Chapter 1

Introduction

- **Rapidly changing field:**
  - **vacuum tube -> transistor -> IC -> VLSI (see section 1.4)**
  - **doubling every 1.5 years:**
    memory capacity
    processor speed ***(Due to advances in technology and organization)***
- **Things you'll be learning:**
  - **how computers work, a basic foundation**
  - **how to analyze their performance (or how not to!)**
  - **issues affecting modern processors (caches, pipelines)**
- **Why learn this stuff?**
  - **you want to call yourself a "computer scientist"**
  - **you want to build software people use (need performance)**
  - **you need to make a purchasing decision or offer "expert" advice**

What is a computer?

- Components:
  - input (mouse, keyboard)
  - output (display, printer)
  - memory (disk drives, DRAM, SRAM, CD)
  - network
- Our primary focus: the processor (datapath and control)
  - implemented using millions of transistors
  - Impossible to understand by looking at each transistor
  - We need...

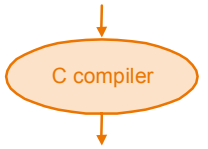
Abstraction

- **Delving into the depths reveals more information**
- **An abstraction omits unneeded detail, helps us cope with complexity**

What are some of the details that appear in these familiar abstractions?

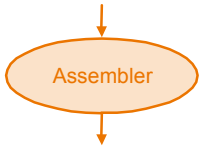
High-level language program (in C)

```
swap(int v[], int k)
{int temp;
   temp = v[k];
   v[k] = v[k+1];
   v[k+1] = temp;
}
```



Assembly language program (for MIPS)

```
swap:
     muli $2, $5,4
     add  $2, $4,$2
     lw   $15, 0($2)
     lw   $16, 4($2)
     sw   $16, 0($2)
     sw   $15, 4($2)
     jr   $31
```



Binary machine language program (for MIPS)

```
00000000101000010000000000011000
00000000100011100001100000100001
10001100011000100000000000000000
10001100111100100000000000000100
10101100111100100000000000000000
10101100011000100000000000000100
00000011111000000000000000001000
```

Instruction Set Architecture

- **A very important abstraction**
  - **interface between hardware and low-level software**
  - **standardizes instructions, machine language bit patterns, etc.**
  - **advantage:** ***different implementations of the same architecture***
  - **disadvantage:** ***sometimes prevents using new innovations***

  True or False: Binary compatibility is extraordinarily important?

- **Modern instruction set architectures:**
  - **80x86/Pentium/K6, PowerPC, DEC Alpha, MIPS, SPARC, HP**

Where we are headed

- **Performance issues (Chapter 2)** ***vocabulary and motivation***
- **A specific instruction set architecture (Chapter 3)**
- **Arithmetic and how to build an ALU (Chapter 4)**
- **Constructing a processor to execute our instructions (Chapter 5)**
- **Pipelining to improve performance (Chapter 6)**
- **Memory: caches and virtual memory (Chapter 7)**
- **I/O (Chapter 8)**

Key to a good grade: reading the book!