CS 240: Big Ideas, Human Impacts

Programming Skills

Few of you will build new HW, OS, compiler, but...
1. Effective programmers understand their tools and systems.
2. The skills and ideas you learn here apply everywhere.

Reason about computational models, translation
Assess costs and limits of representations
Debug for correctness and performance (with tools to help)
A little concurrency

Big Ideas in CS, Systems, and beyond

Abstraction
Do not start every project with transistors. Abstraction is beautiful and empowering, but real abstractions have leaks and wrinkles.

Translation
Between layers of abstraction. Structured computation.

Representation
No representation without taxation. Representations have costs.

Performance
Memory: clever, imperfect abstraction. Tiny code changes, huge impact.

Security + Reliability
Trickiest exploits & errors involve multiple layers, even hardware!

These things matter more every day.
Ariane 5 Rocket, 1996
Exploded due to cast of 64-bit floating-point number to 16-bit signed number. Overflow.

1998
Mars Climate Orbiter
Disintegrated due to mismatched units in Lockheed-Martin / NASA software components.

Toyota "Unintended Acceleration Events"

Oklahoma jury:
"Spaghetti Code" = "reckless disregard"

>10,000 global variables
81,514 violations of MISRA-C coding rules
Expect 3 minor bugs + 1 major bug per 30 violations

Task/process monitoring failed to monitor tasks/processes
Memory corruption

(Wait, it was written in C?!?!?!)

http://www.safetyresearch.net/blog/articles/toyota-unintended-acceleration-and-big-bowl-%E2%80%9Cspaghetti%E2%80%9D-code

"... a Model 787 airplane that has been powered continuously for 248 days can lose all alternating current (AC) electrical power due to the generator control units (GCUs) simultaneously going into failsafe mode ... This condition is caused by a software counter internal to the GCUs that will overflow after 248 days of continuous power. We are issuing this AD to prevent loss of all AC electrical power, which could result in loss of control of the airplane.” — FAA, April 2015

https://xkcd.com/571/
Northeast Blackout, 2003

Things you could improve in the future...
- Reliability
- Security
- Energy-efficiency and manufacturing impacts

Apply computing to improve ______.. it’s 240 at some level!

Just a few of the impacts we usually don’t see:

What a simple phone can do for people: https://opendatakit.org/about/deployments/

Next steps. Research: software reliability, automatic bug-finding tools

- CS 342: Computer Security (Spring 2016)
- CS 301: Compilers (Spring 2016)
- CS 242: Computer Networks (Fall 2015)
- CS 251: Programming Languages
- CS 240: Computer Systems/Organization
- CS 3??: Operating Systems (some day???)
- CS 3??: Concurrent Parallel, and Distributed Systems (some day???)
- CS 37?: Computer Architecture (some day???)

CS 342: Computer Networks (Fall 2015)

Next steps.