Running with Scissors: Live Coding with Data

@stuarthalloway

About Me

30 years programming

Languages: 8086 Assembly, C, C++, Clojure, Java, JavaScript, Ruby, Obj-C, Perl, Python, Smalltalk

Roles: developer, founder, manager, operations, owner, stakeholder, support, tester, trainer

Developer: Clojure, ClojureScript, Datomic

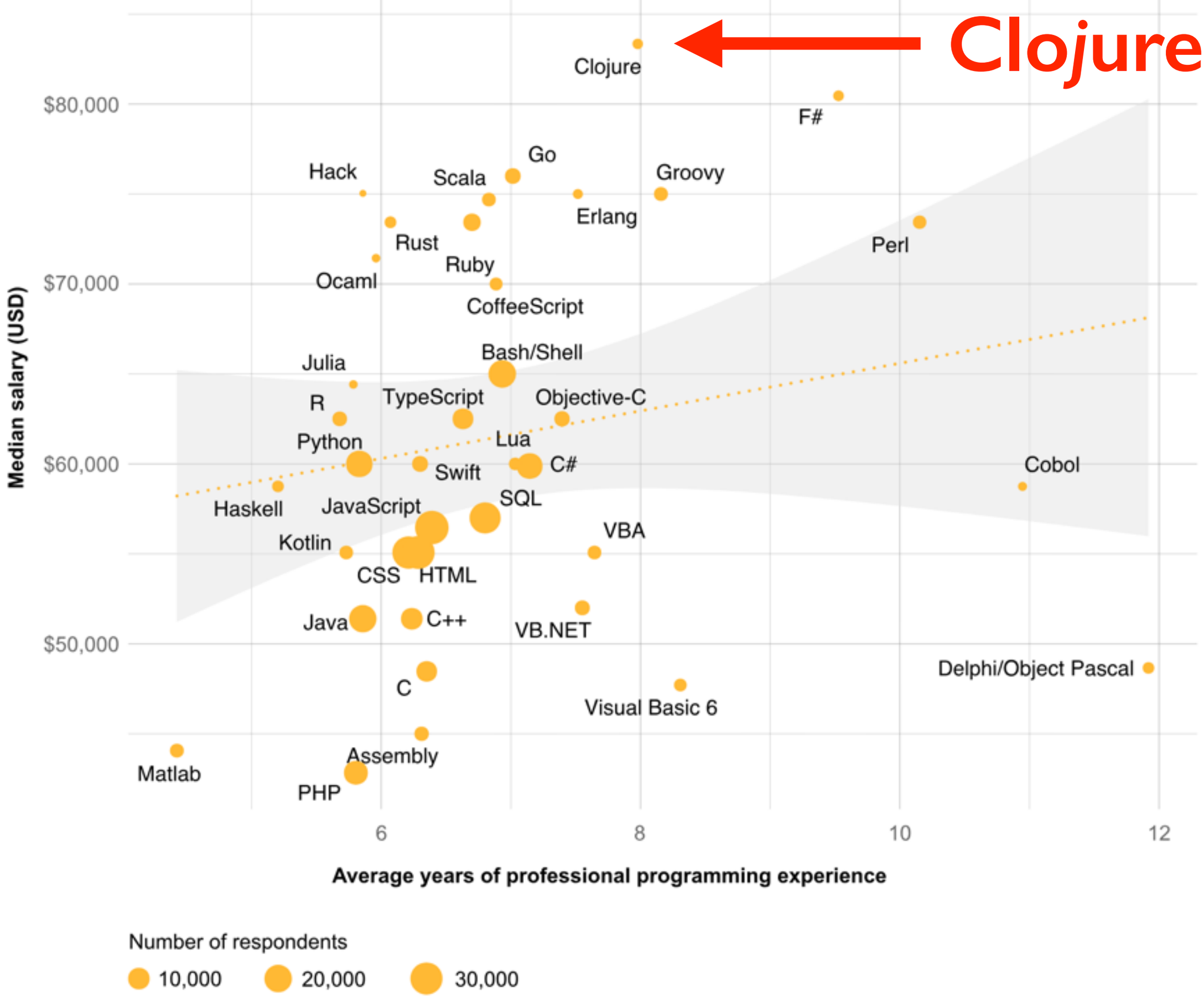
About Clojure

Dynamic

Functional

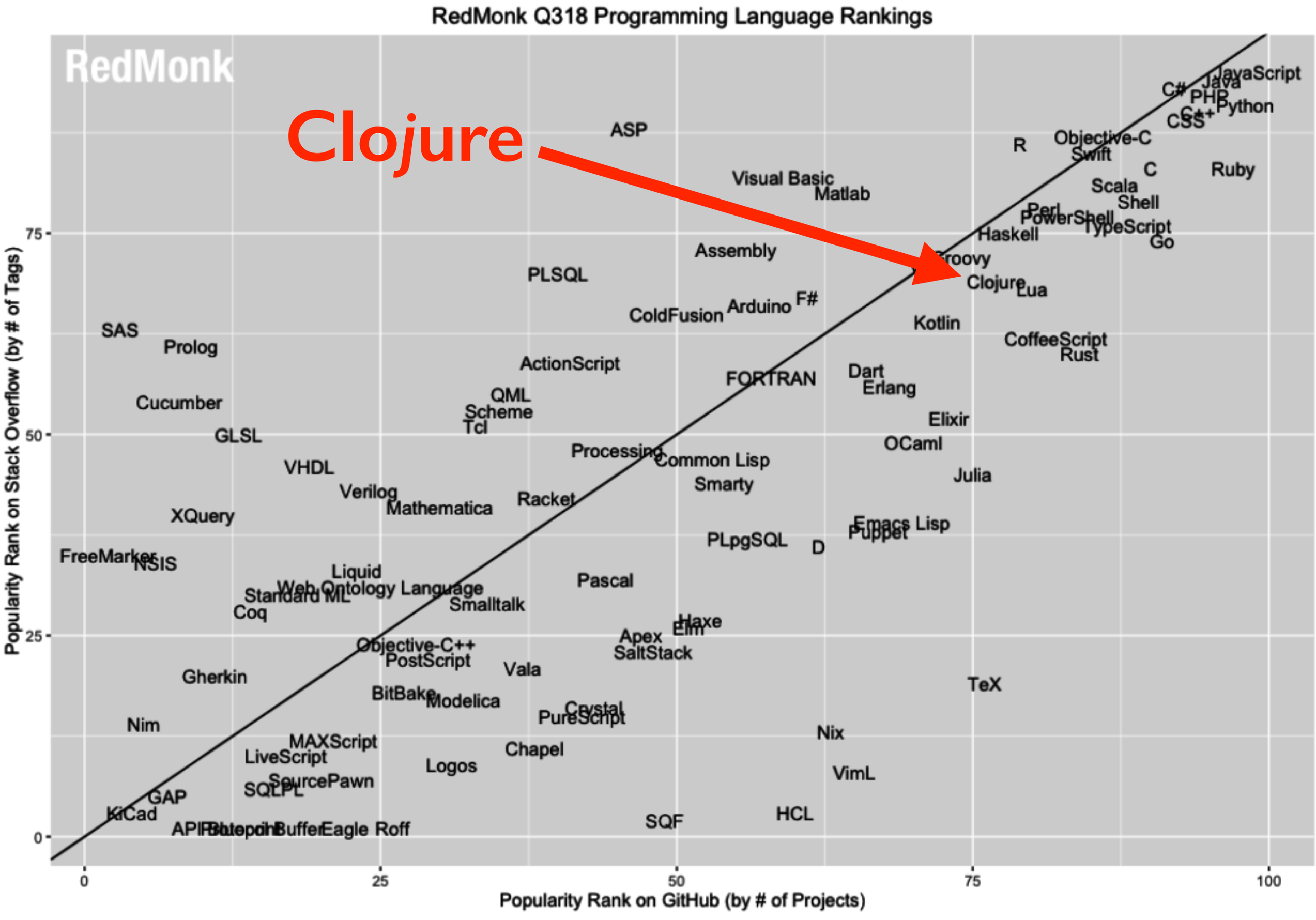
Hosted

Lisp



Clojure

https://insights.stackoverflow.com/survey/2018#work-salary-and-experience-by-language



https://redmonk.com/sogrady/2018/08/10/language-rankings-6-18/

Rationale

Dynamic

Functional

Hosted

Lisp

Running with Scissors: Live Coding with Data

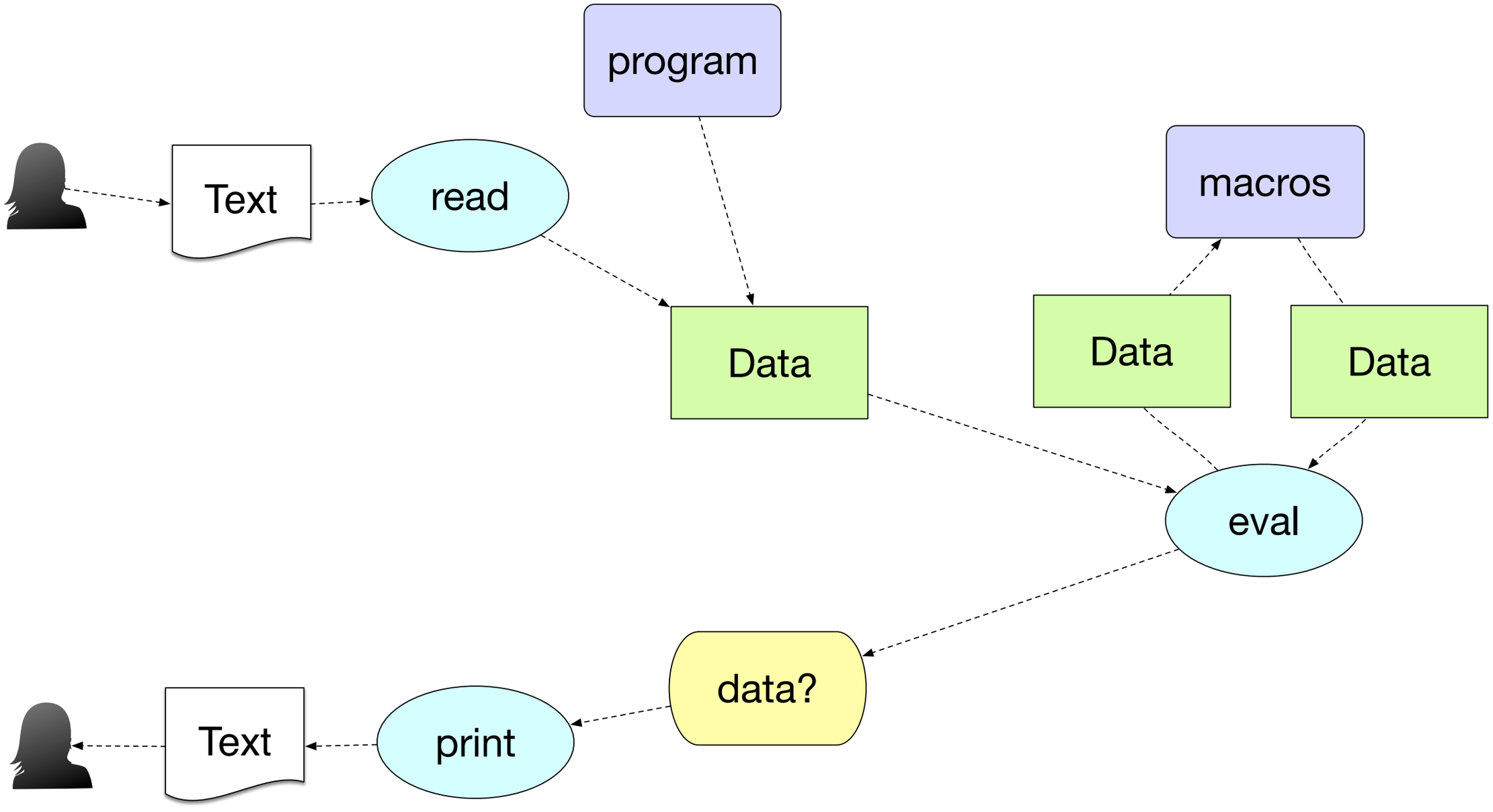
(a Clojure dev workflow)

Running

Work inside your running program

REPL: Read, Eval, Print, Loop

Fast feedback loop


program
Text
read
macros
Data
Data
Data
eval
data?
Text
print

A La Carte Read

reducing over
financial transactions

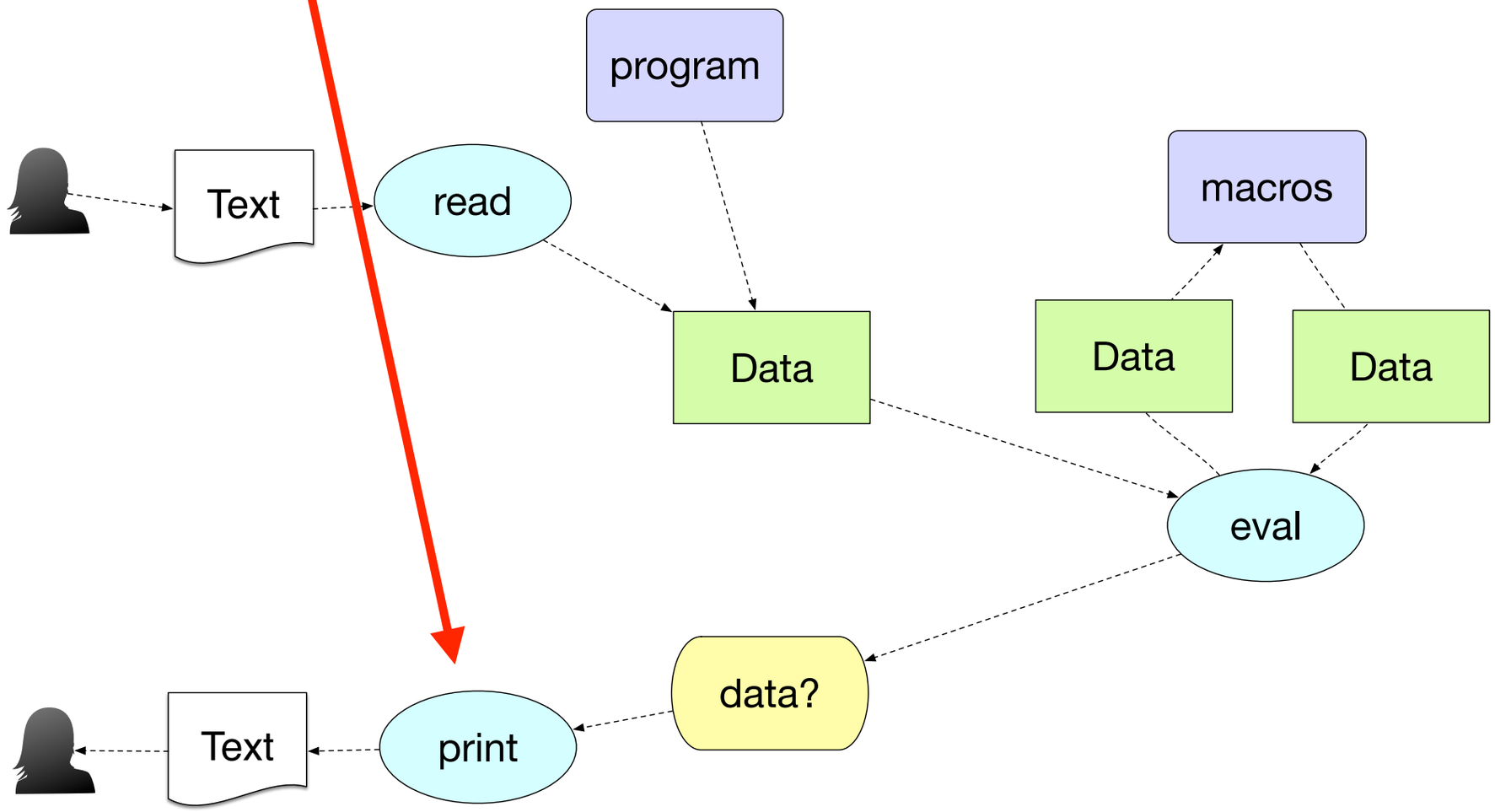
```
1 (let [db (d/db conn)
2       ent (d/entity db ftx)]
3   (println (d/touch ent))
4   (flush)
5   (let [action (edn/read in)
6         result (perform-cat-action action conn ftx)]
7     (case result
8           :quit (reduced total)
9           :next (inc total)
10          :skip total
11          :again (recur))))
```

read
instruction

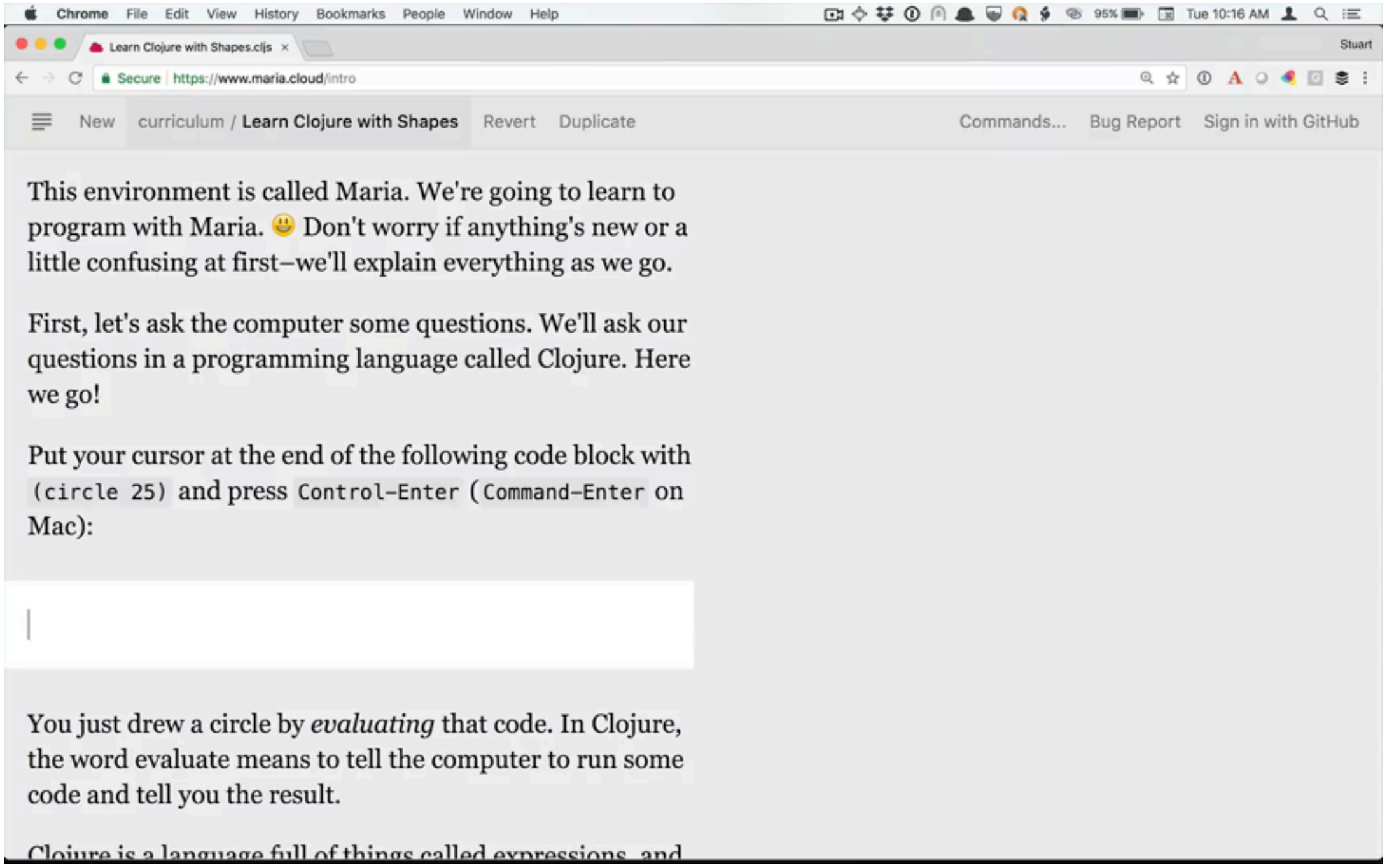
polymorphic
processing

Custom Print

```
1 (require '[clojure.pprint :as pp]
2          '[clojure.main :as main])
3 (clojure.main/repl :print pp/pprint)
```



Custom Error Printing



Common REPL Concerns

I already have a shell…

Typing into a REPL sucks…

Somebody made spaghetti code at a REPL once…

“Just a Shell” is Not Enough

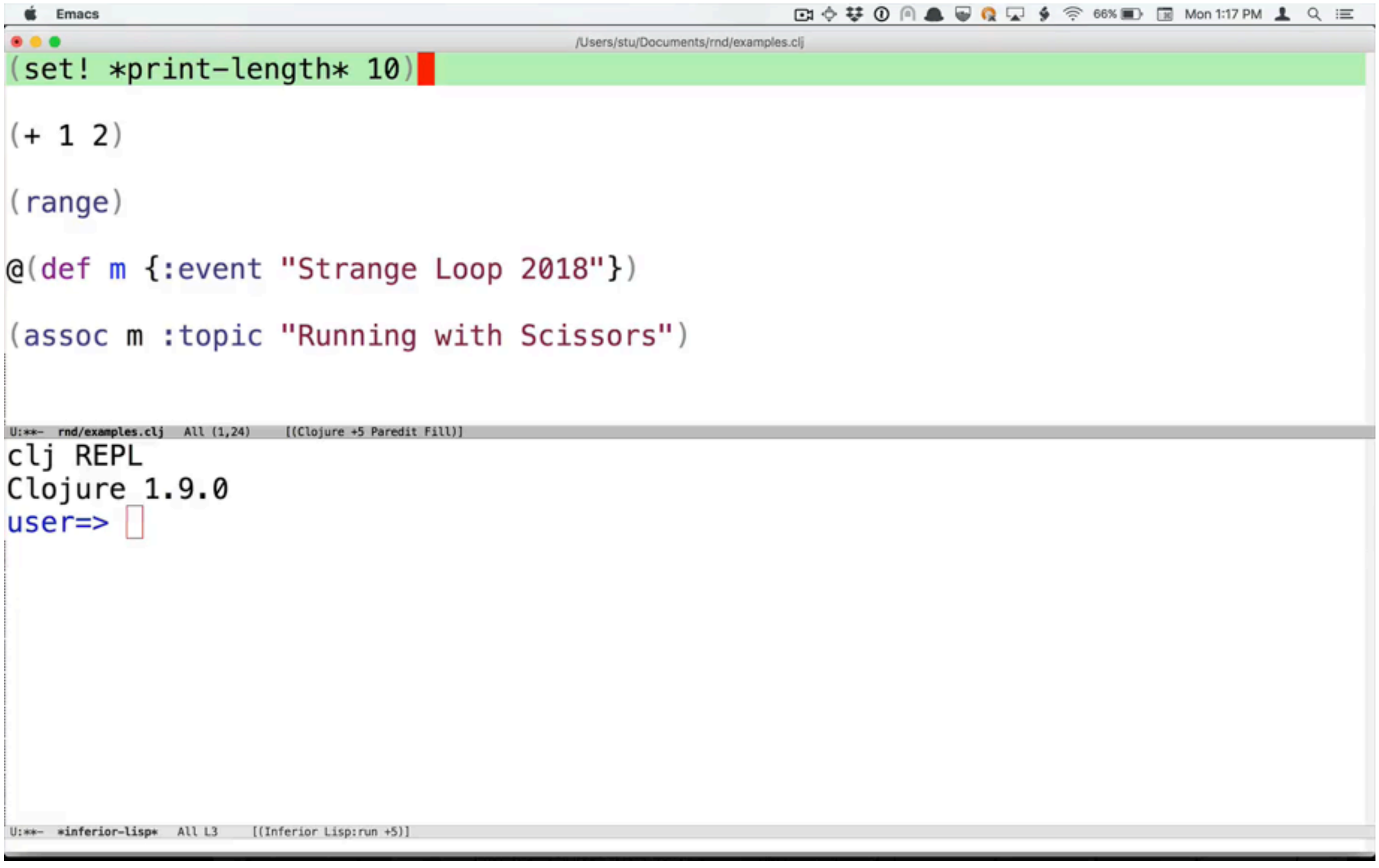
	REPL	**“Sidecar” Shell**
program semantics	sequential evaluation of forms	files, modules, projects, etc.
interactive semantics	sequential evaluation of forms	special, maybe not like programs
text -> data	read	literals? parser?
text -> code	read	parser to AST? eval text? object to text? toString?
execute	eval data	
data -> text	print	

Sidecar Shells: JShell

"The JShell state includes an *evolving code and execution state*. To facilitate rapid investigation and coding, statements and expressions *need not occur within a method*, and variables and method *need not occur within a class*."

— http://openjdk.java.net/jeps/222

REPL is Not About Text Entry

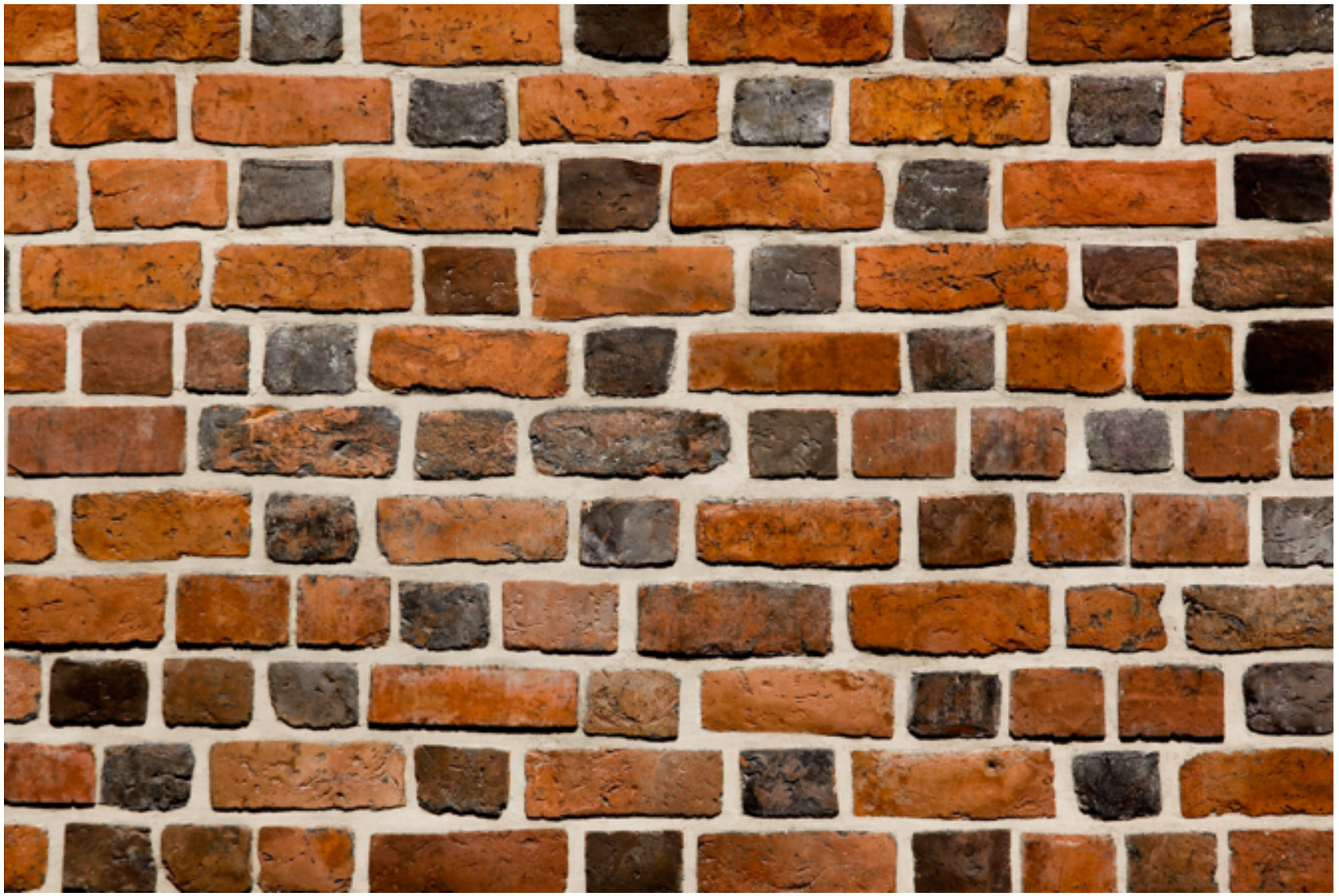


Spaghetti Code?

REPL + imperative = faster spaghetti

Functional Code

REPL + Functional = faster bricks



https://en.wikipedia.org/wiki/Brick#/media/File:Brick_wall_close-up_view.jpg

...with Scissors

Don’t run your entire program!

Focus: cut your code and data

down to match the job at hand

Task-Specific Dev

Start with example data

maybe generate data for exploration

Interactively test some fns

Load what you need (namespaces, vars, etc.)

Custom UI

Example Data

```clojure
(def dominator
  "Map from a move to its dominator."
  {:rock :paper
   :scissors :rock
   :paper :scissors})

(def moves
  "The set of legal moves."
  (into #{} (keys dominator)))
```

Inspired by http://rubyquiz.com/quiz16.html

Generating Data

Emacs 83% Mon 5:39 PM

/Users/stu/code/running-with-scissors/examples/rock_paper_scissors.repl

```
(defn winner
  "Returns the winning move, or nil if a draw."
  [m1 m2]
  (cond
   (= m1 m2) nil
   (= (dominator m1) m2) m2
   (= (dominator m2) m1) m1
   :default (assert false)))

(s/fdef winner :args (s/cat :m1 moves :m2 moves))

(s/exercise-fn `winner)
```

U:**- rock_paper_scissors.repl Bot (20,28) [(Clojure +4 Paredit Fill)]

```
clj REPL
Clojure 1.10.0-alpha8
user=> nil
user=> nil
user=> #'user/dominator
user=> #'user/moves
user=>
```

U:**- *inferior-lisp* All L7 [(Inferior Lisp:run +4)]

Load What You Need

code

```
1 (require '[clojure.data.csv :as csv]
2          '[clojure.java.io :as io]
3          '[clojure.pprint :as pp]
4          '[clojure.spec.alpha :as s]
5          '[datomic.api :as d]
6          '[pfinance.repl :refer :all])
7
8 (set! *print-length* 50)
9 (def uri "datomic:dev://localhost:4334/pfinance")
10 (def conn (d/connect uri))
11 (def db (d/db conn))
```

state

Custom UI

Don’t pound your head against a wall of text

pretty-print (and print-table) it

inspect it

make a spreadsheet

make HTML

make a picture

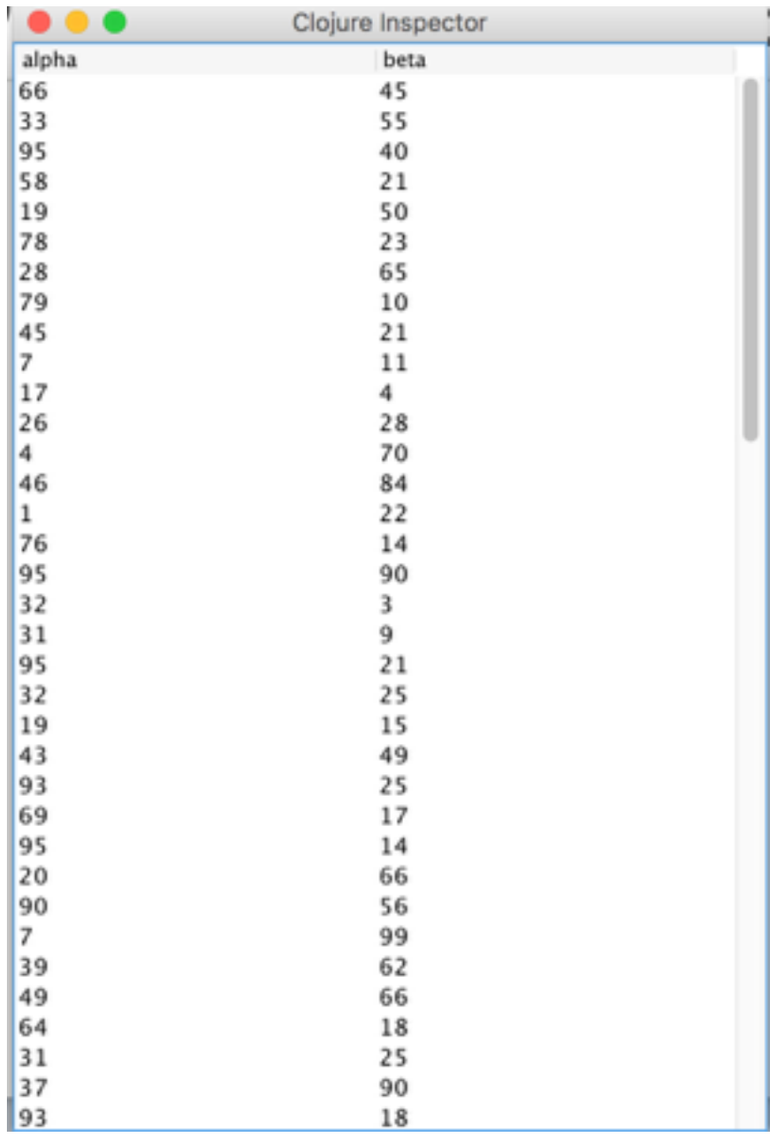
No

```
@(def data (repeatedly 100 (fn [] {:alpha (rand-int 100)
                                   :beta (rand-int 100)})))
```

```
=> ({:alpha 58, :beta 45} {:alpha 45, :beta 83} {:alpha 64, :beta 71} {:alpha 0, :beta
30} {:alpha 8, :beta 24} {:alpha 50, :beta 49} {:alpha 73, :beta 63} {:alpha 1, :beta 3}
{:alpha 30, :beta 34} {:alpha 79, :beta 62} {:alpha 64, :beta 29} {:alpha 72, :beta 74}
{:alpha 28, :beta 15} {:alpha 64, :beta 53} {:alpha 74, :beta 38} {:alpha 93, :beta 26}
{:alpha 9, :beta 89} {:alpha 48, :beta 29} {:alpha 64, :beta 51} {:alpha 35, :beta 15}
{:alpha 0, :beta 79} {:alpha 74, :beta 91} {:alpha 17, :beta 99} {:alpha 2, :beta 14}
{:alpha 66, :beta 70} {:alpha 75, :beta 69} {:alpha 40, :beta 70} {:alpha 29, :beta 82}
{:alpha 85, :beta 94} {:alpha 2, :beta 68} {:alpha 2, :beta 28} {:alpha 30, :beta 34}
{:alpha 57, :beta 48} {:alpha 57, :beta 87} {:alpha 44, :beta 38} {:alpha 29, :beta 14}
{:alpha 55, :beta 88} {:alpha 2, :beta 59} {:alpha 28, :beta 5} {:alpha 17, :beta 4}
{:alpha 44, :beta 35} {:alpha 79, :beta 8} {:alpha 18, :beta 36} {:alpha 7, :beta 7}
{:alpha 32, :beta 5} {:alpha 56, :beta 34} {:alpha 12, :beta 73} {:alpha 88, :beta 98}
{:alpha 20, :beta 41} {:alpha 72, :beta 73} {:alpha 72, :beta 75} {:alpha 5, :beta 29}
{:alpha 68, :beta 9} {:alpha 60, :beta 89} {:alpha 4, :beta 27} {:alpha 11, :beta 28}
{:alpha 4, :beta 91} {:alpha 68, :beta 86} {:alpha 2, :beta 23} {:alpha 62, :beta 38}
{:alpha 19, :beta 81} {:alpha 9, :beta 67} {:alpha 56, :beta 43} {:alpha 59, :beta 69}
{:alpha 52, :beta 68} {:alpha 99, :beta 60} {:alpha 76, :beta 11} {:alpha 55, :beta 73}
{:alpha 48, :beta 64} {:alpha 72, :beta 95} {:alpha 95, :beta 23} {:alpha 89, :beta 65}
{:alpha 28, :beta 14} {:alpha 91, :beta 10} {:alpha 49, :beta 68} {:alpha 95, :beta 43}
{:alpha 31, :beta 90} {:alpha 74, :beta 99} {:alpha 44, :beta 86} {:alpha 17, :beta 77}
{:alpha 93, :beta 56} {:alpha 11, :beta 50} {:alpha 58, :beta 38} {:alpha 27, :beta 88}
{:alpha 92, :beta 62} {:alpha 56, :beta 33} {:alpha 48, :beta 73} {:alpha 14, :beta 14}
{:alpha 56, :beta 97} {:alpha 97, :beta 28} {:alpha 41, :beta 30} {:alpha 99, :beta 47}
{:alpha 30, :beta 18} {:alpha 53, :beta 99} {:alpha 51, :beta 1} {:alpha 96, :beta 95}
{:alpha 40, :beta 23} {:alpha 46, :beta 74} {:alpha 33, :beta 43} {:alpha 27, :beta 84})
```

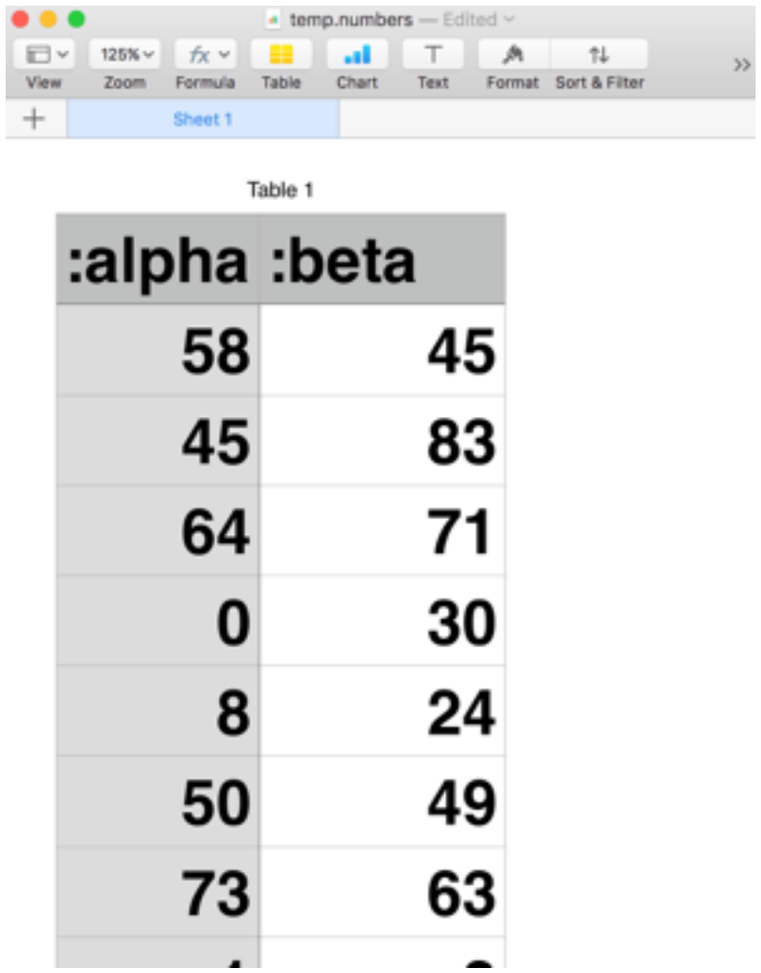
Inspect It

```
(require '[clojure.inspector :as ins])
(ins/inspect-table data)
```



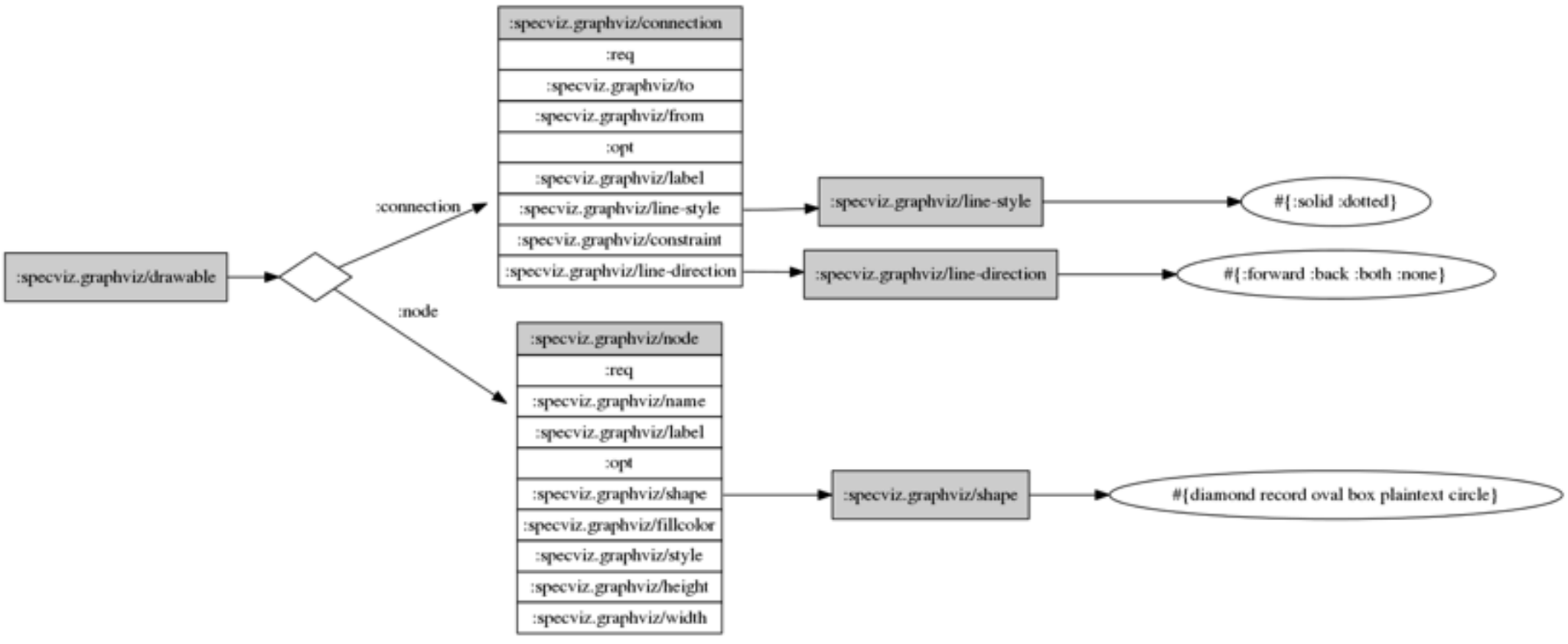
Spreadsheet It

```
(with-open [w (io/writer "temp.csv")]
 (csv/write-csv
  w
  (map->csv data [:alpha :beta])))
(sh/sh "open" "temp.csv")
```



Picture It

Specviz: generate Graphviz from Clojure spec



https://github.com/jebberjeb/specviz

Too Much Work?

"With a REPL first I need to do a load of import statements. Then populate my objects. Then get started with the actual debugging. I personally don't find it anywhere near as efficient as an IDE that has been setup."

— https://news.ycombinator.com/item?id=16315552

"do" block, anyone?

— me

Rich Comment Blocks

At end of a .clj file

Sample data

Sample invocations

Durable history of the dev process

Rich Comments

```
(comment
(do
  (refer 'set)
  (def xs #{{:a 11 :b 1 :c 1 :d 4}
            {:a 2 :b 12 :c 2 :d 6}
            {:a 3 :b 3 :c 3 :d 8 :f 42}})

  (def ys #{{:a 11 :b 11 :c 11 :e 5}
            {:a 12 :b 11 :c 12 :e 3}
            {:a 3 :b 3 :c 3 :e 7 }}))

(join xs ys)
(join xs (rename ys {:b :yb :c :yc}) {:a :a})

(union #{:a :b :c} #{:c :d :e })
(difference #{:a :b :c} #{:c :d :e})
(intersection #{:a :b :c} #{:c :d :e})

(index ys [:b])
)
```

setup

expedition log

What About Tests?

Automate (re)running of REPL interactions

Instead of testing specialness, lean on language for

lifecycle / reuse / scope / state / validation

Transcriptor

```
;; my-test.repl
(require '[cognitect.transcriptor :refer (check!)])

;; check exact match
(+ 1 2)
(check! #{3})

;; check predicate (or any spec!)
(+ 1 1)
(check! even?)
```

```
;; my-suite.repl
(require '[cognitect.transcriptor :as xr :refer (check!)])
(xr/run "my-test.repl")
```

https://github.com/cognitect-labs/transcriptor

Sets: Scissors-Ready Data

Just do it

Strongly-named keys

```
{:name/last "Halloway"
 :name/first "Stuart"}
```

```
{:github/id "stuarthalloway"
 :github/location "Chapel Hill, NC"}
```

```
{:twitter/id "stuarthalloway"
 :twitter/joined #inst "2008-03"}
```

Slots

Enumerate prior to use

Specify names, or types, or both

Sorry, No Scissors! — separate API per struct

```
struct Person {
  String last;
  String first;
};
```

```
struct GithubAccount {
  String id;
  Date joined;
};
```

```
struct TwitterAccount {
  String id;
  Date joined;
};
```

Ad hoc Merge

```
(def about-me
  (merge
   {:github/id "stuarthalloway"
    :github/location "Chapel Hill, NC"}
   {:name/last "Halloway"
    :name/first "Stuart"}
   {:twitter/id "stuarthalloway"
    :twitter/joined #inst "2008-03"}))
```

multiple ids ok, no collision
thanks to namespace names

Ad Hoc Enumeration

```
(defn keys-named
 "Given map m, return all the keys whose
  name component is n."
  [m n]
  (filter #(= (name %) n) (keys m)))

(keys-named about-me "id")
=> (:github/id :twitter/id)
```

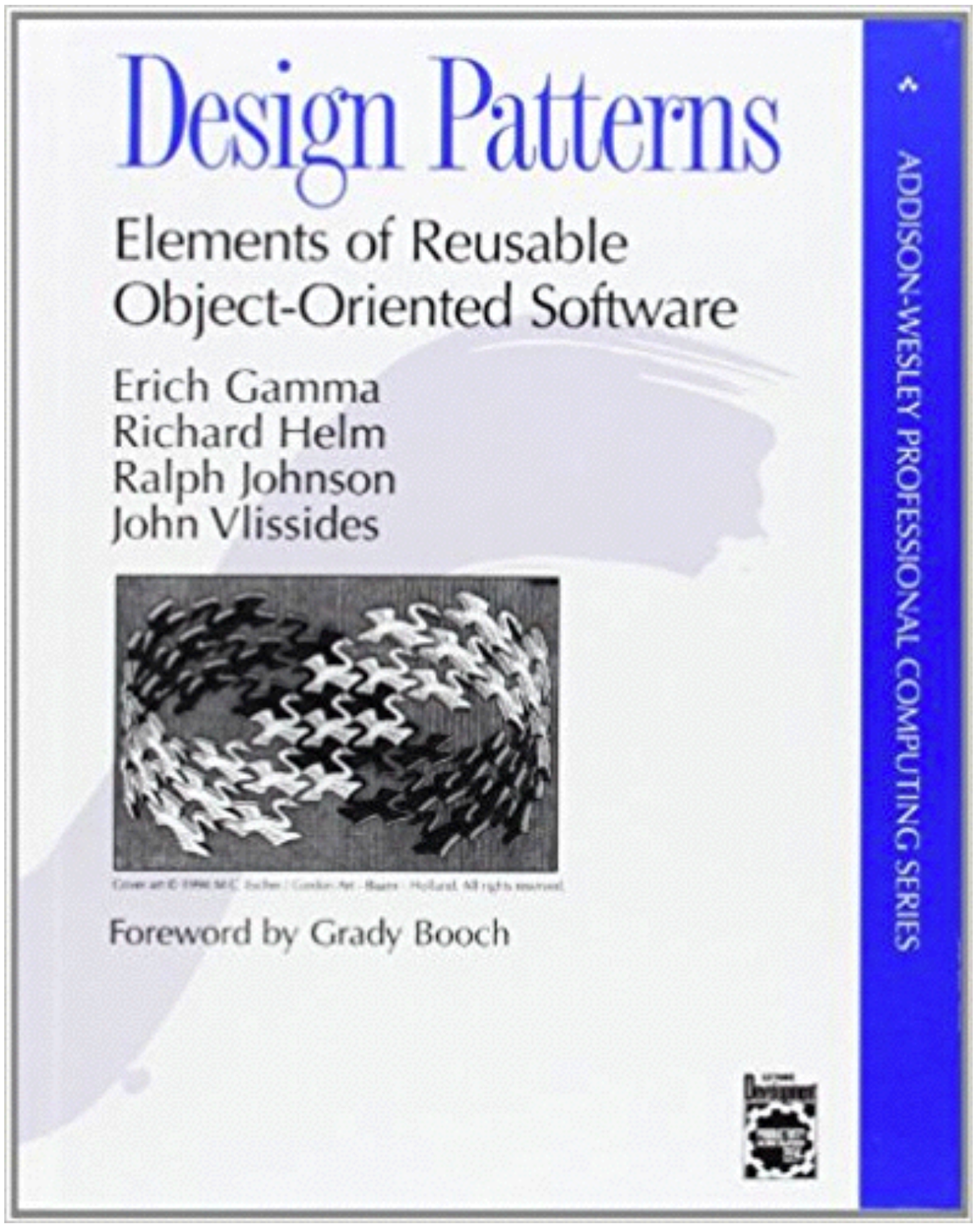
Perfectly Good Fact, or Broken Struct?

```
(select-keys about-me [:github/location])
=> {:github/location "Chapel Hill, NC"}
```

Slots vs. Sets

	Slots	**Sets**
worldview	closed	open
genericity	no	it’s just maps
ad hoc usage	no	carve away!
scaling dev effort	combinatorial	linear

Celebrate Needless Effort



https://www.amazon.com/Design-Patterns-Elements-Reusable-Object-Oriented/dp/0201633612

Live Coding

Your running program is ***tangible***

query it

transform it

program it

Query the Program

Clojure API	args	returns	count
apropos	stringy	symbols	N
find-doc	stringy	docstrings	N
doc	symbol	docstring	1
source	symbol	source string	1
all-ns	-	namespaces	all
ns-publics	namespacey	map sym->var	all
imports	namespacey	classes	all

Transform the Program

finish experiments / undo mistakes

without ever leaving your running program

Clojure API	args	change
in-ns	sym	*ns*
def	symbol, init?	new var root
ns-unmap	ns, sym	remove symbol
ns-unalias	ns, sym	remove alias
remove-ns	sym	remove ns

Codeveloping Two Libs

Load both libs from the REPL

Jump in and study data

  including ad-hoc programs

Make changes one def form at a time

Leave test setup in a comment

Live Coding vs. Reloading

"workflow, reloaded" operates one level higher

files and namespaces, tools help keep track

app state must adhere to certain idioms

live coding is targeted surgery

more precise

developer keeps track

both have utility

http://thinkrelevance.com/blog/2013/06/04/clojure-workflow-reloaded

What About GUI Debuggers?

"Off the rack" experience

improved visibility

limited/special transformations

no/weak programmability

Not scissors

Live Data: Clojure spec

a la carte specificity without sacrificing generality

you get to keep your scissors

dynamic leverage

anytime, anywhere, up to you

fantastic for brownfield development

spec as Exploration Tool

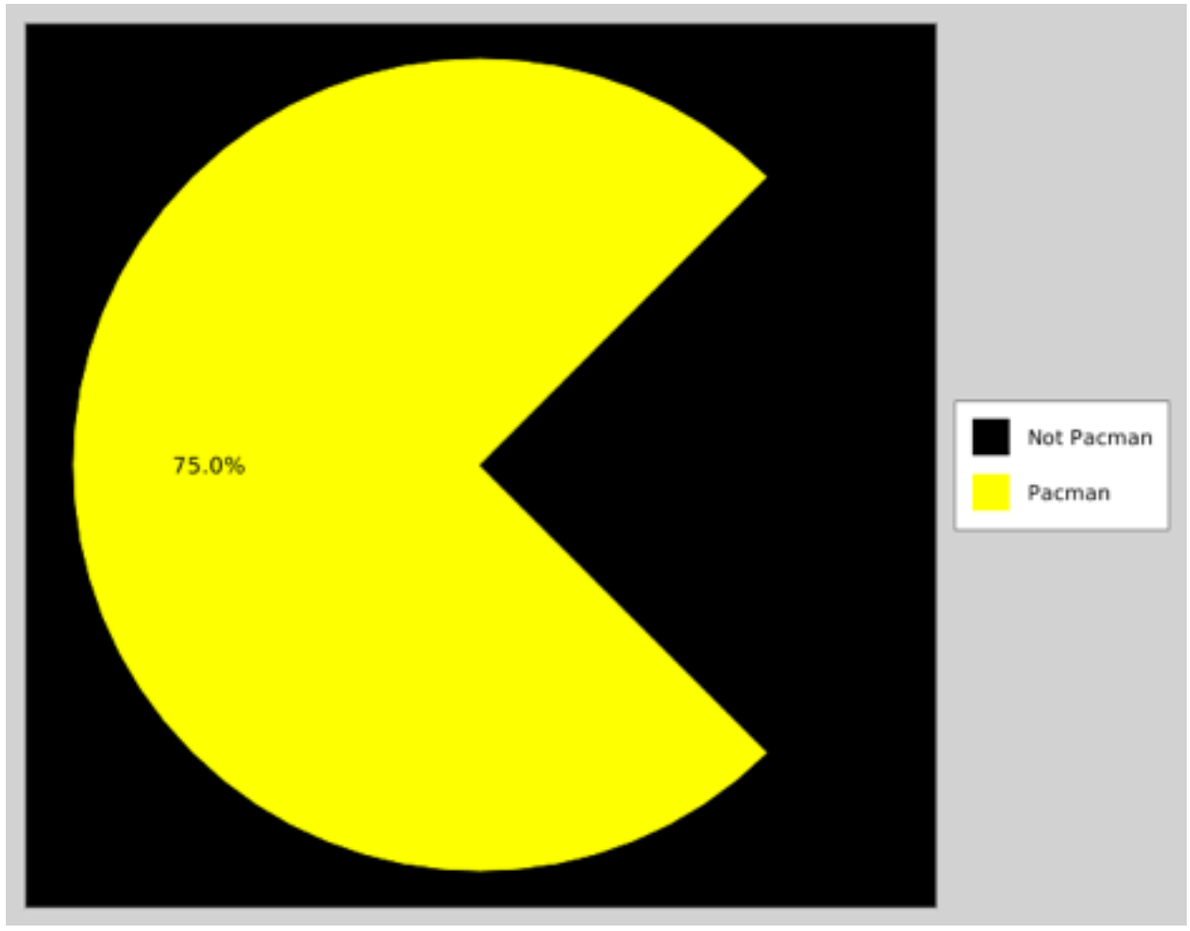
What	How
what are the building blocks?	declarative structure
what invariants hold?	arbitrary predicates
how do I check?	validation
what went wrong?	explanation
what went right?	conformance
docs please	autodoc
examples please	sample generator
am I using this right?	instrumentation
is my code correct?	generative testing
can I recombine pieces like this?	assertion

https://www.youtube.com/watch?v=VNTQ-M_uSo8

clj-xchart

note scissor-ready
generic data

```
(c/pie-chart
 [["Not Pacman" 1/4]
  ["Pacman" 3/4]]
 {:start-angle 225.0
  :plot {:background-color :black}
  :series [{:color :black} {:color :yellow}]})
```



http://blog.cognitect.com/blog/2017/6/19/improving-on-types-specing-a-java-library

From Basic Predicates

```
(s/def ::chartable-number (s/and number? finite?))
(s/def ::x (s/every ::chartable-number :min-count 1))
(s/def ::y (s/every ::chartable-number :min-count 1))
```

http://blog.cognitect.com/blog/2017/6/19/improving-on-types-specing-a-java-library

To Testable Types

```
(defn axis-counts-match?
  [{:keys [x y error-bars bubble] :as args}]
  (= (count (second x))
     (count y)
     (count (or error-bars y))
     (count (or bubble y)))))

(defmethod data-compatible-with-render-style? :area
  [series]
  (ordered? (second (:x series))))
```

http://blog.cognitect.com/blog/2017/6/19/improving-on-types-specing-a-java-library

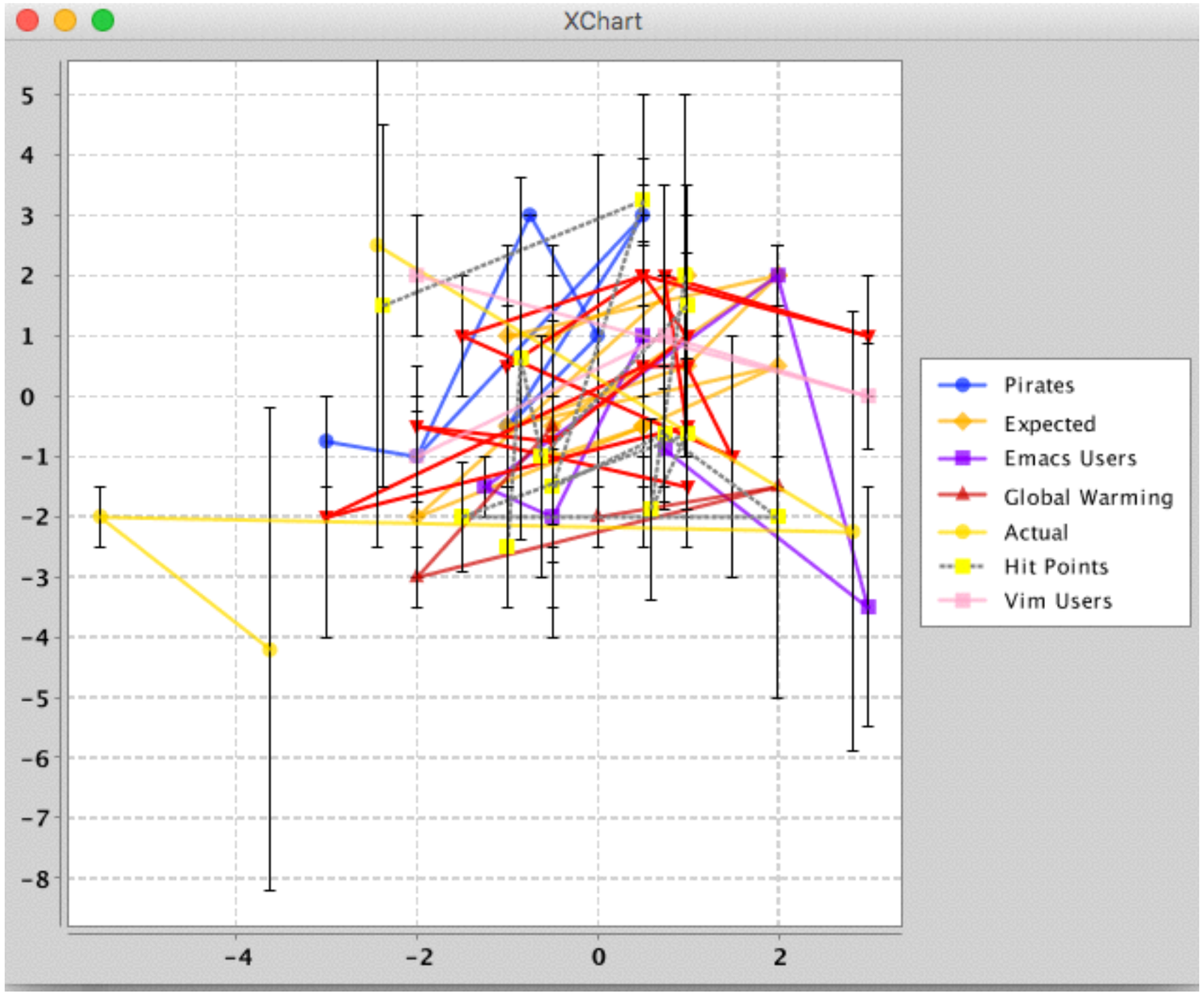
Exercising Data

```
(s/exercise ::series/line-width)
=> ([2.0 2.0] [23 23] [16 16] [1.0 1.0]
    [0.5 0.5] [0.9375 0.9375] [74 74] [1 1] [1 1] [39 39])
```

```
(s/exercise ::series/series-name 5 generators)
=> (["Grommets" "Grommets"] ["Emacs Users" "Emacs Users"]
    ["Grommets" "Grommets"] ["Vim Users" "Vim Users"]
    ["Expected" "Expected"])
```

http://blog.cognitect.com/blog/2017/6/19/improving-on-types-specing-a-java-library

Exercising Code



Instrumentation

```
(xchart/xy-chart {"bad-chart"
                  {:x [3 2 1] :y [4 5 7]
                   :style {:render-style :area}}})
```

```
=> ExceptionInfo Call to #'com.hypirion.clj-xchart/xy-chart
   did not conform to spec:
val: {:x [:numbers [3 2 1]], :y [4 5 7],
      :style {:render-style :area}}
fails spec: :com.hypirion.clj-xchart.specs.series.xy/series-elem
at: [:args :series 1] predicate: data-compatible-with-render-style?
```

Reflections

spec-ing (can be) interactive

specs need not be complete or exact

specs work for you, not you for specs

add support where you need/want it

get your exercise!

generative testing found a bug ***in the JVM!***

Running

work inside your program, from a REPL

with Scissors

precision cut your code and data down to size

Live coding

against a tangible runtime

Live data

explore and extend programs with spec

Running with Scissors: Live Coding with Data

@stuarthalloway