CS 31: Introduction to Computer Systems

01: Course Introduction

January 21, 2020

What is this class about?

1. To understand how computer systems work when you execute a program.

2. The systems costs of program execution

3. An introduction to operating systems

4. Foundations of parallel programming

Instructor: Vasanta Chaganti

http://www.cs.swarthmore.edu/~chaganti/

Please call me Vasanta

(or if you prefer, Professor Chaganti)

Office Hours
SCI Center 252D

- Mondays 2:45 - 4 PM
- Thursdays 11 - 2 PM
- By Appointment

Research interests: Network architecture and privacy

- future internet architectures
- what does your network data reveal about you? (network privacy)

CS 31 Lab Instruction

Sara “Scout” Sinclair Brody

- Office SCI 262A
- Mondays: 12 - 2 PM,
- Thursdays: 11 - 12:30 PM
- By Appointment

Ninjas!

Sessions: Greg, Karin, Tiffany, Fefa

- Saturdays 1-3 pm
- Sundays 7-9 pm

Tonight: Unix help session!

- When? 7:00 PM – 8:00 PM
- Where? SCI 256
- Who is it for?
  - Open to everyone!
  - **If this is your first CS course here, you should go!**

Resources

- Piazza Q&A Forum
  - https://piazza.com/swarthmore/spring2020/cs31

- Slides on course website
- Audio on Piazza

- Lab sections:
  - SCI Center 240
  - Wednesdays 8:50-10:20, 1:15-2:45, 3:00-4:30

Email Policy

- Please use Piazza rather than email
  - Count towards your participation grade
  - Your classmates benefit from your questions
  - Your classmates can answer your questions
  - I will check the forum frequently
- I will attempt to respond to within 24 hours
- If you do email me, please use chaganti@cs.swat...

How does this class work?

- This class is designed a bit differently from what you might normally be used to
  - Class will be centered around discussion
  - Requires your participation

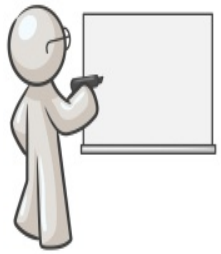
- Ever considered why we have lectures?

Traditional Lectures

Single expert lecturing to an audience that passively listens.

Traditional Lectures

Lecture

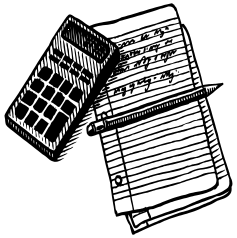


First Exposure

Textbook

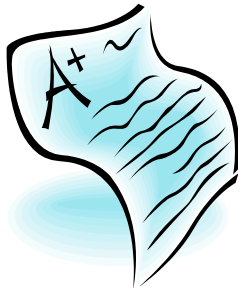
Read Hard Stuff

Assignment



See if You Know Hard Stuff

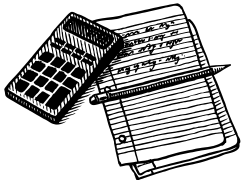
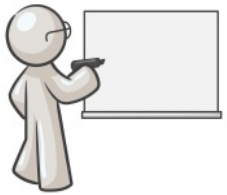
Exam



Show Knowledge Mastery

<u>Little opportunity for feedback</u>

Interactive Classes with Peer Instruction

Readings	Worksheets	Instruction	Exam
			
First Exposure	Gauge understanding	Explore, add context, Provide feedback	Show Knowledge Mastery

- You do the “easy” part before class
- Class is reserved for interactive, customized experiences
- To learn, YOU must actively work with a problem and construct your own understanding of it

Peer Instruction

- Short quiz, at the beginning of class
  - Based on readings for that day
  - Ensure you are familiar with the terminology

Peer Instruction

- Discussion questions during class: question that introduces a new idea

1. Solo vote: Think for yourself and select answer
2. Discuss: Analyze problem in teams of 3
    - Practice analyzing, talking about challenging concepts
    - Reach consensus
    - If you have questions, raise your hand and I'll come over

Peer Instruction

- Discussion questions during class: question that introduces a new idea

1. Solo vote: Think for yourself and select answer
2. Discuss: Analyze problem in teams of 3
3. Group vote: Everyone in group votes
4. Class wide discussion:
   - Led by YOU (students) – tell us what you talked about in discussion that everyone should know!

Why Peer Instruction?

- You get a chance to think.
- I get feedback as to what you understand.
- It's more engaging!
- Research shows it promotes more learning than traditional lecture.

Clickers!

- Lets you vote on questions in real time.
- Like pub trivia, except the subject is always systems.

Clicker Registration

https://forms.gle/TgaXQ9FhmqV7VExe7

If you don't register your clicker, I can't give you credit for quizzes / participation!

Quiz scores count from week 2

Locating your Clicker ID

Will only have numbers 0-9 and letters A – F

A hexadecimal number - More on this next week!

ID is also visible when you turn your clicker on.

Example Question

1. Individual vote (votes with Clicker)

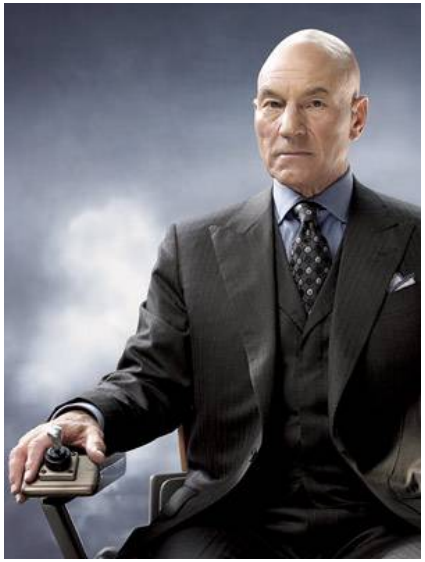
2. Group discussion / group vote
   - Room should be LOUD

3. Class discussion

The most useful super power for a college student would be:

A
Invisibility

B
Lots of $$$



C
Telepathy

D
Weather

E: Some other power (be prepared to discuss!)

Grading

- 5% Reading Quizzes
- 5% Class and Lab participation
- 25% Midterm Exam
- 30% Final Exam
- 35% Lab Assignments and Homeworks

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- 5% Reading Quizzes
- 5% Class and Lab participation
- 25% Midterm Exam
- 30% Final Exam
- 35% Lab Assignments

} drop your three lowest quizzes/no shows to class

Reading Quizzes

- Readings from online sources
- Target low difficulty: did you read?
- Goal: incentivize / reward preparation
  - Can be an easy 5%!

Readings

Dive into Systems: A Gentle Guide to C and the Architectural Reef Below

Suzanne J. Matthews, Tia Newhall, Kevin C. Webb

Dive into Systems

Textbook Access Code on Piazza

A Gentle Introduction to C and the Architectural Reef Below

Authors: Suzanne J. Matthews, Ph.D. - West Point suzanne.matthews@westpoint.edu

Tia Newhall, Ph.D. - Swarthmore College newhall@cs.swarthmore.edu

Kevin C. Webb, Ph.D. - Swarthmore College kwebb@cs.swarthmore.edu

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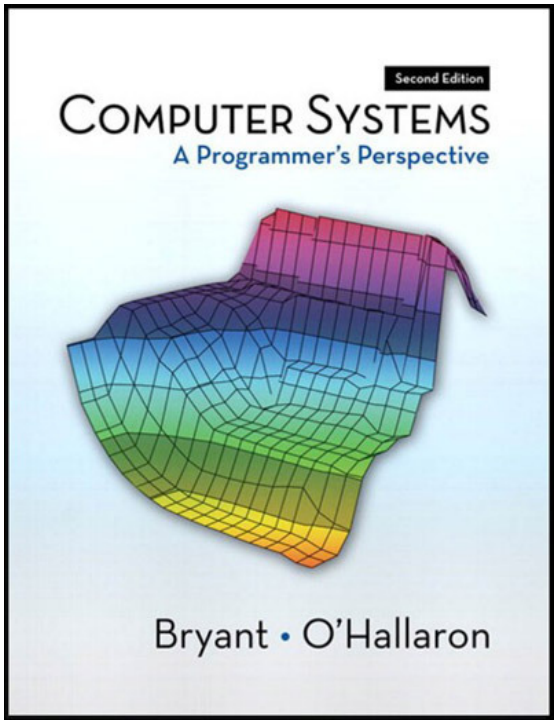
Supplemental Textbook



- Computer Systems: A Programmer's Perspective (2nd Edition)

Policies

- Lab Lateness
  - 48 hours of extra time for the semester
  - Email AFTER you are done!
  - No Email: Grade whatever is present at the deadline.

Policies: academic dishonesty

- Collaboration
  - **You may discuss approaches, not solutions**
  - You must submit your own work
  - Exams may include questions on programming
- Cheating
  - We take this very seriously. It can have a negative impact on your course grade, your GPA and your record at Swarthmore and beyond.
  - **Don't do it!**

Schedule

- Midterm: **March 19, 7 – 9 PM**
  - Mark your calendar!
  - Let me know if this is a problem today!
- FINAL – TBA
- Labs:
  - Labs are held on Wednesday
  - Out (usually) on Monday nights
  - Due on Tuesdays

Schedule

- Midterm: **March 19, 7 – 9 PM**
  - Mark your calendar!
  - Let me know if this is a problem today!
- FINAL – TBA
- Homeworks:
  - Homeworks will be out on Tuesday &
  - Out (usually) on Monday nights
  - Due on Tuesdays

Administrative Questions

- All of this info (should be) on class website
- Feel free to ask on Piazza discussion board!

What is a computer system?

- Hardware and/or software that…
  - allows the user to interact with programs
  - allows programs to run and use machine's resources
  - makes computer easier to use

What is a computer system?

- GOAL: Improve the computer's capabilities
  - performance
  - reliability
  - security
  - usability

Turn undesirable into desirable

Turn undesirable inconveniences: reality….

- Complexity of hardware
- Single processor
- Limited memory

Into desirable conveniences: illusions!

- Simple, easy-to-use resources
- Multiple/unlimited number of processors
- Large/unlimited amount of memory

Three big ideas

- Abstraction
  - What is the desired illusion?
  - How do we interact with it?
- Mechanism
  - How do we create the desired illusion?
  - How does it work?
- Policy
  - How do we make it work well, to meet a goal?

Why should you care?

- To know how your computer works
  - Understand how your program works
  - Increase the performance of your programs
  - How to enhance your computer, applications
  - Build reliable, scalable computer systems
- Systems programmers get respect
  - In high demand, get paid well
- Real-world impact

Pacman

- Pacman freaks out if you complete level 255
- Why?

Therac-25

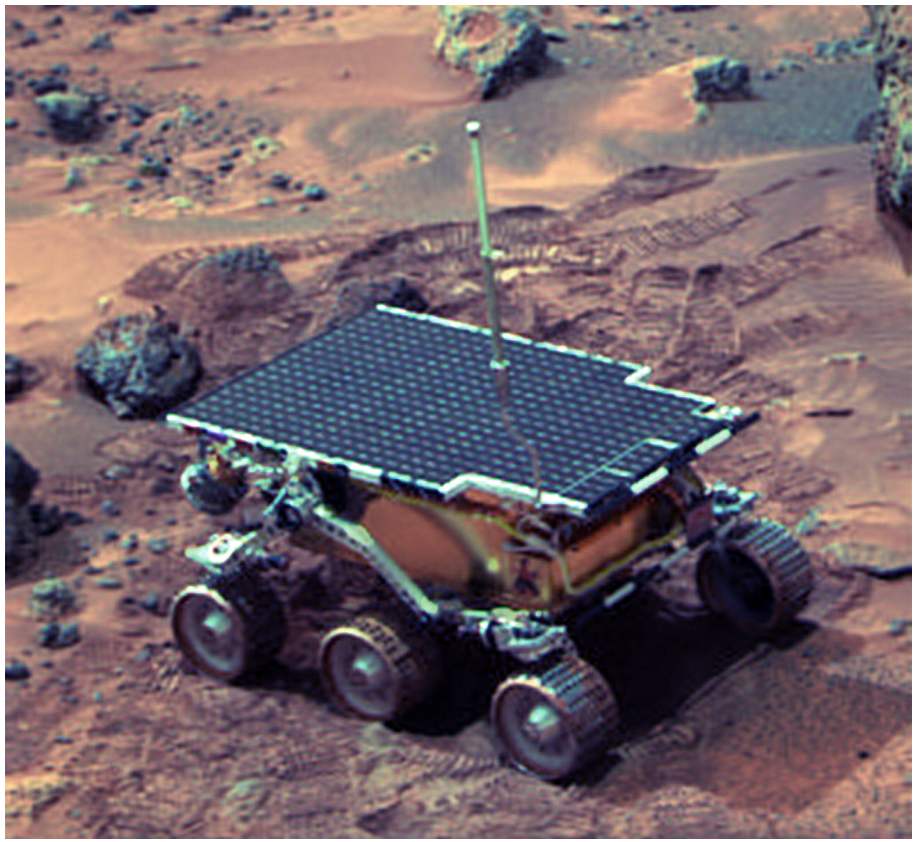
- Anyone heard of this?
- Very similar to Pacman bug, only with tragic consequences.
- Radiation therapy machine, misdosed patients

Toyota Acceleration (2009-2011)

- Unintended acceleration
- ~9 million vehicles recalled
- “Stack overflow”

Mars Pathfinder (1997)

- Frequently locked up and stopped responding
  - (automatic reboot)
- "Priority inversion" in parallel software



Pokémon Yellow

- Cleverly “hacked”, game completed in 1:36
- “Buffer overflow” exploit

This Course

- How your programs *really* execute

- 1st half: focus on hardware execution
- 2nd half: focus on operating system

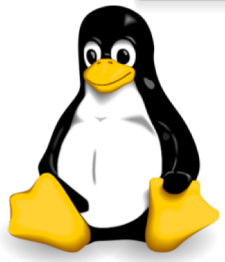
Abstraction

User / Programmer
Wants low complexity

Applications
Specific functionality

Software library
Reusable functionality

Operating system
Manage resources



Complex devices
Compute & I/O

Today

- Number systems and conversion

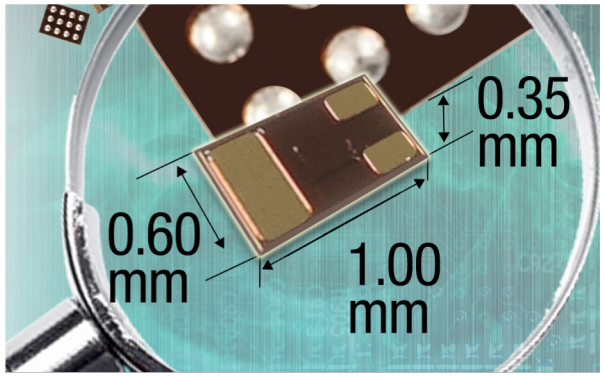
- Data types and storage:
  - Sizes
  - Representation
  - Signedness

Data Storage

Lots of technologies out there:

Magnetic (hard drive, floppy disk)

Optical (CD / DVD / Blu-Ray)

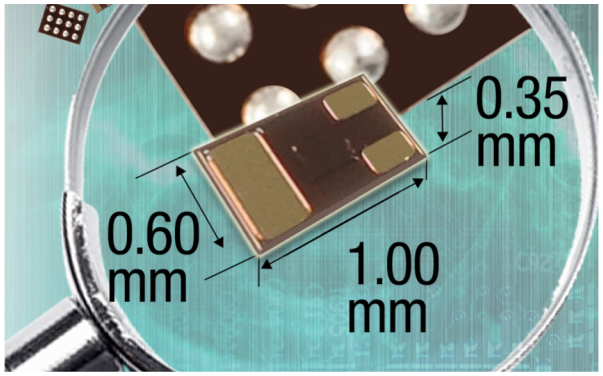


Electronic: RAM, registers

Electronic Data Storage

- Focus on electronic data storage

- Easy to differentiate two states
  - Voltage present
  - Voltage absent



We'll see (and build) digital circuits soon!

Binary Digits (Bits)

Bit: a 0 or 1 value (binary)

- Hardware represents as two different voltages
  - 1: the presence of voltage (high voltage)
  - 0: the absence of voltage (low voltage)

- Transistors: On or Off
- Optical: Light or No light
- Magnetic: Positive or Negative

Bits and Bytes

- Bit: a 0 or 1 value (binary)
  - HW represents as two different voltages
  - 1: the presence of voltage (high voltage)
  - 0: the absence of voltage (low voltage)

- Byte: 8 bits, the smallest addressable unit

  Memory: 01010101 10101010 00001111 …

- Other names:
  - 4 bits: Nibble
  - "Word": Depends on system, often 4 bytes (32 bits)

Files

Sequence of bytes… nothing more, nothing less

Binary Digits: (BITs)

- One bit: two values (0 or 1)
- Two bits: four values (00, 01, 10, or 11)
- Three bits: eight values (000, 001, …, 110, 111)

Discussion question

- Green border

- Recall the sequence
  - Answer individually (room quiet)
  - Discuss in your group (room loud)
  - Answer as a group
  - Class-wide discussion

How many unique values can we represent with 9 bits? Why?

- One bit: two values (0 or 1)
- Two bits: four values (00, 01, 10, or 11)
- Three bits: eight values (000, 001, …, 110, 111)

A. 18
B. 81
C. 256
D. 512
E. Some other number of values.

How many unique values can we represent with 9 bits? Why?

- One bit: two values (0 or 1)
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- Three bits: eight values (000, 001, …, 110, 111)

A. 18
B. 81
C. 256
D. 512 (2^9)
E. Some other number of values.

Your TODO list

- Readings posted on course web page.
- Sign up for Piazza!
- Please let me know (emails OK) about:
  - Your preferred name, if different than roster name
  - Your preferred gender pronoun
  - Disability accommodations
- Register your clicker, if you didn't already…
- Pick up account form if you're new to CS department.

If you're not officially enrolled…

- You should have gotten an email from Jeff!
- If not, come talk to me now!
- Please fill out drop/add forms soon…

Next Class

- Number systems and conversion
  - Decimal
  - Binary
  - Hexadecimal
- Data types and storage:
  - Data sizes
  - Representation