SALT LAB
Software Analysis and Testing

Understanding Asynchronous Interactions In Full-Stack JavaScript

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ICSE 2016

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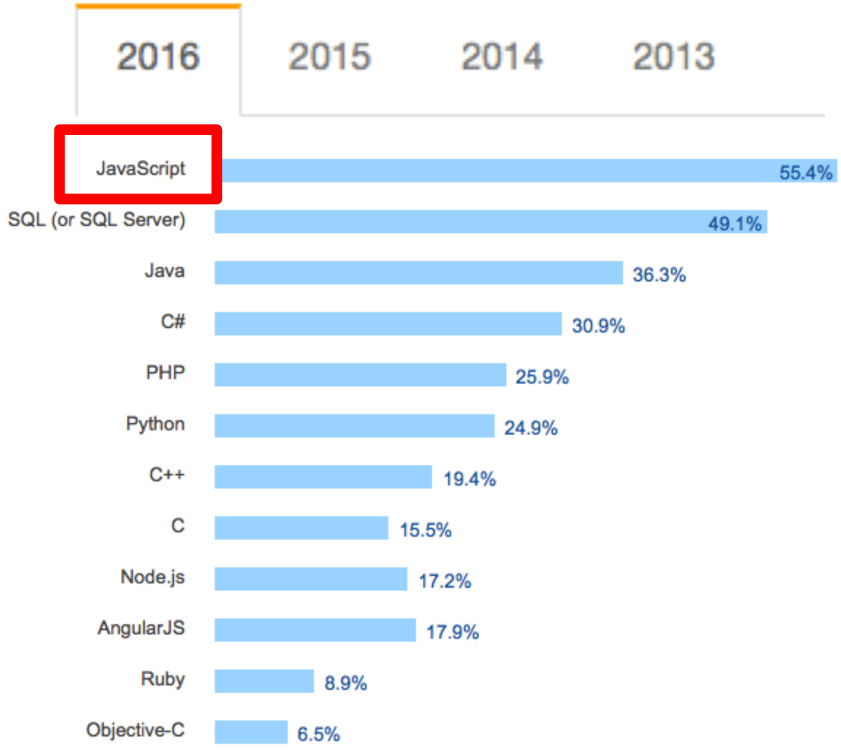
Sahand: http://github.com/saltlab/sahand

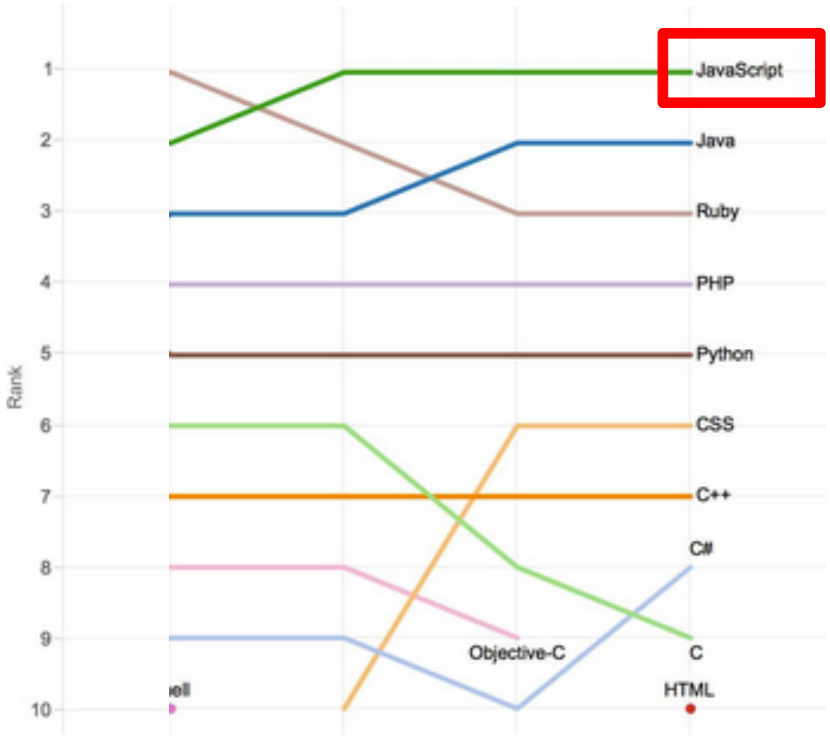
ece Electrical and Computer Engineering

UBC a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

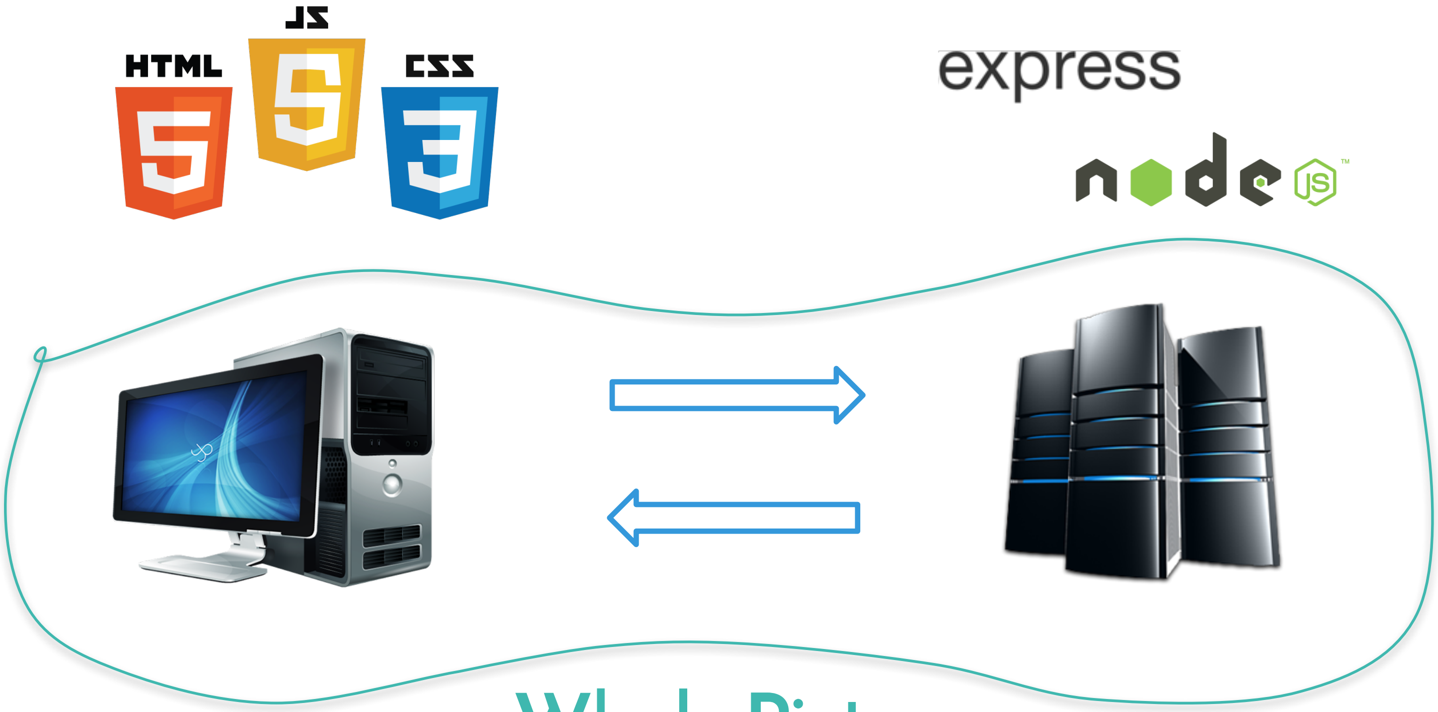
JavaScript:
Most popular language

JavaScript:
Top languages on GitHub





Understanding JavaScript Apps



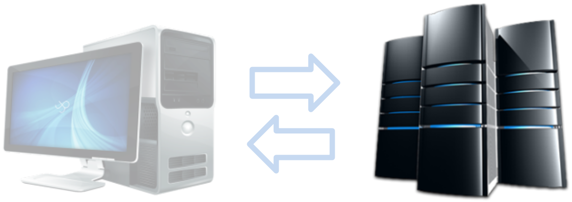
Whole Picture

Challenge 1. **Server**-Side Callbacks

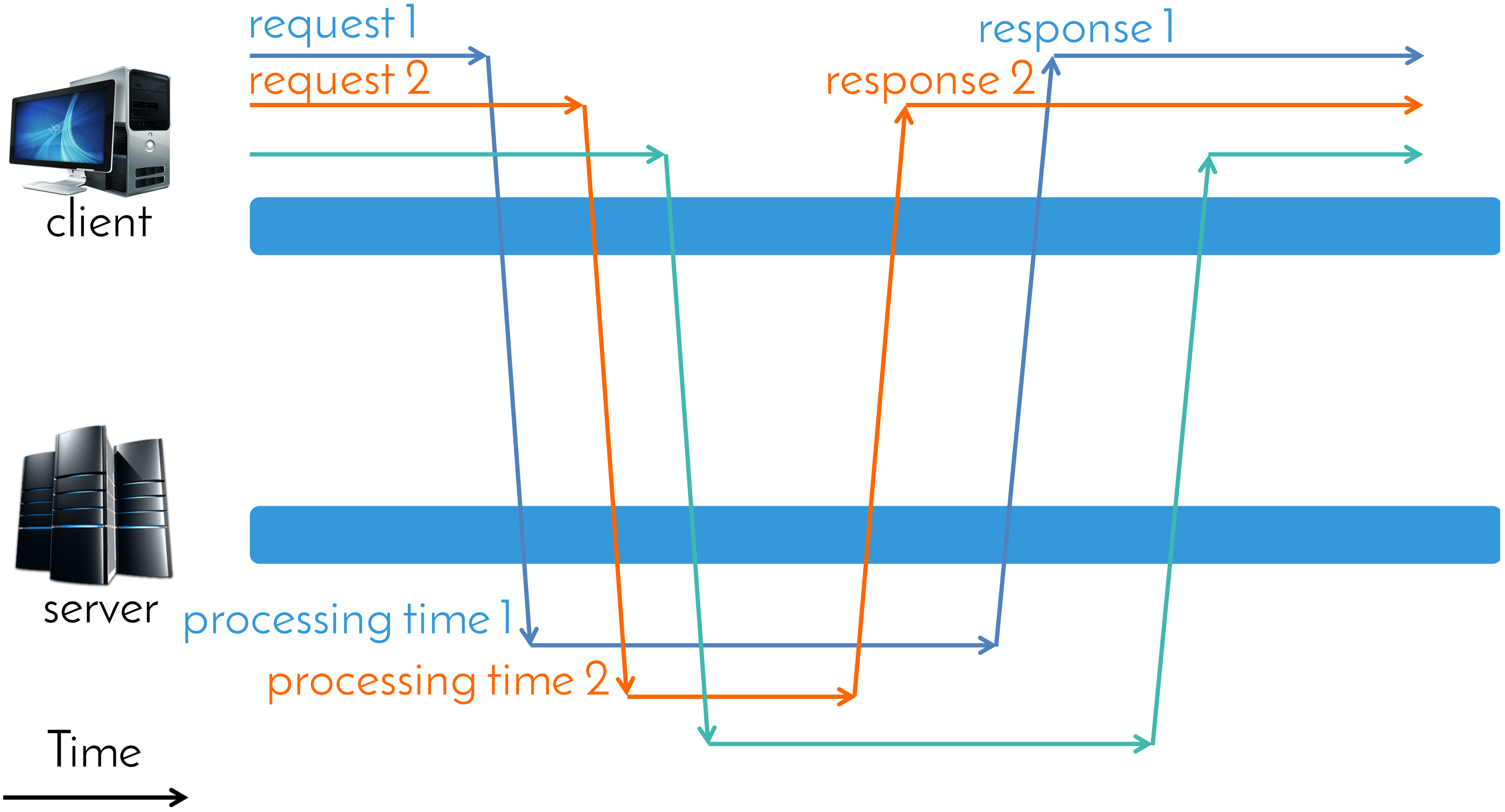
- Asynchronous execution
- Callback hell

Little pyramid of **doom**

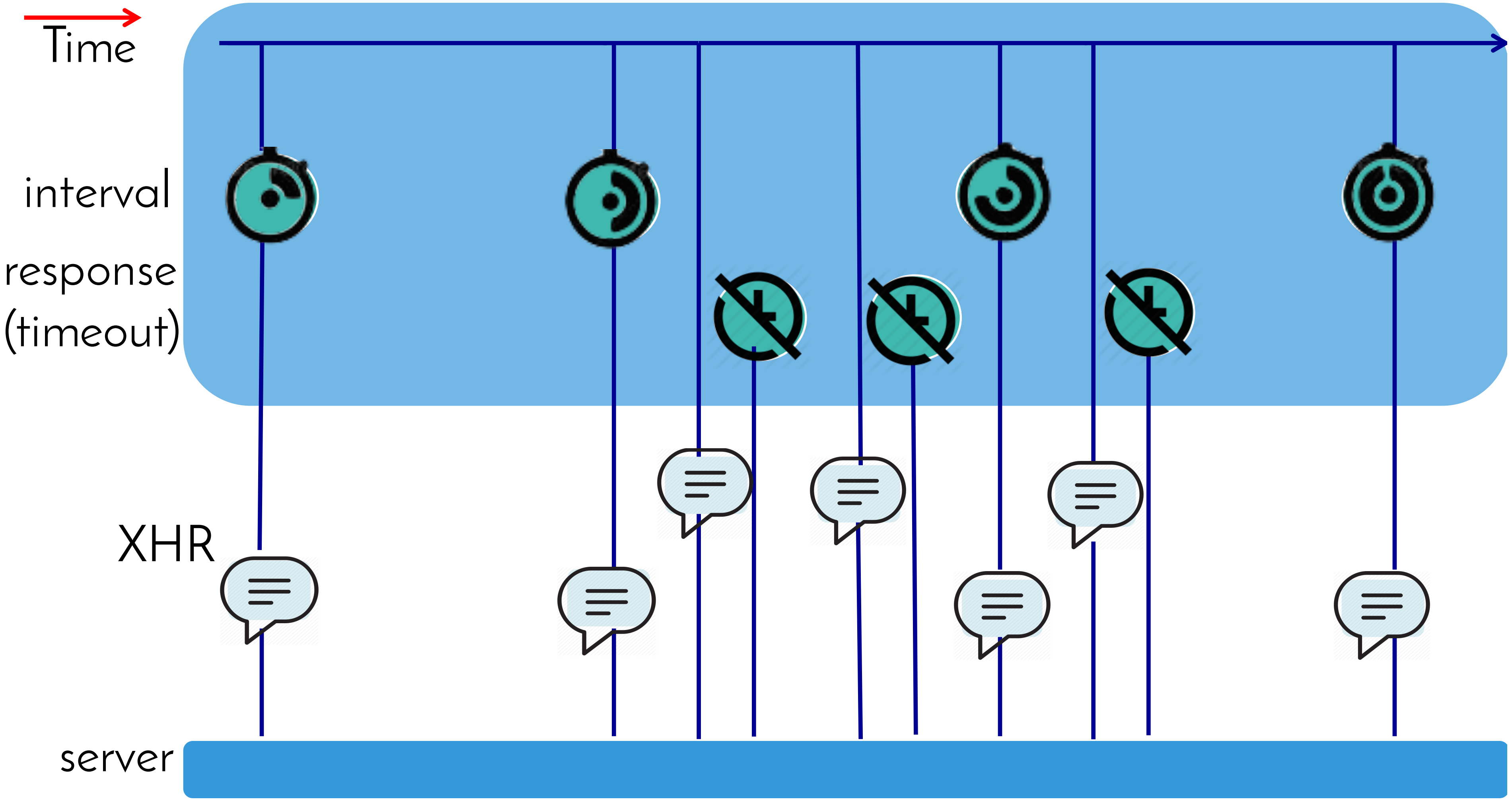
```
fs.readdir(source, function(err, files) {
  files.forEach(function(filename, fileIndex)
    gm(source + filename).size(function(err, values) {
      widths.forEach(function(width, widthIndex) {
        this.resize(w, h).write(newName, function(err) {
        })
      })
    })
  })
})  // example from callbackhell.com
```



Challenge 2. **Network** Communications



Challenge 3. Asynchronous **Client** Side



Summary of Challenges

- Server-side callbacks
- Network communication
- Asynchronous client side

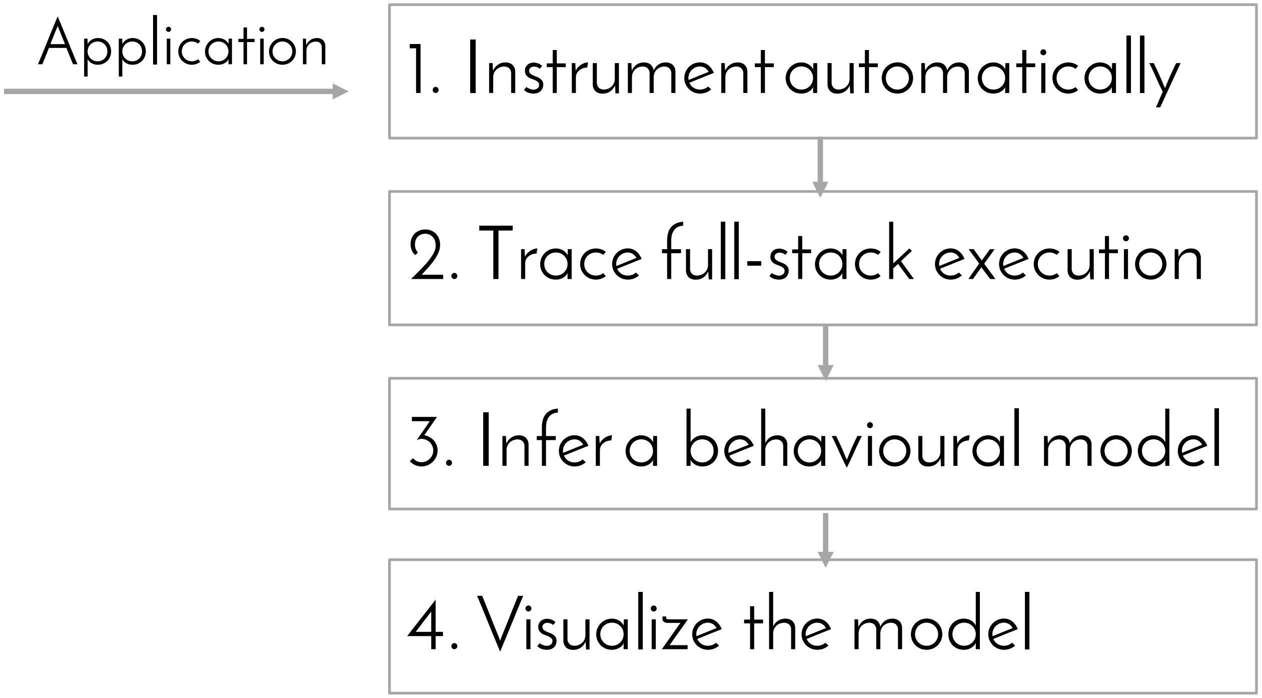
Related work:

Zaidman et al.
EMSE’13

Hibschman et al.
UIST’14

Alimadadi et al.
ICSE’14, ECOOP’15

Our Approach: ***Sahand***



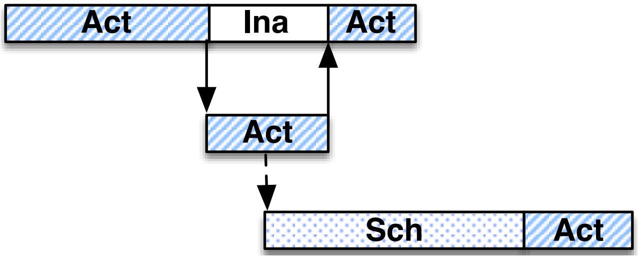
Application

1. Instrument automatically

2. Trace full-stack execution

3. Infer a behavioural model

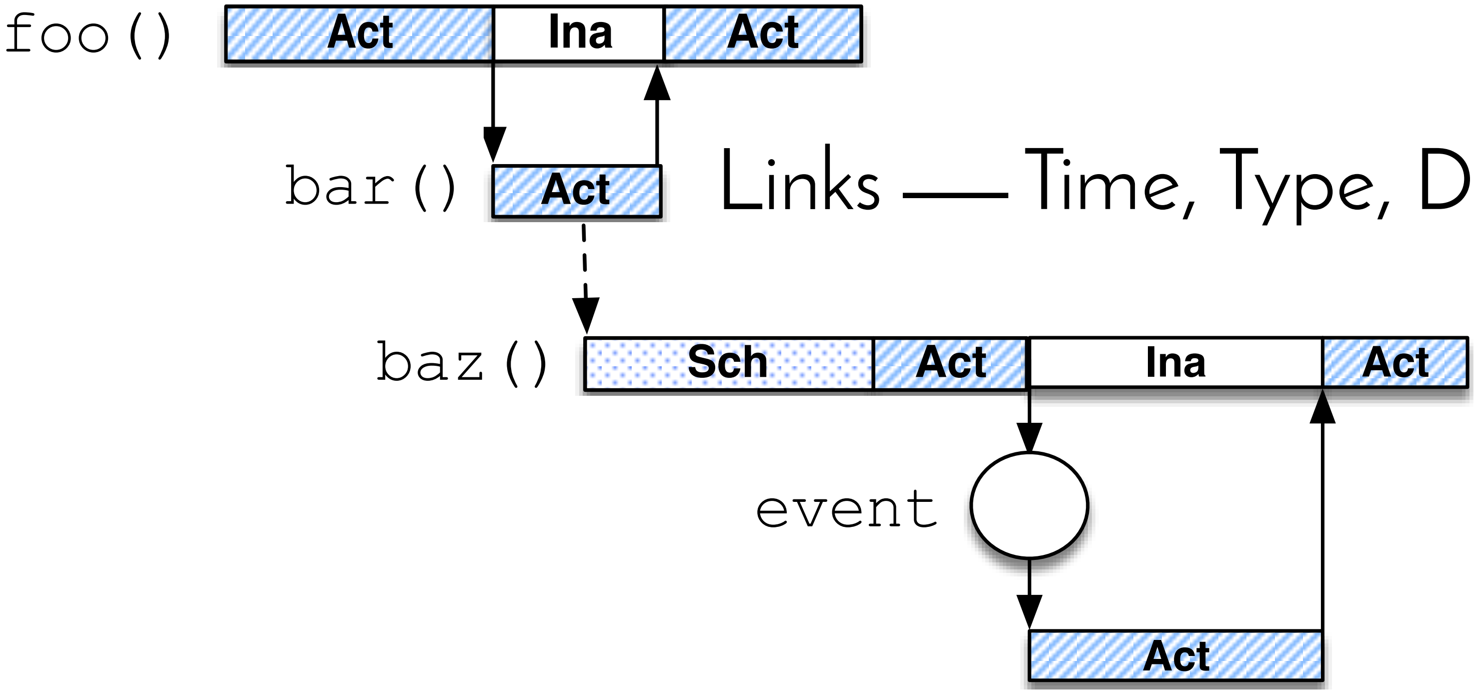
4. Visualize the model



Behavioral Model

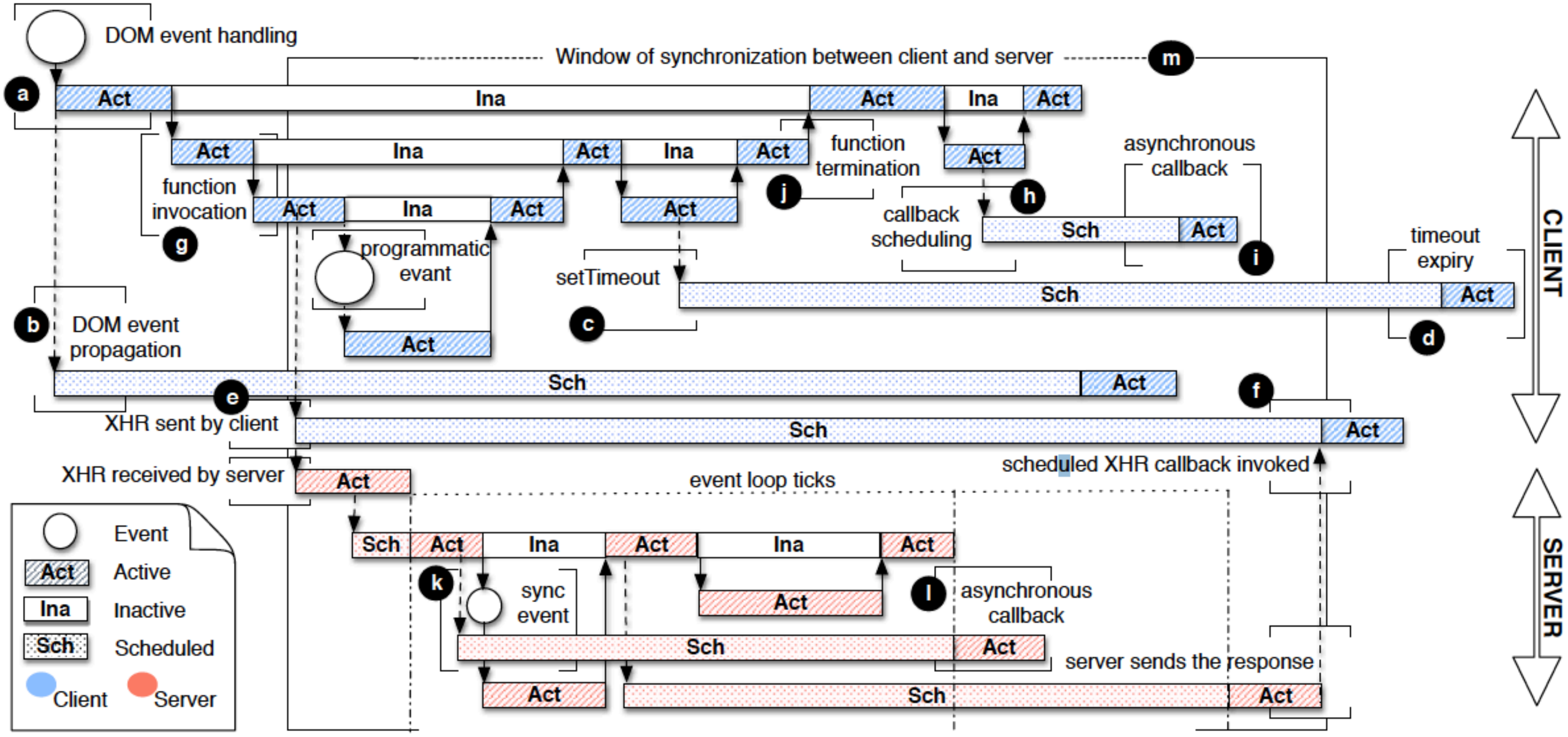
Nodes — Lifelines of function executions

Nodes — (A)Synchronous client/server events



Links — Time, Type, Direction

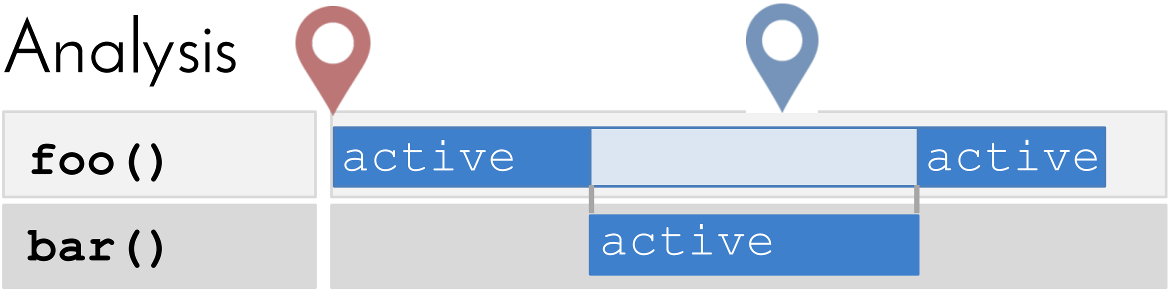
Real Behavioural Models Are Complex



Visualization

Client-Side

Analysis



foo()

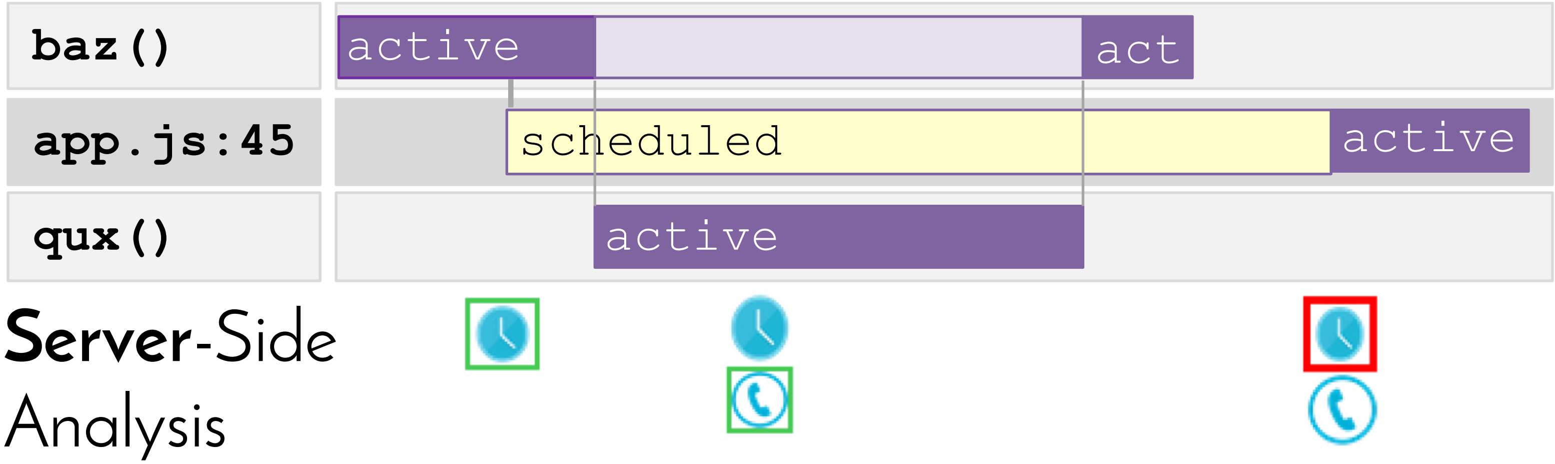
bar()

active

active

active

Connecting client and server



baz()

app.js:45

qux()

active

act

scheduled

active

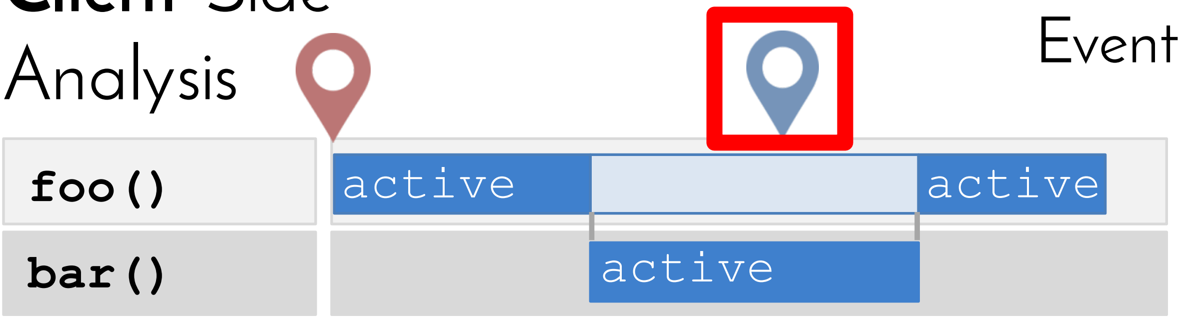
active

Server-Side

Analysis

Visualization

Client-Side
Analysis

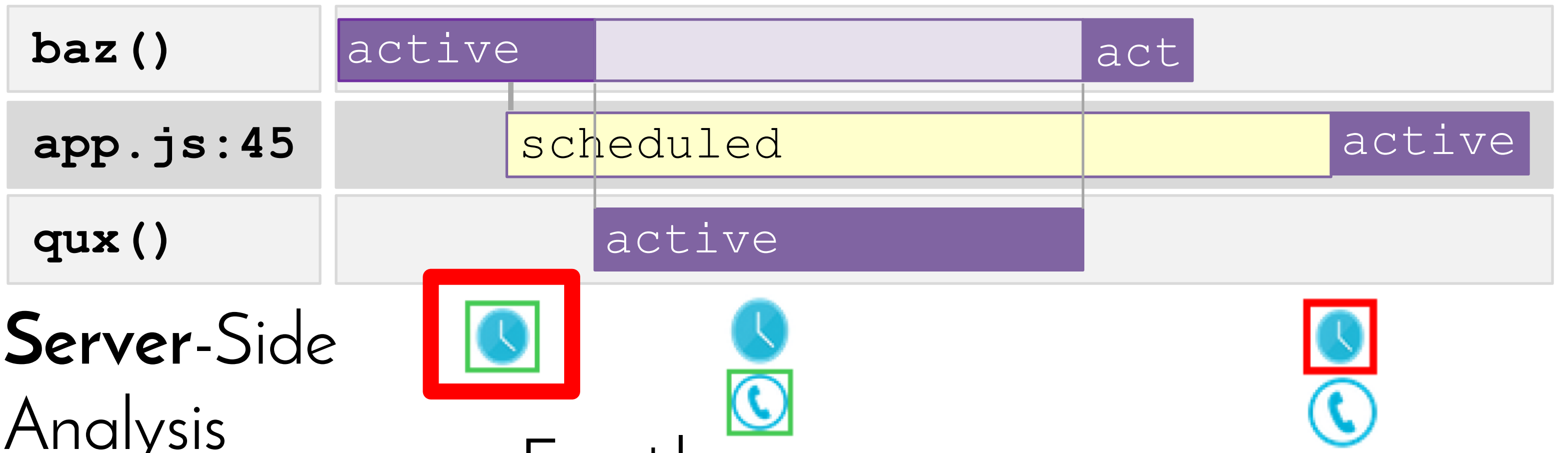


Events and DOM interactions

Timeouts

XHRs

Time ⸺Temporal primitives⟶ Time points

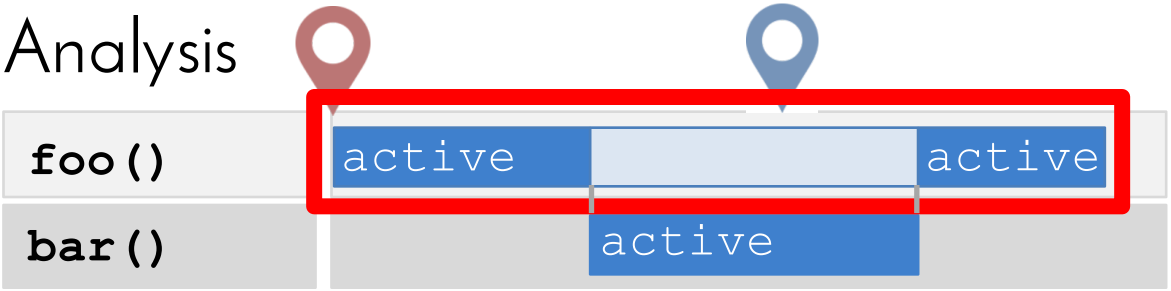


Server-Side
Analysis

Event loop

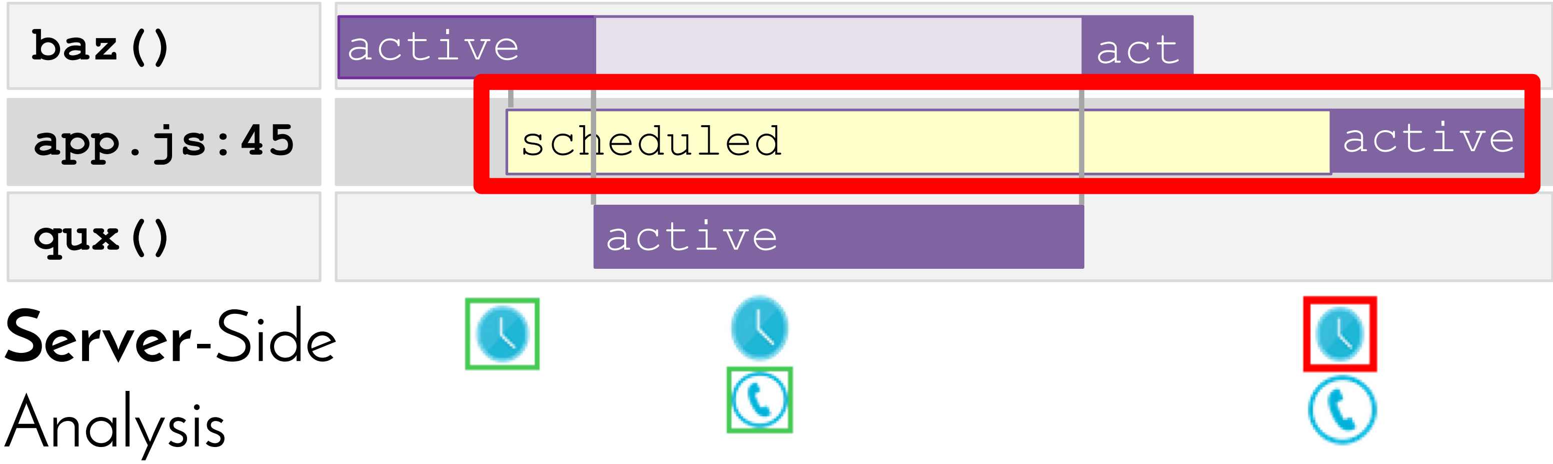
Visualization

Client-Side
Analysis



Function executions

Time —Temporal primitives⟶ Time intervals

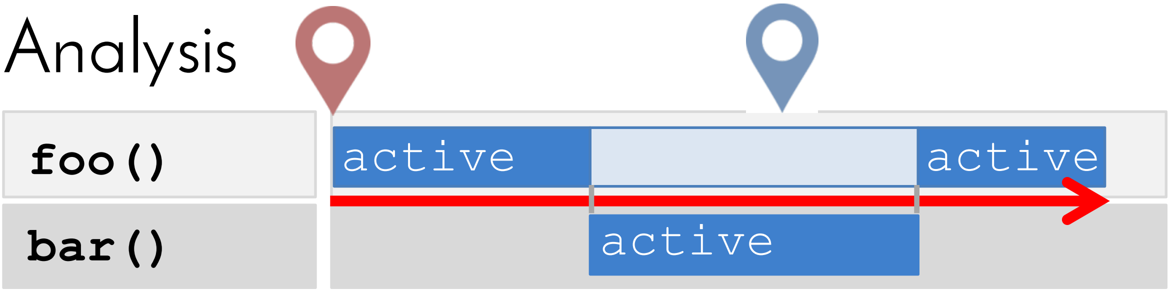


Callbacks

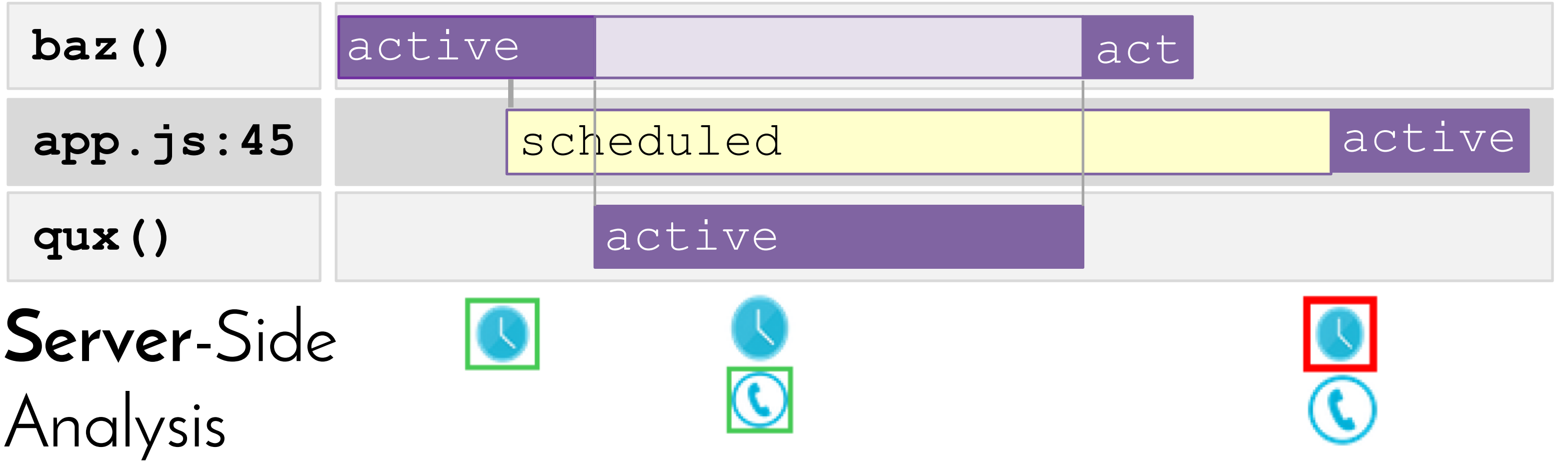
Server-Side
Analysis

Visualization

Client-Side Analysis



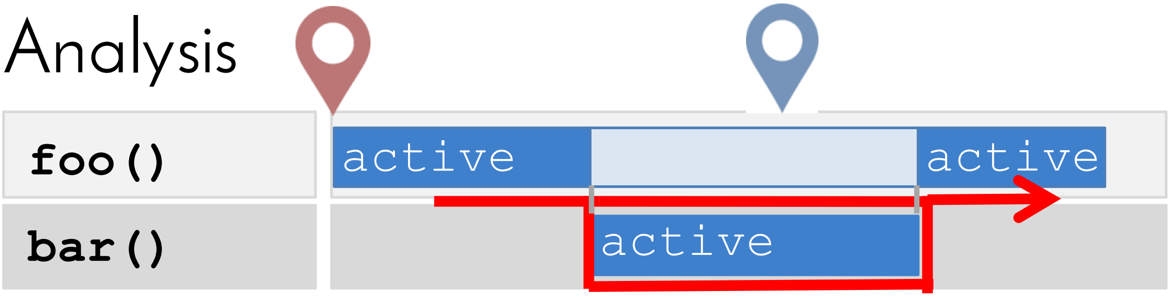
Time — Structure of time → Linear & Branching



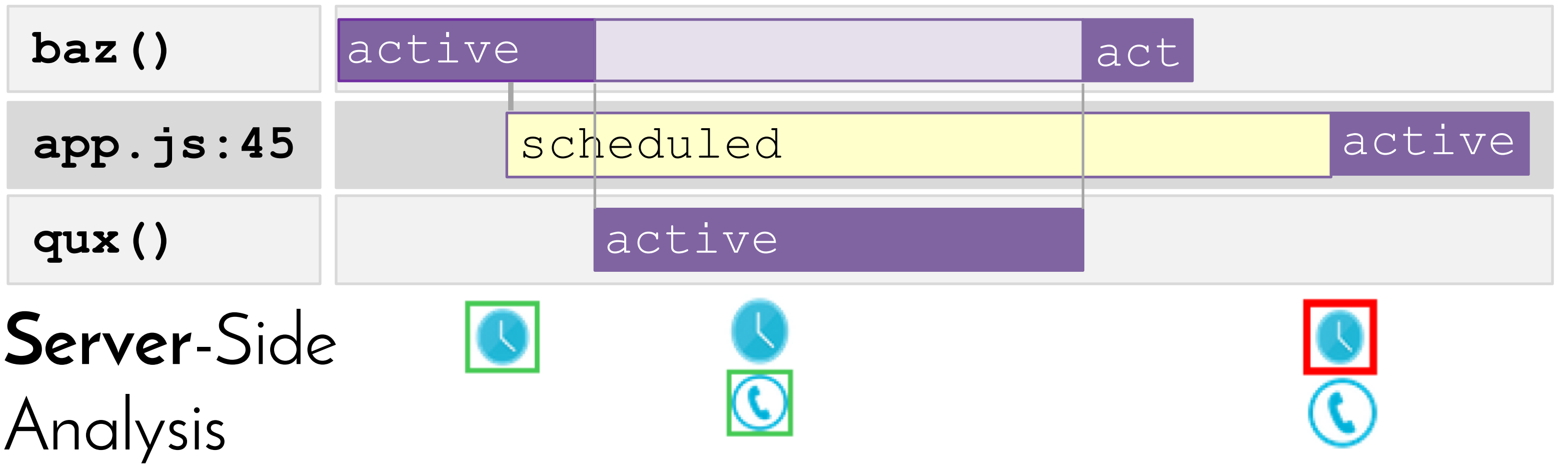
Server-Side Analysis

Visualization

Client-Side Analysis



Time — Structure of time → Linear & Branching

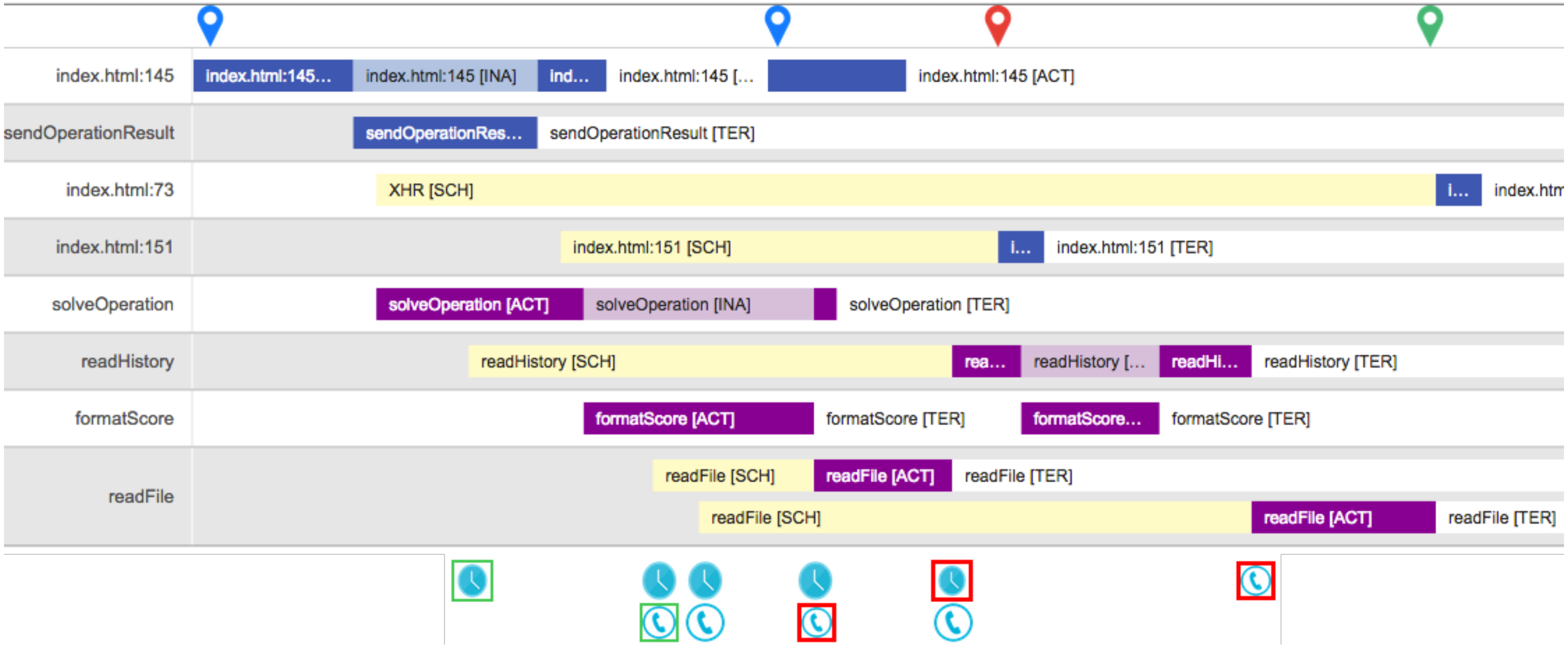


Server-Side Analysis

Implementation: ***Sahand***

- Express.js application
- Proxy -> dynamic instrumentation
- Esprima, Estraverse, Escodegen

https://github.com/saltlab/sahand

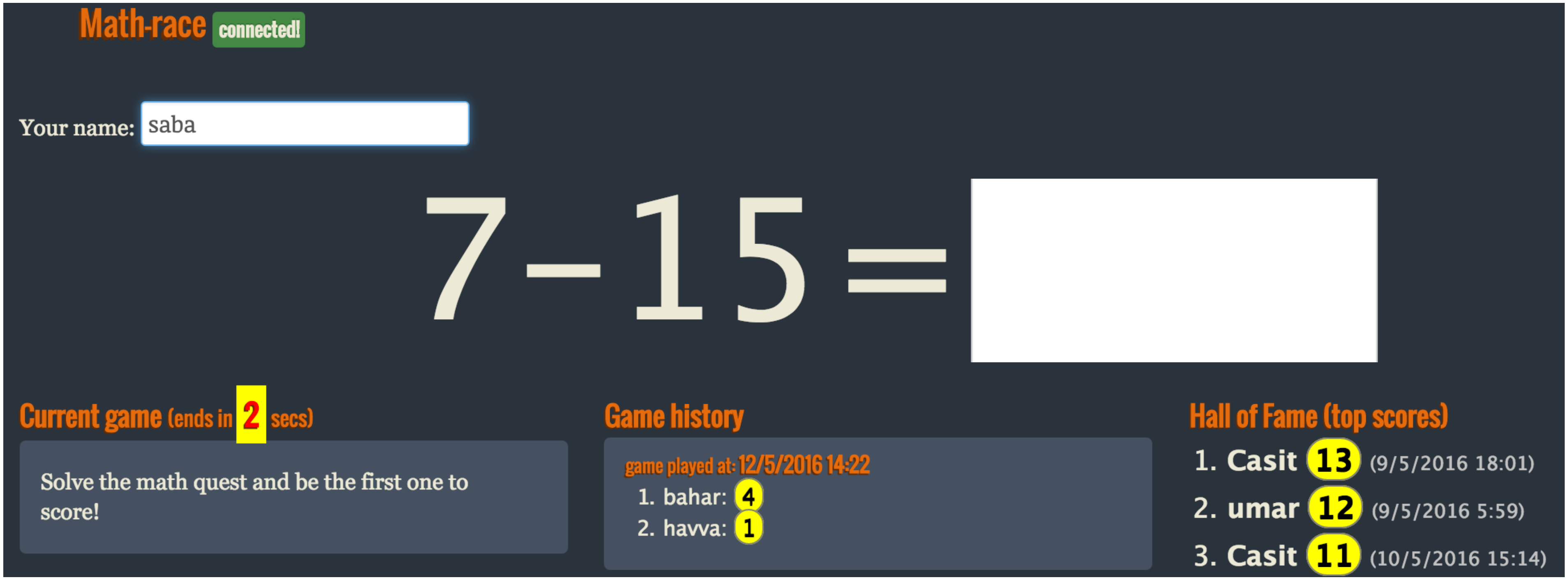


Evaluation

Does using ***Sahand*** improve developers' performance in program comprehension tasks?

Controlled Experiment

- ***Sahand***'s effect on developers' performance
- 12 Participants
- Object: full-stack JavaScript application



Your name: saba

$7 - 15 =$

Solve the math quest and be the first one to score!

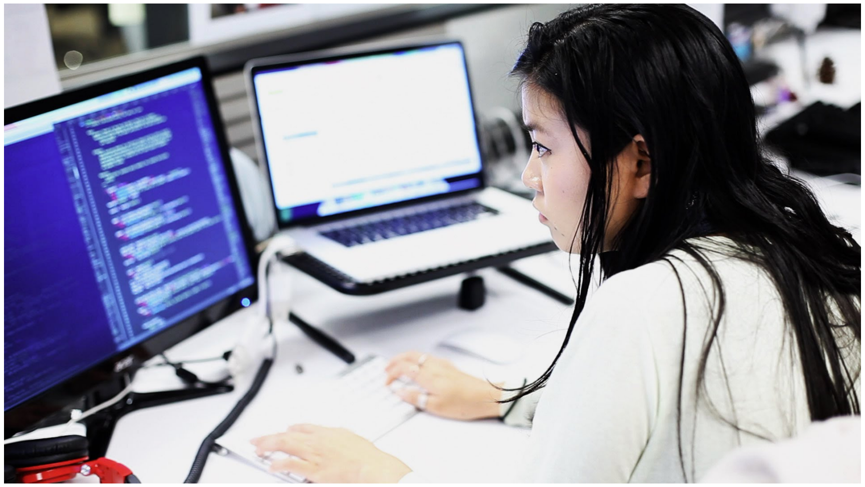
game played at: 12/5/2016 14:22

1. bahar: 4
2. havva: 1

1. Casit 13 (9/5/2016 18:01)
2. umar 12 (9/5/2016 5:59)
3. Casit 11 (10/5/2016 15:14)

Controlled Experiment

- Design
  - Control: tool and expertise level
  - Measure: performance
- Procedure
  - Pre-questionnaire
  - Tutorial
  - Tasks
  - Post-questionnaire

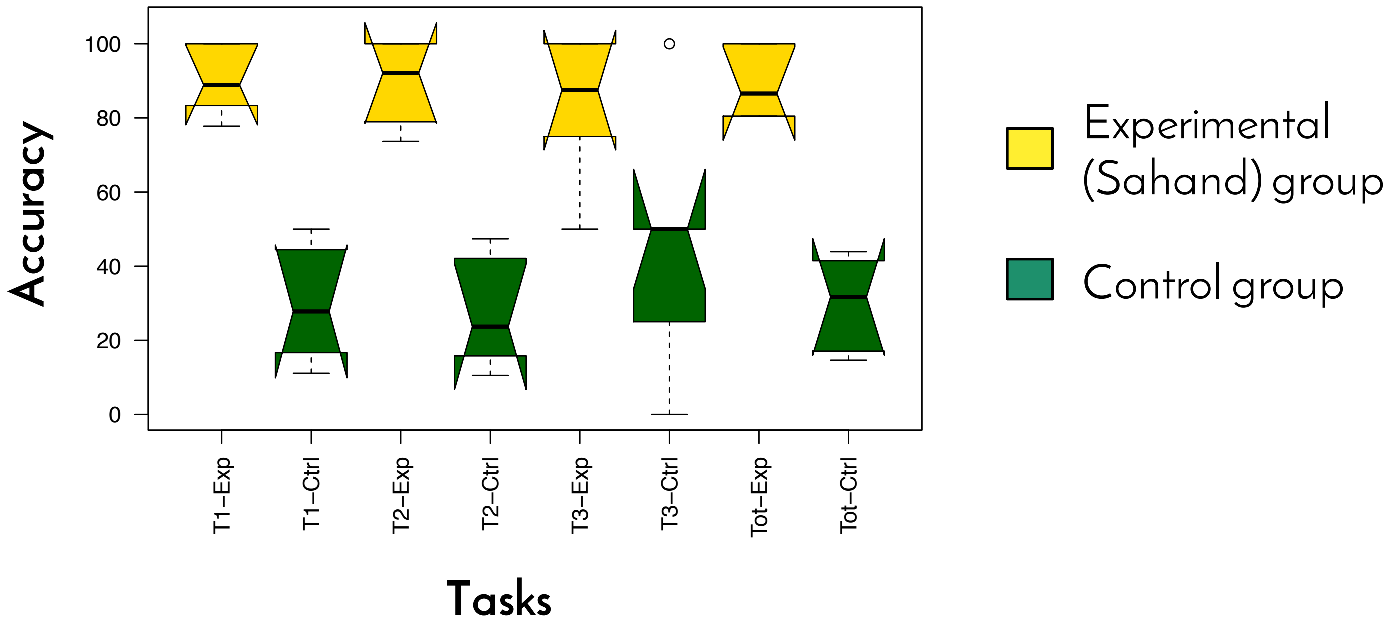


Results Highlight

Using ***Sahand***

3 times more accuracy

In the same time



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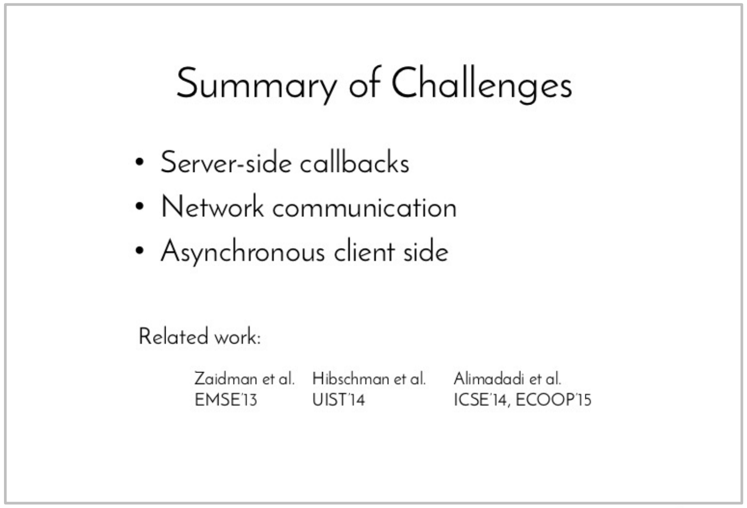

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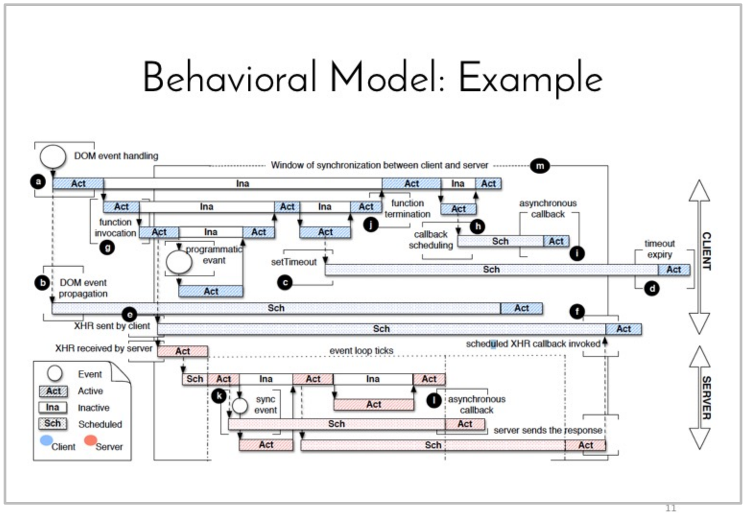

Behavioral Model: Example

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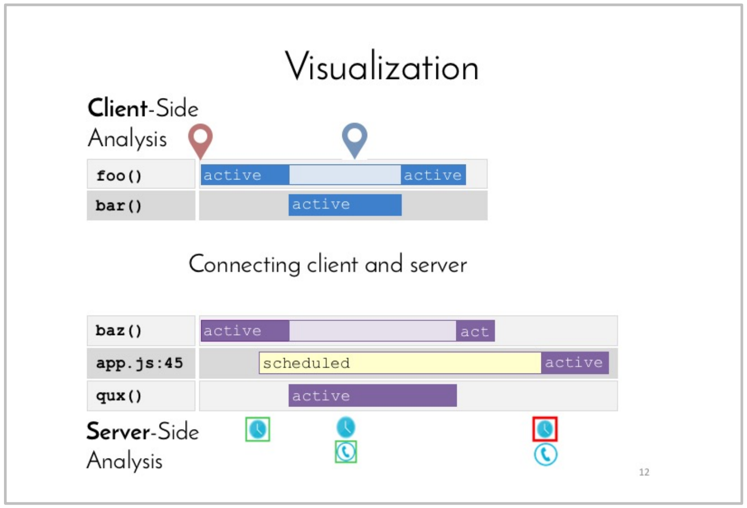


Visualization

Client-Side Analysis

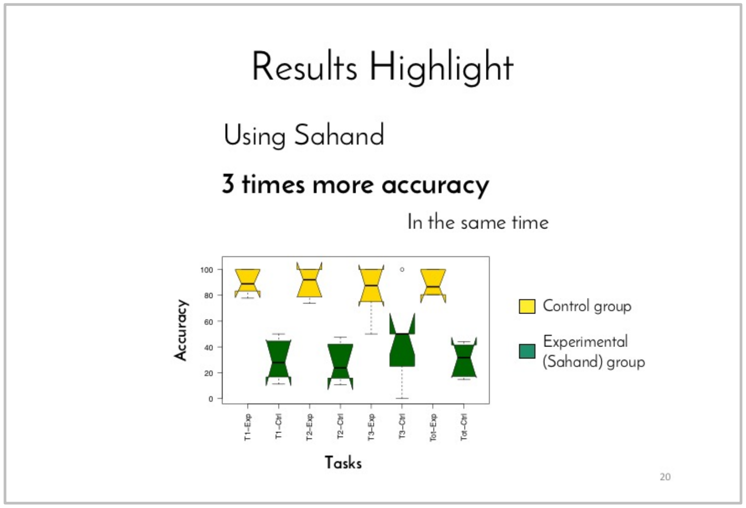
```
foo()     active            active
bar()           active
```

Connecting client and server

```
baz()     active                 act
app.js:45        scheduled                  active
qux()           active
```

Server-Side Analysis

12



Results Highlight

Using Sahand

3 times more accuracy

In the same time

🟨 Control group

🟩 Experimental (Sahand) group

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Saba Alimadadi

Hire Me!