Agenda

- Syllabus
  - Course logistics, info, requirements
- Online nature of the course
- Introduction
- Background Videos and Lectures to Study
Non-Agenda

- Grading and Policies
- Details on Course Project
- Details on Paper Review Assignments
- Initial Assignments and Homeworks
- These are covered in separate videos.
Course Info: Who Are We?

- Instructor: Prof. Onur Mutlu
  - onur@cmu.edu
  - Office: CIC 4105
  - Office Hours: W 2:30-3:30pm (or by appointment)
  - http://www.ece.cmu.edu/~omutlu
  - PhD from UT-Austin, worked at Microsoft Research, Intel, AMD

- Research interests:
  - Computer architecture, hardware/software interaction
  - Many-core systems
  - Memory and storage systems
  - Improving programmer productivity
  - Interconnection networks
  - Hardware/software interaction and co-design (PL, OS, Architecture)
  - Fault tolerance
  - Hardware security
  - Algorithms and architectures for genomics and embedded systems
Course Info: Who Are We?

- Instructor: Prof. Seth Copen Goldstein
  - seth@cmu.edu
  - Office: GHC 7111
  - Office Hours: T 1-2pm (or by appointment)
  - http://www.cs.cmu.edu/~seth
- Research interests:
  - Computer architecture
  - Compilers
  - Massively distributed systems
  - Programmable matter
  - Programming Languages
  - Nanotechnology
  - Modular Robotics
  - Governance
  - Web Technology
Course Info: Who Are We?

- Teaching Assistants
  - Tyler Huberty
    - thuberty@andrew.cmu.edu
  - Brian Osbun
    - bosbun@andrew.cmu.edu
  - Hongyi Xin
    - hxin@andrew.cmu.edu
  - TBD
Where to Get Up-to-date Course Info?

- Website: [http://www.ece.cmu.edu/~ece740](http://www.ece.cmu.edu/~ece740)
  - Syllabus and contact information
  - Links to videos and online education site
  - Lecture notes
  - Readings and link to review website
  - Project information
  - ...

- Blackboard: Linked from website

- Your email

- Email to us: [740-official@ece.cmu.edu](mailto:740-official@ece.cmu.edu)
This is a Hybrid Course

- Heavily online
- With in-person recitations and office hours
Lectures, Readings and Recitations

- **Lectures will be online**
  - Purpose: Learn the basics of a topic
  - You are expected to watch them fully as assigned by the due date
  - Videos and supplemental material will be linked from the website

- **Readings will be online**
  - Purpose: Enhance understanding beyond the lectures
  - You are expected to do them before the due date (& enter reviews)

- **Recitations will be both in-person and online**
  - Purpose: Enhance understanding via deeper discussion
  - During the specified times in the syllabus and course schedule
  - We will announce recitation times and format weekly
  - In-person recitations will be recorded and posted online
Office Hours

- Office hours will be both in-person and online
  - Purpose: Clarify unclear points, delve deeper
  - Locations and times will be posted
A Note

- Please provide us feedback with the online lectures and quality of the online environment
- If there are issues, we would like to know these early
- Especially true if you are remotely attending the class
**What Will You Learn?**

- **Computer Architecture:** The science and art of designing, selecting, and interconnecting hardware components and designing the hardware/software interface to create a computing system that meets functional, performance, energy consumption, cost, and other specific goals.

- **Traditional definition:** “The term *architecture* is used here to describe the attributes of a system as seen by the programmer, i.e., the conceptual structure and functional behavior as distinct from the organization of the dataflow and controls, the logic design, and the physical implementation.” *Gene Amdahl*, IBM Journal of R&D, April 1964
Levels of Transformation

- Problem
- Algorithm
- Programs
- Runtime System (VM, OS, MM)
- ISA
- Microarchitecture
- Circuits/Technology
- Electrons
- User
What Will You Learn?

- Hardware/software interface, major components, and programming models of a modern microprocessor
  - State-of-the-art as well as research proposals
  - Tradeoffs and how to make them
  - Emphasis on cutting-edge research

- Hands-on research in a computer architecture topic
  - Semester-long project
  - How to design better architectures (not an intro course)

- How to dig out information
  - No textbook really required
  - But, see the syllabus
An Example: Multi-Core Systems

*Die photo credit: AMD Barcelona*
Unexpected Slowdowns in Multi-Core

![Graph showing memory performance slowdowns.

- High priority (Core 1): 3.04
- Low priority (Core 0): 1.07

Memory Performance Hoq

- Matlab (Core 0): 1.07
- Gcc (Core 1): 3.04

The graph indicates a significant slowdown in memory performance on Core 1 compared to Core 0. Higher values indicate worse performance.]
Why the Disparity in Slowdowns?

Shared DRAM Memory System

Multi-Core Chip

unfairness
For More Information, Read

Course Goals

- **Goal 1:** To familiarize computer architecture students and those interested in computer system design with both fundamental design tradeoffs and recent research issues/trends in processor, memory, and platform architectures in today’s and future systems.
  - Strong emphasis on fundamentals and design tradeoffs.

- **Goal 2:** To provide the necessary background and experience to advance the state-of-the-art in computer architecture by performing cutting-edge research.
  - Strong emphasis on
    - Critically evaluating research papers (through literature review assignments)
    - Developing new mechanisms that advance the state of the art (through the course research project).
This is a Graduate-Level Class

- Required background:
  - basic architecture (18-447)
  - basic compilers
  - basic OS
  - programming skills
  - spirit, excitement, and dedication for deep exploration of a topic in computer architecture
What Do I Expect From You?

- Learn the material
  - And, research it → find the original source of ideas

- Do the work & **work hard**

- **Ask questions, take notes, participate in discussion**

- Read and review the assigned research papers & readings
  - Discuss/critique them online with peers and us
  - Write your critique/review online

- Start the research project early and focus on it

- If you want feedback, come to office hours
Recommended Background Videos and Lectures (I)

- All 447 lecture videos and notes are at:
  - http://www.youtube.com/playlist?list=PL5PHm2jkkXmidJOd59REog9jDnPDTG6IJ

- Please watch as many as you can, to brush up on background material

- I would especially encourage everyone to watch:
  - Lecture 1: Basics of Computer Architecture
  - http://www.youtube.com/watch?v=BJ87rZCGWU0&list=PL5PHm2jkkXmidJOd59REog9jDnPDTG6IJ&index=1
Recommended Background Videos and Lectures (II)

- Lectures 2-3: Fundamental Concepts and ISA, ISA Tradeoffs
  - [Lecture 2](http://www.youtube.com/watch?v=BqJgYN6S6Qw&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=2)
  - [Lecture 3](http://www.youtube.com/watch?v=BqJgYN6S6Qw&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=3)

- Lecture 8: Pipelining
  - [Lecture 8](http://www.youtube.com/watch?v=5E_W7EeNs8U&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=8)

- Lecture 9: Data Dependence Handling
  - [Lecture 9](http://www.youtube.com/watch?v=Gpz1I47LfDo&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=9)

- Lecture 10-11: Branch Prediction
  - [Lecture 10](http://www.youtube.com/watch?v=XkerLktFtJg&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=11)

- Lecture 16: Virtual Memory
  - [Lecture 16](http://www.youtube.com/watch?v=ppPq-ntaAWU&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=16)
Recommended Background Videos and Lectures (II)

- Lecture 22: Memory Hierarchy
  - http://www.youtube.com/watch?v=JBdfZ5i21cs&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=22

- Lecture 23-24: Caches
  - http://www.youtube.com/watch?v=TpMdBrM1hVc&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=23
  - http://www.youtube.com/watch?v=TboaFbjTdE&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=24

- Lecture 30B: Multiprocessors
  - http://www.youtube.com/watch?v=7ozCK_Mgxfk&list=PL5PHm2jkkXmidJ0d59REog9jDnPDTG6IJ&index=31
740: Computer Architecture
Introduction, Logistics, and Background Assignments

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