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

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

Sara “Scout” Sinclair Brody
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 → Textbook → Assignment → Exam

First Exposure → Read Hard Stuff → See if You Know Hard Stuff → Show Knowledge Mastery

Little opportunity for feedback
Interactive Classes with Peer Instruction

- 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
Grading

- 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%!

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

Dive into Systems

A Gentle Introduction to C and the Architectural Reef Below

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Supplemental Textbook

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)
- Two bits: four values (00, 01, 10, or 11)
- Three bits: eight values (000, 001, ..., 110, 111)

A. 18
B. 81
C. 256
D. \( 512 \ (2^{9}) \)
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