CS 696 Functional Programming and Design
Fall Semester, 2015
Doc 24 Debugging & Scientific Method
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Debugging with the Scientific Method

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Talk At:

https://www.youtube.com/watch?v=FihU5JxmnBg

Why Debugging?

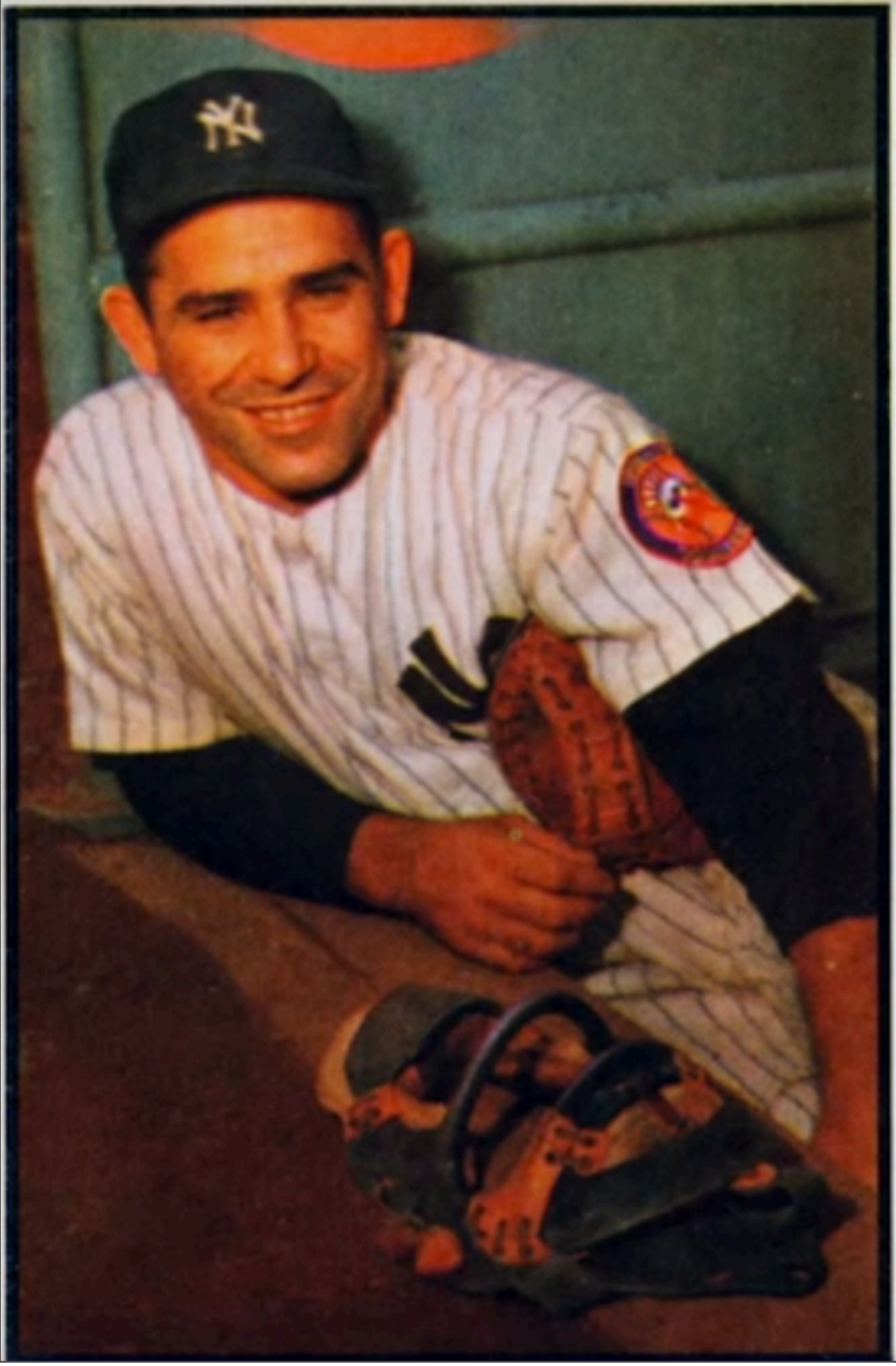
because bugs!

look smart to you friends

understand Clojure

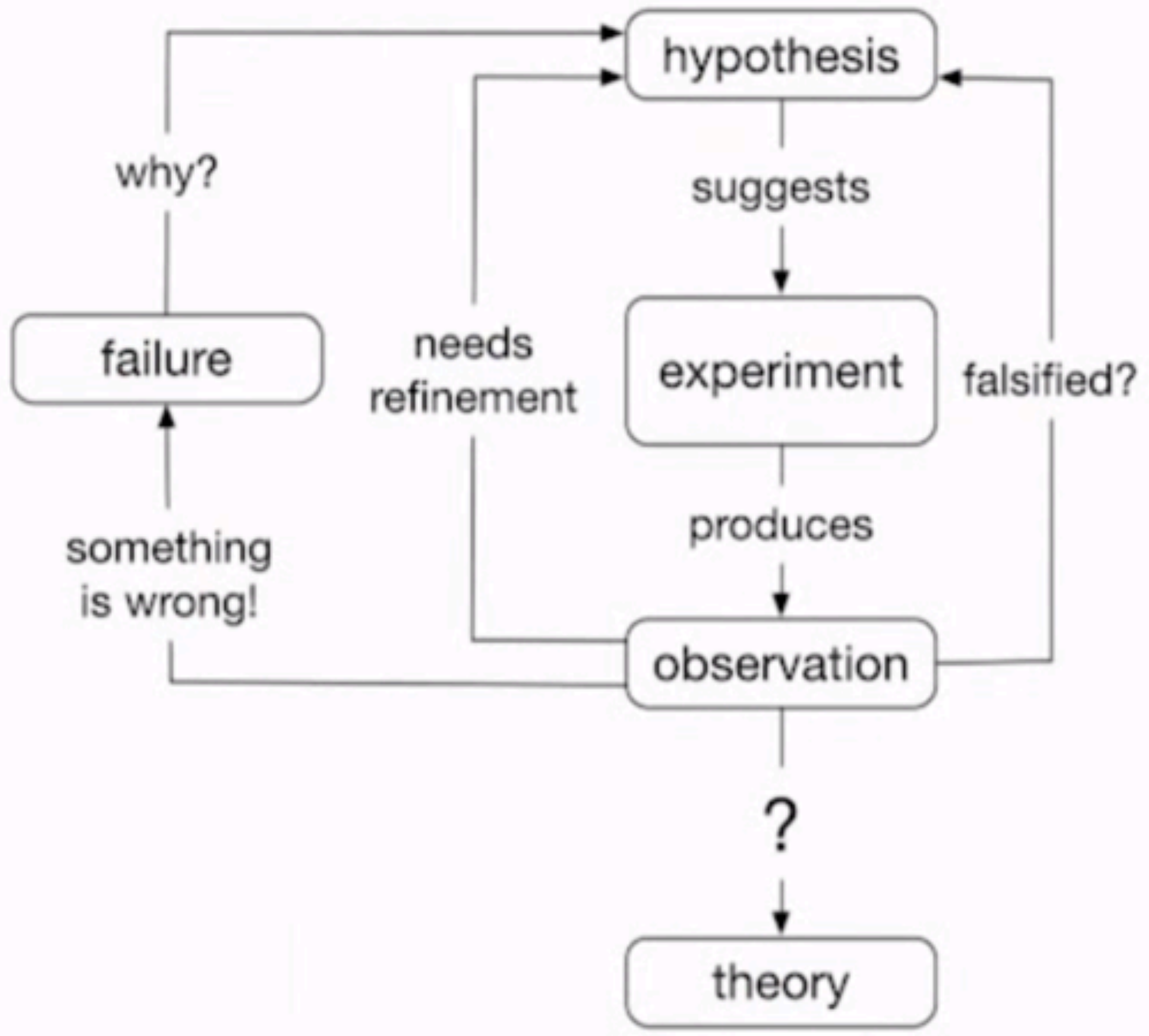
Why Clojure?

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.

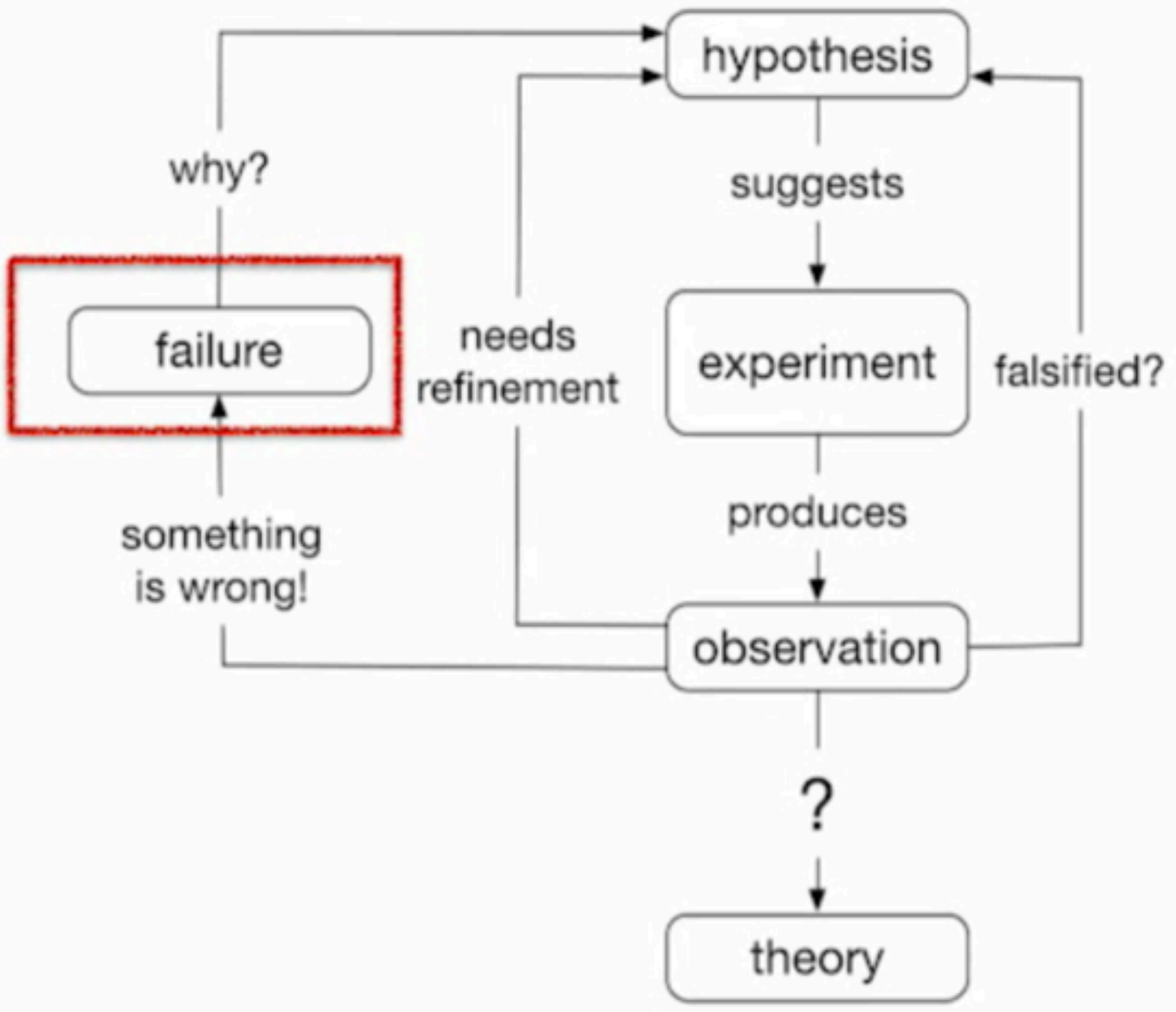


If you don't know where you are going, you might wind up someplace else.

SM for Debugging



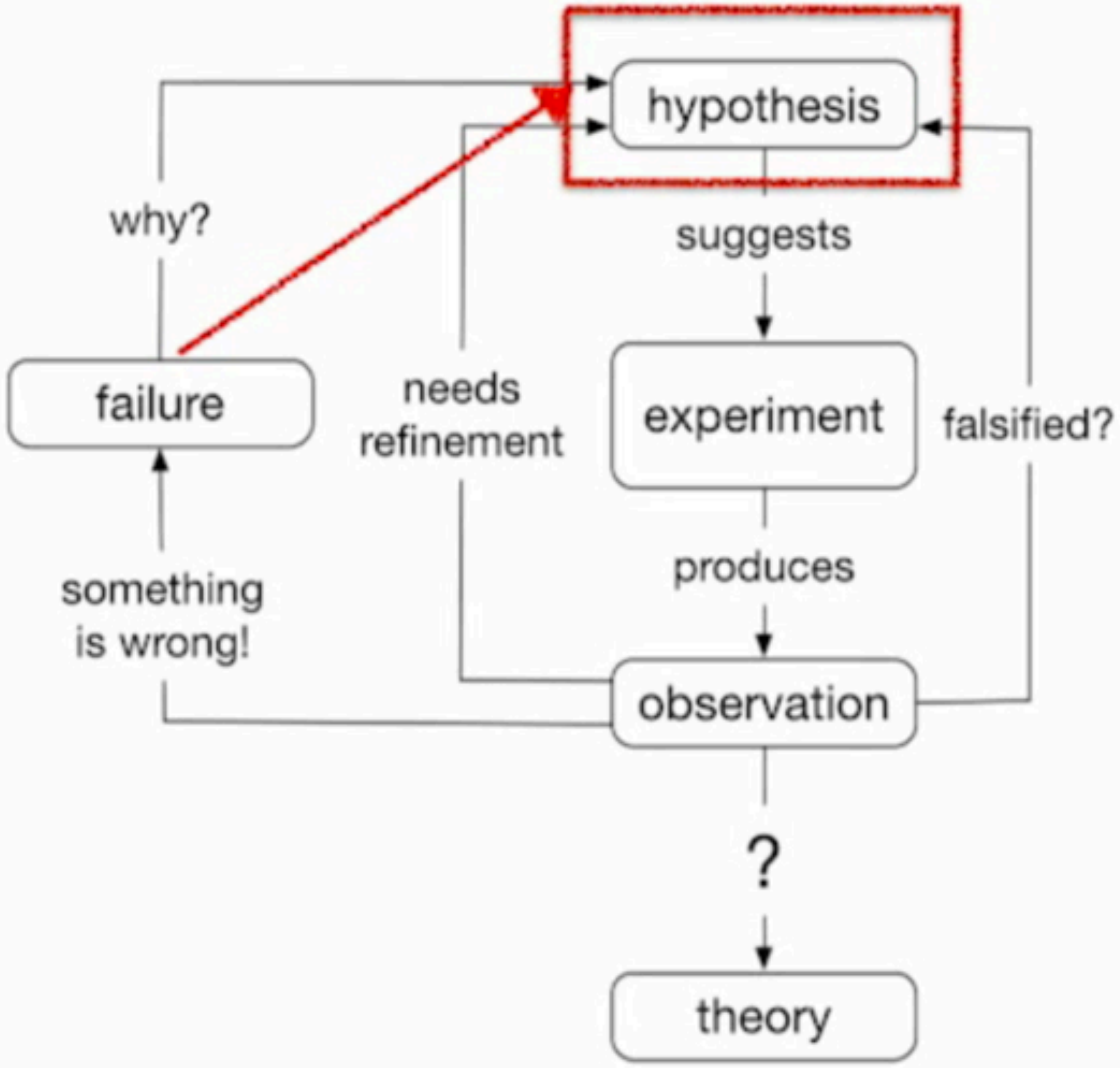
Failure



lack of success

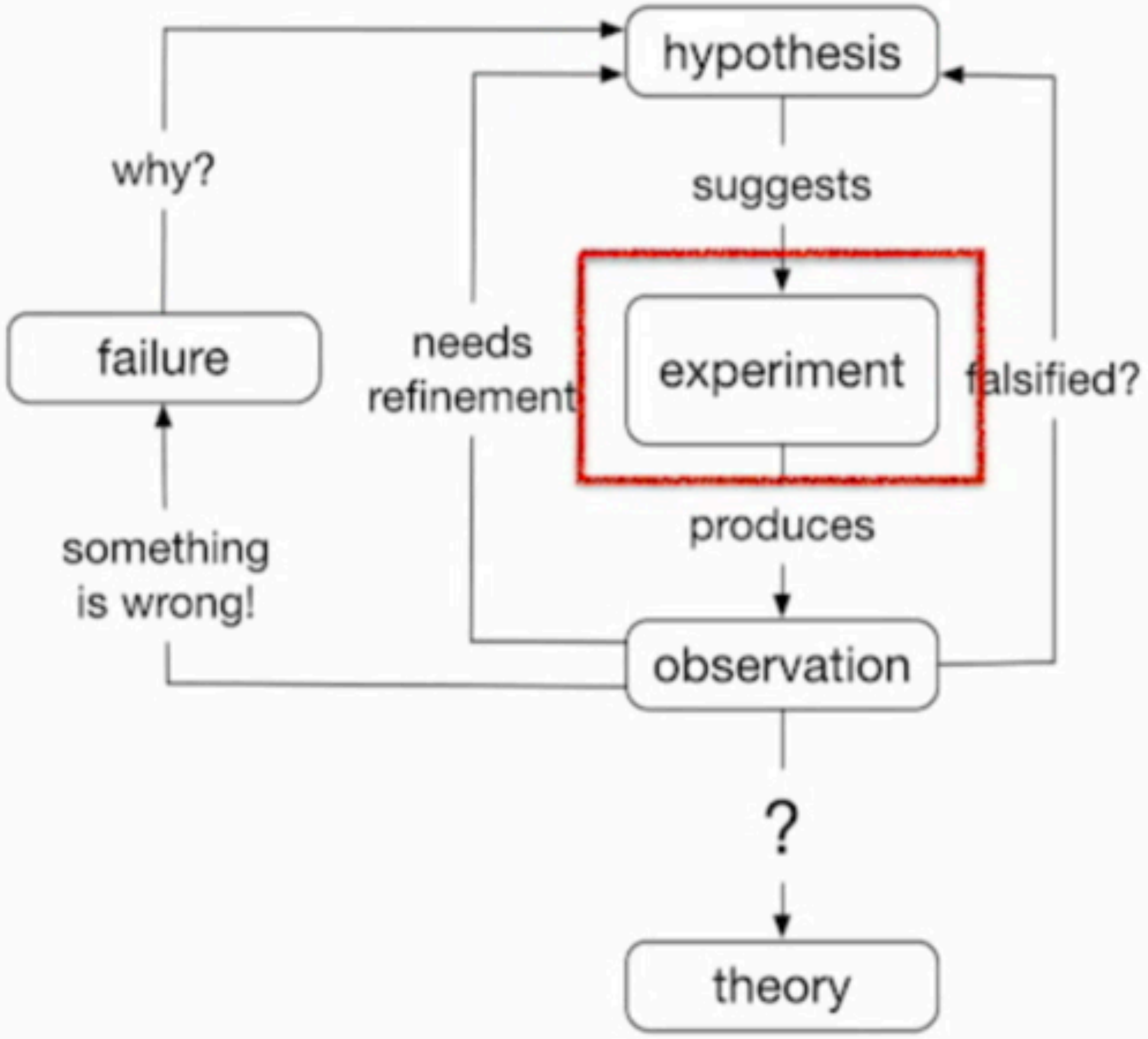
omission of expected action

Hypothesis



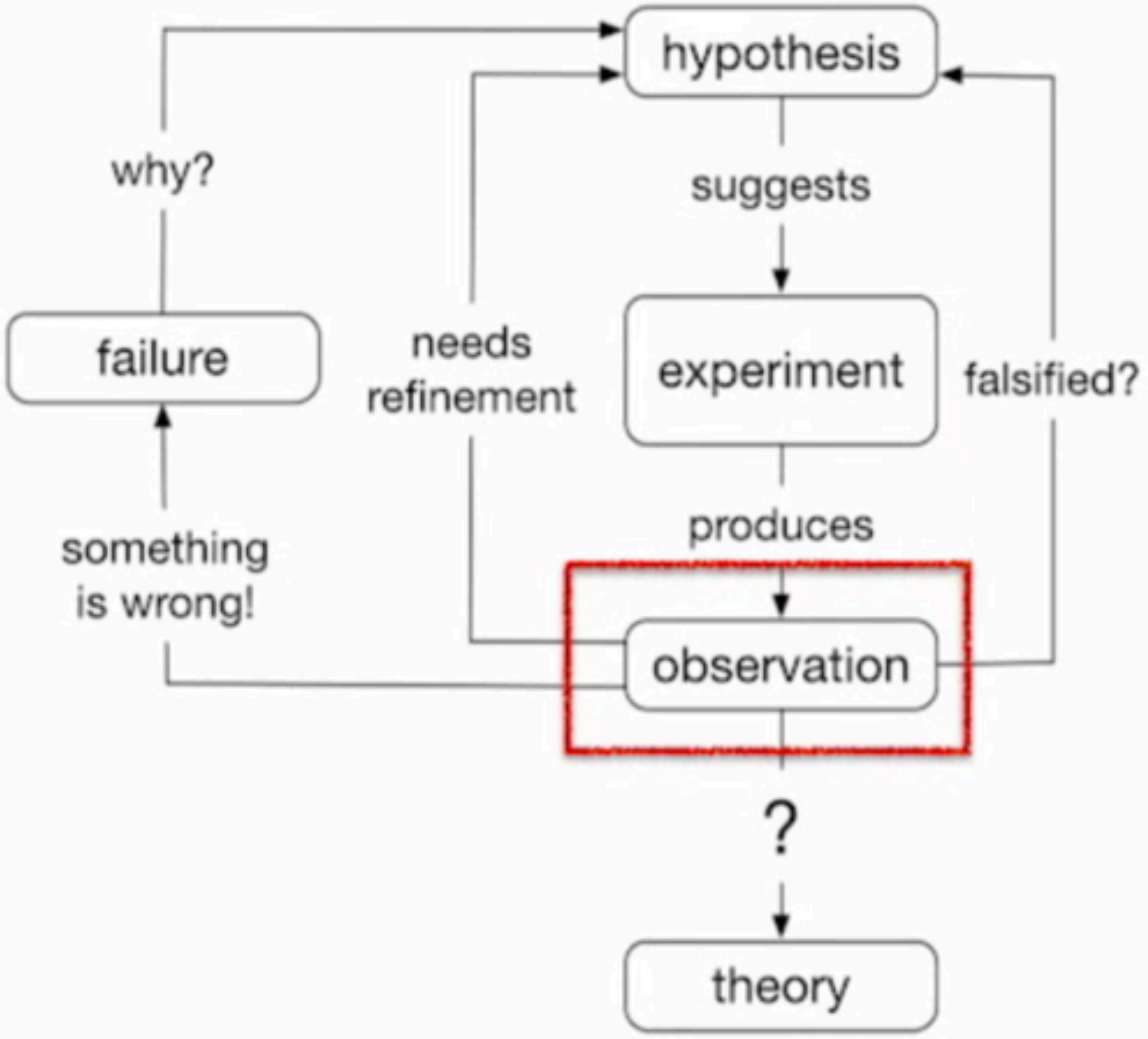
a proposed explanation made on the basis of limited evidence as a starting point for further investigation

Experiment



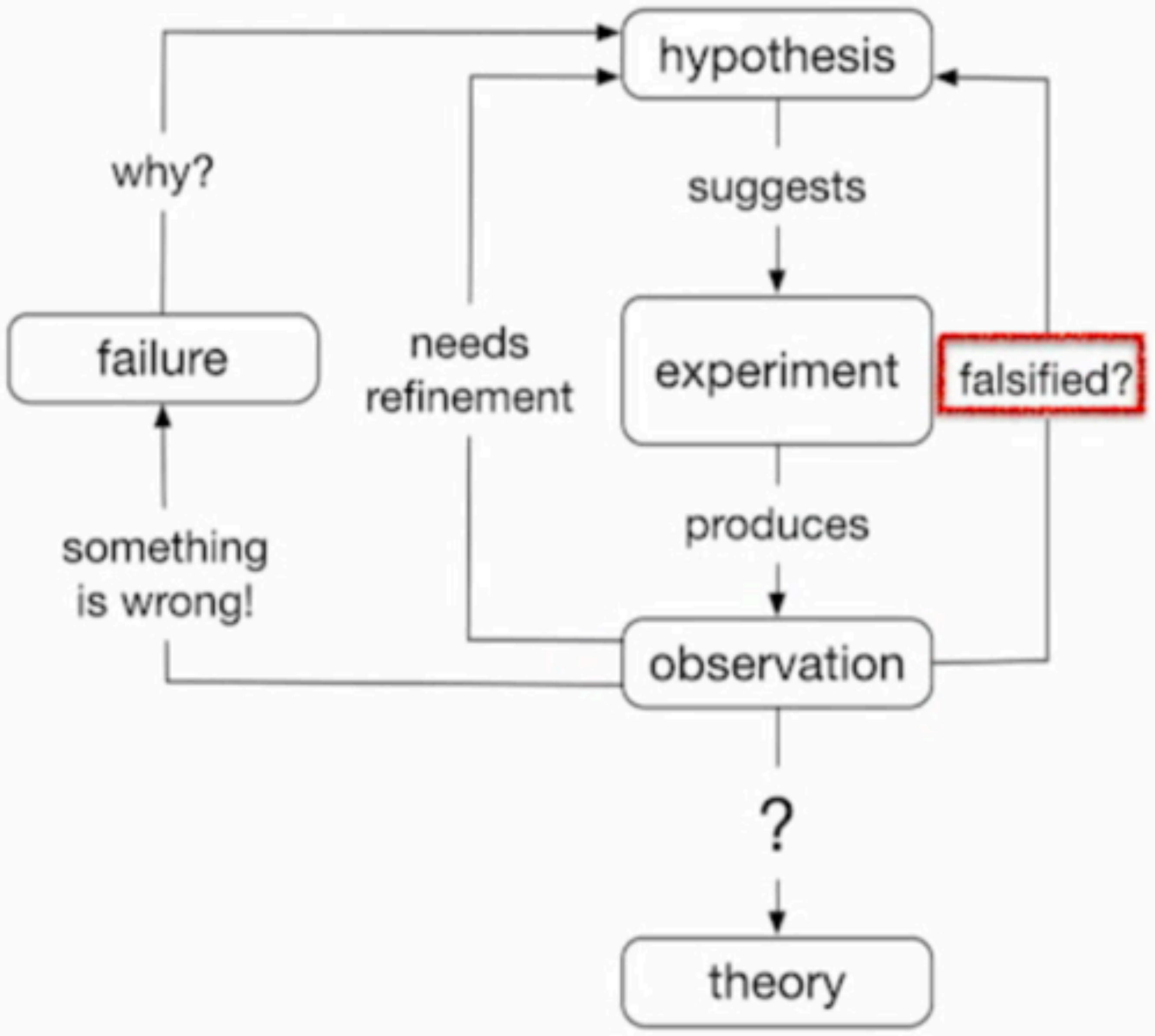
a test, trial, or tentative procedure

Observation



active acquisition of information from a primary source

Falsification

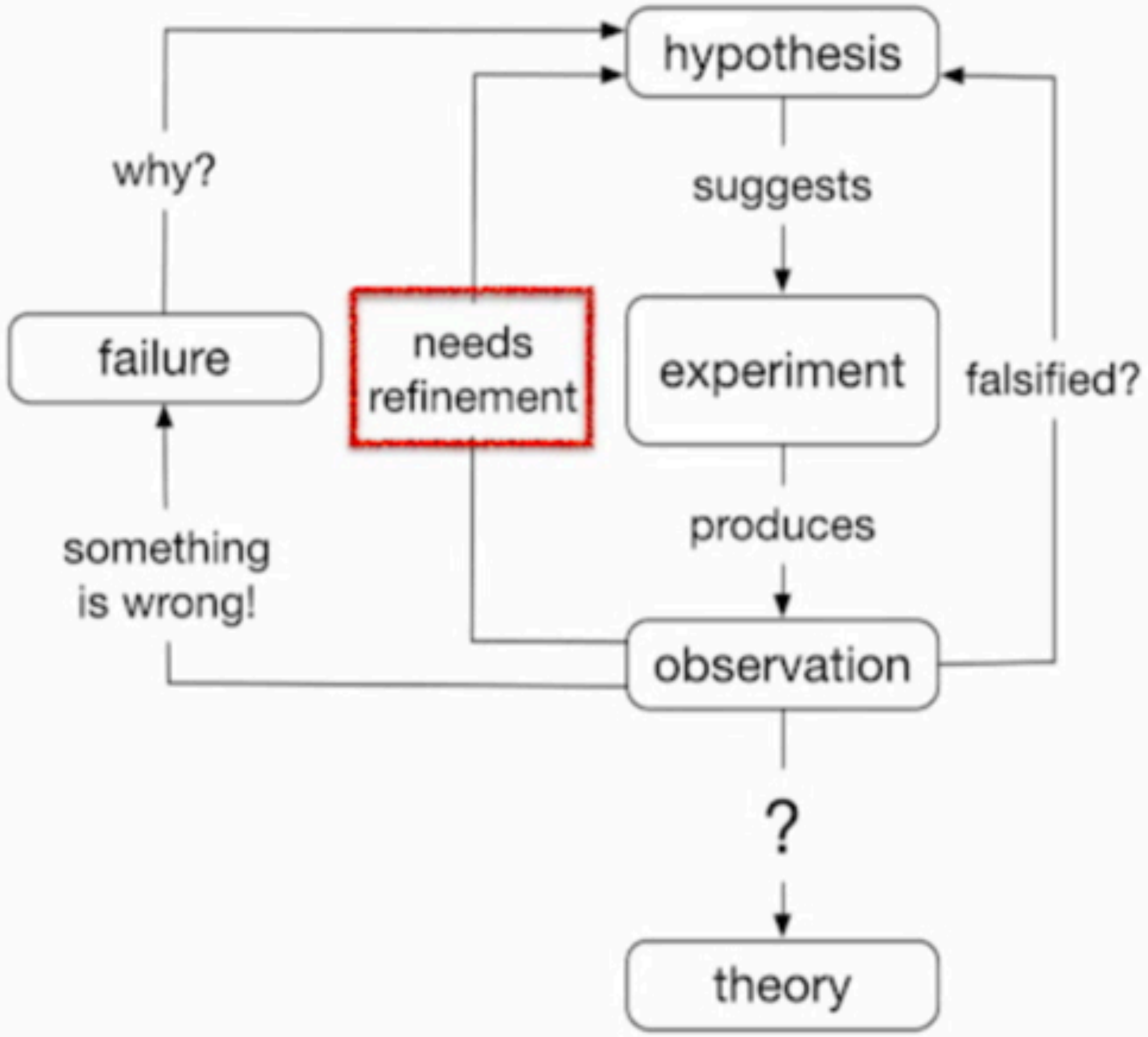


deductive process using modus tollens:

$$H \rightarrow \neg O$$
$$O$$

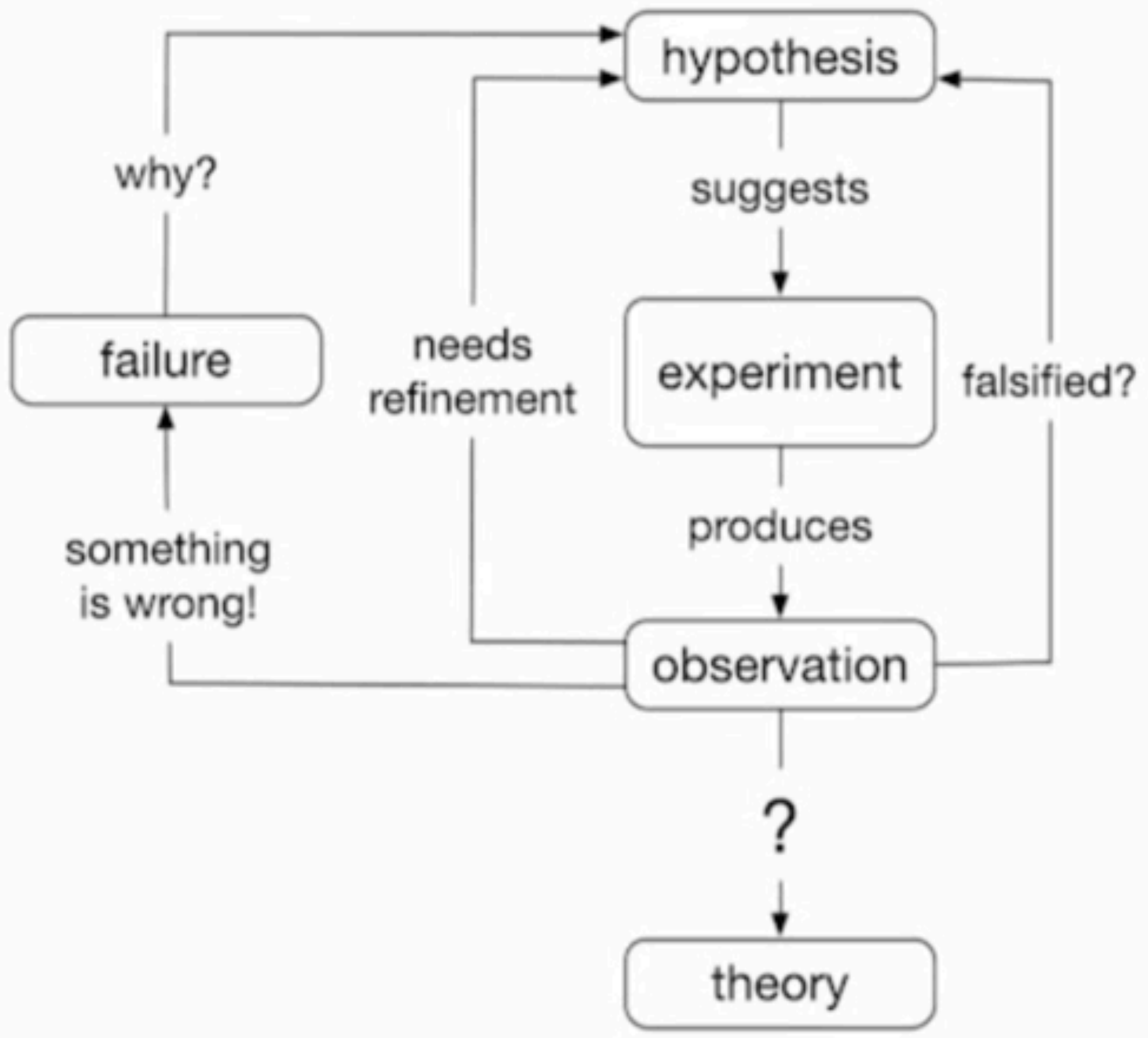
$$\neg H$$

Refinement



the process of
removing impurities
or unwanted elements
from a substance

Theory



a hypothesis offering valid predictions that can be observed

Debugging: Most “Scientific” Thing Ever!

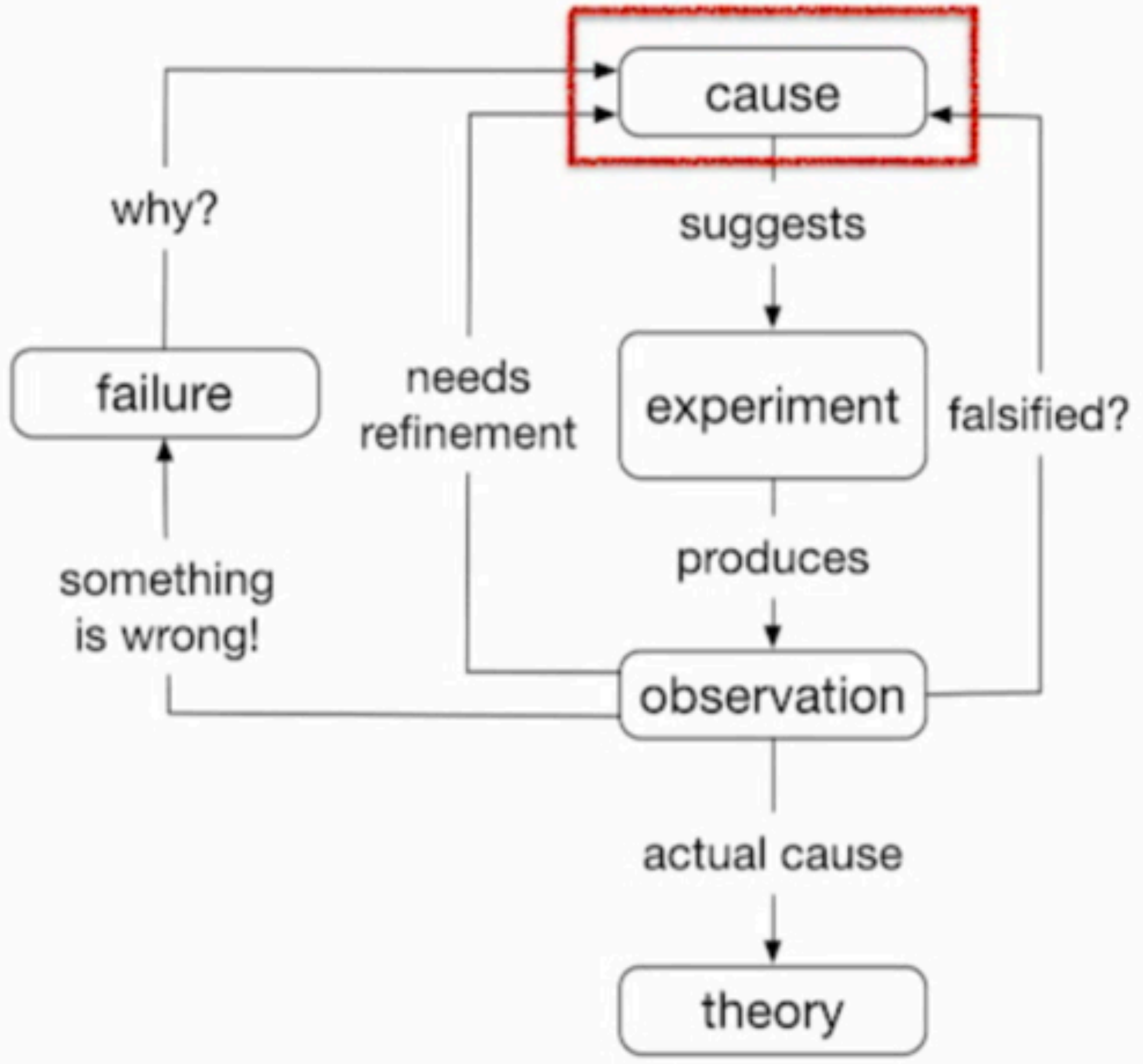
more constrained than science

deductive, not inductive

stakeholders typically identified

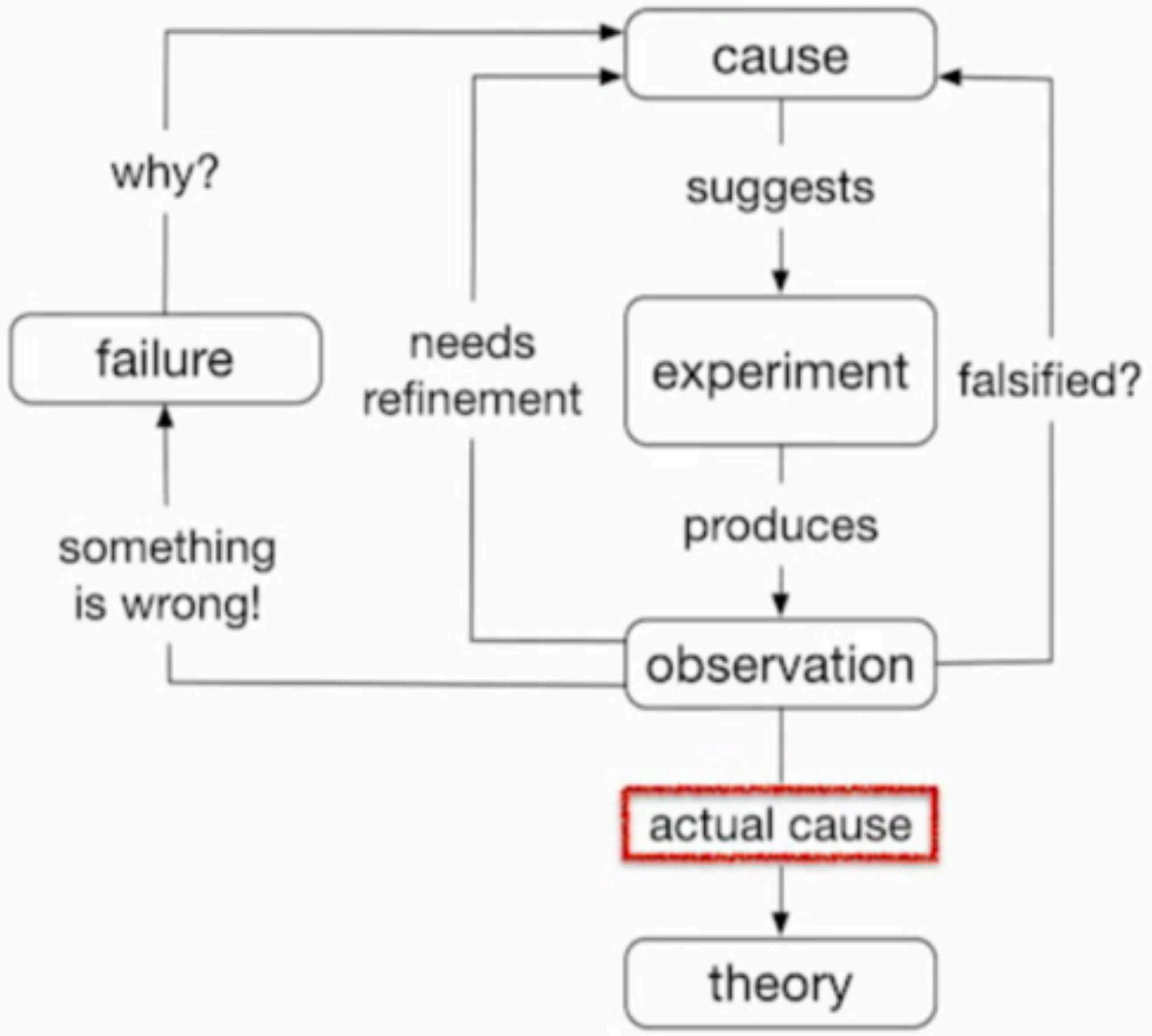
moral outrage pleasantly rare

Cause



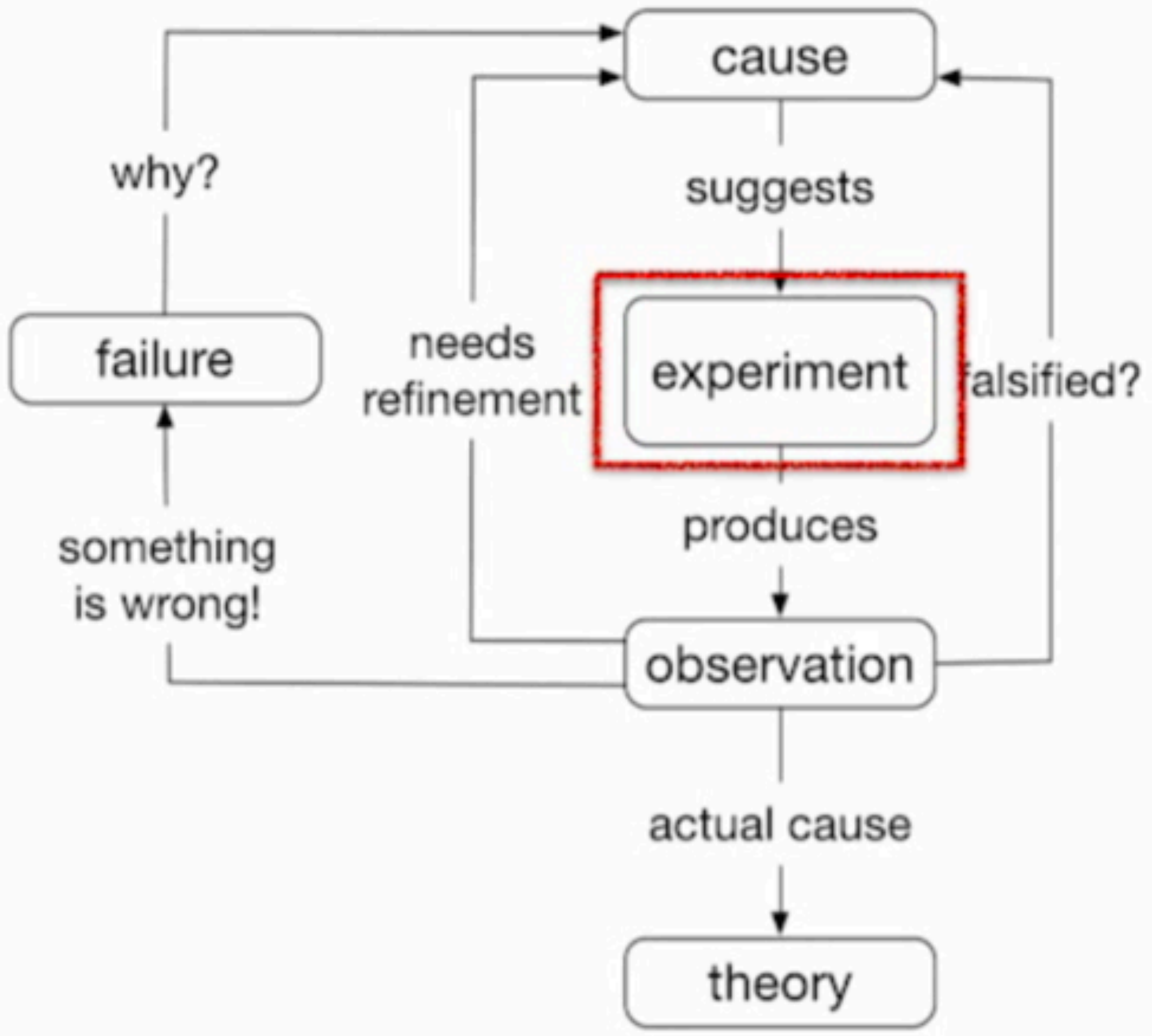
an event preceding an effect without which the effect would not have occurred

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.lang.IFn .
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

Bottom Up REPL Check

```
(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

The $100 slide

steps you took

what you expected

what actually happened

it
didn't
work

http://oceans11.wikia.com/wiki/File:Vlcsnap-2013-08-28-00h56m04s3.png

Quick! Where's the Bug?

Your App	
Clojure Wrappers	
Clojure Lang	Popular Java Lib
JVM	
OS	
hardware	
physics	

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

https://en.wikipedia.org/wiki/Mastermind_(board_game)

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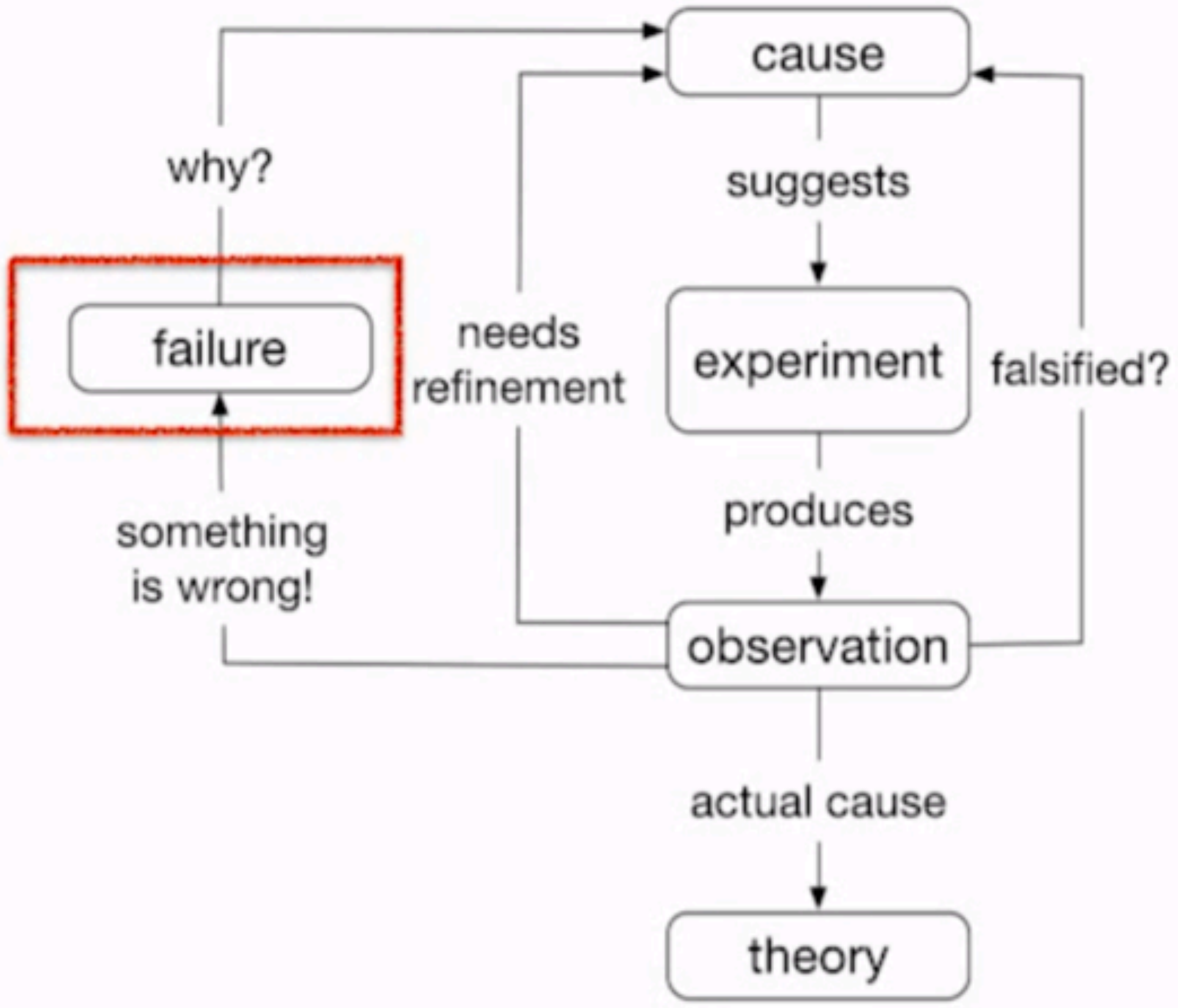
The Failure is not the Defect

(Exception)



Example: Is HornetQ Broken?

large Datomic query

high CPU utilization

IllegalStateException in HornetQ