Debugging with the Scientific Method

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Talk At:

https://www.youtube.com/watch?v=FihU5JxmxBg
Why Debugging?

because bugs!

look smart to you friends

understand Clojure
Why Clojure?

I often find myself "guessing" what's wrong with my Clojure code. Especially when interacting with dependencies and I handle some of the data incorrectly ("type" errors), it's not uncommon to get only some cryptic "Cannot cast Java.lang.xyz to abc". Then I go through the code adding tests or print statements, stare at different parts of the code, and finally realize the problem was that I forgot to retrieve the first element of a list, and returned a unitary list instead, or something silly like that.
If you don't know where you are going, you might wind up someplace else.
SM for Debugging

- failure
  - why?
  - something is wrong!

- experiment
  - needs refinement

- observation
  - produces

- hypothesis
  - suggests
  - falsified?

- theory
  - ?
Failure

- **failure**
  - why?
  - something is wrong!
  - needs refinement

- **hypothesis**
  - suggests

- **experiment**
  - produces
  - falsified?

- **observation**

- **?**

- **theory**

- **lack of success**
- **omission of expected action**

*Tuesday, December 1, 15*
Hypothesis

a proposed explanation made on the basis of limited evidence as a starting point for further investigation
Experiment

a test, trial, or tentative procedure
Observation

active acquisition of information from a primary source

why?

failure

needs refinement

something is wrong!

hypothesis

suggests

experiment

falsified?

produces

observation

? 

theory
Falsification

deductive process using modus tollens:

\[ H \rightarrow \sim \mathcal{O} \]

\[ \mathcal{O} \]

\[ \sim H \]
Refinement

the process of removing impurities or unwanted elements from a substance
a hypothesis offering valid predictions that can be observed
Debugging: Most “Scientific” Thing Ever!

more constrained than science

deductive, not inductive

stakeholders typically identified

moral outrage pleasantly rare
an event preceding an effect without which the effect would not have occurred
Actual Cause

difference between the actual world and the closest possible world in which the effect does not occur
Fix

an experiment that establishes an actual cause
Why Is This Partial Not Working?

(def partial-join
  (partial (clojure.string/join ","))

=> (partial-join ["foo" "bar"])

ClassCastException
java.lang.String cannot be cast to clojure.langIFn.
repl/eval12557 (form-init2162333644921704923.clj:1)
What to Do?

Better error messages?
Better docs?
Debugger? Syntax highlighter?
Static typing? Schema?
Stare at It?

Science

Scientific Method is more general and powerful than all the others
Hypotheses

“why is this partial not working”

join doesn’t (do what I expected)

partial doesn’t (do what I expected)

def doesn’t (do what I expected)

(def partial-join
  (partial (clojure.string/join "","")))
Bottom Up REPL Check

For small problems

Take inner most form and evaluate it in the REPL

Replace the result in the next most inner form and evaluate that in REPL

Repeat
(def partial-join (partial (clojure.string/join ",” )))

(clojure.string/join ",” ) => ",”

(partial ",”) => ",”

(def partial-join ",”)
Weak Science is Stronger than Strong Tools

Consider the previous example

Poor problem statement

Incomplete hypotheses

Exploratory experiments

Minimal domain knowledge
Doing SM Well

clear problem statement
efficient hypotheses
good experiments
useful observations
writing it all down
Problem Statements

steps you took
what you expected
what actually happened

The $100 slide
# Quick! Where's the Bug?

<table>
<thead>
<tr>
<th>Your App</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clojure Wrappers</td>
</tr>
<tr>
<td>Clojure Lang</td>
</tr>
<tr>
<td>Popular Java Lib</td>
</tr>
<tr>
<td>JVM</td>
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<tr>
<td>hardware</td>
</tr>
<tr>
<td>physics</td>
</tr>
</tbody>
</table>

Tuesday, December 1, 15
Bisect the Problem

Divide & Conquer
Good Experiments

reproducible

driven by hypothesis

small

change only one thing

Trying random stuff is not being driven by hypothesis
Making Observations

understand all the outputs
suspect correlations
use good tools
Write It Down

problem statement

hypotheses

what experiment should show

why experiment even makes sense

observations
The Failure is not the Defect

(Exception)
Example: Is HornetQ Broken?

large Datomic query

high CPU utilization

IllegalStateException in HornetQ