstThing()  
2 .then(function(){  
3     return doSecondThing();  
4 })  
5 .then(function(){  
6     return doThirdThing();  
7 })  
8 .then(  
9     complete,  
10    error  
11 );
```

Async Patterns: promise flow control

```
1 function delay(num) {  
2     return new Promise(function(resolve,reject){  
3         setTimeout(resolve,num);  
4     });  
5 }  
6  
7 delay(100)  
8 .then(function(){  
9     return delay(50);  
10 })  
11 .then(function(){  
12     return delay(200);  
13 })  
14 .then(function(){  
15     console.log("all done!");  
16 });
```

```
1 function getData(d) {  
2     return new Promise(function(resolve, reject){  
3         setTimeout(function(){resolve(d); },1000);  
4     });  
5 }  
6  
7 var x;  
8  
9 getData(10)  
10 .then(function(num1){  
11     x = 1 + num1;  
12     return getData(30);  
13 })  
14 .then(function(num2){  
15     var y = 1 + num2;  
16     return getData("Meaning of life: " +(x + y));  
17 })  
18 .then(function(answer){  
19     console.log(answer);  
20     // Meaning of life: 42  
21});
```

Async Patterns: promise flow control

(exercise #3: 5min)

(exercise #4: 5min)

Abstractions

Async Patterns: promises

```
1 Promise.all([
2     doTask1a(),
3     doTask1b(),
4     doTask1c()
5 ])
6 .then(function(results){
7     return doTask2(
8         Math.max(
9             results[0],
10            results[1],
11            results[2]
12        );
13    );
14});
```

Async Patterns: promise "gate"

```
1 var p = trySomeAsyncThing();
2
3 Promise.race([
4     p,
5     new Promise(function(_,reject){
6         setTimeout(function(){
7             reject("Timeout!!");
8         },3000);
9     })
10 ])
11 .then(
12     success,
13     error
14 );
```

Async Patterns: promise timeout

blog.getify.com/promises-part-1/

github.com/getify/native-promise-only

Async Patterns: learn more

sequence = automatically
chained promises

Async Patterns: promises sequence

<https://github.com/getify/asynquence>

```
1 ASQ()
2 .then(function(done){
3     setTimeout(done,1000);
4 })
5 .gate(
6     function(done){
7         setTimeout(done,1000);
8     },
9     function(done){
10        setTimeout(done,1000);
11    }
12 )
13 .then(function(done){
14     console.log("2 seconds passed!");
15 }));
```

Async Patterns: sequences & gates

```
1 function getData(d) {  
2     return ASQ(function(done){  
3         setTimeout(function(){done(d); },1000);  
4     });  
5 }  
6  
7 ASQ()  
8 .waterfall(  
9     function(done){ getData(10).pipe(done); },  
10    function(done){ getData(30).pipe(done); }  
11 )  
12 .seq(function(num1,num2){  
13     var x = 1 + num1;  
14     var y = 1 + num2;  
15     return getData("Meaning of life: " + (x + y));  
16 })  
17 .val(function(answer){  
18     console.log(answer);  
19     // Meaning of life: 42  
20 });
```

Async Patterns: sequence tasks

(exercise #5: 5min)

(exercise #6: 5min)

davidwalsh.name/asynquence-part-1

Async Patterns: learn more

Async Patterns

Generators (`yield`)

```
1 function* gen() {  
2     console.log("Hello");  
3     yield;  
4     console.log("World");  
5 }  
6  
7 var it = gen();  
8 it.next(); // Hello  
9 it.next(); // World
```

```
1 function *main() {  
2     yield 1;  
3     yield 2;  
4     yield 3;  
5 }  
6  
7 var it = main();  
8  
9 it.next(); // { value: 1, done: false }  
10 it.next(); // { value: 2, done: false }  
11 it.next(); // { value: 3, done: false }  
12  
13 it.next(); // { value: undefined, done: true }
```

Async Patterns: generators

```
1 function coroutine(g) {  
2     var it = g();  
3     return function() {  
4         return it.next.apply(it, arguments);  
5     };  
6 }
```

Async Patterns: generator coroutines

```
1 var run = coroutine(function*(){
2     var x = 1 + (yield);
3     var y = 1 + (yield);
4     yield (x + y);
5 });
6
7 run();
8 run(10),
9 console.log(
10    "Meaning of life: " + run(30).value
11 );
```

Async Patterns: generator messages

```
1 function getData(d) {  
2     setTimeout(function(){run(d); },1000);  
3 }  
4  
5 var run = coroutine(function*(){  
6     var x = 1 + (yield getData(10));  
7     var y = 1 + (yield getData(30));  
8     var answer = (yield getData(  
9         "Meaning of life: " + (x + y)  
10    ));  
11    console.log(answer);  
12    // Meaning of life: 42  
13});  
14  
15 run();
```

generators + promises

Async Patterns: `async` generators

yield promise

Async Patterns: `async` generators

```
1 function getData(d) {  
2     return ASQ(function(done){  
3         setTimeout(function(){done(d)}, 1000);  
4     });  
5 }  
6  
7 ASQ()  
8 .runner(function*(){  
9     var x = 1 + (yield getData(10));  
10    var y = 1 + (yield getData(30));  
11    var answer = yield (getData(  
12        "Meaning of life: " + (x + y)  
13    ));  
14    yield answer;  
15 })  
16 .val(function(answer){  
17     console.log(answer);  
18     // Meaning of life: 42  
19 });
```

Async Patterns: generator+sequence tasks

(exercise #7: 10min)

Quiz

1. What is “callback hell”? Why do callbacks suffer from “inversion of control” and “un**reason**ability”?
2. What is a Promise? How does it solve inversion of control issues?
3. How do you pause a generator? How do you resume it?
4. How do we combine generators and promises for flow control?

davidwalsh.name/es6-generators

Async Patterns: learn more

Async Patterns

Concurrency: Events (+ Promises)?

Async Patterns

```
1 var p1 = new Promise(function(resolve,reject){  
2     $("#btn").click(function(evt){  
3         var className = evt.target.className;  
4         if (/foobar/.test(className)) {  
5             resolve(className);  
6         }  
7         else {  
8             reject();  
9         }  
10    });  
11});  
12  
13 p1.then(function(className){  
14     console.log(className);  
15});
```

Async Patterns: events + promises

```
1  $("#btn").click(function(evt){  
2      var className = evt.target.className;  
3      var p1 = new Promise(function(resolve,reject){  
4          if (/foobar/.test(className)) {  
5              resolve(className);  
6          }  
7          else {  
8              reject();  
9          }  
10     });  
11     p1.then(function(className){  
12         console.log(className);  
13     });  
14 });
```

Async Patterns: events + promises

```
1 $("#btn").click(function(evt){  
2  
3     [evt]  
4     .map(function mapper(evt) {  
5         return evt.target.className;  
6     })  
7     .filter(function filterer(className) {  
8         return /foobar/.test(className);  
9     })  
10    .forEach(function(className){  
11        console.log(className);  
12    });  
13}  
14});
```

Observables

Async Patterns

	A	B	C	D	E	F	G	H	I	J
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

Ratio Analysis

Values in grey cells are automatically calculated using predefined formula, no alterations required.

Line Item	Beginning of Year
Inventory	\$12,500
Total assets	\$120,000
Owners' equity	\$29,000
Number of common shares	25,000

● assets
● liabilities
● equity

Line Item	Q1	Q2	Q3	Q4	Annual
Current assets	45,000	46,000	46,500	56,000	\$56,000
Fixed assets	80,000	80,000	80,000	80,000	\$80,000
Total assets	125,000	126,000	126,500	136,000	\$136,000
Average total assets	122,500	123,000	123,250	128,000	\$128,000
Cash and cash equivalents	15,000	18,000	16,500	14,350	\$14,350
Inventory	15,000	18,000	16,500	14,350	\$14,350
Average inventory	13,750	15,250	14,500	13,425	\$13,425
Current liabilities	23,000	25,000	22,500	25,600	\$25,600
Total liabilities	125,000	125,000	125,000	110,000	\$110,000
Owners' equity	28,000	30,900	32,000	26,000	\$26,000
Number of common shares	25,000	25,000	25,000	25,000	25,000
Average number of common shares	25,000	25,000	25,000	25,000	25,000
Average owners' equity	28,500	29,950	30,500	27,500	\$27,500

Async Patterns: observables

```
1 var obsv = Rx.Observable.fromEvent(btn,"click");
2
3 obsv
4   .map(function mapper(evt) {
5     return evt.target.className;
6   })
7   .filter(function filterer(className) {
8     return /foobar/.test(className);
9   })
10  .distinctUntilChanged()
11  .subscribe(function(data){
12    var className = data[1];
13    console.log(className);
14  });

```

RxMarbles.com



distinctUntilChanged



Async Patterns: RxJS observables

asynquence: Reactive Sequences

Async Patterns: events

```
1 function fromEvent(el,eventType) {
2     return ASQ.react(function(proceed){
3         $(el).bind(eventType,proceed);
4     })
5 }
6
7 // aka: observable
8 var rsq = fromEvent(btn,"click");
9
10 rsq
11     .val(function(evt){
12         return evt.target.className;
13     })
14     .then(function(done,className){
15         if (/foobar/.test(className)) {
16             done(className);
17         }
18     })
19     .val(function(className){
20         console.log(className);
21     });

```

Async Patterns: reactive sequences

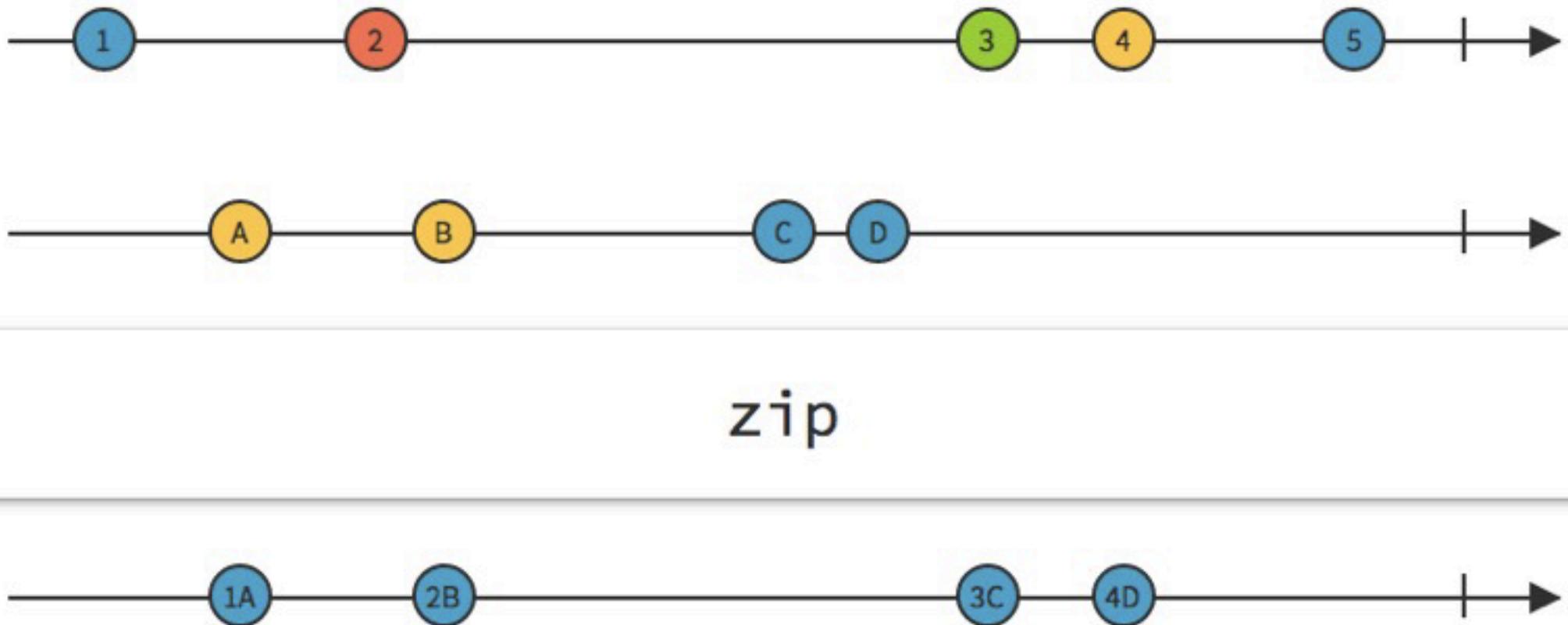
```
1 function fromEvent(el, eventType) {  
2     var rsq = ASQ.react.of();  
3     $(el).bind(eventType, rsq.push);  
4     return rsq;  
5 }
```

```
1 var rsq1 = ASQ.react.of();
2 var rsq2 = ASQ.react.of(1,2,3);
3 var x = 10;
4
5 setInterval(function(){
6     rsq1.push(x++);
7     rsq2.push(x++);
8 },500);
9
10 rsq1.val(function(v){
11     console.log("1:",v);
12 });
13 // 1: 10  1: 12  1: 14 ...
14
15 rsq2.val(function(v){
16     console.log("2:",v);
17 });
18 // 2: 1  2: 2  2: 3  2: 11  2: 13 ...
```

Async Patterns: reactive sequences

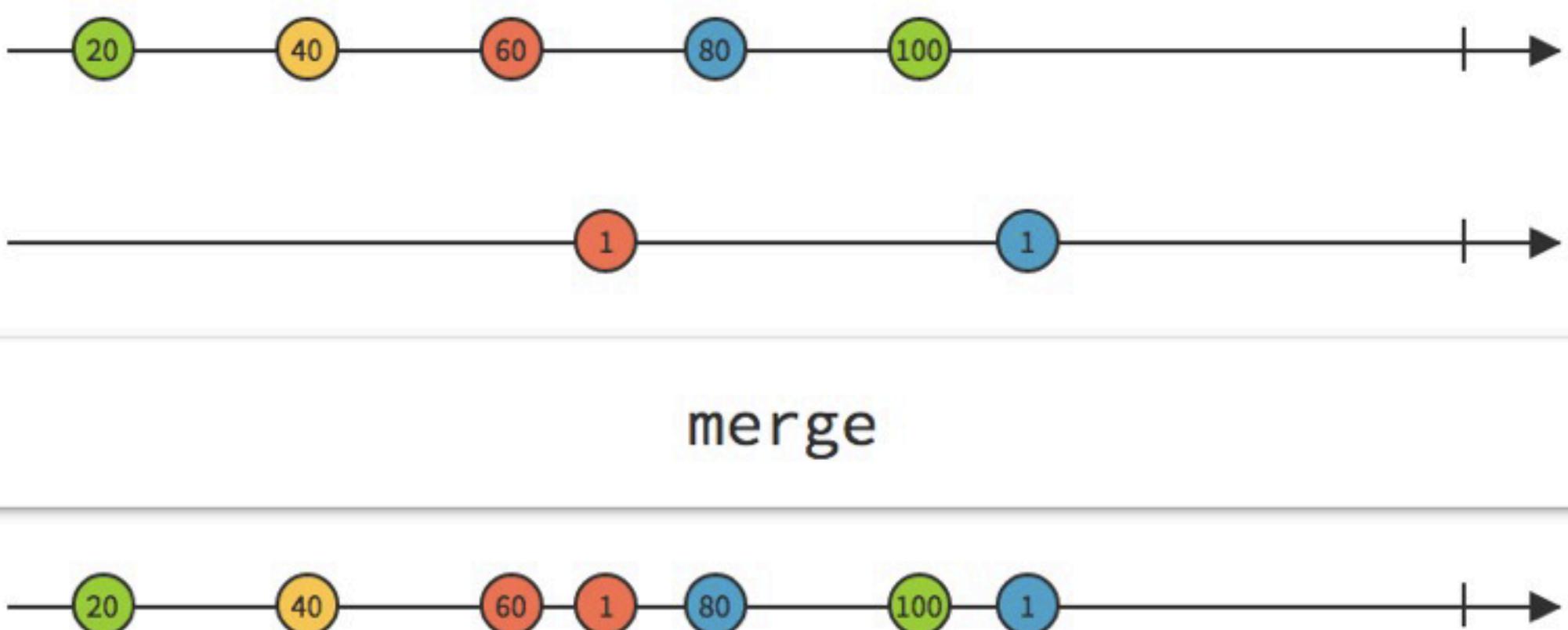
```
1 var rsq1 = fromEvent(btn,"click"),
2     rsq2 = fromEvent(inp,"keypress"),
3
4     rsq3 = ASQ.react.all(rsq1,rsq2),
5     rsq4 = ASQ.react.any(rsq1,rsq2);
6
7 rsq3.val(function(evt1,evt2){
8     // ..
9 });
10
11 rsq4.val(function(evt){
12     // ..
13 });
```

aka "all"



Async Patterns: reactive sequences

aka "any"



Async Patterns: reactive sequences

(exercise #8: 20min)

Async Patterns

Concurrency (+ Channels)

Async Patterns

CSP: Communicating Sequential Processes

(aka go-style concurrency)

Async Patterns: concurrency

```
1 var ch = chan();
2
3 function *process1() {
4     yield put(ch, "Hello");
5     var msg = yield take(ch);
6     console.log(msg);
7 }
8
9 function *process2() {
10    var greeting = yield take(ch);
11    yield put(ch, greeting + " World");
12    console.log("done!");
13 }
14
15 // Hello World
16 // done!
```

```
1 csp.go(function*() {
2     while (true) {
3         yield csp.put(ch, Math.random());
4     }
5 });
6
7 csp.go(function*() {
8     while (true) {
9         yield csp.take( csp.timeout(500) );
10    var num = yield csp.take(ch);
11    console.log(num);
12 }
13});
```

```
1 csp.go(function*() {
2     while (true) {
3         var msg = yield csp.alts(ch1,ch2,ch3);
4         console.log(msg);
5     }
6 });
```

```
1 csp.go(function* () {
2     var table = csp.chan();
3
4     csp.go(player, ["ping", table]);
5     csp.go(player, ["pong", table]);
6
7     yield csp.put(table, {hits: 0});
8     yield csp.timeout(1000);
9     table.close();
10 });
11
12 function* player(name, table) {
13     while (true) {
14         var ball = yield csp.take(table);
15         if (ball === csp.CLOSED) {
16             console.log(name + ": table's gone");
17             return;
18         }
19         ball.hits += 1;
20         console.log(name + " " + ball.hits);
21         yield csp.timeout(100);
22         yield csp.put(table, ball);
23     }
24 }
```

Async Patterns: channel CSP

```
1 function fromEvent(el,eventType) {
2     var ch = csp.chan();
3     $(el).bind(eventType, function(evt){
4         csp.putAsync(ch,evt);
5     });
6     return ch;
7 }
8
9 csp.go(function*(){
10    var ch = fromEvent(el,"mousemove");
11    while (true) {
12        var evt = yield csp.take(ch);
13        console.log(
14            evt.clientX + "," + evt.clientY
15        );
16    }
17});
```

asynquence CSP

Async Patterns: asynquence

```
1 ASQ().runner(  
2   ASQ.csp.go(function *process1(ch){  
3     yield ASQ.csp.put(ch,"Hello");  
4     var msg = yield ASQ.csp.take(ch);  
5     console.log(msg);  
6   }),  
7   ASQ.csp.go(function *process2(ch){  
8     var greeting = yield ASQ.csp.take(ch);  
9     yield ASQ.csp.put(ch,greeting + " World");  
10    console.log("done!");  
11  })  
12 );  
13 // Hello World  
14 // done!
```

Async Patterns: asynquence CSP

(exercise #9: 20min)

Callbacks / Thunks
Promises
Generators
Observables
CSP go-routines

Async Patterns

github.com/getify/a-tale-of-three-lists

A Tale Of Three Lists (Callbacks)

Donec quam orci, aliqu...

Pellentesque habitant m...

Nunc interdum, urna at ...

Suspendisse potenti. Cu...

pause list

Nullam pharetra est nunc, a accumsan metus
pellentesque ut. Duis auctor justo sit amet
tincidunt iaculis. Pellentesque sollicitudin
mauris ut ligula suscipit sagittis.

Praesent egestas tortor et nibh rutrum
accumsan. Suspendisse potenti. Proin
vehicula massa id pretium aliquet.

Pellentesque egestas ultrices tempus.
Vestibulum interdum accumsan nulla quis
ornare. Duis cursus vel ipsum nec mattis.

Integer turpis nulla, rutrum a nunc non,
maximus malesuada massa. Suspendisse vel
egestas felis. Donec vehicula neque augue, sit
amet mattis nulla pellentesque eu.

In id interdum velit. Du...

Vestibulum id sodales ...

Vestibulum et turpis tin...

Maecenas quis egestas ...

Ut sem lorem, rhoncus ...

resume

Async Patterns

Callbacks / Thunks +
Promises +
Generators +
Observables +
CSP go-routines

Async Patterns

Kyle Simpson
@getify
<http://getify.me>

Thanks!

Questions?