Informatics 43

LECTURE 7-2

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Last Time

- We use HCI/UCD methods…
  - Interviews/observations, personas, scenarios, storyboards, swimming lane diagrams, site maps, mockups, design guidelines, heuristic evaluation, user testing
- …for good reasons
  - Sales double
  - Performance doubles
  - Traffic counts increase
- It's all about the user!

Today's lecture

- Failures: a second look
- Quality assurance
- Testing
- Quiz 4 study guide

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What do these have in common?

- Airbus 320
- Toyota
- Mariner 1 launch
- AT&T telephone network
- Ariane 5
- Mars Polar Landing
- Radiation therapy machine
- NSA
- Y2K

They all failed!

- Airbus 320
  - http://catless.ncl.ac.uk/Risks/10.02.html#subj1.1
- Toyota
  - "unintended" acceleration problem
- Mariner 1 launch
  - http://catless.ncl.ac.uk/Risks/5.73.html#subj2.1
- AT&T telephone network
  - Ripple effect, from switch to switch, network down/dark for 2-3 days
- Ariane 5
  - http://catless.ncl.ac.uk/Risks/18.24.html#subj2.1
- Mars Polar Landing
  - http://spaceflight.nasa.gov/spacenews/releases/2000/mpl/mpl_report_1.pdf
- Radiation therapy machine
  - http://courses.cs.vt.edu/~cs3604/lib/Therac_25/Therac_5.html
- Y2K

Toyota Failure

- Overly complex spaghetti code
- Violated standards set by the industry
  - Single-point failures
- No peer code reviews
- System threw away error codes

Toyota did not follow good quality assurance practices

Y2K Facts

- Bug description
  - Date formats were MM/DD/YY, e.g., 01/01/98, 02/02/99, 03/03/00
  - Does 00 mean 2000 or 1900?
  - Does 1999 turn to 19100?
- Effects
  - Relatively minor
- Cost: $300 billion!

Impact of Failures

- Not just "out there"
  - Space shuttle
  - Rocket
  - Mars Polar Landing
- But also "at home"
  - Your car
  - Your call to your mom
  - Your wireless network, social network, mobile app
  - Your homework
  - Your hospital visit

Peter Neumann's Risks Digest: http://catless.ncl.ac.uk/Risks

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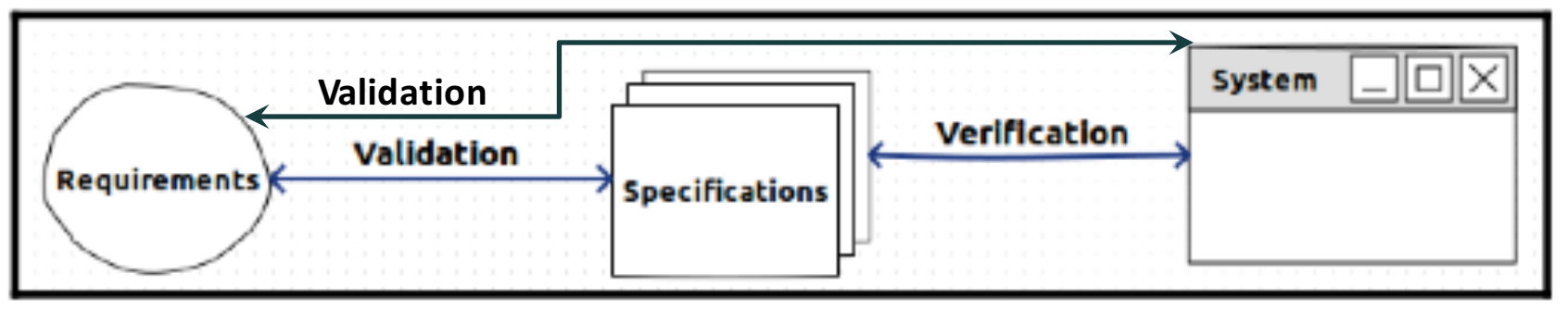
QA Goals: Verification and Validation

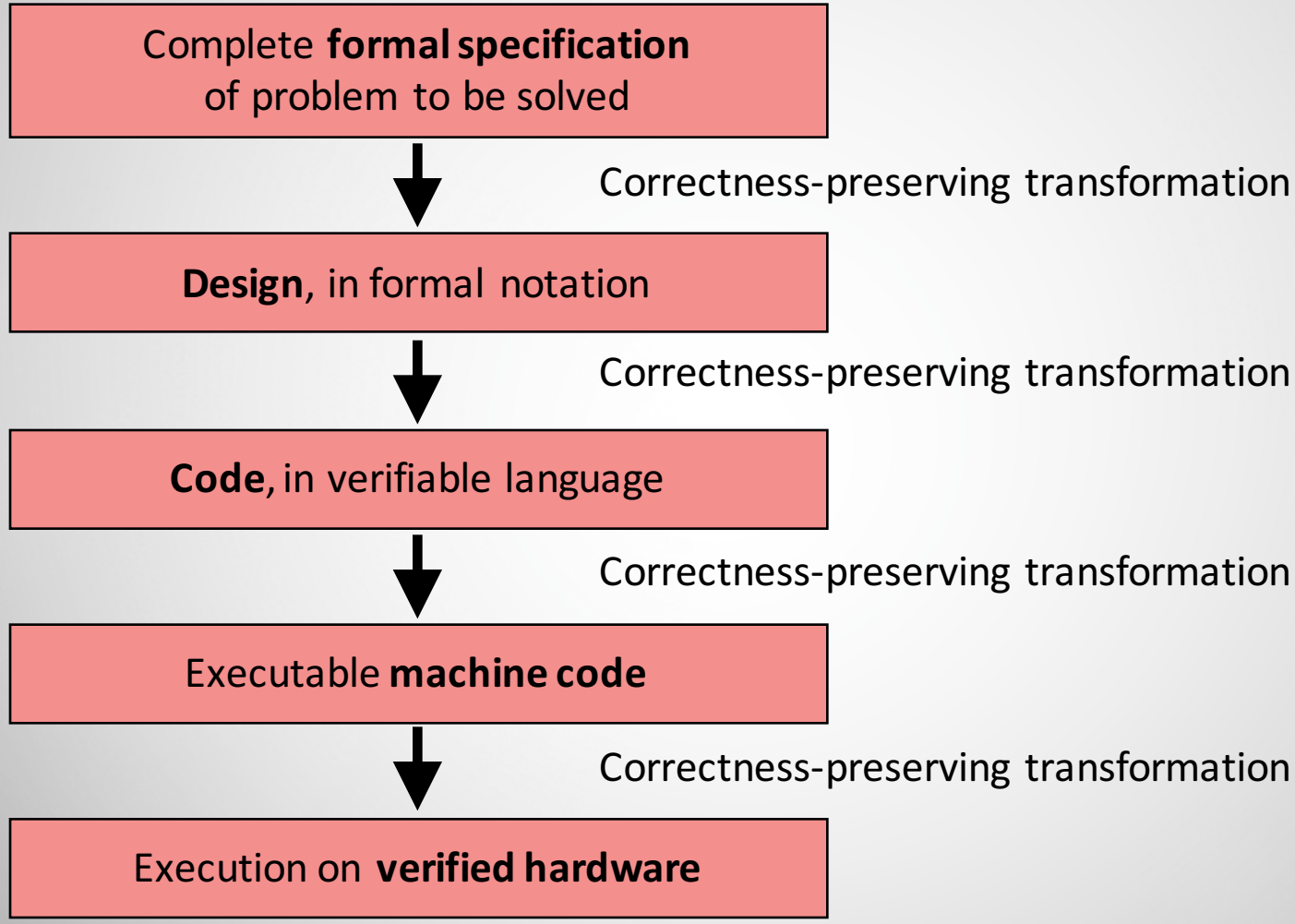
- Quality Assurance = All activities designed to measure and improve quality in a product



- Verification: "Implement the idea properly"
- Validation: "Implement the proper idea"

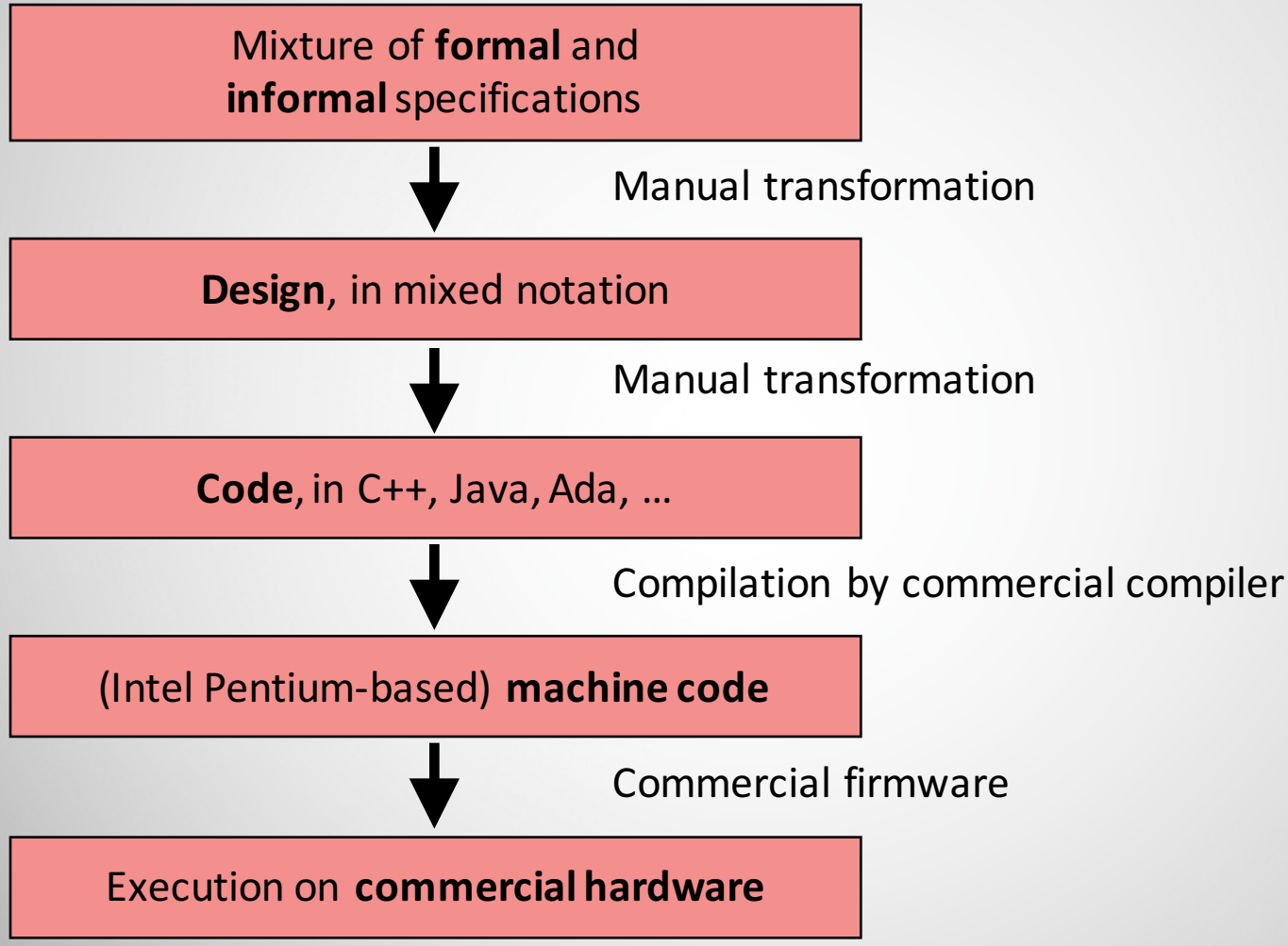
Why do we need QA?

Ideal world scenario:

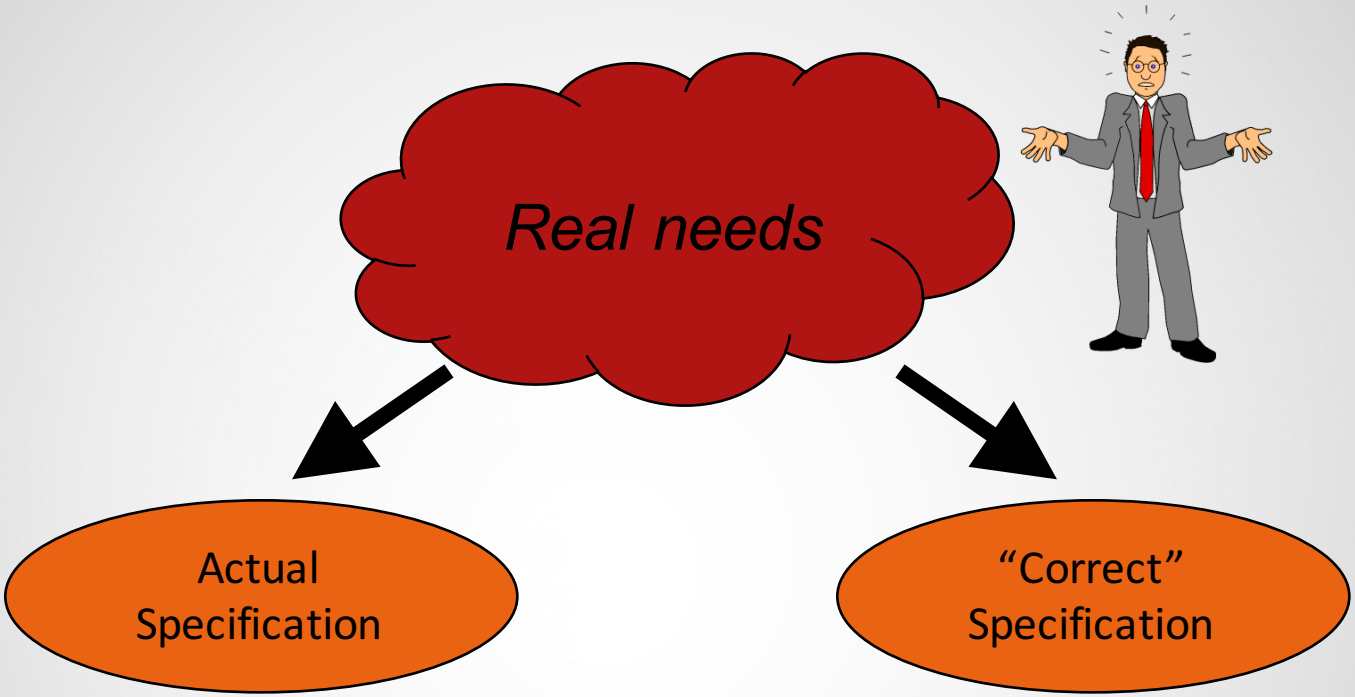


Why do we need QA?

Real world scenario:



Why is QA so difficult? (I)

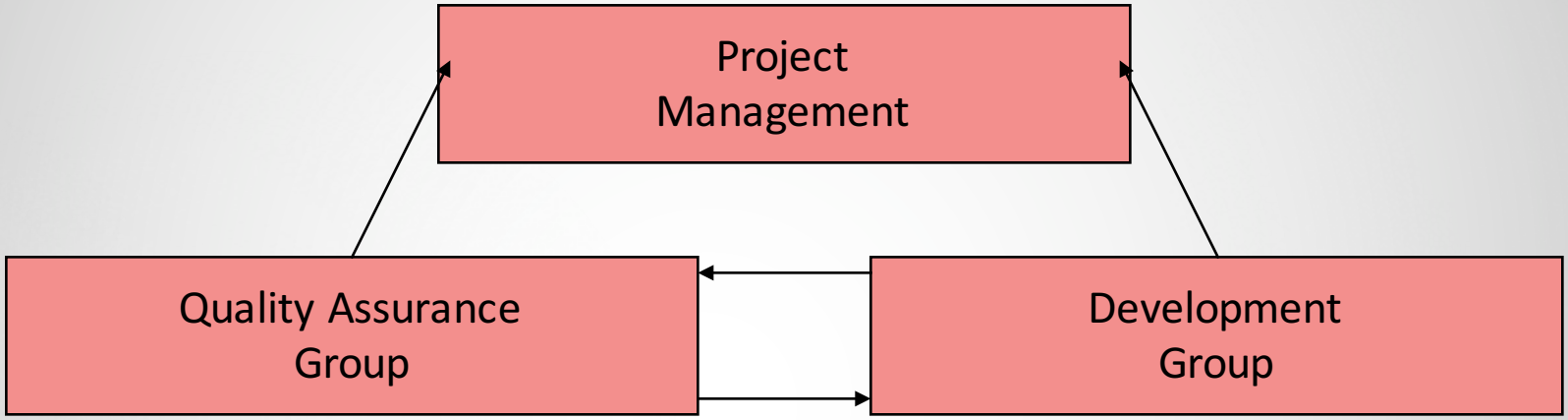


Why is QA so difficult? (II)

Why is QA so difficult? (III)

- Complex data communications
  - Electronic fund transfer
- Distributed processing
  - Web search engine
- Stringent performance objectives
  - Air traffic control system
- Complex processing
  - Medical diagnosis system

Why is QA so difficult? (IV)



Why is QA so difficult? (V)

- Quality assurance lays out the rules
  - You will check in your code every day
  - You will comment your code
  - You will…
- Quality assurance also uncovers the faults
  - Taps developers on their fingers
  - Creates image of "competition"
- Quality assurance is viewed as cumbersome, "heavy"
  - "Just let me code"

QA Techniques

- Formal methods
- Static analysis of program properties
- Reviews and inspections
- Testing

Use a mixture of techniques!

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Testing – Basic Process

- Detect and correct errors in a software product
- Exercise a module, collection of modules, or system
  - Devise test case (input)
    - Create expected output
  - Run test case
  - Capture actual output
  - Compare actual output to expected output

Actual output = expected output	**Actual output ≠ expected output**
Test case **SUCCEEDS**	Test case **FAILS** (report failure)

- (Lather, rinse, and repeat)

Testing Terminology

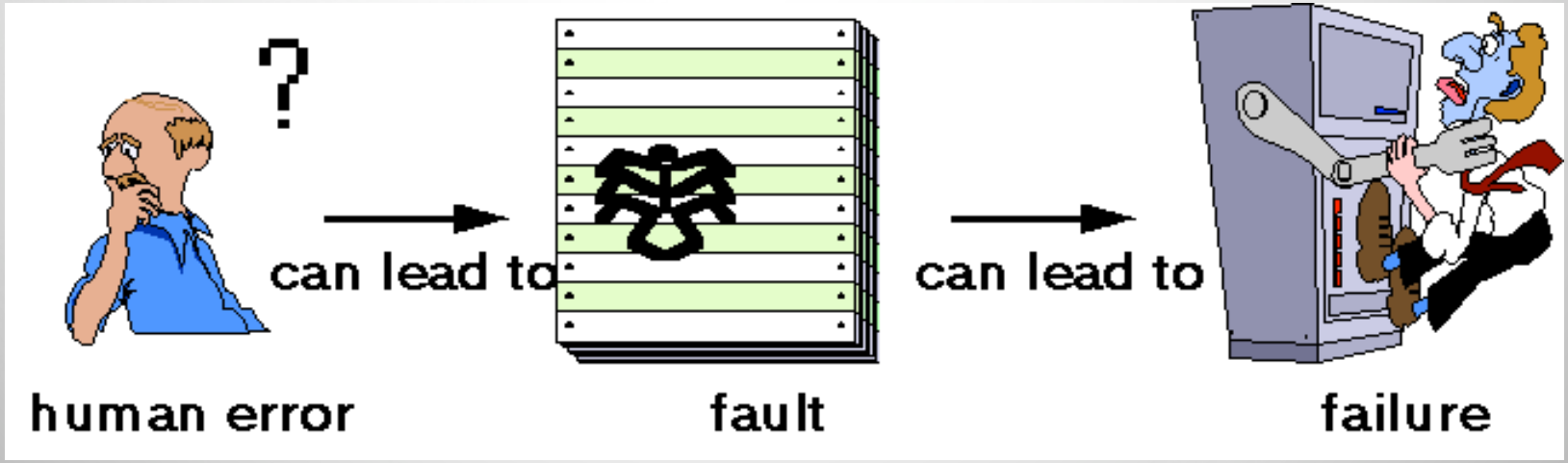
Error (human mistake in programmer's mind)

↓

Fault or defect (discrepancy in code)

↓

Failure (external behavior/execution/output is incorrect)



Poor Mrs. Null…

"I feel like I still have to do things the old-fashioned way."
– Jennifer Null

Source: http://www.bbc.com/future/story/20160325-the-names-that-break-computer-systems

Testing Goals

- Find and fix failures/faults/errors
- Improve confidence that the system performs as specified (verification) and as desired (validation)
- All in a manner that is
  - Accurate
  - ~~Complete~~ Thorough
  - Repeatable
  - Systematic

Program testing can be used to show the presence of bugs, but never to show their absence [Dijkstra]

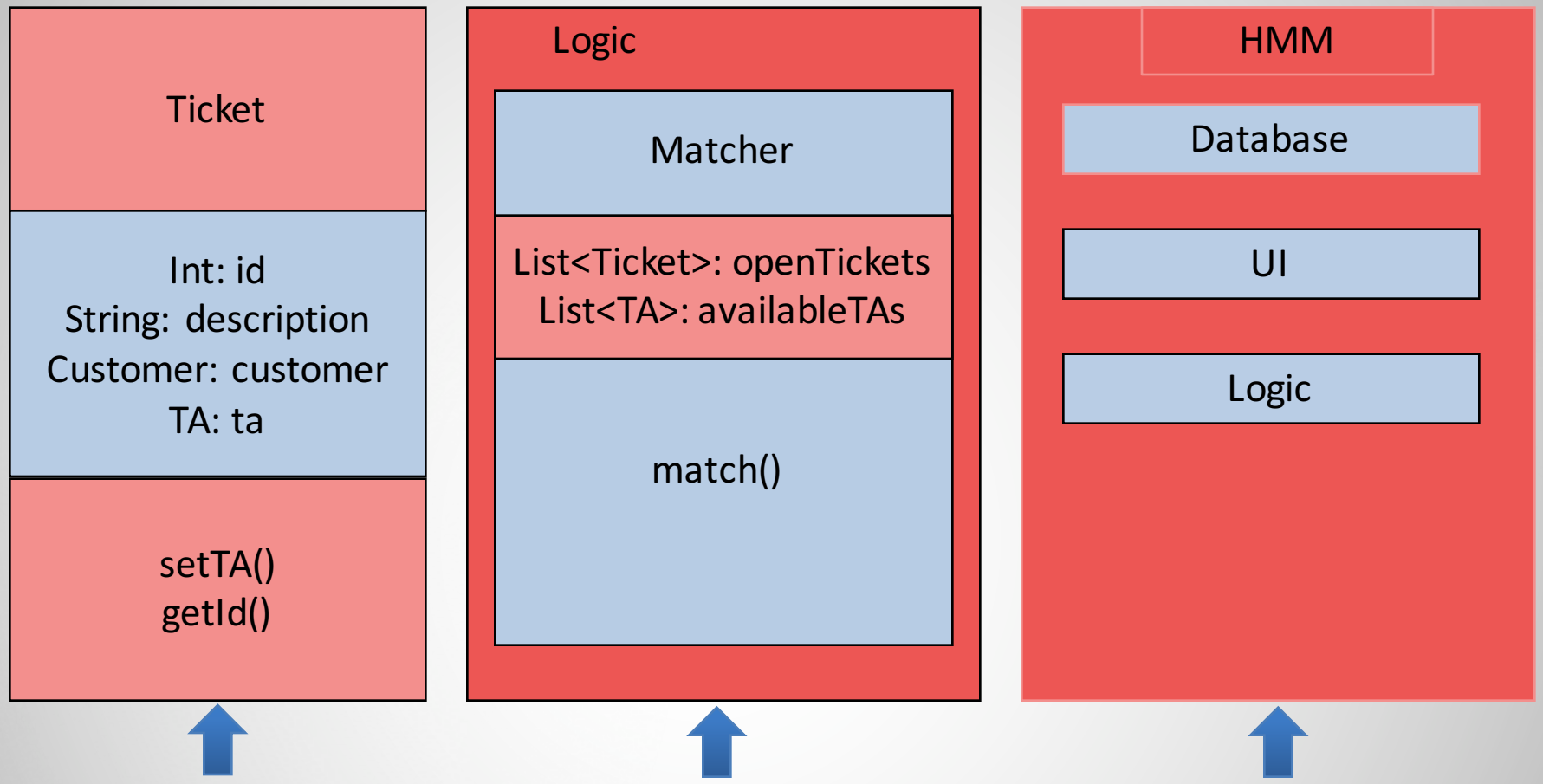
Who does the testing?

- Programmers
- Testers
- Users

Levels of Testing

- Unit testing
  - Testing of a single code unit
- Functional/integration testing
  - Testing of interfaces among integrated units
- System/acceptance testing
  - Testing of complete system for satisfaction of requirements

Levels of Testing



Unit testing

Ticket.setTA()

Functional/integration testing

Matcher.match()

System/acceptance testing

Create ticket

Pay ticket

Login

Logout

How to choose test cases?

- There are usually an infinite number of possible test cases, so we must take a small sample

```
int multiplier(int a, int b) {
      return a * b;
}
```

Ways to choose test cases

- Intuition
- Specification (black-box testing)
  - Equivalence class partitioning
  - Boundary-value analysis
- Code (white-box testing)
  - Path analysis
- Existing test cases (regression testing)
- Faults

Test Oracles

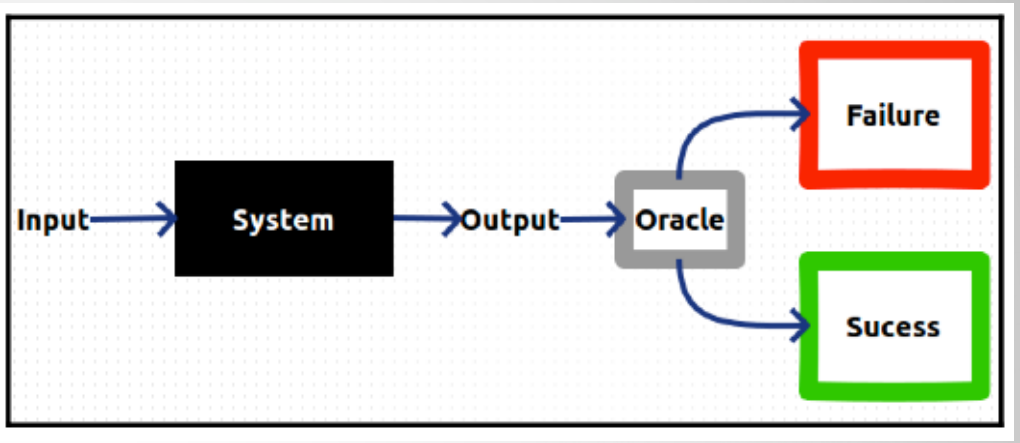
- A mechanism for deciding whether a test case execution succeeds or fails
- Difficult to automate

Oracle Example: Cosine

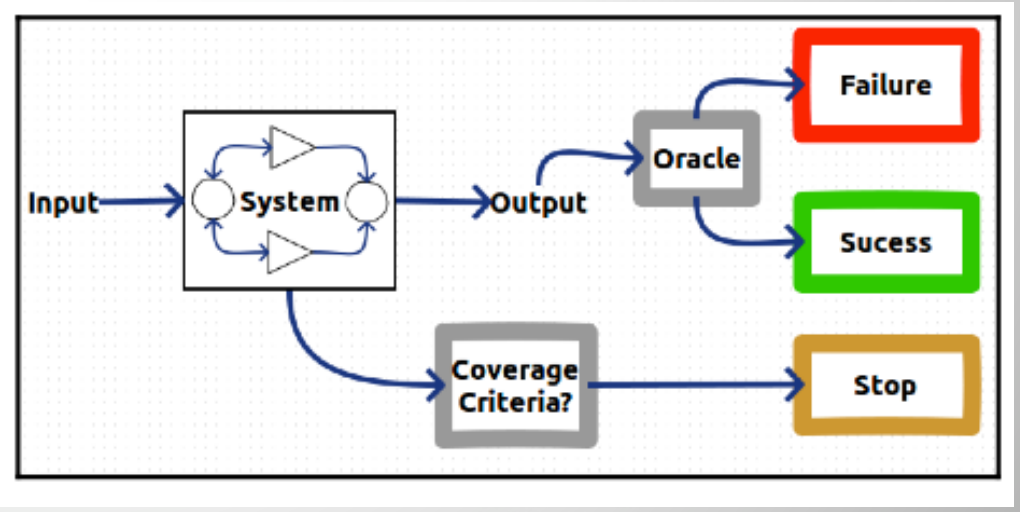
- Your test execution shows cos(0.5) = 0.87758256189
- Oracles?
  - Drawing a triangle and measuring the sides
  - A cosine table in a book
  - A website
  - Computing the value using Taylor series expansion
  - Calculator

Two Overall Testing Approaches

- Black box testing
  - Specification-based testing



- White box testing
  - Structural testing



All software has bugs!

"***All nontrivial code has defects***, *and the probability of nontrivial defects increases with code size. The more code you use to solve a problem, the harder it gets for someone else to understand what you did and to maintain your code when you have moved on to write still larger programs.*"

- Code Inflation, Holzmann (IEEE SW 2015)

All software has bugs!

Q: What is the required period of failure-free operation for conventional takeoffs and landings of the F35 Joint Strike Fighter?

A) 6,000 years
B) 600 years
C) 60 years
D) 6 hours

All software has bugs!

Q: What is the required period of failure-free operation for conventional takeoffs and landings of the F35 Joint Strike Fighter?

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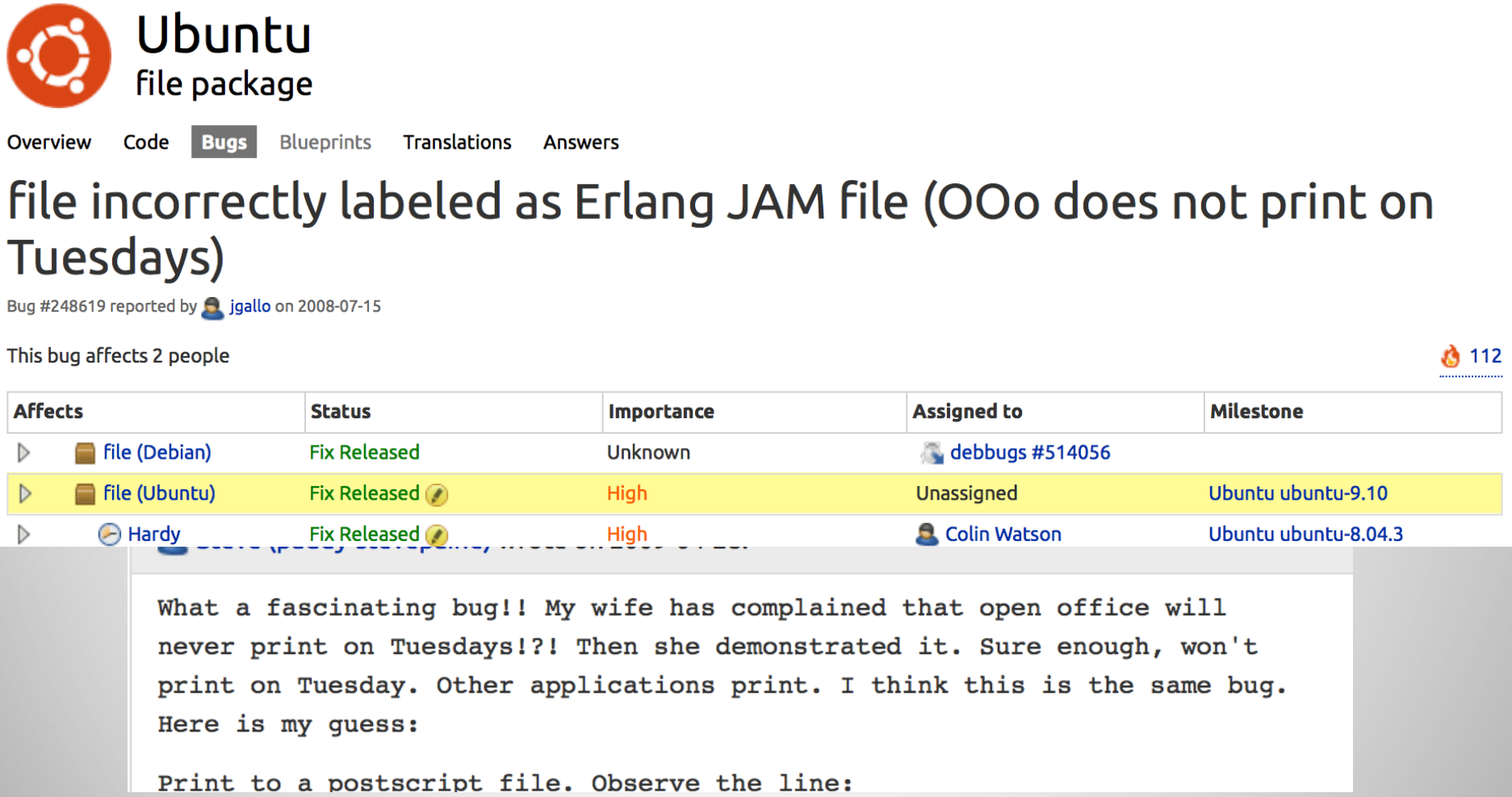
AND a recent government report stated that this target had not yet been realized!

Some bugs are bizarre…



Ubuntu
file package

Overview Code **Bugs** Blueprints Translations Answers

file incorrectly labeled as Erlang JAM file (OOo does not print on Tuesdays)

Bug #248619 reported by jgallo on 2008-07-15

This bug affects 2 people 112

Affects	Status	Importance	Assigned to	Milestone
file (Debian)	Fix Released	Unknown	debbugs #514056	
file (Ubuntu)	Fix Released	High	Unassigned	Ubuntu ubuntu-9.10
Hardy	Fix Released	High	Colin Watson	Ubuntu ubuntu-8.04.3

What a fascinating bug!! My wife has complained that open office will never print on Tuesdays!?! Then she demonstrated it. Sure enough, won't print on Tuesday. Other applications print. I think this is the same bug. Here is my guess:

Print to a postscript file. Observe the line:

Source: https://bugs.launchpad.net/ubuntu/+source/cupsys/+bug/255161

Some bugs are long-lived…

Friday, September 25, 2015

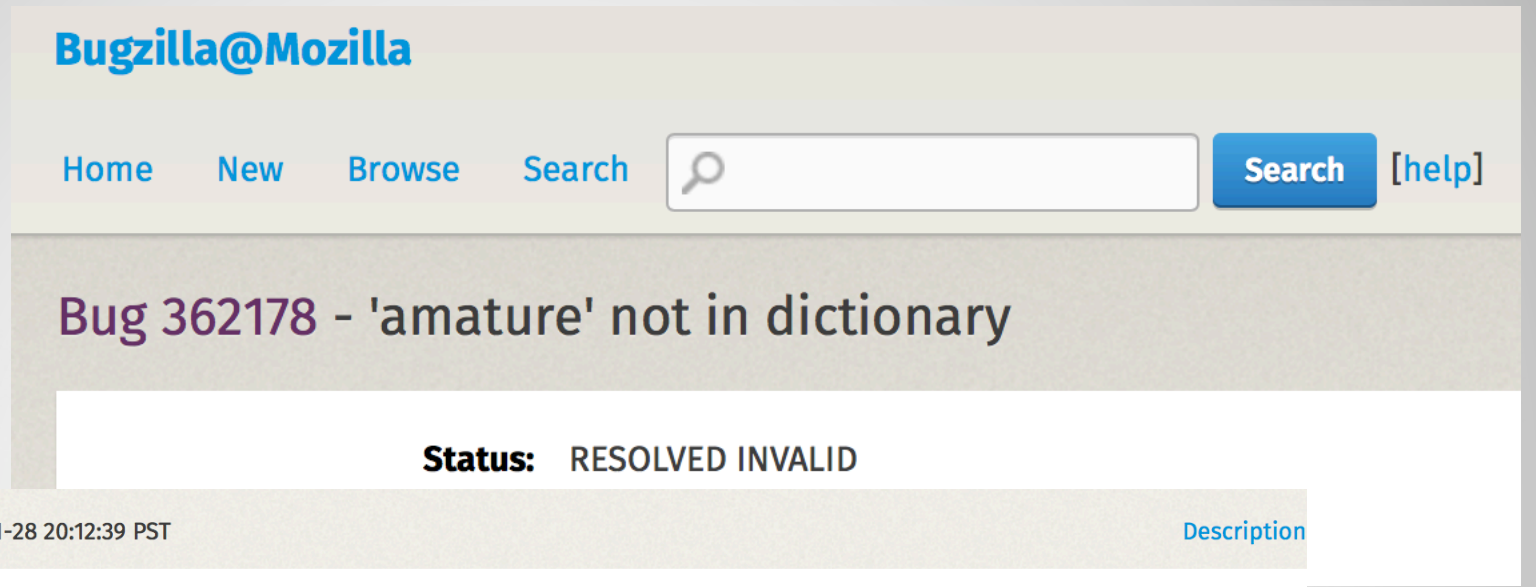
Thanks Google for Open Source TCP Fix!

The Google transport networking crew (QUIC, TCP, etc..) deserve a shout out for identifying and fixing a nearly decade old Linux kernel TCP bug that I think will have an outsized impact on performance and efficiency for the Internet.

Their patch addresses a problem with cubic congestion control

Source: http://bitsup.blogspot.com/2015/09/thanks-google-tcp-team-for-open-source.html

Some bugs are not bugs…

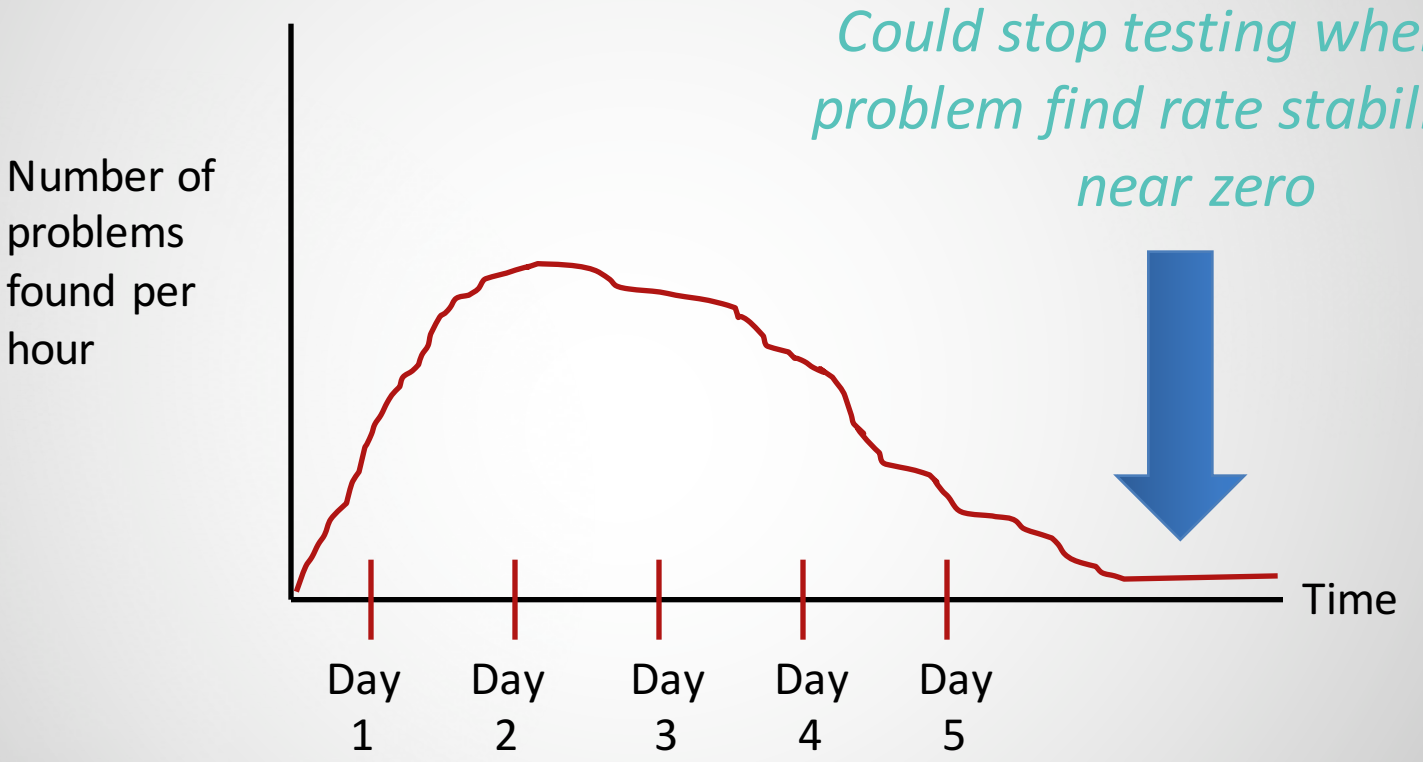


Source: https://bugzilla.mozilla.org/show_bug.cgi?id=362178

How do we know when we are done testing?

- Aim to reveal as many faults as possible in a fixed period of time with a fixed budget
  - Target specific areas of the system
- Aim to meet the quality requirements established for the project

How do we know when we are done testing?



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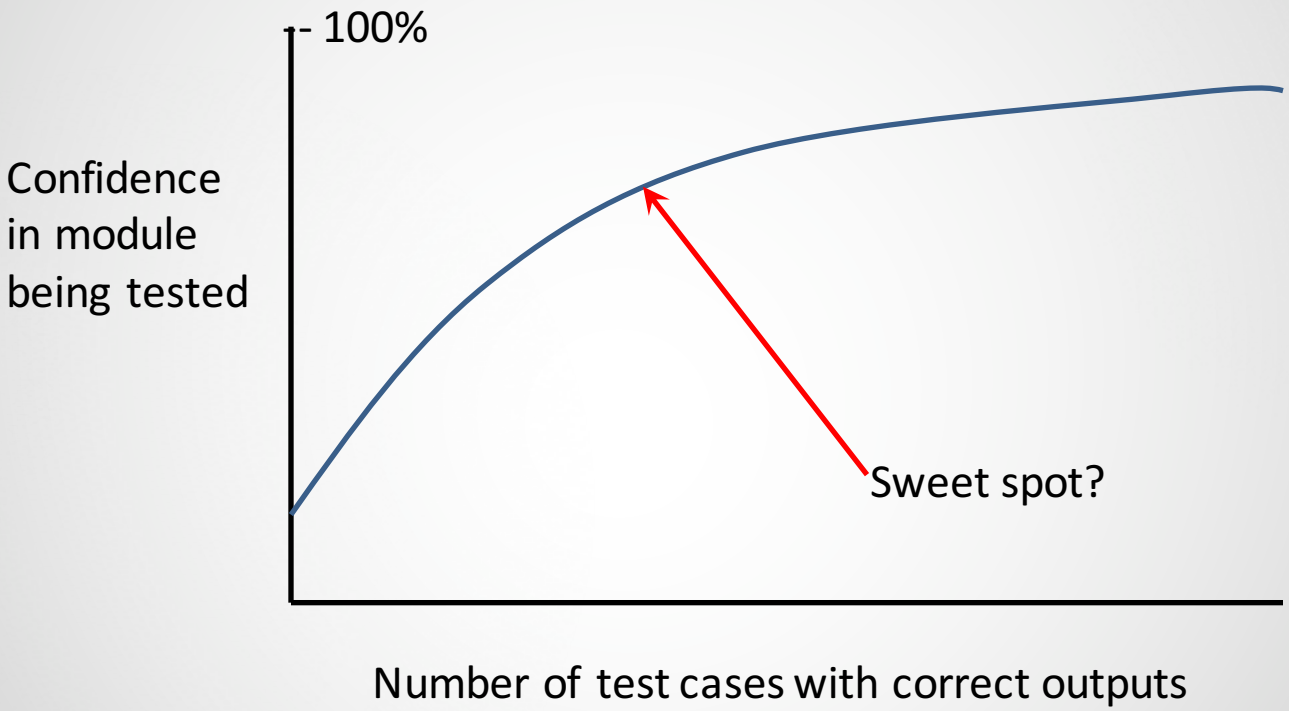

How do we know when we are done testing?

- Pepper the code with defects and observe how many of the seeded defects are discovered
  - From this, infer how many bugs are left to find
- This technique assumes that nonseeded defects are similar to the seeded ones

Summary

- Many failures are caused by a lack of good quality assurance (QA) practices
- QA = All activities designed to measure and improve quality in a product
  - Validation & verification
- Testing is the most common QA activity
  - Different levels: unit/functional/system
  - Goal: find and fix failures/faults/errors
  - Can never be exhaustive
  - Can never prove a system's correctness
- All software has bugs!

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Quiz 4 – Topics (1)

- Designs/models/notations
  - Approaches to software design
  - Purposes of the different types of diagrams presented
    - For UML, only class diagrams
- User orientation
  - Understand the 10 user-centered design methods
    - Understand all the Nielsen heuristics (Discussion exercise)

Quiz 4 – Topics (II)

- Testing
  - Validation/verification
  - Error, fault, failure
  - Levels of testing
  - Oracles
- Readings - know main idea of:
  - LinkedIn story
  - "GoodUX" article
  - Toyota article

Next Time

- Black box testing
- Attend discussion tomorrow (user orientation)