What We’ve Learned

CS31: First Half
The Hardware Level

- Basic Hardware Units:
  - Processor
  - Memory
  - I/O devices

- Connected by buses.
Foundational Concepts

- **Von Neumann architecture**
  - Programs are data.
  - Programs and other data are stored in main memory.

- **Binary data representation**
  - Data is encoded in binary.
    - Two’s complement
    - ASCII
    - etc.
  - Instructions are encoded in binary.
    - Opcode
    - Source and destination addresses
Architecture and Digital Circuits

• Circuits are built from logic gates.
  • Basic gates: AND, OR, NOT, …

• Three types of circuits:
  • Arithmetic/Logic
  • Storage
  • Control

• The CPU uses all three types of circuits.

• Clock cycle drives the system.
  • One instruction per clock cycle.

• ISA defines which operations are available.
Assembly Language

• Assembly instructions correspond closely to CPU operations.

• Compiler converts C code to assembly instructions.

• Types of instructions:
  • Arithmetic/logic: ADD, OR, …
  • Control Flow: JMP, CALL
  • Data Movement: MOV, (and fake data mvmt: LEAL)
  • Stack & Functions: PUSH, POP, CALL, LEAVE, RET

• Many ways to compile the same program.
  • Conventions govern choices that need to be consistent.
    • Location of function arguments, return address, etc.
C Programming Concepts

• Arrays, structs, and memory layout.

• Pointers and addresses.

• Function calls and stack memory.

• Dynamic memory on the heap.
Some of the (many) things we’ve left out...

• EE level: wires and transistors.
• Optimizing circuits: time and area.
  • Example: a ripple carry adder has a long critical path; can we shorten it?
• Architecture support for complex instructions.
  • Often an assembly instruction requires multiple CPU operations.
• Compiler design.
  • The compiler automates C →IA32 translation. How does this work? How can it be made efficient?
Midterm Info

• Arrive early on Thursday. We will start right at 11:20.
• Bring a pencil.
  • Please don’t use a pen unless you’re REALLY certain of your answer.
• Closed notes, but you may bring the following:
  • IA32 cheat sheet
  • IA32 stack diagram
• Q&A-style review session in lab tomorrow.
  • I will not prepare slides for this.
  • You need to prepare questions to make this useful.
Midterm Tips

• Don’t leave questions blank: a partial answer is better than none.
• If you don’t understand a question, ask for clarification during exam.
• If you’re not sure how to do problem, move on and come back later.
• Use a question’s point value as rough guide for how much time to spend on it.
• Review your answers before turning in the exam.
• Show your work for partial credit.