Welcome to CS2630!

• Syllabus:
  • [http://homepage.cs.uiowa.edu/~bdmyers/cs2630_fa17//syllabus/](http://homepage.cs.uiowa.edu/~bdmyers/cs2630_fa17//syllabus/)

• or linked from ICON > Syllabus
CS 2630
Computer Organization

Meeting 1: Introduction
Brandon Myers
University of Iowa
One of my research projects

Make programming this

...feel like programming this
What’s with the classroom?

• “TILE (Transform, Interact, Learn, Engage) is a nationally-recognized University of Iowa initiative that encourages team-based, inquiry-guided pedagogies.”
  • from “TILE at The University of Iowa”

• Less about the technology and more about a classroom design that supports student-centered learning
Think (write), pair, share

1. What do you think you will learn in CS2630?

2. What is one thing you are excited about in this course?

3. What is one thing you are not excited about in this course?

a) write answers to the three questions;
b) turn to 1 person next to you, introduce yourself;
c) share your answers
Why take 2630?

• Brandon’s esoteric answer: graduates of a Computer Science program should have an appreciation for how real computers work

• ACM and IEEE’s answer: Computer Organization and Architecture is a topic in Computer Science Curricula 2013 (https://www.acm.org/education/CS2013-final-report.pdf)

• But more concretely...
Why take 2630?

1. It will be up to you to **design** our new computer systems (software AND hardware)...computer architects have been panicking for nearly a decade and they are *not* calming down.
Computer Architecture topics post

A chance for you to bring information to the course, perhaps including articles about new computer architectures!

(syllabus and ICON for more details)
Word cloud generated by Spring & Summer semester posts
2. at some point you will be have to **measure a system you’ve built**: performance (latency & throughput), energy usage, reliability, ... To be able to measure/interpret/improve your system, it helps to understand how more of the computer works.

What metrics would you measure to know how good a car is?

What can the engineer do to change the values of those metrics?
The computing stack you’ll focus most on the shaded layers.

Each layer presents a convenient abstraction to the layer above.
Recurring theme: The reality of our abstractions
Microprocessor Transistor Counts 1971-2011 & Moore's Law

date shows transistor count doubling every two years

Transistor count

Date of introduction
In pairs, generate 3 observations or questions about this plot; then as a table, decide on 3 to share with the class.
Why isn’t multicore working?

To create this plot, the experimenter:

1. found 4 different programs with different amounts of the program that could potentially be run in parallel (50%, 75%, 90%, 95%)
2. ran each program on 1 processor (aka core); let’s call the running time $T_1$
3. ran the same programs on X processors, plotting $Y = T_1 / T_x$ (speedup)

Your task: in group of 3, come up with a description of what the plot is telling us!

Here is some context to help:
Multicore will increase performance up to a point, but because of power issues as well as Amdahl’s Law, we can’t bet on the million-core chip. We need entirely new designs for the computers of the near future.
Let’s discuss the syllabus

• ICON > 2630 Fall 2017 > Syllabus
• Or,
  • [http://homepage.cs.uiowa.edu/~bdmyers/cs2630_fa17//syllabus/](http://homepage.cs.uiowa.edu/~bdmyers/cs2630_fa17//syllabus/)
• In triples, find 1 unique question to ask about the syllabus
  • try your best to find a question that is not directly answered by the syllabus
  • elect one group member that will report to the class
# Course calendar

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>In class</th>
<th>Reading</th>
<th>Notes</th>
<th>Homework / Projects</th>
<th>Quiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8/21</td>
<td>(Eclipse)</td>
<td></td>
<td></td>
<td>HW1: Bits, bytes, memory organization</td>
<td>Quiz 1</td>
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<tr>
<td></td>
<td>8/23</td>
<td>Introduction</td>
<td>Introduction</td>
<td></td>
<td>tentatively due Aug 28</td>
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<tr>
<td></td>
<td>8/25</td>
<td>Team: Bits and</td>
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- Material used in class
- Look at reading/videos before class
- Homework and quizzes outside of class
Approach of the course

• Review the content knowledge (resources on the website)
  • textbook or other readings
  • notes
  • videos and other resources
  • and finally, some live lecture (augments and doesn’t replace the above)

• Learn higher order skills: application, analysis, synthesis, evaluation
  • In-class activities and lab assignments
  • ICON quizzes (immediate feedback)
  • Homeworks and projects
Be successful in CS2630

• Prepare for class; review the materials before and do pre-labs
• Attend class to do the activities and labs with your peers
• Help your peers on ICON and in class
• Attend Debug Your Brain and/or office hours
• Midterm in class
• Keep on top of announcements in ICON
What to do now

• Review this week’s readings
• Take Quiz 1 until you get 100%
• Start on HW1
• Take the poll for agreeing on late policy
conventional design of a general-purpose processor
Why take 2630?

- The esoteric answer: **Computer** Science graduates should have an appreciation for how real **computers** work.
- But really...
  - 1. It will be up to you to **design our new computer systems**...computer architects have been panicking for nearly a decade and they are *not* calming down.
  - 2. Even if you vow to never, ever, EVER do anything except applications programming...at some point you will be have to **measure a system you’ve built**: performance (latency & throughput), energy usage, reliability, ... To understand how to measure/interpret/improve your system, you need to understand more of the computer.
Why is my program slow?

• Application programmer’s ideal view of the underlying system: ”performance is solely determined by the number of operations (remember O(N) from 2230?)”
  • The program is slow, so I’ll fix my algorithm to be O(N^3) instead of O(N^4)
  • It’s still slow, now what?

• Sometimes the programmer needs a more detailed view of the underlying computer system
  • Suppose the program was not using the computer’s cache or parallel processing effectively
  • Methodology is important, too: What is the process for discovering why the program is slow? Scientific method: hypothesize, measure, interpret, repeat...
What is CS2630 about?

- Instruction set architecture (e.g., MIPS)
  - Compiler: translating source code (C or Java) Programs to assembly language And linking your code to Library code
  - Memory system
  - Processor
  - I/O system
  - Datapath & Control
  - Digital logic

How the software talks To the hardware

How a processor runs MIPS Programs!

How switches (1 or 0) can be used to build Interesting functions: from integer arithmetic to programmable computers
Rough schedule of CS2630

- ~week 1-5: How do we represent and store numbers? How do we program a computer?
- ~week 6-8: How do we build complex functions from simpler components like switches?
- ~week 8-10: How do we design a basic processor that runs MIPS programs?
- ~week 10-14: What are the techniques for diagnosing performance issues and improving performance of a processor?
- Bonus: e.g., How do we run more than one program at a time on a processor? How do we represent real numbers?
Textbook

• Harris & Harris, *Digital Design and Computer Architecture*, 2nd ed.

• (1st edition is okay, too)
Be successful in CS2630

• Come to class; reading slides is a poor substitute
• Active learning, peer teaching, and other activities to replace the lack of labs/discussions
• Attend Debug Your Brain and/or office hours
• Help your peers on ICON and in class
• Midterm in class (March 6)
• Keep on top of announcements in ICON/website
Peer instruction

• Think, answer, discuss...
• **See syllabus** for information on purchasing a clicker license if you do not yet have one
• Use your smartphone or any web-enabled device!
• Participation counts, *not* right answers

• Too shy to ask a question in class? You can also anonymously ask questions on the ResponseWare app using the chat feature

• Some class meetings involve use of your computer (need at least 1 per pair of students)
  • If bringing a laptop presents a hardship, email me
What to do now

• HW 1 is out
• Quiz 1 is out
• Read the syllabus online
  • go on ICON and take the syllabus survey if you want to vote on policies
• Buy your clicker license (if you don’t yet have one) and go through getting started doc
• Check ICON and reply to the discussion question