



THE UNIVERSITY  
of NORTH CAROLINA  
at CHAPEL HILL

# COMP 110

## Introduction to Programming

Fall 2015

Time: TR 9:30 – 10:45

Room: AR 121 (Hanes Art Center)

Jay Aikat

FB 314, [aikat@cs.unc.edu](mailto:aikat@cs.unc.edu)



## Previous Class

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- What did we discuss?



## Today

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- Announcements
  - Still registering...
  - TA Office hours begin tomorrow (Fri, Aug 21)
  - See class webpage for TA office hours
  - Join Piazza:  
[piazza.com/unc/fall2015/comp110](http://piazza.com/unc/fall2015/comp110)
  - Assignment1: **due Fri, Aug 28 at 11:55 PM**
  - **Check Sakai, Piazza and class webpage regularly**
- Computer and Programming basics
- Your first program

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## Software

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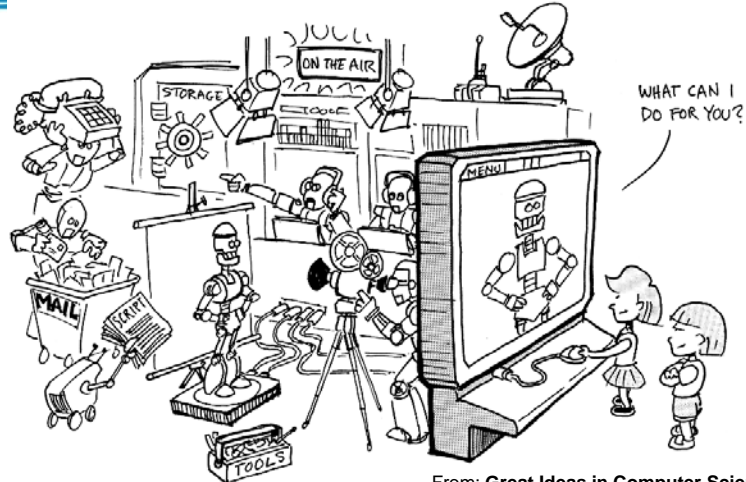
- Java and Eclipse
  - See the course website for detailed installation instructions
- How many got this installed?

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## Computers - not Magic



From: *Great Ideas in Computer Science* by JAVA,  
by A. W. Biermann and D. Ramm,  
The MIT Press 2002.

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## Hardware vs Software (concretely)

- Hardware
  - CPU, Memory, disks
- Software
  - Windows 7, Google Chrome, Games, Eclipse
  - Microsoft Word

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## Hardware vs Software (abstractly)

- Software
  - An organized collection of instructions
- Hardware
  - Circuits that execute, store and interact with **instructions**
    - Execution: CPU
    - Storage: Memory
    - Interaction: Peripherals, like keyboards, monitors, networks

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## Software Categories

- Operating System
  - first program to load when a computer is turned on
  - controls all machine activities
  - provides the user interface to the computer
  - manages computer resources, such as the CPU, memory, and hard drive
  - Examples?
- Application
  - generic term for any other kind of software
  - examples: word processors, missile control systems, games

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## Operating System (OS)

- OS monitors overall activity of the computer and provides services
- Written using programming language
- Example services:
  - memory management
  - input/output
  - storage management

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## Application Programs

- Written using programming languages
- Perform a specific task
- Run by the OS
- Example programs:
  - Browsers
  - Word Processors
  - Spreadsheets
  - Games

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## Questions

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Classify the following pieces of software as *operating system* or *application*:

1. Microsoft Windows 8
2. Microsoft PowerPoint
3. Linux
4. Your COMP 110 programs



## Instructions

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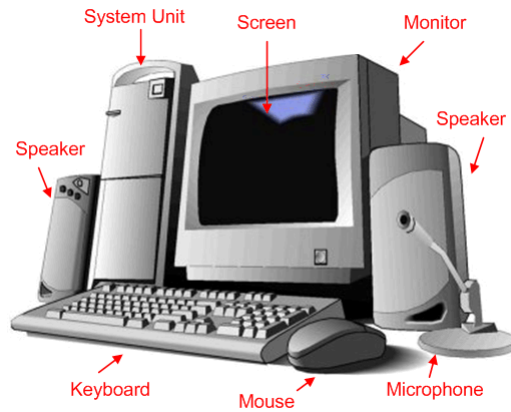
- An instruction is a sequences of 0's and 1's that represents a single operation on the computer

<i>Instruction</i>	<i>Data</i>	<i>Data</i>
– Example: 00000101	00000001	00000010
– Means: ADD	1	2
– What is the output? -- 3		

- These 0's and 1's are called **bits**
  - Why only 0 and 1?
    - Because it is easier to make an electrical device that has only two stable states



# A Computer

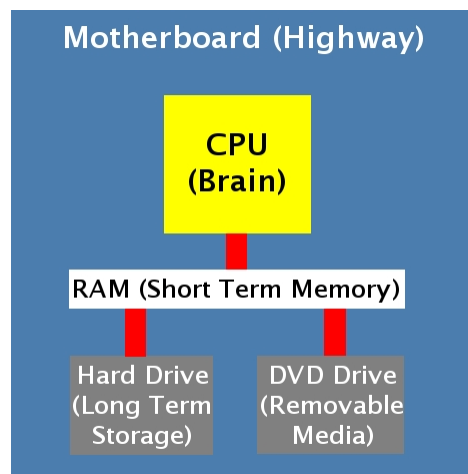


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# Memory



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## CPU (Central Processing Unit)

- It is the “brain” of the computer
  - CPU executes the instructions
  - CPU’s working routine
    - read instructions and data from memory
    - do calculation
    - write calculation results back to memory
- Intel Core i7 **3.4 GHz**
  - Executes *at most* 3,400,000,000 instructions per second



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## Central Processing Unit (CPU)

- Control Unit (CU)
  - “the brain” of the CPU
- Program Counter (PC)
  - points to the next instruction to be executed
- Instruction Register (IR)
  - holds the currently executing instruction
- Arithmetic Logic Unit (ALU)
  - carries out all arithmetic and logical ops
- Accumulator (ACC)
  - holds the results of the operations performed by the ALU

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## Memory

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- Holds instructions and data for the computer
  - How much the “brain” can remember
- Main Memory
  - For intermediate calculations (program you are running)
  - Disappears when you shut down your computer
- Secondary Memory
  - Hard drives, CDs, Flash drives
  - Exists until you delete it

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## GB? MB? KB?

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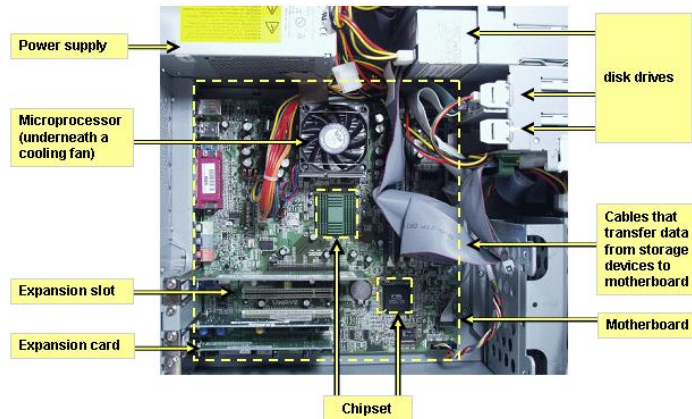
- 1 bit = 0 or 1
- 1 byte = 8 bits
  - Smallest addressable unit of memory
- Kilo, Mega, Giga, Tera
  - 1 KB = 1,000 bytes (1 thousand bytes)
  - 1 MB = 1,000 KB = 1,000,000 bytes (1 million bytes)
  - 1 GB = 1,000 MB = 1,000,000,000 bytes (1 billion bytes)
    - The same for GHz (1 Giga Hertz)
  - 1 TB = 1,000 GB = 1,000,000,000,000 bytes!

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## A Computer Motherboard



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## Main Memory

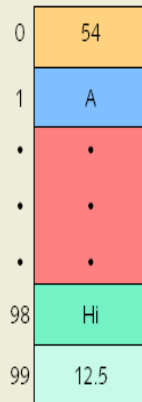
- Memory address
  - To locate certain memory positions
  - CPU fetches data according to memory address
- *Another interesting fact: characters are also saved in bits, and so is everything else*

Memory address	Memory content	
.	.	
.	.	
.	.	
2000	01001010	Encoding for character 'J'
2001	01100001	Encoding for character 'a'
2002	01110110	Encoding for character 'v'
2003	01100001	Encoding for character 'a'
2004	00000011	Encoding for number 3
.	.	



## Main Memory with 100 Cells

Each memory cell has a numeric *address*, which uniquely identifies it



## CPU and Main Memory

**All programs must be brought into main memory before execution**



Chip that executes program instructions

Primary storage area for programs and data that are in active use (RAM)

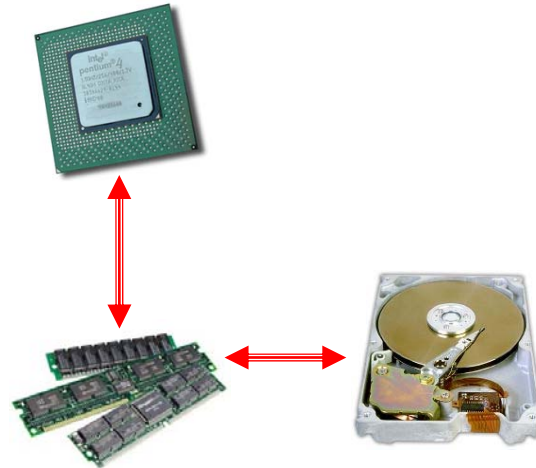




## Secondary Storage

Secondary memory devices provide long-term storage

Information is moved between main memory and secondary memory as needed



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## Secondary Storage

- Provides permanent storage for information
- Retains information even when power is off
- Examples of secondary storage:
  - Hard Disks
  - USB Drives
  - DVDs
  - CDs
  - Tapes

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## Peripherals

- Input devices
  - Keyboard, mouse, game controller.....
  - When they get input, they save that at certain memory addresses
- Output devices
  - Monitor, speaker, printer.....
  - They are projected to certain memory addresses
  - When CPU wants to output, it writes to those addresses
- **CPU sees everything as memory**

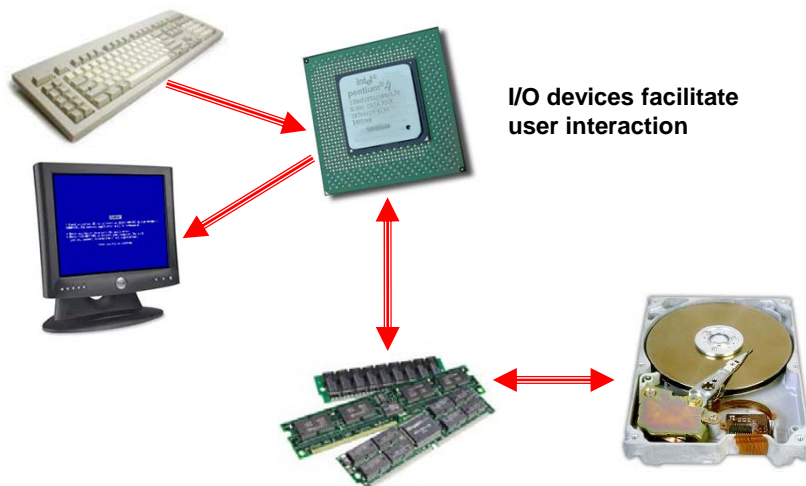


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## Input/Output Devices



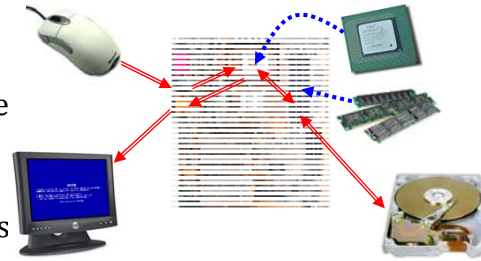
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## Opening Notepad

- Use the mouse to select Notepad
- The CPU requests the Notepad application
- Notepad is loaded from the hard drive to main memory
- The CPU reads instructions from main memory and executes them one at a time
- Notepad is displayed on your monitor



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## Programs

- Set of instructions for a CPU to follow
  - Also known as software
- You will be writing programs
  - We will write one today
- Our programs will be in **Java**

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## Programming Languages

- Why do we need languages when we have instructions?
  - Too hard for humans to write bits directly



From: **Great Ideas in Computer Science** by JAVA,  
by A. W. Biermann and D. Ramm,  
The MIT Press 2002.

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## Programming Languages

- Different languages are good at different aspects
  - C/C++: close to instructions, runs fast
  - Matlab: good at scientific computation
  - Python: relatively easy, fast development
- We choose Java
  - Not because...
    - It's the best language (there is no such thing!), or
    - It's easiest to learn (not!)
  - But because
    - It's widely used, incorporates (most) modern features

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## Programming languages

- Java - General purpose. Best for writing larger programs.
- Javascript - No relationship to Java! Very specialized. Runs in your web browser and adds advanced behavior to web pages.
- Python - General purpose but a scripting language. Much easier to write small programs (compared to Java), but much less appropriate for larger ones.
- Matlab - Very different from the other 3 languages. Very powerful but highly specialized. Excellent for solving equations, graphing data, etc. since much less programming is required.

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## From Languages to Instructions

- The translator is called a **compiler**
  - It is also a program
  - From human-readable to machine-readable



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## From Java to Machine Language

- Computers understand only 0 and 1 (*machine language*)
- *Compiler* translates source code into machine code
- *Java compiler* translates source code (file ending in .java) into *bytecode* (file ending in .class)
  - bytecode is portable (not machine-specific)
- *Java interpreter* reads and executes bytecode
  - different Java interpreters for different types of CPUs and operating systems (OS)
    - Intel/Windows, Motorola/Mac OS X, Intel/Linux

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## Programming Languages

- Programming languages have rules of grammar just as English does
- ***syntax rules*** - which statements are legal and which are not
- ***semantic rules*** - determine the meaning of the instructions
- ***token*** - smallest individual unit of a program
  - special symbols
  - word symbols
  - identifiers

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## Special Symbols

+      -      \*      /  
 .      ;      ?      ,  
 <=    !=    ==    >=

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## Word Symbols (aka reserved words or keywords)

- int
  - float
  - double
  - char
  - void
  - public
  - static
  - throws
  - return
- reserved words are always all lowercase
  - each word symbol is considered to be a single symbol
  - cannot be used for anything other than their intended purpose in a program

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## Next class (Tue, Aug 25)

- More Programming Basics
  - Program in class: Hello World!
  - Assignment0 DUE Fri, Aug 28
- Reading Assignment: Chapter 1