Debugging and all that

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Read

- “The Pragmatic Programmer” (Hunt & Thomas)
- “Why Programs Fail, a guide to systematic debugging” (Zeller)

Today

- Motivating debugging (attitude)
- Terms and concepts (knowledge)
- How to debug (skill)
- Stories (fun)

Programmer Activities

- Learning (API, domain, ...)
- Setting up (tools)
- Designing
- Explorative coding
- Exploring code
- Accidental coding (hacking)
- Productive coding
- Testing
- Deploying
- Docum[illegible]g

All valid!

Continuous Go/No-Go

- Different best practices with different goals and activities
    - know what you are doing and why and how
    - be able to switch activities and come back
    - step back, realize, plan ahead, take notes
- Go or No-Go: continuously make the technical-debt trade-off
    - quickly estimate cost of activities (in time or in quality)
    - estimate return-on-investment (in time or in quality)
    - estimate available resources (in time)
- Communicate
    - Learn to really listen to what your colleague is saying (and yourself)
    - Learn to explain better and faster what you are thinking

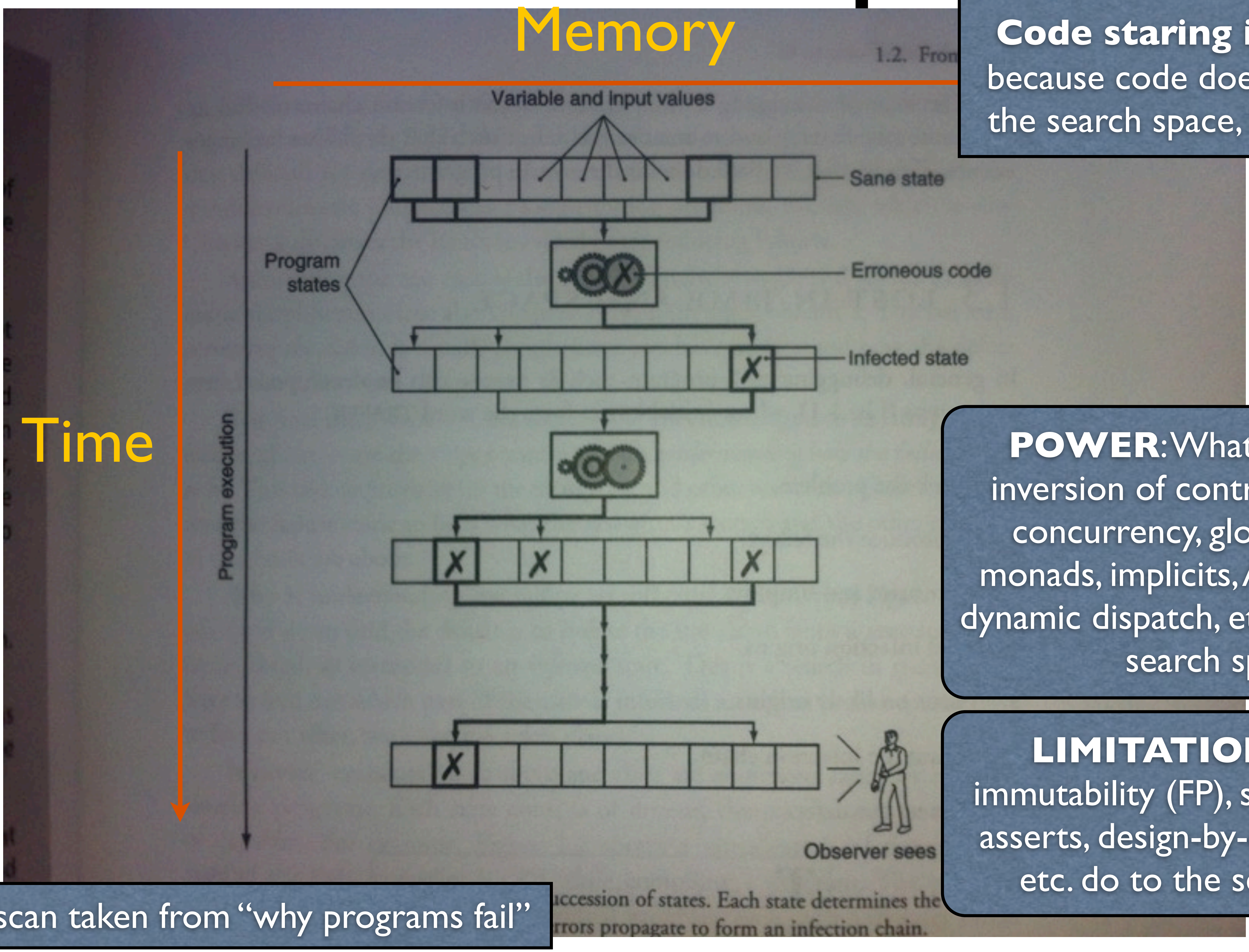
Debugging exists! Plato versus Aristotle

- Wishful thinking and the reality of software
  - Plato: better safe than sorry; “if only we had”
  - Aristotle: wake up in the real world!
- What if you have a bug?
  - Blame somebody else!
  - Blame something else!
  - Give up! Start from scratch!
  - Or… be a **professional programmer**

Debugging is search

- Debugging is searching
    - a path from effect (“failure”)
    - to cause (“defect”)
- Preventive (Plato, theoretical)
    - keeping the search space small
- Curative (Aristotle, pragmatic)
    - making the search effective
- Programmers are Researchers

Search space


Memory
Time
1.2. Fron
Variable and input values
Sane state
Program states
Erroneous code
Infected state
Program execution
Observer sees
ıccession of states. Each state determines the
rrors propagate to form an infection chain.

Code staring is "useless" because code does not describe the search space, it generates it!

POWER: What do pointers, inversion of control, parallelism, concurrency, global variables, monads, implicits, AOP, interfaces, dynamic dispatch, etc. etc. do to the search space?

LIMITATION: What do immutability (FP), synchronization, asserts, design-by-contract, types, etc. do to the search space?

scan taken from "why programs fail"

Debugging is awesome

"a humbling experience"

Debugging is possible!

it takes guts and brains and perseverance

First Plato

- Defensive coding
  - express assumptions (in asserts, types, tests)
  - minimize dependencies (locality of debugging)
  - what else?
- Understand why it (should) work!
  - how can you understand a failure if you don't know how to recognize success?
  - understand the relationship between requirements, specification and implementation (bug or feature)
- What else can we do to prevent bugs? Or to make fixing them easier?

Then Aristotle

- The <u>sci</u>entific method
  - Observe (actually read the error message...)
  - Document (use an issue tracker; take notes)
  - Reproduce (automate a test)
  - Analyze
  - Simplify
  - Form hypotheses
  - Run a test
  - Fix and see if problem goes away, or <u>go back, without forgetting what you have learned</u>
- Be con<u>sci</u>ous, and <u>do</u> stuff:
  - What are your (implicit) assumptions/claims/hypotheses?
  - How can you experiment/test/assert that they are true?

Thinking vs Reasoning

- There is a difference
- There are different valid ways of reasoning
  - Deductive (“consequentially”)
  - Inductive (generalizing, “so always/never”)
  - Abductive (guessing, hypothesizing)
- Debugging paradox:
  - The dangerous forms of reasoning are most effective in debugging, making the search space smaller.
  - The safe form of reasoning can get you easily started on wild goose chase.

Deduction

- Direction: from cause to effect
- A deduction guarantees that the conclusion is true given that the premise is true
- “programs only throw segmentation faults if there is a bug in the program” and “this program throws a segmentation fault”, so “this program has a bug

Induction

- Making a general statement after seeing some specific examples
- An induction is/should be made based on <u>many</u> similar observations
- “the program fails every time I pressed the ESC button” (3 times), so “the ESC button must be causing the failure”.

Abduction

- Direction: from effect to cause (!)
- Finding an explanation that fits the facts
- Abduction is guessing based on insight
- "The program crashes on my clients machine which runs Windows" and "The program does not crash on my machine which runs Linux", so: "The cause of the crash is due to

Delta debugging

- How to make a search space smaller?
- Analyze only the differences between what fails and what does not fail
- A definition of "cause": the minimal difference between a world that shows the effect and a world that does not
- Find the minimal difference, and you have found a cause of the defect.
- Can be iterative, can be automated (Zeller, AskIgor)

Omniscient debugging

- Log EVERYTHING
- Apply delta debugging on the log
- Omniscient debugging tools
  - can automate delta debugging
  - can look back in time, reverse run the program

Live coding

- Debugging is the new programming
- See the effect while you are causing it
- Fixes the forward search, not the backward search

War stories!

- Debugging is a skill of the mind
- Skills are learned by practice and by example
- Let’s learn from each other now.

STAR + SNOWBALL

- STAR
  - What was the <u>S</u>ituation?
  - What was your <u>T</u>ask?
  - How did you <u>A</u>pproach?
  - What was the <u>R</u>esult?

- SNOWBALL
  - first in pairs of 2
  - then groups of 4, 8, 16
  - each round 5 minutes
  - the method?

First listen, then ask, then analyze, then choose

reminiscent?