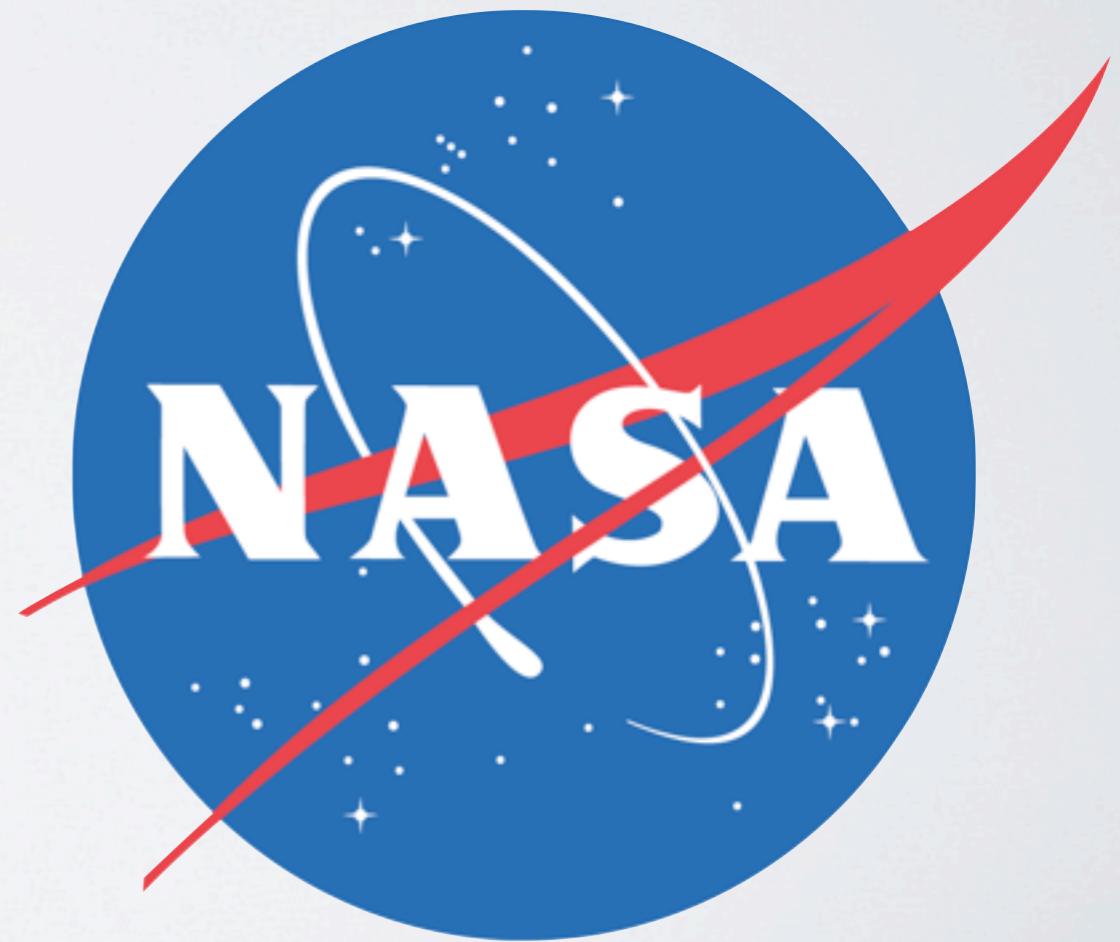


Visualization Driven Development

Jason Gilman
@jasongilman

element 84

About Me



Are we at the pinnacle of
computing?

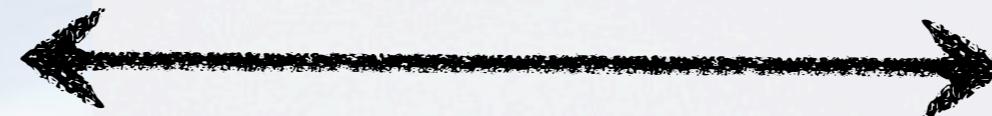
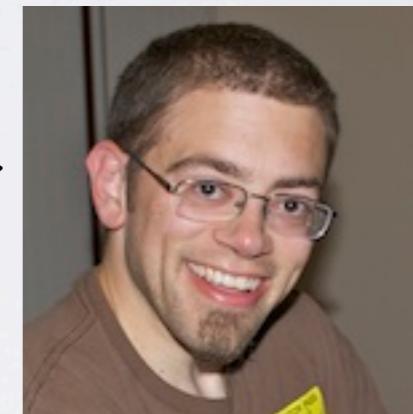
Of course not!

Communication

Computer



Developer

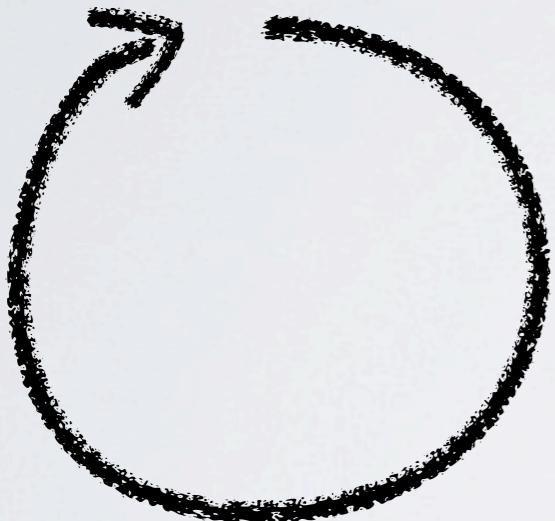


Source: Heinz Nixdorf
MuseumsForum

What's happening?



1. Write code



2. Execution



3. Output

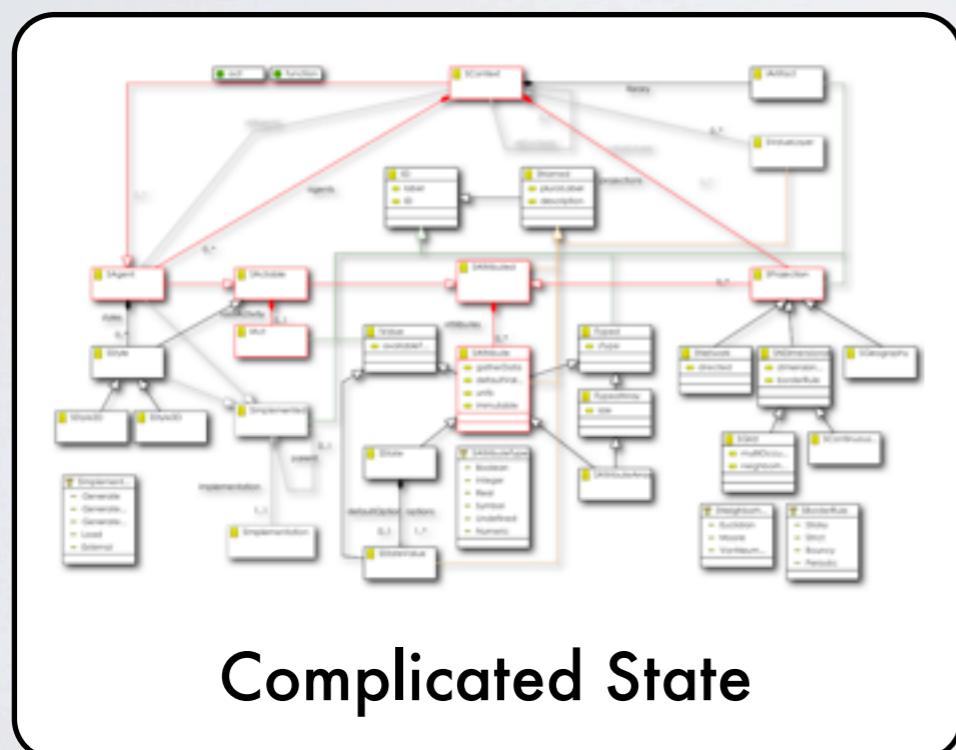
NullPointerException

Tool Belt

Logging Debugger REPL

Deficiencies:

Computer



Developer

Logs,
stack traces,
alerts



Which of these is bigger?

550mm 3m

Which of these is bigger?



source: commons.wikimedia.org/wiki/File:Baseball_(crop).jpg

3000

2250

1500

750

0

550mm

550mm

3000mm

3m



Steam_SetMinidumpSteamID: Caching Steam ID: 76561198025064504 [API loaded no]
Endless Space(863,0xac65aa28) malloc: *** error for object 0x20afa84c: pointer being freed was not allocated
*** set a breakpoint in malloc_error_break to debug
Endless Space(863,0xac65aa28) malloc: *** error for object 0x20afa94b: pointer being freed was not allocated
*** set a breakpoint in malloc_error_break to debug
Endless Space(863,0xac65aa28) malloc: *** error for object 0x92d3552: pointer being freed was not allocated
*** set a breakpoint in malloc_error_break to debug
Endless Space(863,0xac65aa28) malloc: *** error for object 0x20afa94b: pointer being freed was not allocated
*** set a breakpoint in malloc_error_break to debug
Endless Space(863,0xac65aa28) malloc: *** error for object 0x9169d52: pointer being freed was not allocated
*** set a breakpoint in malloc_error_break to debug
Endless Space(863,0xac65aa28) malloc: *** error for object 0x20afa94b: pointer being freed was not allocated
*** set a breakpoint in malloc_error_break to debug
Lib.dll into Unity Child Domain
Exception in thread "main" java.io.FileNotFoundException: Could not locate clojure/tools/nrepl/ack_init.class or clojure/tools/nrepl/ack.clj on classpath:
(lein2.clj:1)
at clojure.lang.Compiler.eval(Compiler.java:5440)
at clojure.lang.Compiler.eval(Compiler.java:5415)
at clojure.lang.Compiler.load(Compiler.java:5857)
at clojure.lang.RT.loadResourceScript(RT.java:340)
at clojure.lang.RT.loadResourceScript(RT.java:331)
at clojure.lang.RT.load(RT.java:409)
at clojure.lang.RT.load(RT.java:381)
at clojure.core\$load\$fn_4519.invoke(core.clj:4915)
at clojure.core\$load.doInvoke(core.clj:4914)
at clojure.lang.RestFn.invoke(RestFn.java:408)
at clojure.core\$load_one.invoke(core.clj:4729)
at clojure.core\$load_lib.doInvoke(core.clj:4766)
at clojure.lang.RestFn.applyTo(RestFn.java:142)
at clojure.core\$apply.invoke(core.clj:542)
at clojure.core\$load_libs.doInvoke(core.clj:4800)
at clojure.lang.RestFn.applyTo(RestFn.java:137)
at clojure.core\$apply.invoke(core.clj:542)
at clojure.core\$require.doInvoke(core.clj:4881)
at clojure.lang.RestFn.invoke(RestFn.java:408)
at leinjacker.utils\$try_resolve\$fn_383.invoke(utils.clj:12)
at leinjacker.utils\$try_resolve.invoke(utils.clj:12)
at clojure.lang.AFn.applyToHelper(AFn.java:161)
at clojure.lang.AFn.applyTo(AFn.java:151)
at clojure.lang.Compiler\$InvokeExpr.eval(Compiler.java:2906)
at clojure.lang.Compiler\$MapExpr.eval(Compiler.java:2472)
at clojure.lang.Compiler\$DefExpr.eval(Compiler.java:361)
at clojure.lang.Compiler.eval(Compiler.java:5429)
at clojure.lang.Compiler.load(Compiler.java:5857)
at clojure.lang.RT.loadResourceScript(RT.java:340)
at clojure.lang.RT.loadResourceScript(RT.java:331)
at clojure.lang.RT.load(RT.java:409)
at clojure.lang.RT.load(RT.java:381)
at clojure.core\$load\$fn_4519.invoke(core.clj:4915)
- Completed reload, in 0.075 seconds
Switching to 800x600 fullscreen
Platform assembly: /Users/mark/Library/Application Support/Steam/SteamApps/common/Endless Space/Endless Space.app/Contents/Data/Managed/System.dll (this message is harmless)
Platform assembly: /Users/mark/Library/Application Support/Steam/SteamApps/common/Endless Space/Endless Space.app/Contents/Data/Managed/System.Xml.dll (this message is harmless)
Platform assembly: /Users/mark/Library/Application Support/Steam/SteamApps/common/Endless Space/Endless Space.app/Contents/Data/Managed/UnityScript.Lang.dll (this message is harmless)
Platform assembly: /Users/mark/Library/Application Support/Steam/SteamApps/common/Endless Space/Endless Space.app/Contents/Data/Managed/Boo.Lang.dll (this message is harmless)
[Bootloader] version: 1.00.18 - 02

(Filename: /Applications/buildAgent/work/b0bcff80449a48aa/Runtime/ExportGenerated/MacStandalonePlayer/UnityEngineDebug.cpp Line: 43)
[Bootloader] command line: /Users/mark/Library/Application Support/Steam/SteamApps/common/Endless Space/Endless Space.app/Contents/MacOS/Endless Space -single-instance -windowed -w 2560 -h 1440

Concrete examples are much more useful in the real world

You're planning a wedding



<http://www.flickr.com/photos/gavinbell/81011618>

Is this a good choice?

A page of musical notation from a score, showing ten staves of music for various instruments. The instruments listed on the left are Picc, Fl, Fl c a (G), Ob, C ingl, Cl picc, (A), Cl (B), and (B). The music consists of measures of notes and rests, with some measures containing numerical markings like '3', '10', '5', '7', '6', '5', and '3'. The notation is on five-line staves with various clefs and key signatures.

A good cake for the reception?

INGREDIENTS:

For Cupcakes:

1 (18.25 ounce) package white cake mix with pudding
1/3 cup vegetable oil
3 egg whites
1 1/4 cups water
6 ounces bittersweet chocolate, chopped fine

For Filling:

1 cup cold heavy whipping cream
2 tablespoons confectioners' sugar
1/2 cup frozen unsweetened raspberries
1/4 cup chocolate-coated toffee bits
1/2 cup finely chopped toasted hazelnuts

, skins removed

For Ganache:

1/2 cup heavy cream
6 ounces semisweet chocolate, chopped

For Frosting:

1 (12 ounce) package white chocolate chips
1 cup unsalted butter, at room temperature
2 (8 ounce) packages cream cheese, softened
2 teaspoons vanilla extract
food coloring, if desired (optional)

DIRECTIONS:

1. Preheat an oven to 350 degrees F (175 degrees C). Line muffin tins with 24 cupcake liners.
2. Combine the cake mix, oil, egg whites, and water in a mixing bowl. Beat with an electric mixer on low speed for 30 seconds, then increase the speed to medium and beat for 2 minutes, scraping down the sides of the bowl. Stir in the chopped bittersweet chocolate and scoop the batter into the cupcake liners, filling them two-thirds full.
3. Bake in the preheated oven until golden and the tops spring back when lightly pressed, 15 to 20 minutes. A toothpick inserted into the center of a cupcake should come out clean. Remove the cupcakes from the pans and cool completely on wire racks.
4. Beat 1 cup cold whipping cream on medium-high speed until the cream has thickened, about 1 minute. Add confectioners' sugar and beat until stiff peaks form. Stir in the frozen raspberries, toffee bits, and chopped toasted hazelnuts.
5. Remove the centers of the cupcakes using an apple corer or paring knife, cutting out the middles in a funnel shape by holding the knife at a 45-degree angle. Spoon

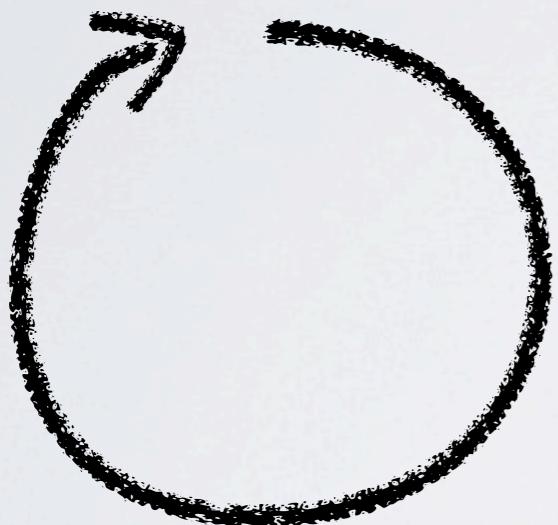
source: allrecipes.com/recipe/zuccotto-cupcakes



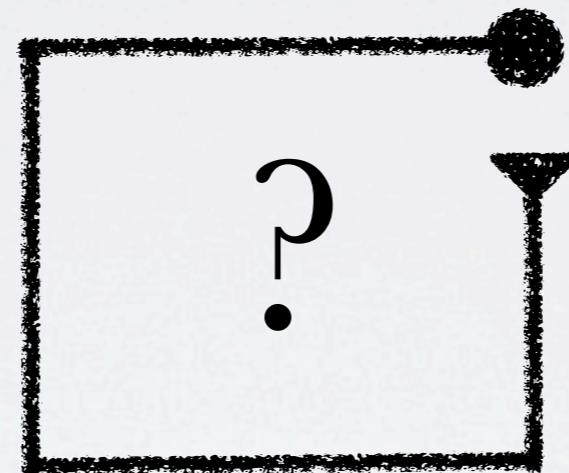
source: flickr.com/photos/louisephotography/8100744225/

Mystery in the Middle

1. Write code



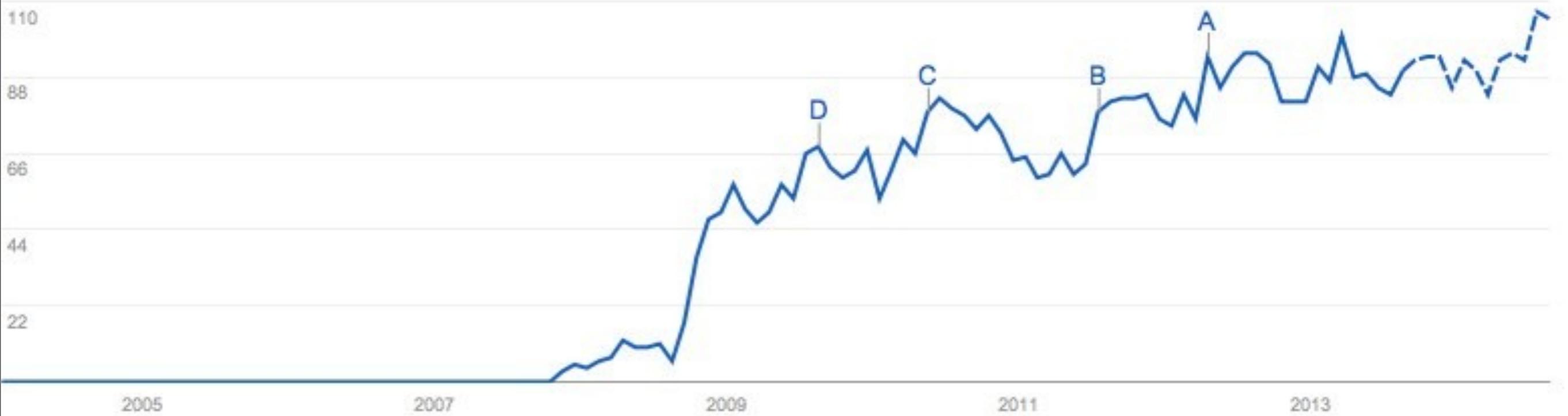
2. Execution



3. Output

NullPointer
Exception

Data Visualization



source: google.com/trends/explore#q=clojure&cmpt=q

Code is Data

(map inc (range 5))

Code Execution
is Data

data $\longrightarrow \lambda \longrightarrow$ data

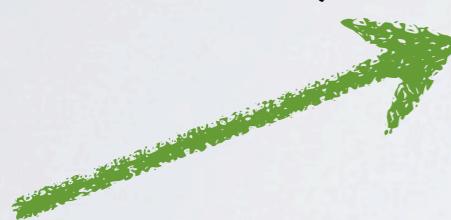


Quick Sort

```
(defn qsort [[pivot & xs]]  
  (when pivot  
    (let [smaller #(< % pivot)  
          before-pivot (filter smaller xs)  
          after-pivot (remove smaller xs)]  
      (lazy-cat (qsort before-pivot)  
                [pivot]  
                (qsort after-pivot))))))
```

source: rosettacode.org/wiki/Sorting_algorithms/Quicksort#Clojure

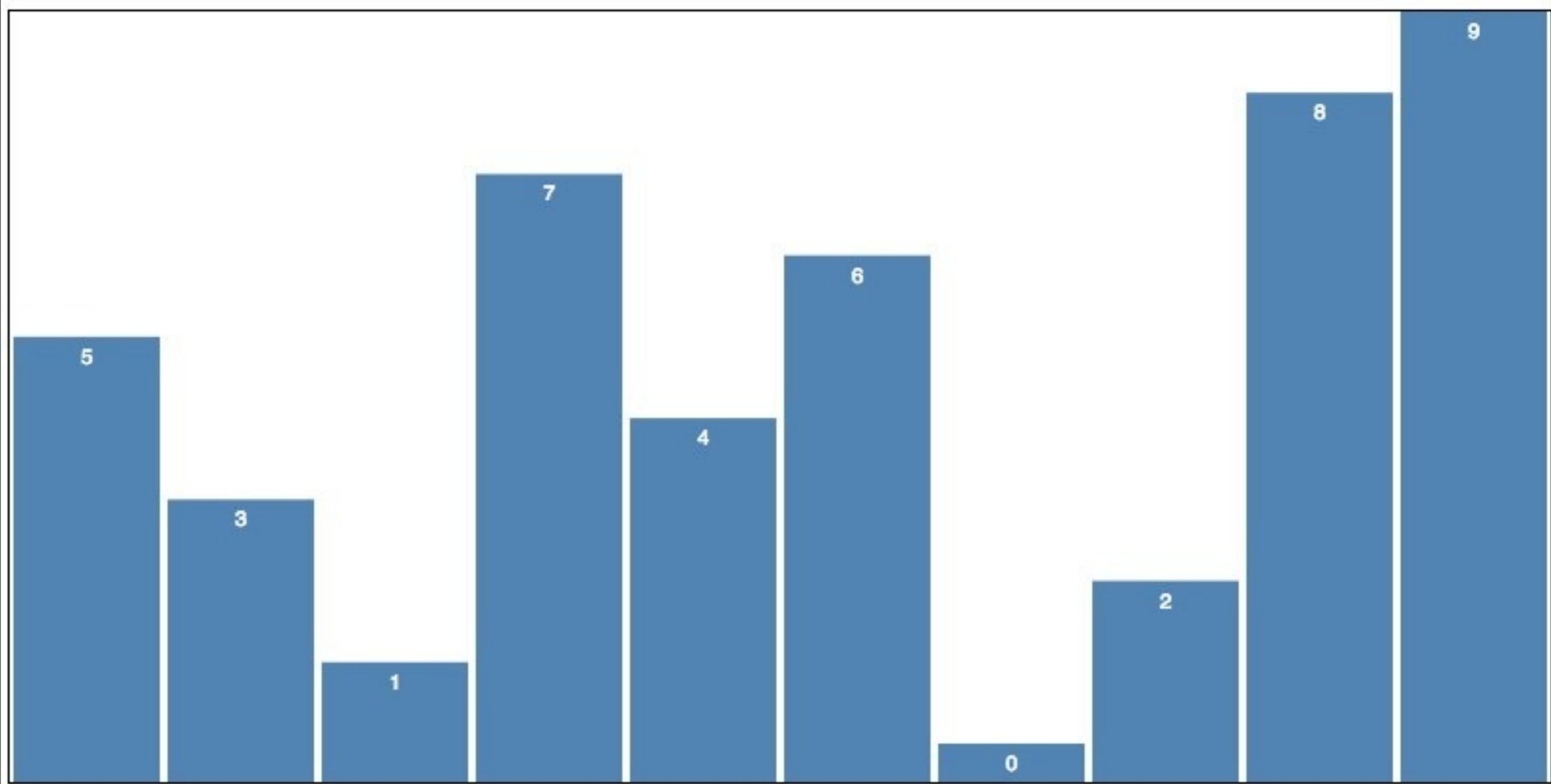
```
(defn qsort [[pivot & xs]]
  (when pivot
    (let [smaller #(< % pivot)
          before-pivot (filter smaller xs)
          after-pivot (remove smaller xs)]
      (capture! {:left before-pivot
                 :pivot pivot
                 :right after-pivot}))
      (lazy-cat (qsort before-pivot)
                [pivot]
                (qsort after-pivot))))))
```

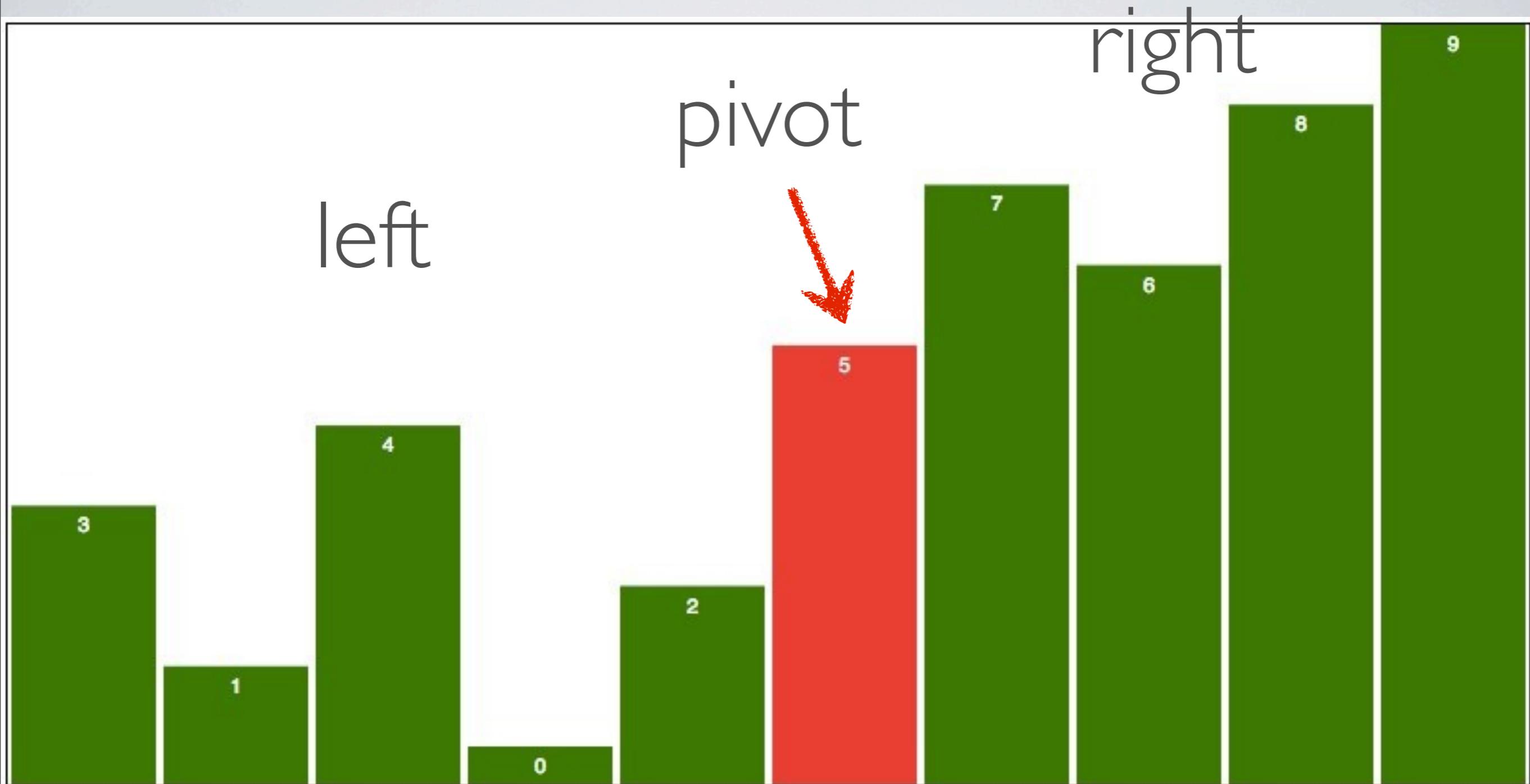


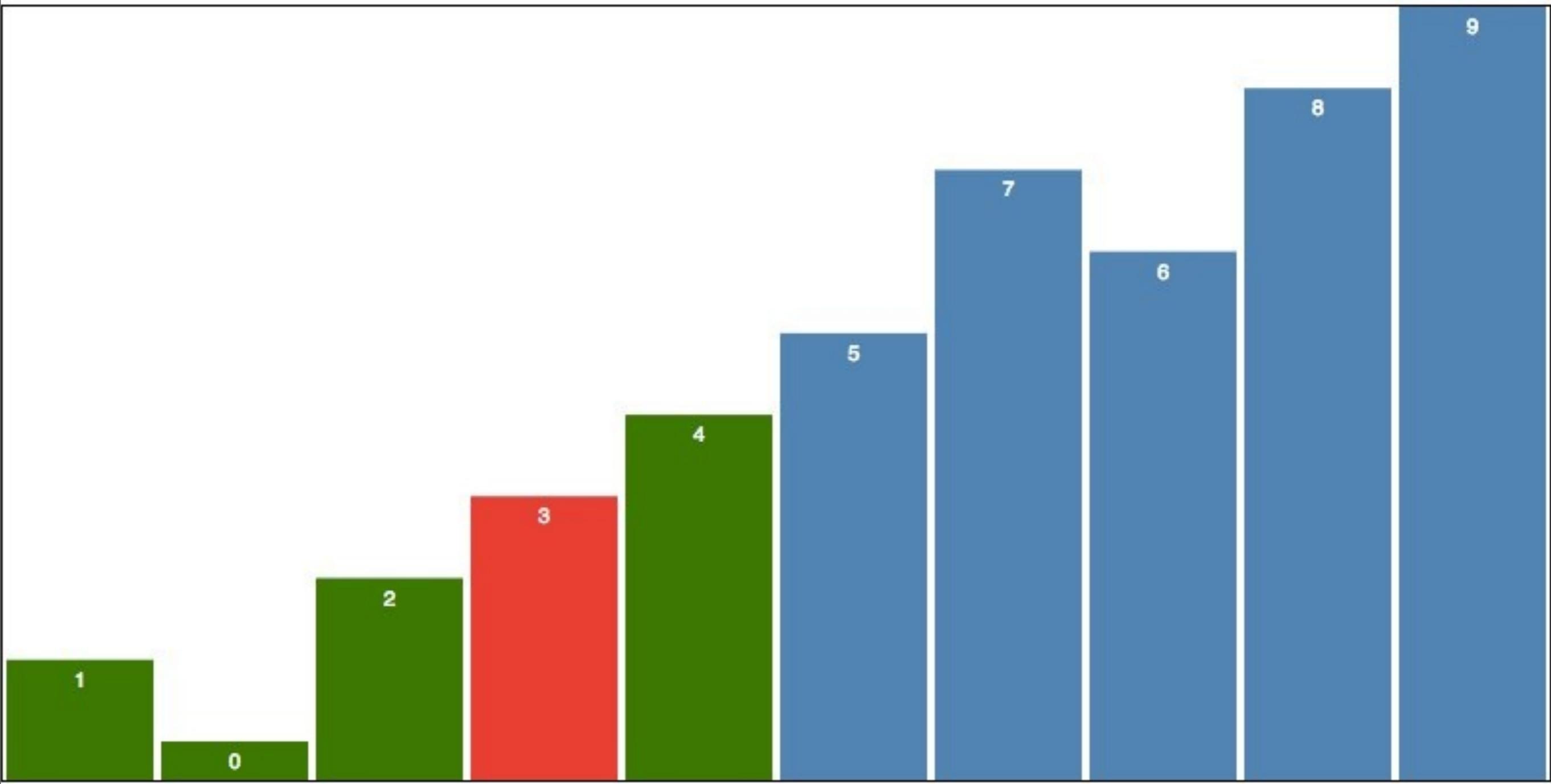
```
(qsort [5 3 1 7 4 6 ...])
```

Captured

```
{:left [3 1 4 0 2] :pivot 5 :right [...]
{:left [1 0 2] :pivot 3 :right [4]}
{:left [0] :pivot 1 :right [2]}
{:left [] :pivot 0 :right []}
{:left [] :pivot 2 :right []}
{:left [] :pivot 4 :right []}
...
...
```



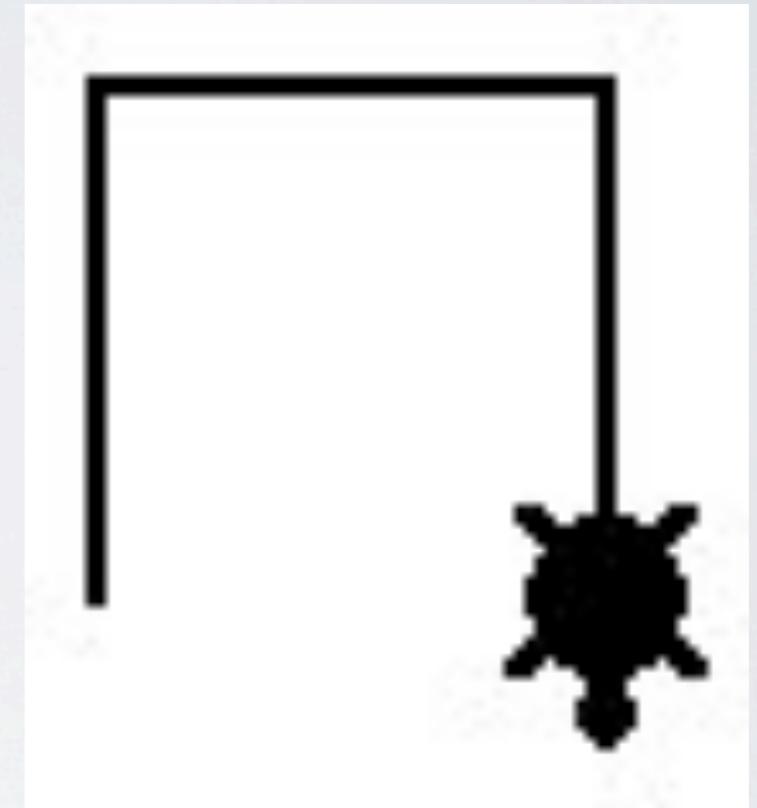




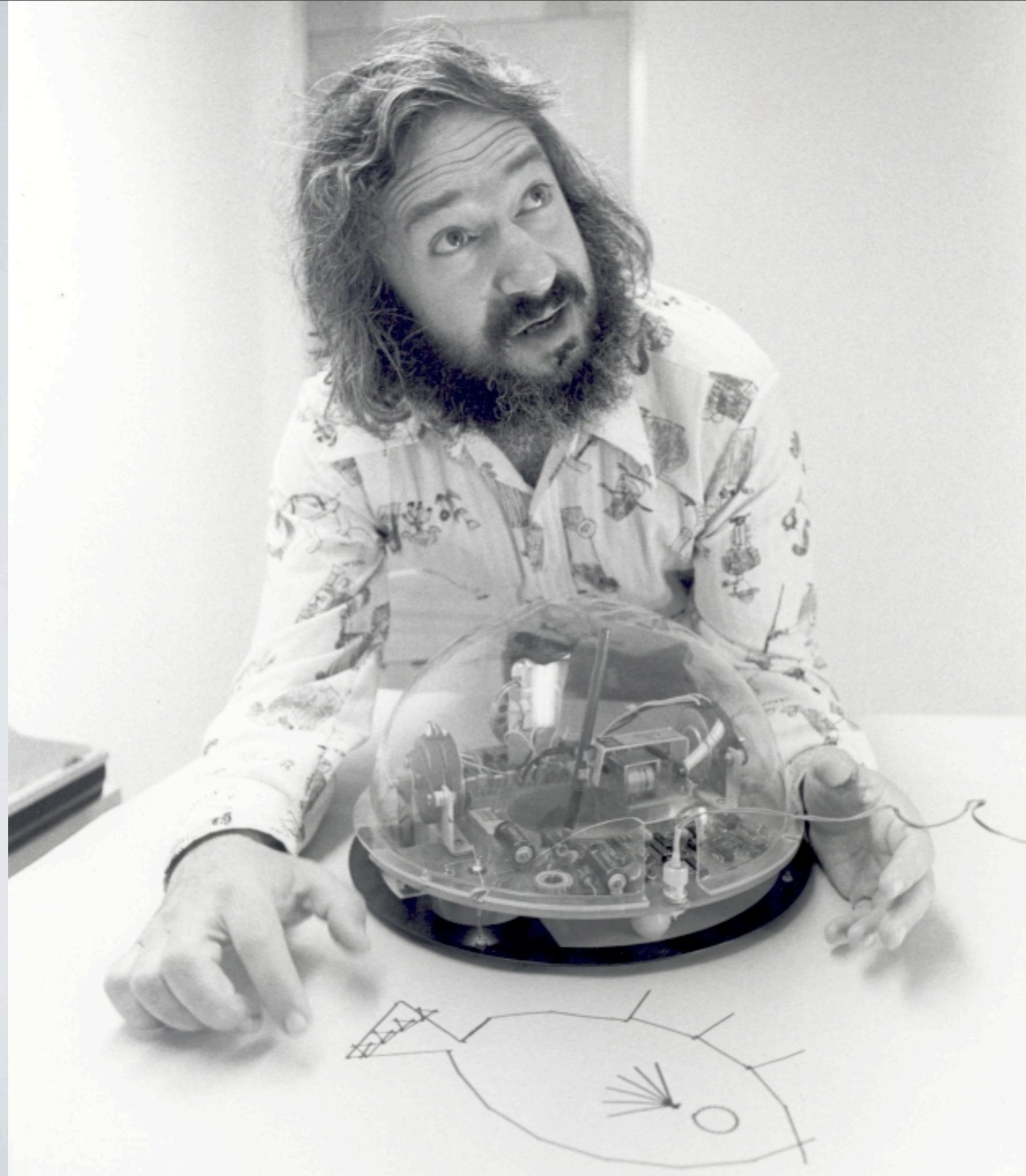
New ideas are old ideas.

LOGO

```
forward 50  
right 90  
forward 50  
right 90  
forward 50  
...  
...
```



source: <http://el.media.mit.edu/logo-foundation/logo/turtle.html>



All About LOGO-
How It Was Invented and How It Works

MINDSTORMS

Children, Computers,
and Powerful Ideas

WITH AN INTRODUCTION BY JOHN SCULLEY
AND A NEW PREFACE BY THE AUTHOR

SEYMOUR PAPERT



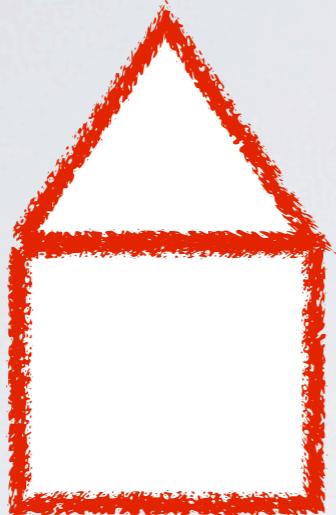
Not Just for Kids



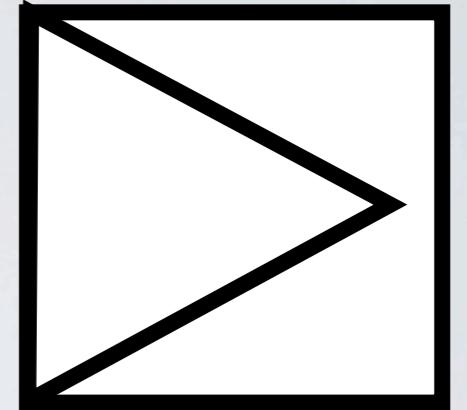
source: <http://cyberneticzoo.com/?p=1711>

Drawing a House

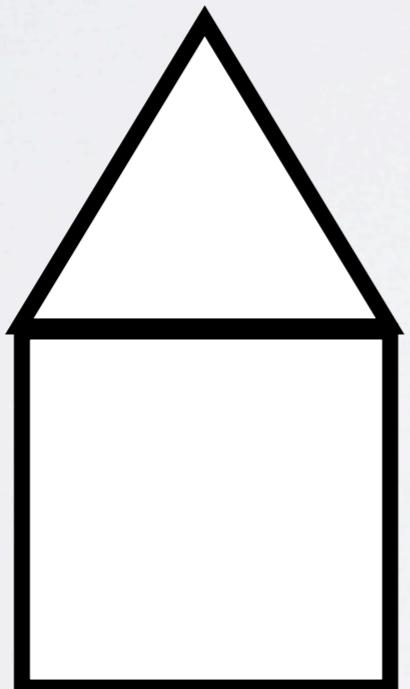
A Plan



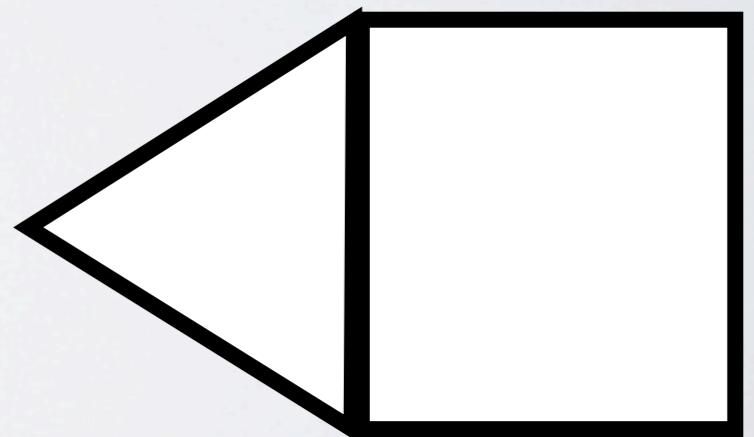
square
triangle



right 90
square
right 30
triangle



square
right 30
triangle

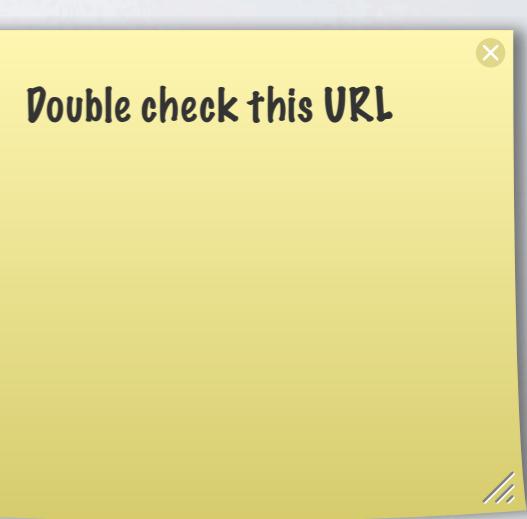


Success!

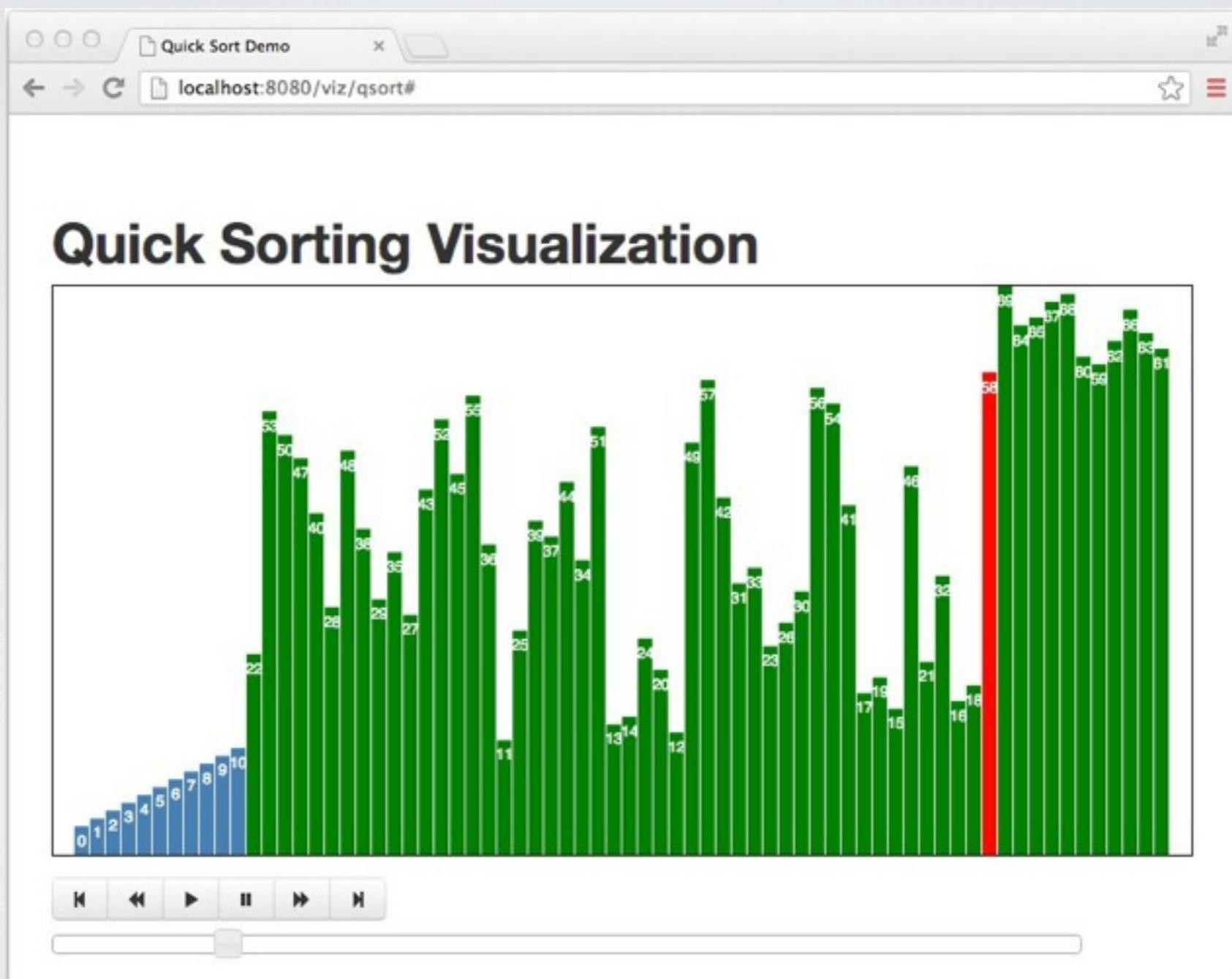
Visualization Driven Development

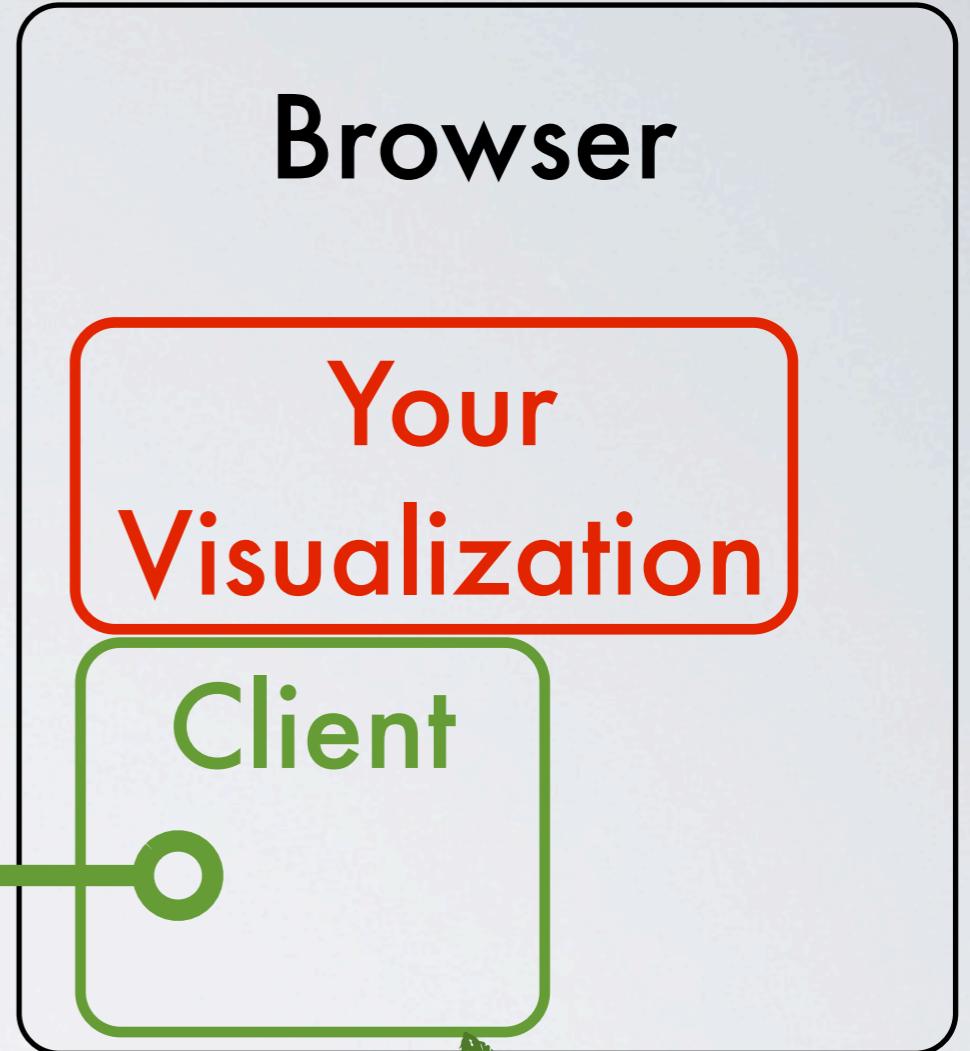
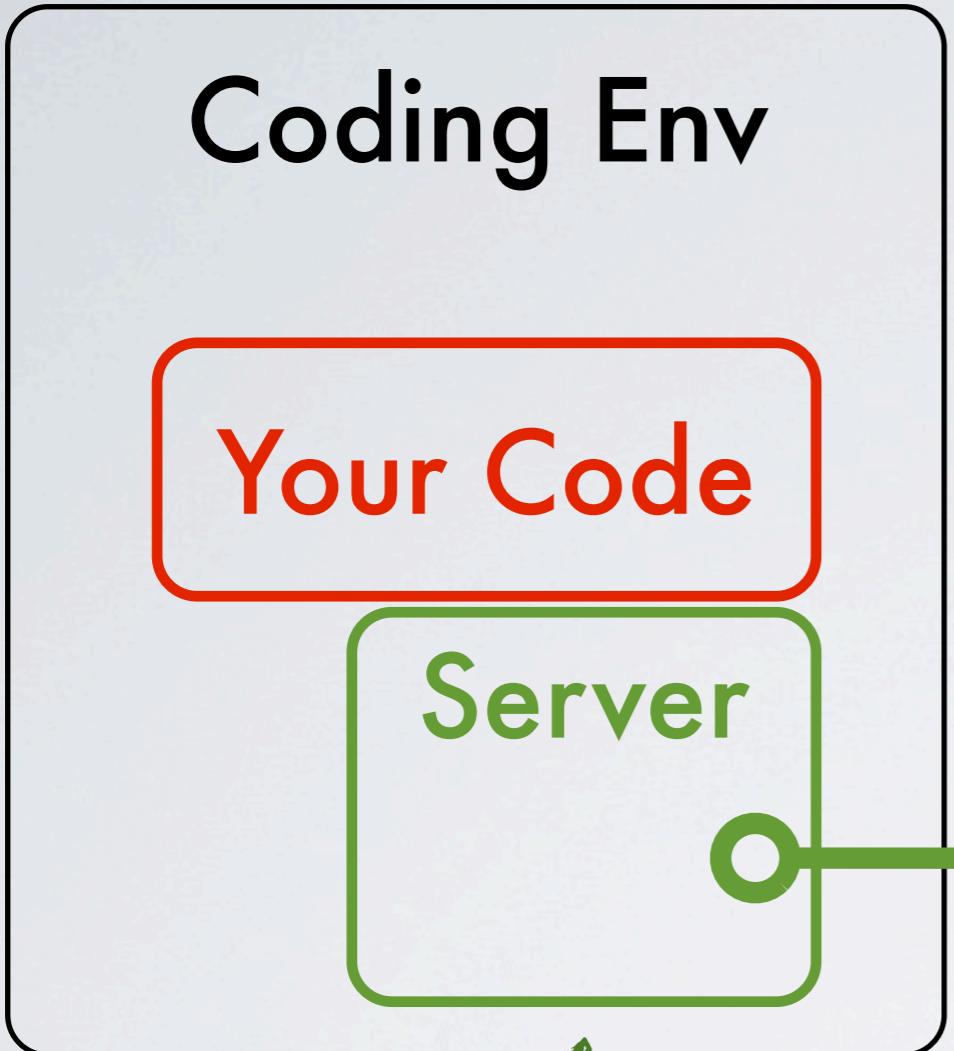
VDD Core

github.com/element84/vdd-core



Web Browser





Embedded
HTTP Server

WebSockets

Viz utilities

Using VDDCore

```
(defn qsort [[pivot & xs]]
  (when pivot
    (let [smaller #(< % pivot)
          before-pivot (filter smaller xs)
          after-pivot (remove smaller xs)]
      (capture! {:left before-pivot
                 :pivot pivot
                 :right after-pivot}))
      (lazy-cat (qsort before-pivot)
                [pivot]
                (qsort after-pivot))))))
```

Your Code

Server

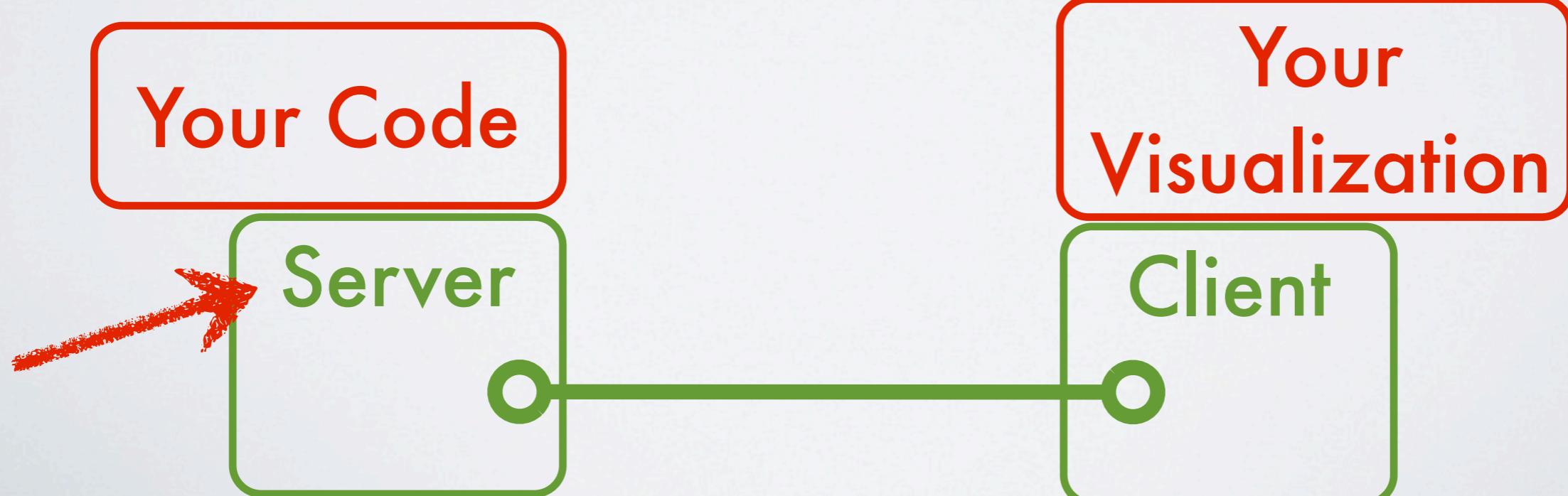
Your
Visualization

Client

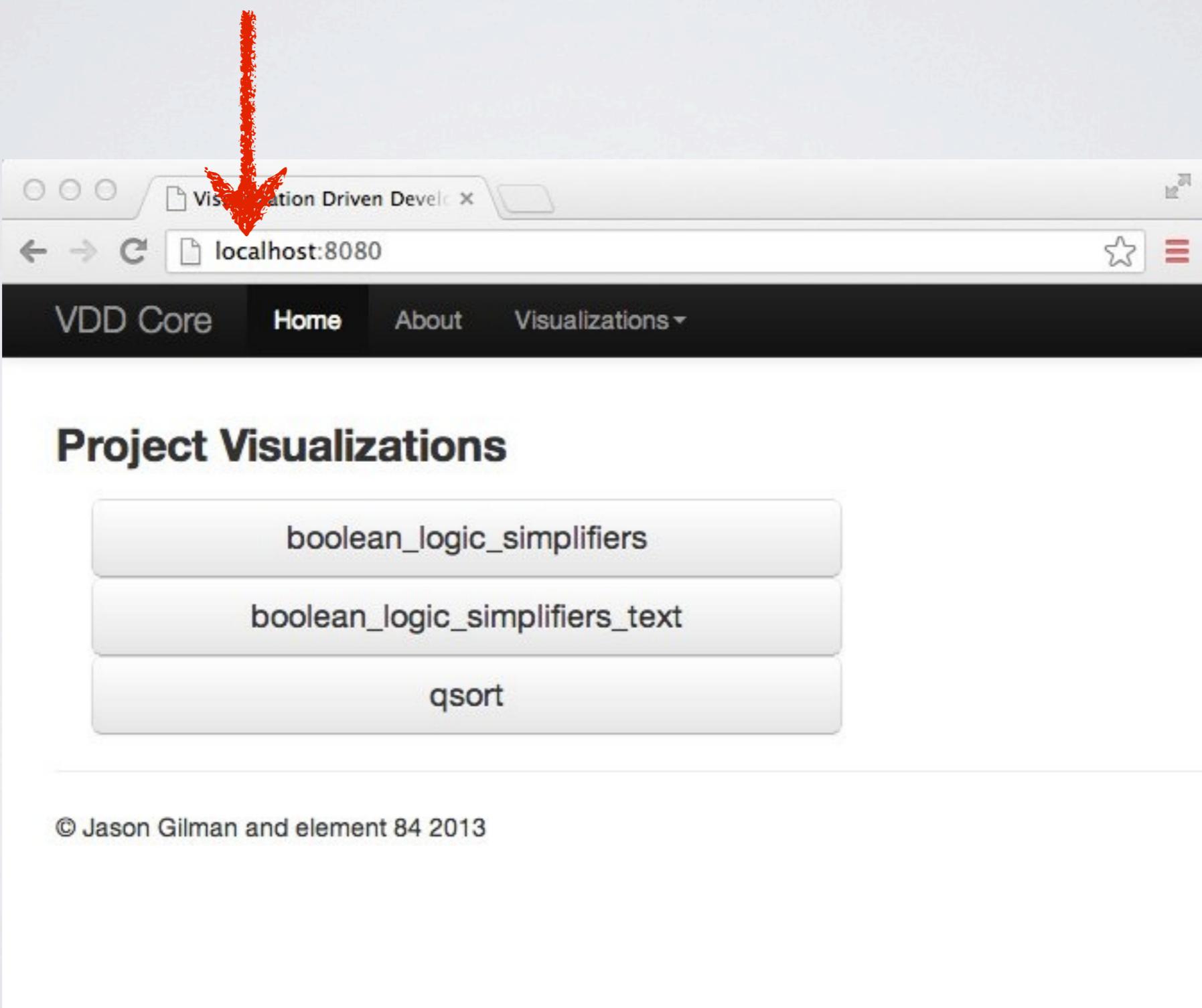


In the REPL:

```
(require '[vdd-core.core :as vdd])  
(def server (vdd/start-viz))
```



In the Browser:



In the REPL:

```
(use 'qsort.driver)  
(viz-qsort [3 2 4 5 1])
```

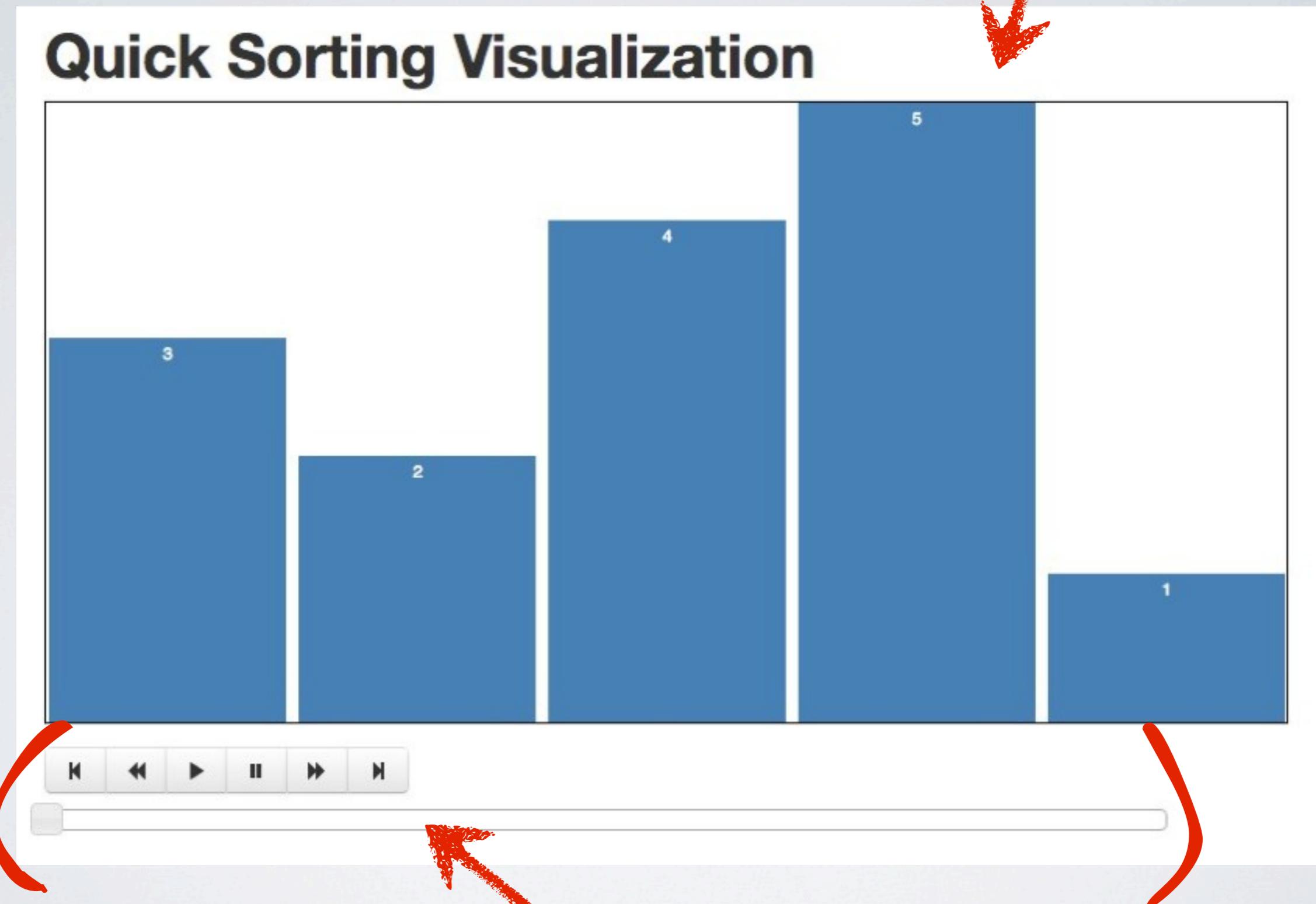
TODO explain the driver code and why we need it
- reset captured output
- call the function
- sends it to viz

```
(defn viz-qsort [data]  
  ; Reset the global captured state  
  (capture/reset-captured!)  
  ; Run quicksort. Visualization data will be captured  
  (let [results (doall (sorter/qsort data))  
        combined (qsort-list-combiner (capture/captured)))  
    ; Prepend the unsorted data  
    combined (concat [{:items data :left [] :right []}]  
                  combined  
                  [{:items results :left [] :right []}]))  
  ; Send the data to be visualized  
  (vdd/data->viz combined)))
```

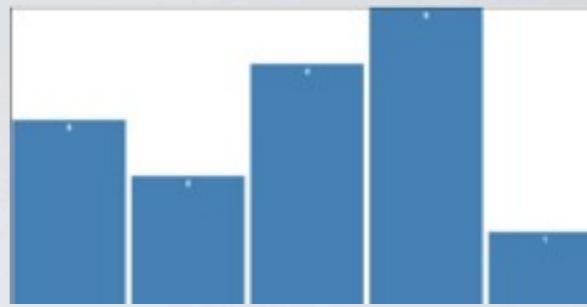
Data Sent to the Visualization

```
[{"items": [3,2,4,5,1], "left": [], "right": []},  
 {"items": [2,1,3,4,5], "left": [2,1], "pivot": 3, "right": [4,5]},  
 {"items": [1,2,3,4,5], "left": [1], "pivot": 2, "right": []},  
 {"items": [1,2,3,4,5], "left": [], "pivot": 1, "right": []},  
 {"items": [1,2,3,4,5], "left": [], "pivot": 4, "right": [5]},  
 {"items": [1,2,3,4,5], "left": [], "pivot": 5, "right": []},  
 {"items": [1,2,3,4,5], "left": [], "right": []}]
```

Bar Chart in D3



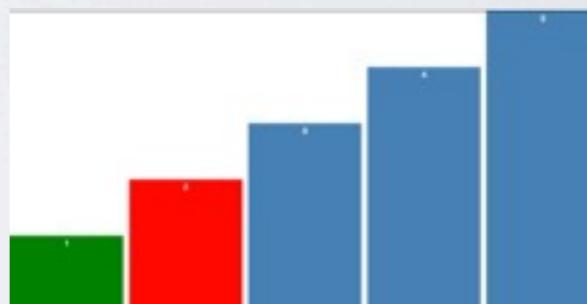
{"items": [3, 2, 4, 5, 1], ...}



{"items": [2, 1, 3, 4, 5], ...}



{"items": [2, 1, 3, 4, 5], ...}

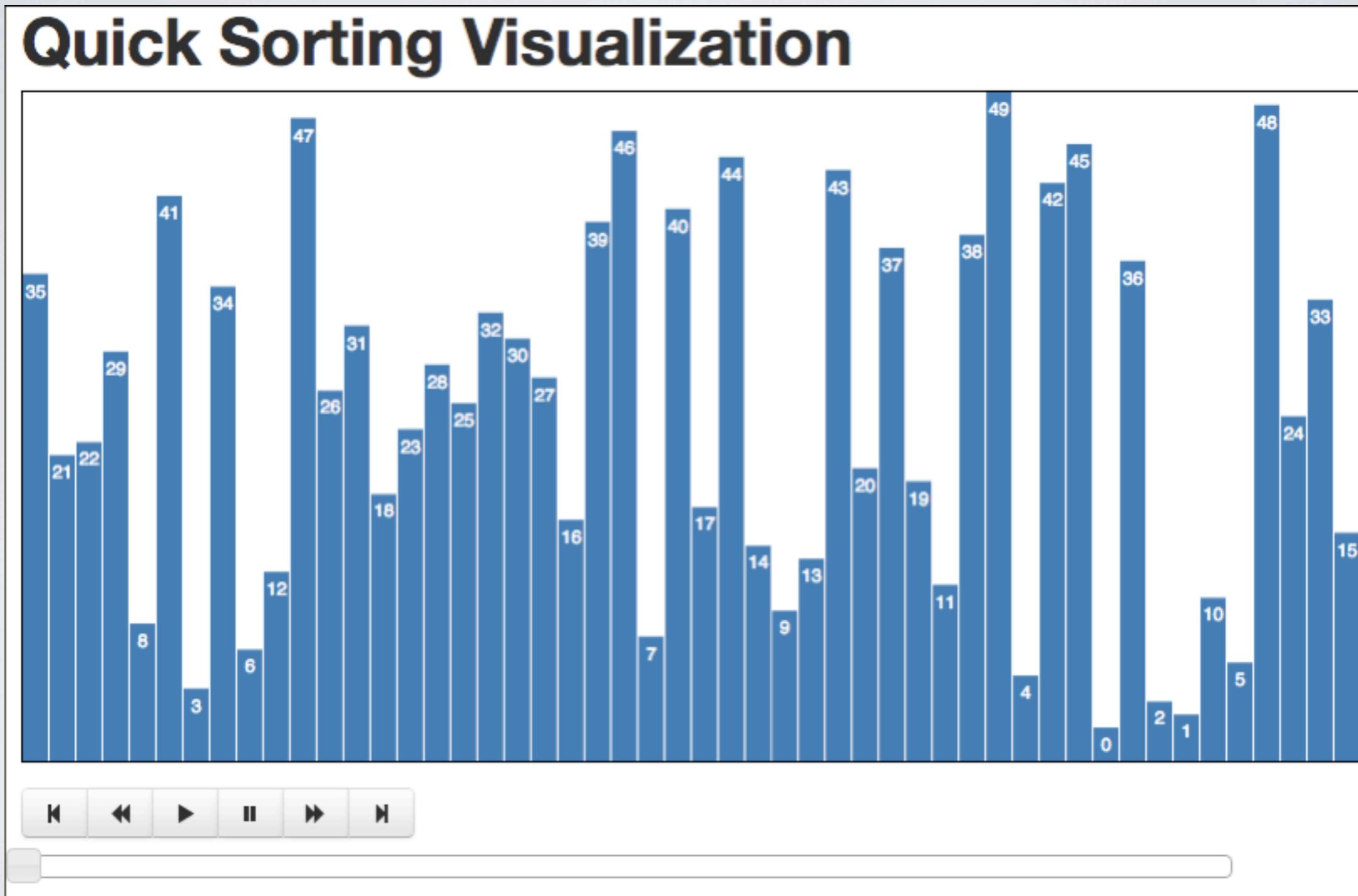


• • •

{"items": [1, 2, 3, 4, 5], ...}



(viz-qsort (shuffle (range 50)))

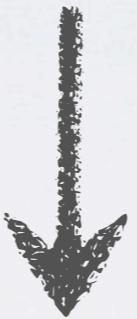


How can I make my code visual?

1. Identify nouns.
2. Choose visual representation.
3. Choose layout.

Data Search

GET /search?point=45,78&cloud_max=32
&keywords=rain



- AND
 - point = 45, 78
 - cloud < 0.32
 - keywords = rain

permitted
data rules

- AND
- OR
- ~~provider=FOO~~

original
query

- AND
- point = 45, 78
- cloud < 0.32
- keywords = rain

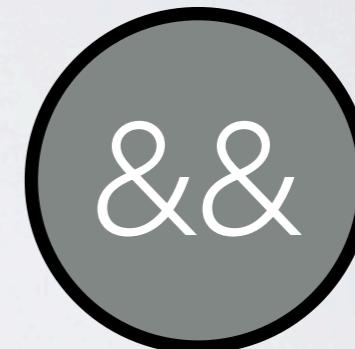
I. Identify Nouns

- Conditions
- Operations - and, or, not
- Query

2. Choose Visual Representation

Conditions cloud < 0.32

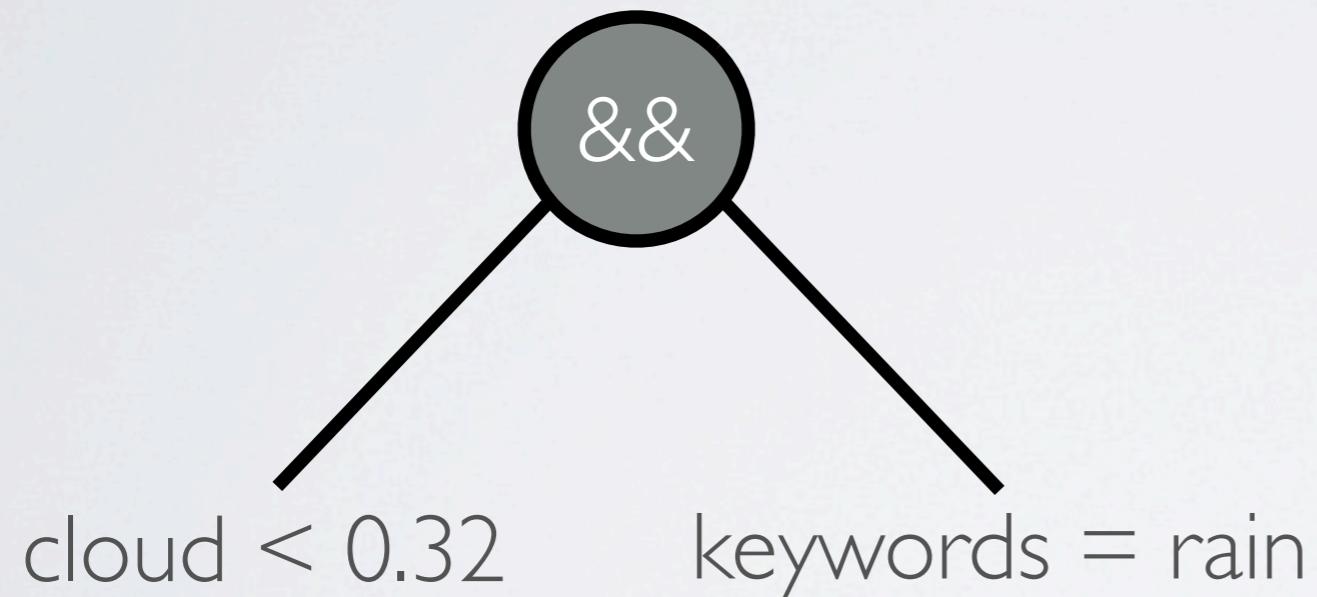
Operations AND or



Query Tree Layout

3. Choose a Layout

1. D3 Tree Layout



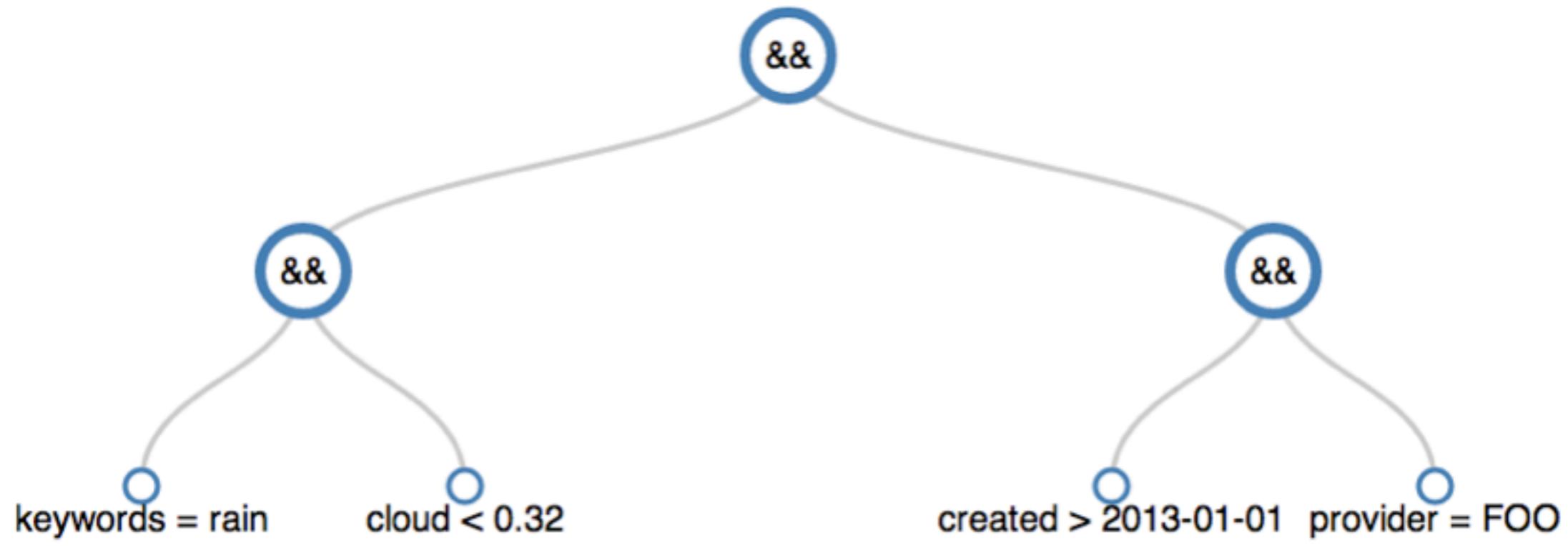
2. HTML Lists

- AND
 - cloud < 0.32
 - keywords = rain

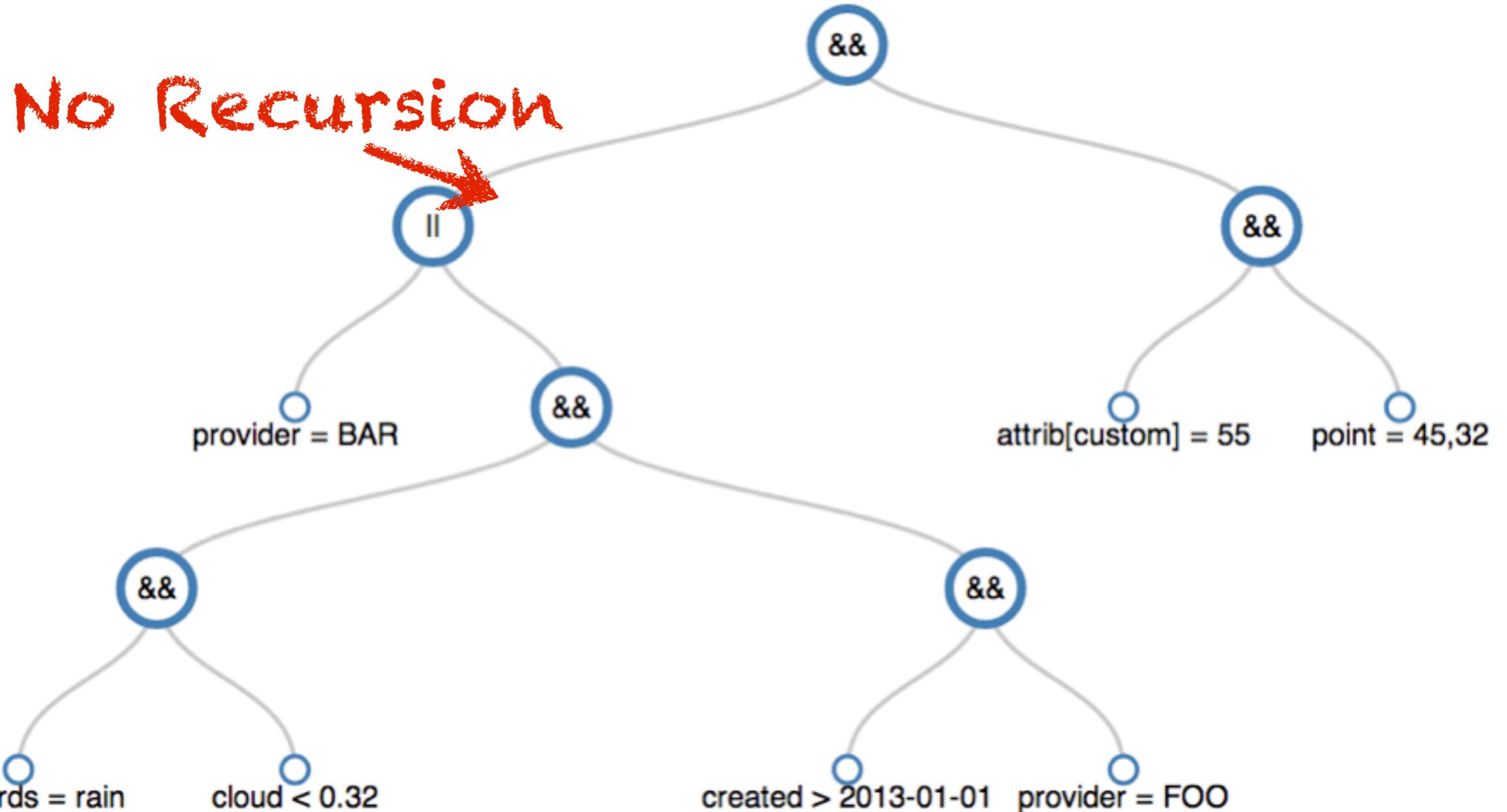
Implementation

- vdd-core-examples/
 - src/
 - ...
 - viz/
 - boolean_logic_simplifiers/
 - driver.clj
 - index.html
 - simplifiers.css
 - simplifiers.js

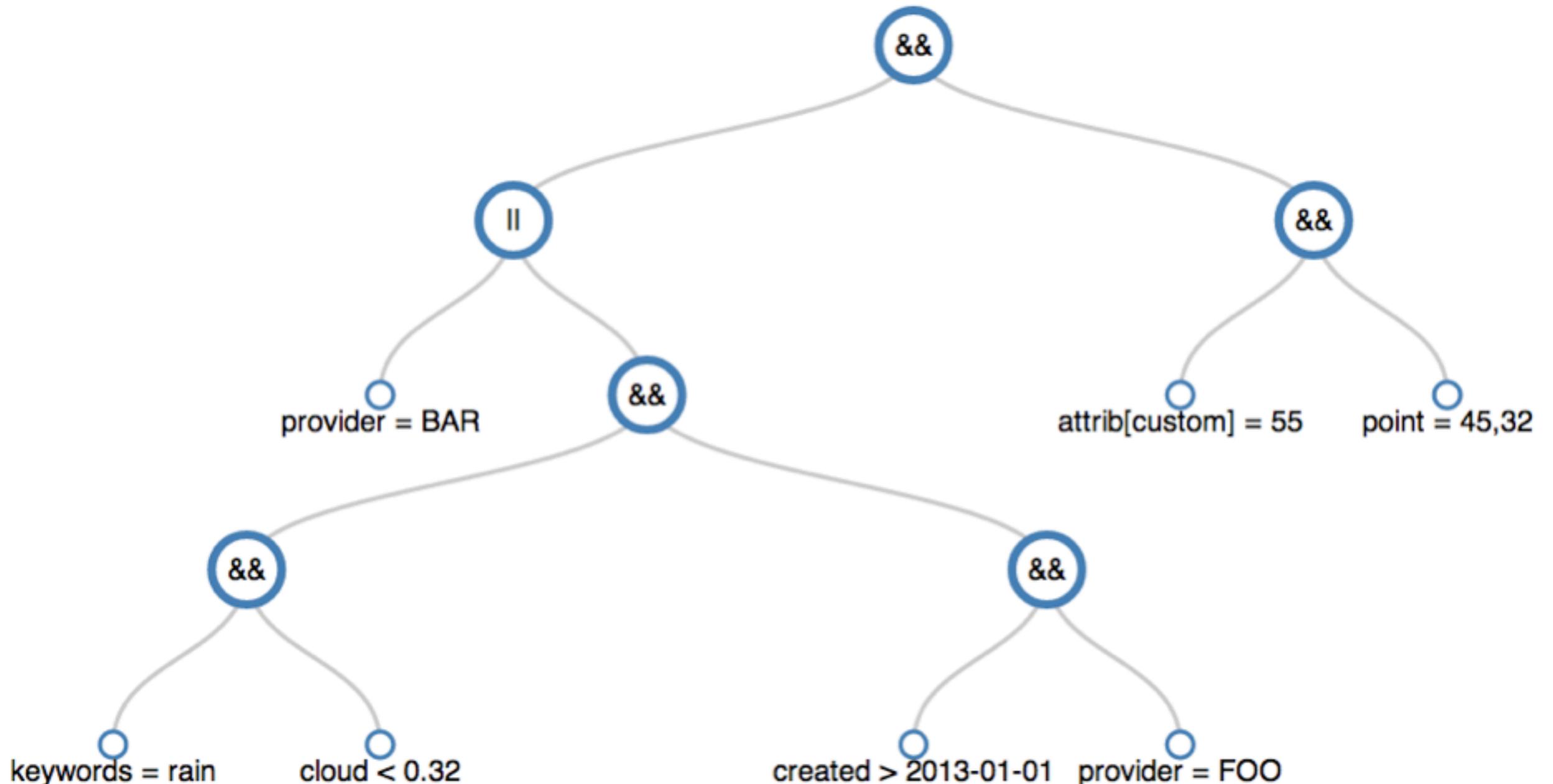
github.com/element84/vdd-core-examples



A Problem



Fixed



This sounds hard!

Keep it simple.

- AND:
 - AND:
 - provider = FOO
 - created > 2013-01-01
 - AND:
 - cloud < 0.32
 - keywords = rain

Lifecycle of a request

Before query state

After query state

The screenshot shows a browser window titled "Catalog REST Query Model" with the URL "localhost:4567/#". The page displays the "Simplification Results" for step 22, "MatchNoneSimplifier".

Request NA.

22. MatchNoneSimplifier

Elapsed 30 ms

[<< Previous](#) [Next >>](#)

Before

Granule Query

- And Group
 - Spatial Condition: GEODETIC; {"srid":1,"with_z":false,"z":0,"y":56.0702777777778,"x":160.47,"with_m":false,"m":0}
 - String Condition: provider_id = 'LPDAAC_ECS'; pattern
 - Or Group
 - And Group
 - String Condition: provider_id = 'LPDAAC_ECS'
 - Or Group
 - String Condition: echo_collection_id = 'C187016586-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C187016590-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C187016591-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C187016592-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C189202233-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C190468293-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C190653998-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C190733713-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C190733714-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C195647394-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759666-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759671-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C247596779-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C108956780-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C108956781-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C108956785-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C111553410-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C115314846-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C115314847-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C115315499-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C115315500-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C115315501-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C115315502-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759676-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759679-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759681-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759684-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C24759687-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C50878288-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C50878289-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C107705230-LPDAAC_ECS'
 - String Condition: echo_collection_id = 'C107705231-LPDAAC_ECS'

Build reusable
visualizations.

Home - Strange Loop

https://thestrangeloop.com

Attend

Meet us in St. Louis, Sept 18-20th, 2013, to make connections with the creators and users of the languages, libraries, tools, and techniques at the forefront of the industry.

Find out where we're going... and where we're not.

Name Path	Method	Status Text	Type	Initiator	Size Content	Time Latency	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s
thestrangeloop.com	GET	301 Moved Permanently	text/html	Other	387 B 0 B	382 ms 381 ms	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s
thestrangeloop.com	GET	200 OK	text/html	http://thestrangeloop.com	5.5 KB 15.3 KB	382 ms 360 ms	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s
common-datauri.css?1377255969/assets	GET	200 OK	text/css	thestrangeloop.com	11.2 KB 42.6 KB	135 ms 134 ms	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s
rails.js/javascripts	GET	200 OK	application/javascript	thestrangeloop.com	2.4 KB 5.4 KB	75 ms 73 ms	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s
workspace.js?1377255969/assets	GET	200 OK	application/javascript	thestrangeloop.com	84.2 KB 238 KB	498 ms 277 ms	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s
jquery.js/ajax.googleapis.com/ajax/libs/jquery/2.0.3/jquery.min.js	GET	200 OK	text/javascript	thestrangeloop.com	46.4 KB 160 KB	206 ms 171 ms	Timeline	735 ms	1.10 s	1.47 s	1.84 s	2.21 s

Elements Resources Network Sources Timeline Profiles Audits Console

□ ○ ○ Home - Strange Loop × 🔍 ↻ 🔍 https://thestrangeloop.com ⭐ ⚓

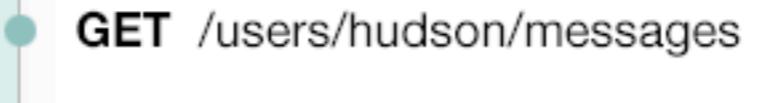
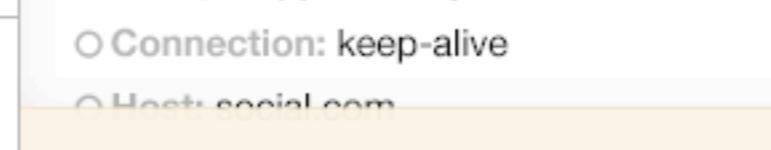
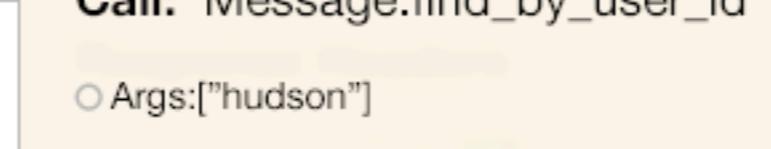
Requests	Request Details
08:34:03 GET /users/hudson/messages 0.15s	GET /users/hudson/messages 0.15s 3 Calls Headers ○ Accept: application/json ○ Connection: keep-alive ○ Host: social.com
08:35:44 GET /messages 0.07s	User#find 0.03s
08:35:58 GET /users/hudson.json 0.04s	Message#find_by_user_id 0.08s

Response Headers

- Content-Encoding: gzip
- Content-Type: application/json
- ETAG: EF976AB34572

Body

```
{
  friend_requests:
    "ryder", "bogdin", "c84"
  messages:
    {
      from: "bogdin",
      date: "2013-08-04T12:15",
      contents: "Check out my new car: http://bit.ly/2"
    }
}
```

Requests	Request Details
08:34:03 GET /users/hudson/messages 0.15s	GET /users/hudson/messages 0.15s 3 Calls 
08:35:44 GET /messages 0.07s	Headers ○ Accept: application/json ○ Connection: keep-alive ○ Host: social.com 
08:35:58 GET /users/hudson.json 0.04s	Call: Message.find_by_user_id Message#find_by_user_id 0.08s ○ Args:["hudson"] 

Developing
software is like
Woodworking
&
Carpentry



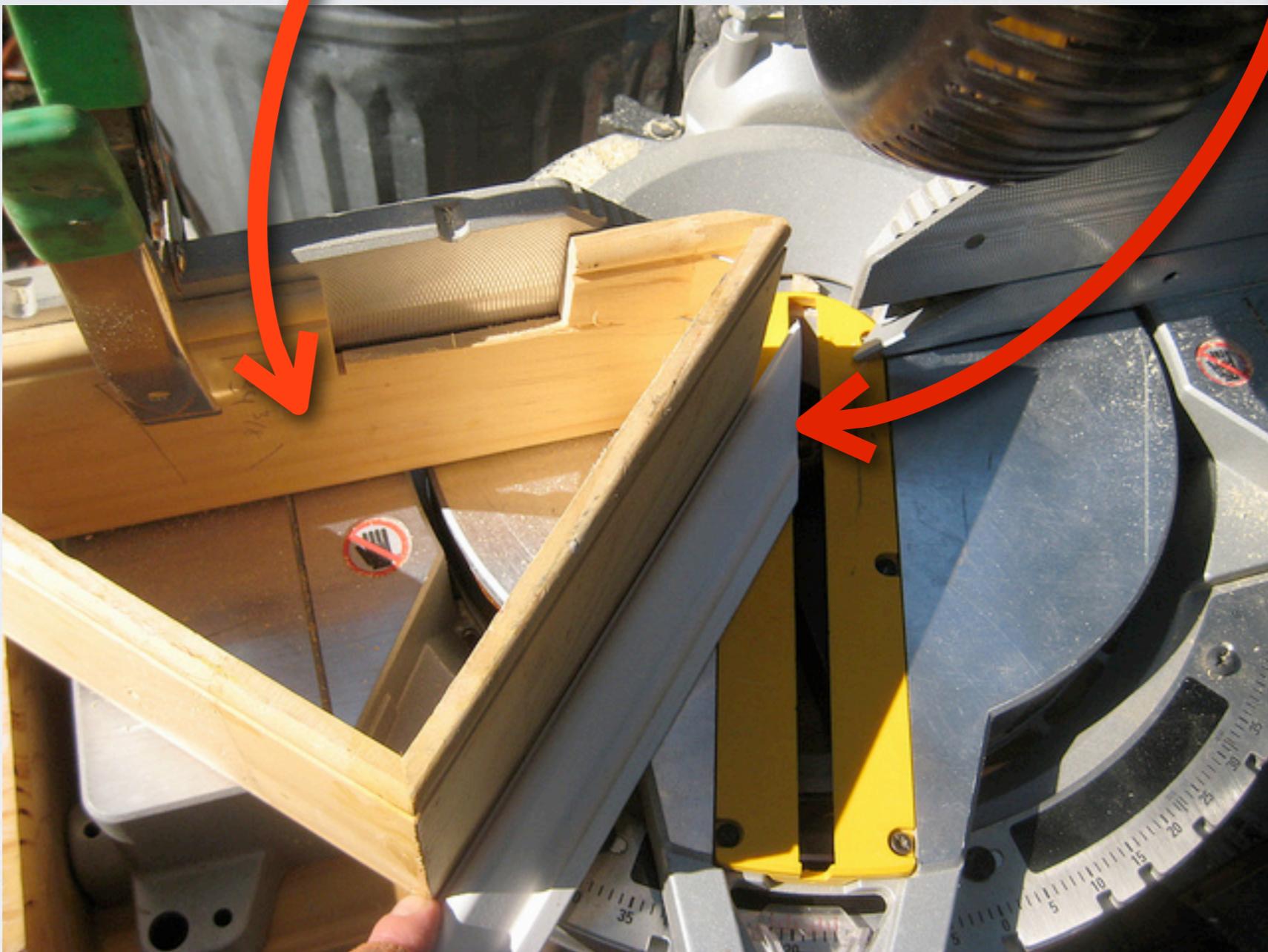
source: flickr.com/photos/epso/6018530849



Thursday, November 28, 13

jig

wood to cut



source: flickr.com/photos/crown_molding/5079441077

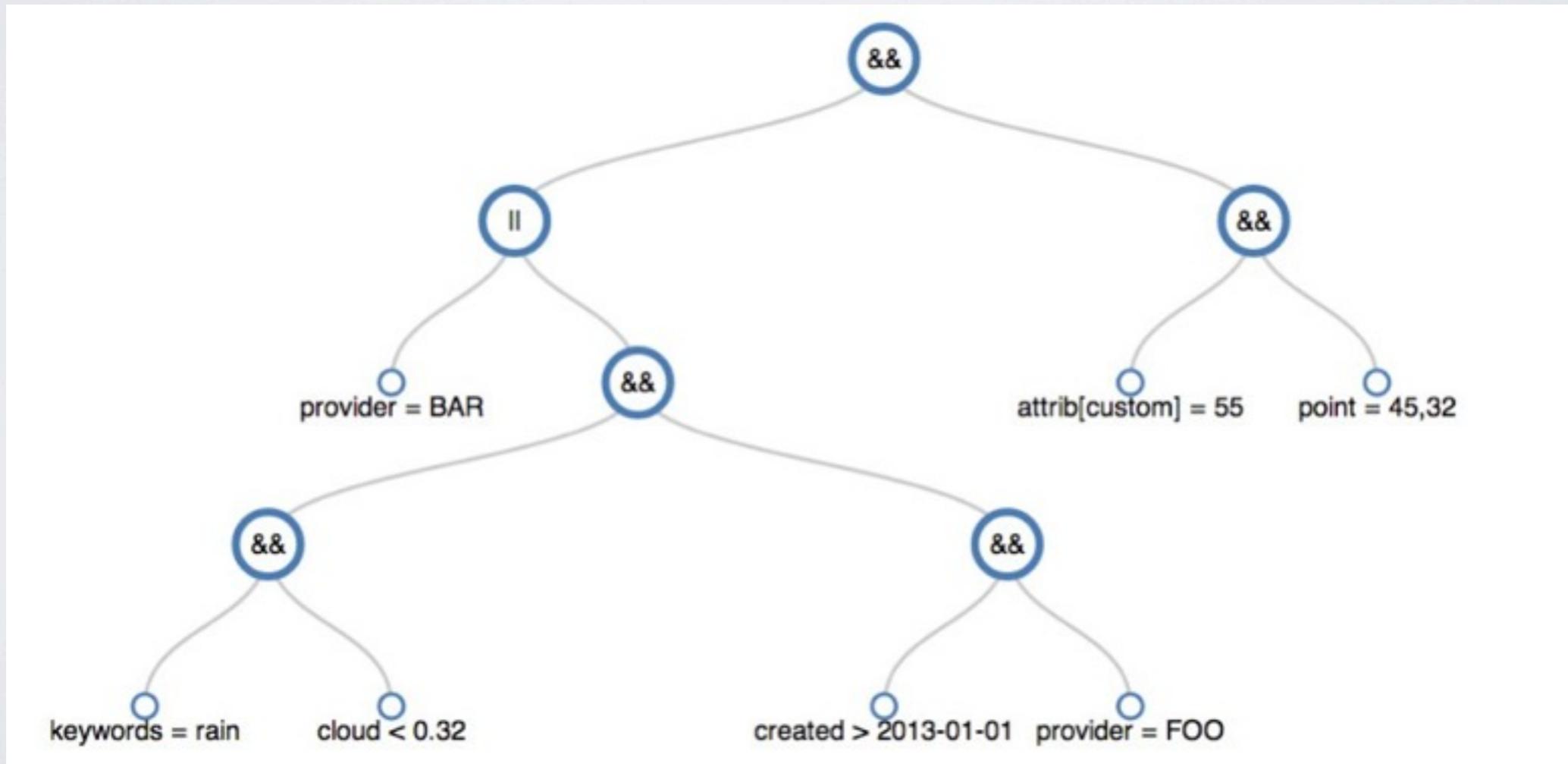
Jig Benefits

- Makes work easier (faster)
- Higher quality results



Visualization Benefits

- Makes work easier (faster)
- Higher quality results



thanks

Jason Gilman
@jasongilman

element 84