15-740/18-740
Computer Architecture
Lecture 0: Logistics and Introduction

Prof. Onur Mutlu
Carnegie Mellon University
Fall 2011, 9/7/2011
Summary

- First full-blown lecture: September 12 (Next Monday)

- Homework 0
  - Due September 14 (Next Wed)

- Homework 1
  - Due September 16 (Next Fri)

- Review Set 0 (two readings)
  - Due September 14 (Next Wed)

- Review Set 1 (two seminal readings)
  - Due September 16 (Next Fri)

- Project ideas and groups
  - Proposal due September 26: Read, think, and brainstorm
Agenda

- Syllabus
  - Course logistics, info, requirements

- Homework assignments for next week

- Reading/review assignments for next week

- Introduction

- Potential project topics
Course Info: Who Are We?

- Instructor: Prof. Onur Mutlu
  - onur@cmu.edu
  - Office: Hamerschlag Hall-A305
  - Office Hours: W 4:30-5:30pm (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?

- **Teaching Assistants**
  
  - **Yoongu Kim**
    - Hamerschlag Hall A313C
    - yoongukim@ece.cmu.edu
    - Office hours: Mon 1-2pm, Tue 1-2pm
  
  - **Justin Meza**
    - Hamerschlag Hall A5
    - justinme@ece.cmu.edu
    - Office hours: Thu 3-4pm, Fri 1-2pm
Where to Get Up-to-date Course Info?

- **Website**: [http://www.ece.cmu.edu/~ece740](http://www.ece.cmu.edu/~ece740)
  - Lecture notes
  - Readings and link to review website
  - Project information
  - Homeworks

- **Blackboard**: Linked from website
  - Upload homeworks here except for HW0

- **Your email**

- **Me and the TAs**
Lectures and Course Schedule

- **Reserved Lecture Times:**
  - MWF 2:30-4:20pm
  - Doherty Hall 1112
  - Days and load will be determined dynamically. Some days, we might have discussion sessions.

- **Tentative schedule in your syllabus**
  - But don’t believe all of it
  - Systems that perform best are usually dynamically scheduled.
    - Static vs. Dynamic Scheduling
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

User

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

- Hardware/software interface and major components 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

Multi-Core Chip

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

Memory Performance Hoq
Low priority

High priority

Slowdown

1.07

3.04

matlab
(Core 0)

gcc
(Core 1)
Why the Disparity in Slowdowns?
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).
What Do I Expect From You?

- Required background: basic architecture (18-447), basic compilers, basic OS, programming

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

- Do the work & **work hard**

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

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

- Come to class on time

- Start early and focus on the research project

- If you want feedback, come to office hours
How Will You Be Evaluated?

- Homeworks, Online Reviews, Quizzes: 10%
- Research Project: 35%
- Midterm I: 20%
- Midterm II (comprehensive): 35%
- Our evaluation of your performance: 5%
- Participation+discussion counts

- Grading will be back-end heavy. Most of your grade will be determined in December
  - How you prepare and manage your time is important
More on Homeworks and Policy

- **Homeworks**
  - Content from lectures, readings, project, discussions
  - All homeworks *must* be your own work
  - Do them to truly understand the material, not to get the grade

- **Research project in groups**

- **Late policy:** Maximum five late days total

- **Absolutely no tolerance on cheating or academic dishonesty**
  - See syllabus, CMU Policy, and ECE Academic Integrity Policy
  - Cheating $\rightarrow$ Failing grade (no exceptions)
Research Project

- Your chance to explore in depth a computer architecture topic that interests you
- Perhaps even publish your innovation in a top computer architecture conference.

- Start thinking about your project topic from now!
- Interact with me and Yoongu, Justin

- Groups of 2-3 students (will finalize this later)
- Proposal due: Sep 26
Homeworks for Next Week

- **Homework 0**
  - Our way of getting to know about you fast
  - Due Sep 14
  - You have to turn in a hard copy
  - You have to turn in your picture

- **Homework 1**
  - Questions on initial readings and more
  - Due Sep 16
  - Upload PDF on Blackboard
Readings + Reviews for Next Week

- **Review Set 0**
  - Due Sep 14

- **Review Set 1**
  - Due Sep 16
  - G. M. Amdahl *Validity of the single processor approach to achieving large scale computing capabilities*, AFIPS Conference, April 1967.
How to Do the Paper Reviews

- Brief summary
  - What is the problem the paper is trying to solve?
  - What are the key ideas of the paper? Key insights?
  - What is the key contribution to literature at the time it was written?
  - What are the most important things you take out from it?

- Strengths (most important ones)
  - Does the paper solve the problem well?

- Weaknesses (most important ones)
  - This is where you should think critically. Every paper/idea has a weakness. This does not mean the paper is necessarily bad. It means there is room for improvement and future research can accomplish this.

- Can you do (much) better? Present your thoughts/ideas.

- What have you learned/enjoyed most in the paper? Why?

- Review should be short and concise (~half a page or shorter)
Further Reading for Next Week

  - Read this to get an idea of the publication process

- Levin and Redell, “How (and how not) to write a good systems paper,” OSR 1983.
  - Read this for your research project

- Fong, “How to Write a CS Research Paper: A Bibliography”
Research Project

- **Goal:**
  - Develop new insight
  - **Approach 1:**
    - Develop novel ideas to solve an important problem
    - Rigorously evaluate the benefits and limitations of the ideas
  - **Approach 2:**
    - Derive insight from rigorous analysis and understanding of previously proposed ideas
    - Propose potential new solutions based on the new insight

- The problem and ideas need to be concrete

- You should be doing problem-oriented research