Class 3 – Software Engineering, Bugs, and generally bad things

*Software Bugs and some consequences*

*(Or why you should give a damn)*
Notes

Computer Museum Next Thursday
• Tour starts at 4:30 PM
• You can drive yourself or choose to walk with the class
• 4:15PM - We will meet at the lights on 11th & Kagy (in front of Town and Country kind of, across from the field house)
• Please bring $3 (or discuss with me beforehand)

Reminder: Homework 1 is due tomorrow at 11:59PM
Reminder: Project proposals are due Monday at 11:59PM
Reminder: Tomorrow we will do our first retro, please bring a laptop
Review

• What is it called when Facebook makes a profile for you when you are not even a user?

• Which of the following is not something Social Media can determine about you (At least as far as we discussed yesterday)?:
  • A) Political Affiliation
  • B) Pregnancy Details
  • C) Your best friend and how much you trust them
  • D) Number of siblings you have

• What is it called when you alter search engine results to point to specific information?:
  • A) CEO-Shaming
  • B) SEO-Shaming
  • C) Being a jerk
Software Bugs

Or why you should care about the quality and design of your code

Where the term “Bug” came from?
Moth trapped in a relay

"H96566k" by Courtesy of the Naval Surface Warfare Center, Dahlgren, VA., 1988
Some really big bugs - SPACE

• **1962 - Mariner I space probe**
  • Paper and Pencil calculation miscopied to computer code when calculating trajectory
    • Official Report: referred to hyphen
    • Others referenced: “overbar transcription error”, or a misplaced decimal point
  • had to crash into Atlantic Ocean less than 5 minutes after take off
  • ~$18.5 Million in (1960’s dollars)
  • Mariner 1 was “wrecked by the most expensive hyphen in history,” ~Arthur C. Clarke
Some really big bugs - SPACE

• **1996 - Ariane 5 Flight 501 - ESA**
  • $500 Million Dollars for rocket and cargo
  • Reused Ariane 4 Code, however did not account for upgrades to hardware.
  • 30 seconds into flight, trajectory veered off of flight path due to a bug which reported position 90 degrees off
Some really big bugs - SPACE

1999 – Mars Climate Orbiter

- $193.1 million for spacecraft development
- Engineers failed to convert from English measurements to Metric
- Orbiter flew too close to the planet

Some really big bugs - SPACE

2006 – Mars Global Surveyor
• Launched in 1996
• $154 Million
• It mistakenly thought that motor had failed, and so turned to sun
• Battery overheated

• http://apod.nasa.gov/apod/ap970911.html
Some really big bugs - Medical

• **1985-1987 - Therac-25 medical accelerator**
  • Radiation therapy device malfunctions and delivers lethal radiation doses at several medical facilities
  • Built on faulty OS with a race condition
  • At LEAST 5 people died, several injured (including amputations)
Some really big bugs - Medical

• **2009 - Gamma Knife**
  • Radiation therapy device to zap brain tumors
  • bug that could cause the system’s emergency stop button to fail to stop
  • Cleveland had to manually pull a patient from a machine
Some really big bugs - Medical

• 2000 - Multidata Systems - National Cancer Institute, Panama City
  • Software made by Multidata Systems International in the US to calculate how much radiation to give a patient
  • Not necessarily a bug, but when the technicians used in an unexpected way the calculations were far too high (between 20% - 100% above)
  • at LEAST 8 people died, 20 receive so much radiation it is likely to cause significant health problems
Discussion Points

• The 3 technicians who used the software to figure out how much radiation to apply to patients were tried in Panama City on charges of second-degree murder.

• 2004: Two of the indicted physicists are sentenced to four years in prison and barred from practicing their profession for seven years; they appeal the sentence. The third physicist is acquitted.

• How much of this tragedy is the technicians fault? Do the software engineers share in their responsibility?
Some really big bugs - Transportation

• 2006 – Malaysia Airlines Jetliner
  • Malaysia Airlines jetliner cruised from Perth, Australia, to Kuala Lumpur, Malaysia
  • Defective software program had provided incorrect data about the aircraft's speed and acceleration, confusing flight computers.
  • Didn’t recognize Pilot’s commands
  • [http://www.wsj.com/articles/SB114895279859065931](http://www.wsj.com/articles/SB114895279859065931)

2015 - Boeing 787 and Airbus A400M

• Boeing 787: Federal Aviation Administration warn it is possible for all 4 engines to enter “safety mode” while in flight, locking out the pilot
• Airbus A400M: Software improperly set up, test flight crashed in Spain. Killed 4 crew members
Some really big bugs - Transportation

2007 - Toyota electronic throttle control system
• Faulty software caused vehicle to accelerate uncontrollably, resulting in at least 1 death, possibly up to 89 – Maybe

• 2012: NASA team issued report that could not conclusively rule out software defects

• 2013: Oklahoma court ruled against Toyota
Plug for Software Engineering

• What is ‘software engineering’ (vs say programming)?

• One way we care about quality: Technical Debt
  • E.G. : taking a “short cut” to meet a deadline, it is likely you’ll have to spend more time fixing it later than if you had done it properly to begin with
  • Note, just like financial debt, it is not always bad – it just needs to be managed
Plug for Software Engineering

Example:

• If completed all tickets by 5pm on Friday, company would pay for developers to go to go-cart tracks in Belgrade, as well as pay for lunch

• $Cost_{\text{saved}} = \sim 5 \text{ hours} \times \frac{\$12}{\text{hour}} = \$60$

• $Cost_{\text{paid back}} = \sim 2 \text{ hours} \times 4 \text{ teams} \times \frac{\$40}{\text{hour}} = \$320$
Plug for Software Engineering

Martin Fowler’s Technical Debt Quadrant

- Reckless
  - “We don’t have time for design”
- Prudent
  - “We must ship now and deal with consequences”
- Deliberate
  - “What’s Layering?”
- Inadvertent
  - “Now we know how we should have done it”
Discussion Point

• Other departments in COE have to take the FE exam (Fundamentals of Engineering) exam towards getting their PE
  • It’s a way to tell that the people building our bridges have some sort of background/knowledge on the subject – in other words, are qualified

• There exists a Software Engineering FE exam, do you think it should be a requirement for CS?
Software Development - Waterfall
Software Development - Agile