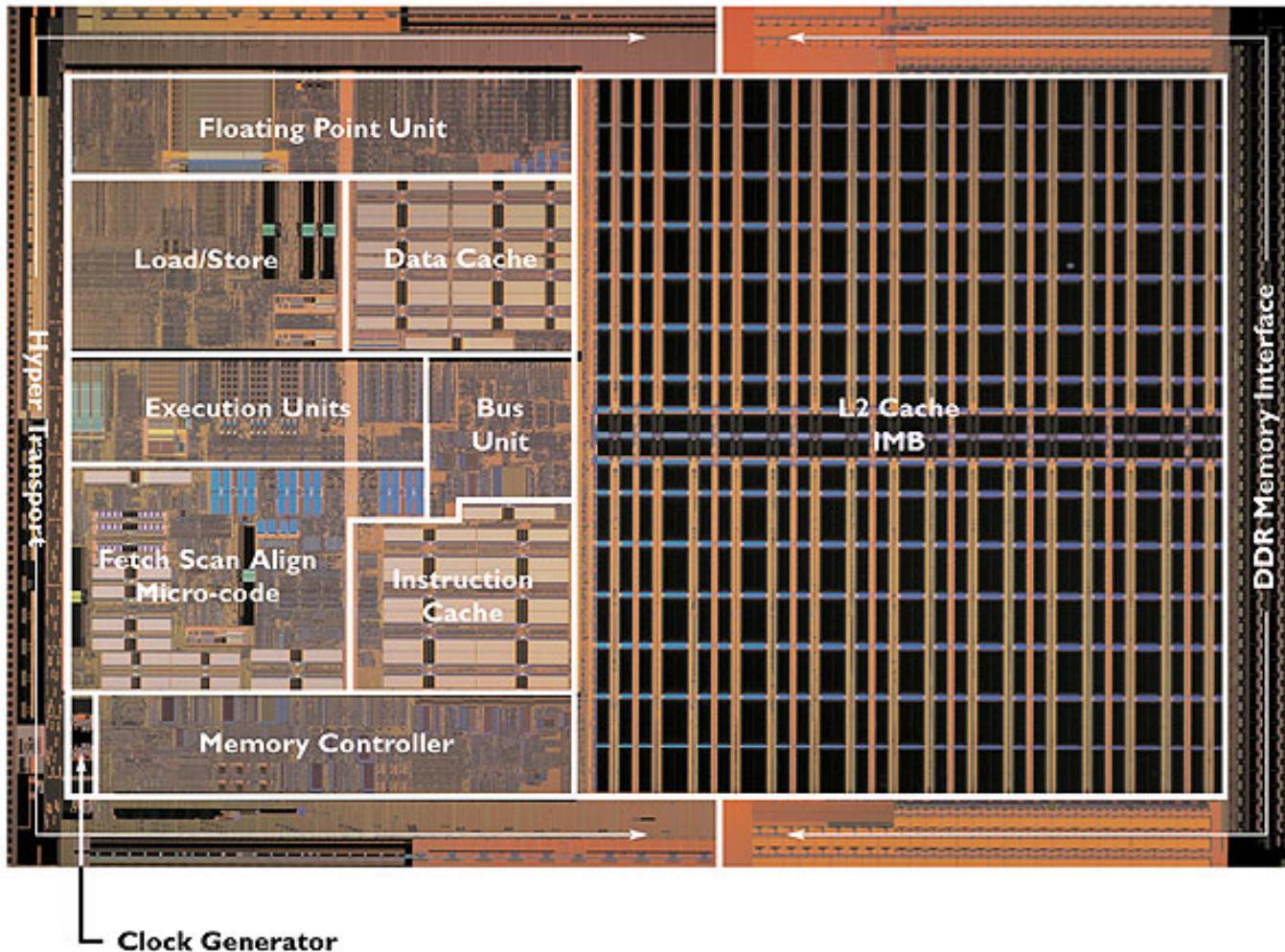


# Advanced Computer Architecture

Fall 2007



# Slides from ...

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- We use course slides from :
  - “CS232: Advanced Computer Architecture II”
  - <http://www.cs.uiuc.edu/class/fa07/cs232/lectures/>
- ©2006 Craig Zilles (adapted from slides by Howard Huang)

*department of*  
**COMPUTER SCIENCE**



UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

# What is computer architecture about?

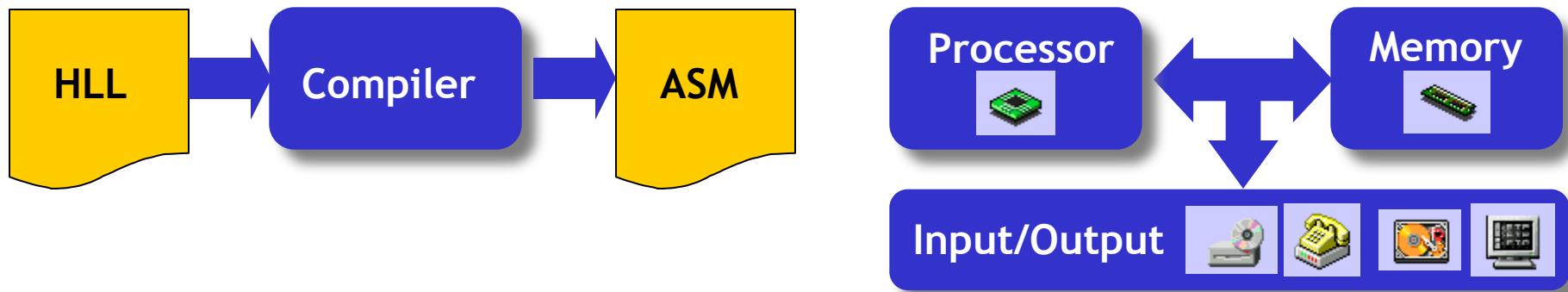
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- Computer architecture is about building and analyzing computer systems.
- This course is roughly split into three parts.
  - The first third discusses instruction set architectures—the bridge between hardware and software.
  - Next, we introduce more advanced processor implementations. The focus is on pipelining, which is one of the most important ways to improve performance.
  - Finally, we talk about memory systems, I/O, and how to connect it all together.

# What is computer architecture about?

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- Computer architecture is about building and analyzing computer systems.



- We will take a tour of the whole machine.
- Specifically, we'll...

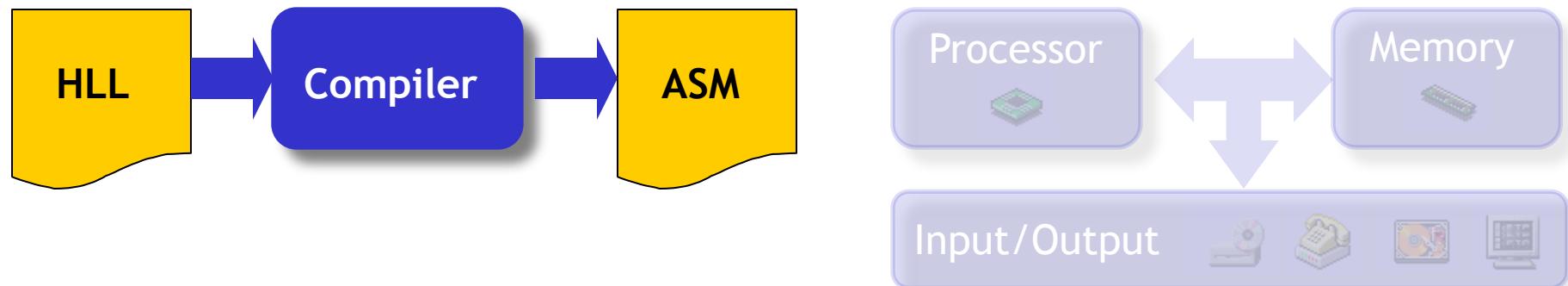
# Do low-level programming in a high-level language



- We'll look at bit-wise logical and shifting operations in C (Stage HLL: *High Level Language* ).

# Study Instruction Set Architectures

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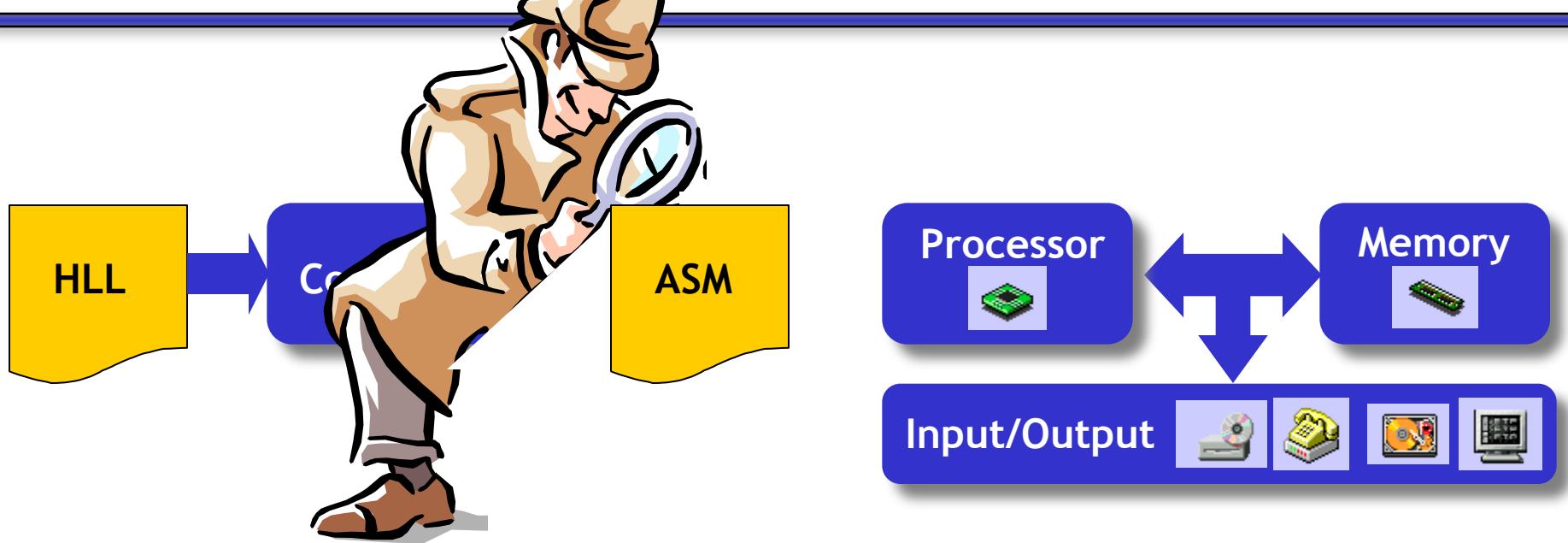
- The Instruction Set Architecture (ISA) is the bridge between the hardware and the software.
  - We'll learn the MIPS ISA in detail
  - We'll get a brief introduction to the x86 ISA
  - We'll learn how HLL program constructs are represented to the machine
  - We won't learn how compilers work, but we'll learn what they do

# MIPS (in Turkish)

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- Microprocessor without Interlocked Pipeline Stages, MIPS Technologies, 1985
  - [http://tr.wikipedia.org/wiki/MIPS\\_Mimarisi](http://tr.wikipedia.org/wiki/MIPS_Mimarisi)
- İndirgenmiş komut kümesi türü ilk mikroişlemci mimarisidir.
  - Her komut aynı boyuttadır ve komut bilgisayar donanımı tarafından kolayca çözülebilir.
- Intel x86 ise karmaşık komut kümeli bilgisayar sayılır.
  - Komutların boyutları farklıdır ve komutları çözebilmek için bilgisayar donanımına gömülü programlar (microcode) gereklidir.
- RISC yapısından ötürü tasarımlı çok temiz ve basittir.
  - Sistem karmaşık işlemleri destekleyen yapılar yaratmaktansa sık yapılan basit işlemleri iyileştirme üzerine kuruludur.
  - Bu tasarım avantajından dolayı üniversitelerdeki bilgisayar mimarisi derslerinde genellikle MIPS mimarisi okutulur.
  - Yine basit ve sağlam tasarımından ötürü çoğu modern mikroişlemci mimarisi (IBM/Motorola PowerPC, DEC, ARM) MIPS mimarisinden esinlenerek geliştirilmiştir.
- 1990 itibarıyle üretilen her üç RISC işlemciden birinin MIPS mimarisinde olduğu tahmin edilmektedir. İlk MIPS tasarımları 32 bit, daha yeni tasarımlar ise 64 bittir.
- MIPS mimarisi SGI bilgisayarlarından gömülü sistemlere kadar geniş bir yelpazede kullanılmaktadır.
  - Örneğin; Nintendo 64, Sony PlayStation ve Sony PSP MIPS mimarisi ile çalışan işlemcilere sahiptirler.

# Learn about performance



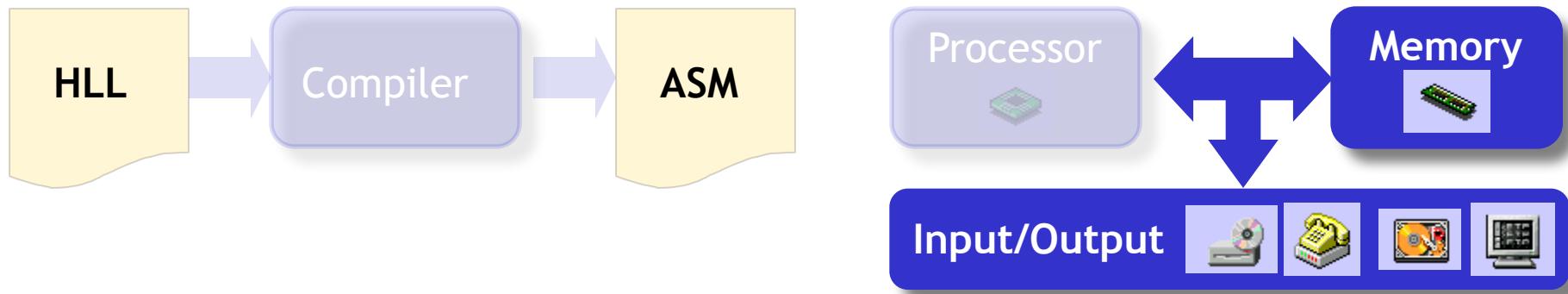
- We'll learn how to performance tune programs.
- We'll exploit explicit parallelism to make programs run faster
  - We'll optimize a program using SSE instructions

# Learn about Modern Processor Organization



- The key technique we'll focus on is: Pipelining
  - Pipelining allows processors to work ~~on multiple~~ instructions at the same time.

# Learn about Memory and I/O systems



- We'll learn how virtual memory makes programming easy
- We'll learn how caches make memory fast
- We'll learn about buses and disks

# Why should you care?

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- It is **interesting**.
  - How do you make a processor that runs at 3Ghz?
- It will help you be a **better programmer**.
  - Understanding how your program is translated to assembly code lets you reason about correctness and performance
  - Demystify the seemingly arbitrary (e.g., bus errors, segmentation faults)
- Many cool jobs require an understanding of computer architecture.
  - The cutting edge is often pushing computers to their limits.
  - Supercomputing, games, portable devices, etc.
- Computer architecture illustrates many **fundamental ideas** in computer science
  - Abstraction, caching, and indirection are CS staples