


# Software Testing

## Motivation



# Software has bugs.



(033) PRO 2 2.130476415  
 coned 2.130676415  
 Relays 6-2 in 033 failed special speed test  
 in Relay " 10.00 test.  
 Relays changed  
 1100 Started Cosine Tape (Sine check)  
 1525 Started Multi Adder Test.  
 1545  Relay #70 Panel F  
 (moth) in relay.  
 First actual case of bug being found.  
~~1630~~ 1630 Antangut started.  
 1700 closed down.

Relay  
 2145  
 Relay 3376

<https://commons.wikimedia.org/wiki/File:H96566k.jpg>

# Why Does Software Have Bugs?

- Complexity
- Human error
- Unclear goals or requirements
- Unrealistic goals or requirements
- Limited resources
  - Time, money, expertise
- Poor communication
- Poor management
- And more...

<http://spectrum.ieee.org/computing/software/why-software-fails/>



# Bug Finding and Elimination

- **Able to guarantee there exists a bug**
  - Demonstrate a specific test fails
  - Proves a bug... but is it in software or in the test?
- **Unable to guarantee there are no bugs**
  - Are there bugs in your code?
  - Are there bugs in your tests?
  - Are there bugs in your tests' tests?



# Famous Software Bugs

- **1990 AT&T**

- Bug brings down AT&T's long distance switches
- Leaves 60,000 customers without service for 9 hours

- **1993 Intel**

- Bug in floating-point division in Pentium chips
- Leads to recalls and costs Intel \$475 million

<http://www.wired.com/software/coolapps/news/2005/11/69355>



# Famous Software Bugs

- **1962 NASA**

- Bug in transcribing formula into code
- Results in destruction of Mariner 1 space probe

- **1996 ESA**

- Bug in converting 64-bit float to 16-bit signed int
- Caused Ariane 5 rocket (flight 501) to disintegrate

<http://www.wired.com/software/coolapps/news/2005/11/69355>



# Famous Software Bugs

- **1985 Therac-25**

- Bug in radiation therapy device
- Delivers lethal dose, killing at least 5 patients

- **2000 Multidata**

- Bug in radiation therapy interface
- Physicians using it were indicted for murder

<http://www.wired.com/software/coolapps/news/2005/11/69355>





# More Recent Bugs?

- **2011 Sony: Multiple breaches resulting in theft of credit cards**  
[http://www.techhive.com/article/226875/sony\\_online\\_entertainment\\_hacked\\_12700\\_credit\\_cards\\_stolen.html](http://www.techhive.com/article/226875/sony_online_entertainment_hacked_12700_credit_cards_stolen.html)
- **2012 Knight: Bug in HFT software results in \$460 million in losses**  
<http://pythonsweetness.tumblr.com/post/64740079543/how-to-lose-172-222-a-second-for-45-minutes>
- **2013 Affordable Care Act: Website bugs affect program rollout**  
<http://www.npr.org/blogs/itsallpolitics/2013/10/22/239848684/for-democrats-obamacare-web-woes-create-2014-headache>

[http://en.wikipedia.org/wiki/List\\_of\\_software\\_bugs](http://en.wikipedia.org/wiki/List_of_software_bugs)



# Apple Fail 2014

```
1  if ((err = ReadyHash(&SSLHashSHA1, &hashCtx)) != 0)
2      goto fail;
3  if ((err = SSLHashSHA1.update(&hashCtx, &clientRandom)) != 0)
4      goto fail;
5  if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
6      goto fail;
7  if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
8      goto fail;
9      goto fail;
10 if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
11     goto fail;
12 err = sslRawVerify(...)
13 ...
```

<http://www.dwheeler.com/essays/apple-goto-fail.html>



# Why Should We Test Software?

- **Software has bugs**
  - Human error, complexity, limited resources, etc.
- **Software bugs are difficult to find and eliminate**
  - Unable to guarantee software is bug-free
- **Software bugs can have serious consequences**
  - Loss of money, reputation, resources, or worse



# TED: All Your Devices Can Be Hacked

*by Avi Rubin, 2011*



[http://www.ted.com/talks/avi\\_rubin\\_all\\_your\\_devices\\_can\\_be\\_hacked?language=en](http://www.ted.com/talks/avi_rubin_all_your_devices_can_be_hacked?language=en)





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