Introduction to Java Programming
Part 1: Computer and Program

Course: CPSC 1150

Instructor: Dr. Bita Shadgar

Lecture 1

Learning Outcomes

- Identify different part of a computer
- Identify and recognize the relation between hardware and software of computer
- Define program, different level of programming languages
- Identify the role of operating system as an interface between application software and hardware
- Justify the role of high-level language

The Computer Discipline

Required skills:

- Algorithmic thinking
- Design
- Representation
- Programming

Question: Mathematics vs. science vs. engineering where does computing live?

Answer: Theory vs. experimentation vs. design

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Why? We will talk about this semester

What is programming?

Definition

Programming is creating software, or programs

A **program** is a set of instructions telling a computer what to do

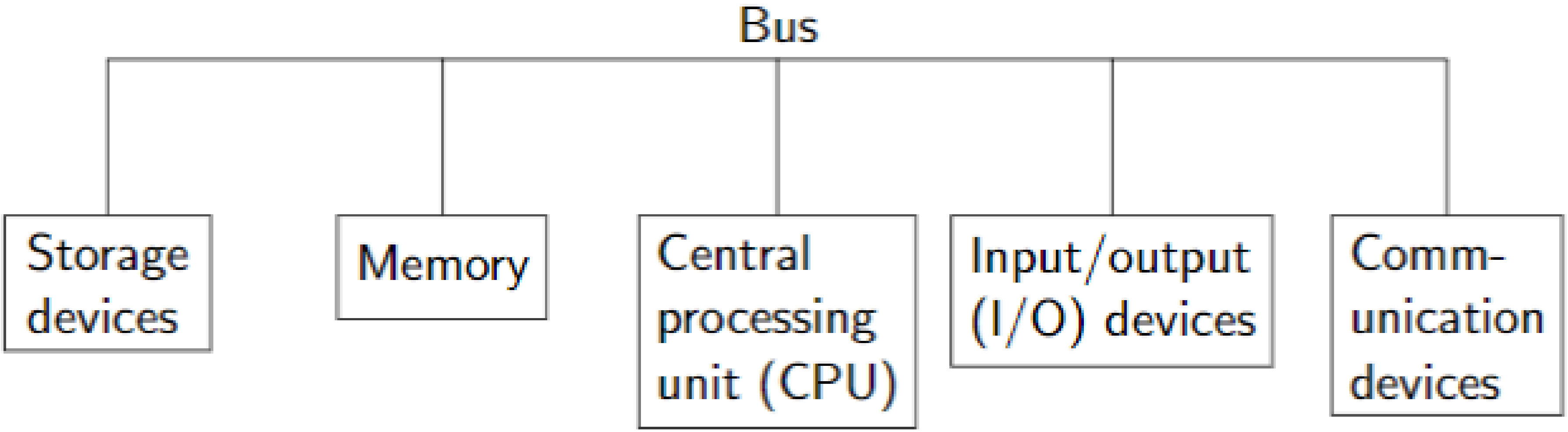
- Todays, computers are found every where!
- Computers have two types of components:
  - Software: Invisible collection of programs.

    What we will discuss for the rest of the course.
  - Hardware: Physical and tangible parts.

    Overview of this today.

Computer Hardware

- As programmers, understanding hardware helps us to know what our programs are really doing



- Components communicate via the bus.
- We'll learn a little about each type of hardware component

Central Processing Unit

- Where the magic happens : The ‘Brain’ of a computer
- Physically made from a small silicon chip with millions of **transistors** (electronic switches)
- **Multiple cores** in a CPU can read and execute instructions independently
- CPU retrieves instructions from memory and executes them

CPU Components

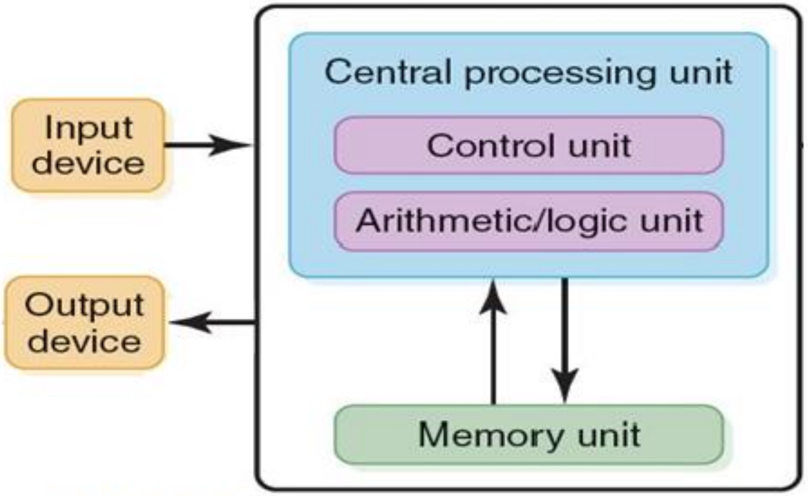


FIGURE 5.1 The von Neumann architecture.

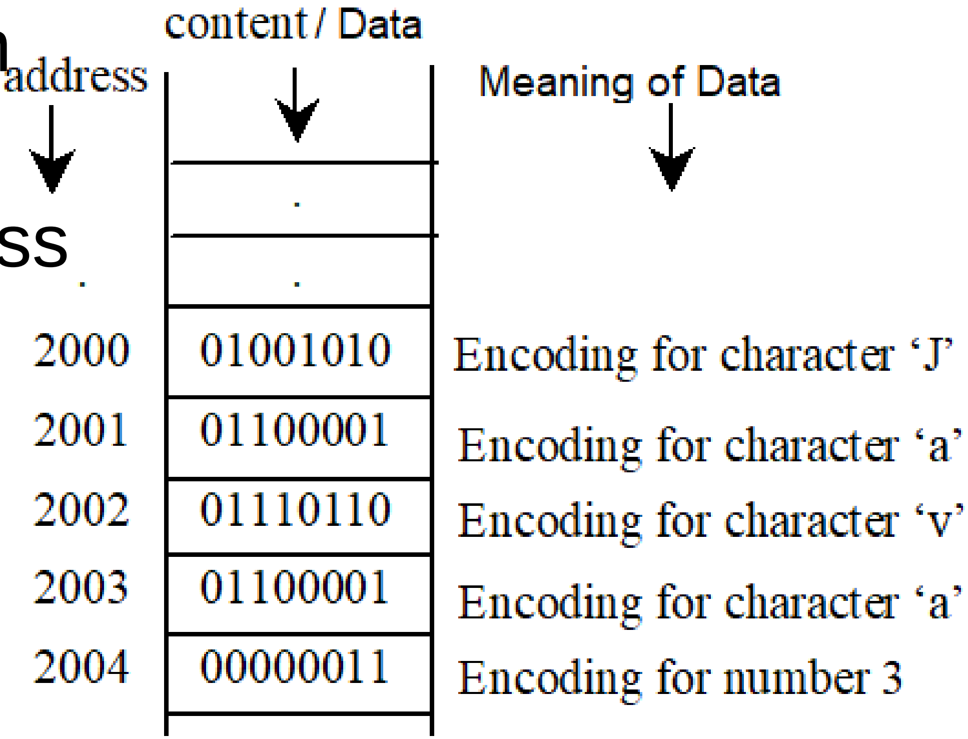
- **Clock** - emits regular pulses
  - Clock speed is measured in Hertz (Hz) = pulses per second
  - Current CPUs can run at 3 GHz, or about 3 billion pulses per second
- **Control unit** - executes instructions each clock cycle
- **ALU** - arithmetic/logic unit

Information in a computer

- Computer can be thought of as a collection of switches
  - Storing data/programs just turns certain switches on and off
- **Bits** (binary digits) represent the state of switches
  - The \`on' position is represented as a 1
  - The \`off ' position is represented as a 0
- Minimum unit of storage is one **byte** = 8 bits
- An encoding scheme (like ASCII) is used to translate characters, numbers, and symbols into byte
  - Example : The byte 01100001 represents the character \`a' under the ASCII encoding scheme

Memory

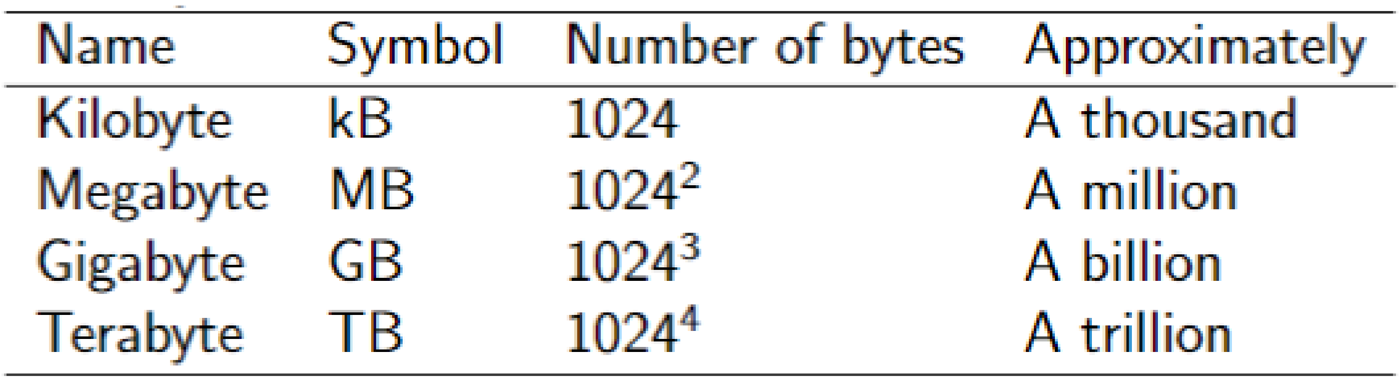
- Short-term storage
- Called random access memory (RAM) since it doesn't have to be accessed in order
- Memory is an ordered in sequence of bytes
- Each byte has an address
- Bytes never get erased, just overwritten



address	content / Data	Meaning of Data
	.	
.	.	
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

Memory (cont.)

- A program and associated data need to be in memory to be executed
- Physically, memory is built on silicon chips with millions of transistors, like a CPU
- Everything in memory is reset when power is turned off
- Memory size is measured in:



Name	Symbol	Number of bytes	Approximately
Kilobyte	kB	1024	A thousand
Megabyte	MB	1024^2	A million
Gigabyte	GB	1024^3	A billion
Terabyte	TB	1024^4	A trillion

- Today, memory on personal computers is usually between 6-8 GB

Storage devices

- Long-term memory
- Slower to access than RAM
- Different types of media, and each one has a drive to read from and write to it:
  - Magnetic disk drive - main chunk of storage on a computer
  - Optical disk drive - reads/writes CDs and DVDs
  - USB flash drive - Universal Serial Bus allows many I/O devices to connect to a computer, including a flash drive

Input/output (I/O) devices

Hardware that allows the user to interact with the computer

- Examples of input devices
  - Keyboard
  - Mouse/touchpad
  - Touchscreen
- Examples of output devices
  - Monitor
  - Printer
  - Speaker

Communication devices

Hardware that allows the computer to communicate with a network

- Examples
  - Dial-up/cable modem
  - Digital subscriber line (DSL)
  - Network adapter

Levels of programming languages

- Low level
  - Understandable to a computer
    - e.g. Machine language
- Mid-level
    - e.g. Assembly language
- High level
  - Understandable to a human
    - e.g. High-level languages such as Java and Python

Machine language

- The code that computers understand and can execute
  - Example

    Machine code as follows: 111001011 00000110 may contain an instruction to add 6 to a stored number
- Sequences of bytes represent primitive built-in instructions, that differ from machine to machine
- Extremely difficult for humans to create, edit and maintain this kind of code

Assembly language

- An instruction in assembly is basically shorthand for a machine code instruction
  - Example

    An assembly instruction to add 6 to a stored number might look like this: ADDX 06
- Written in a way that humans can (tediously) understand and manipulate
- Assembly source code gets passed through a program called an assembler which spits out equivalent machine code

High-level languages

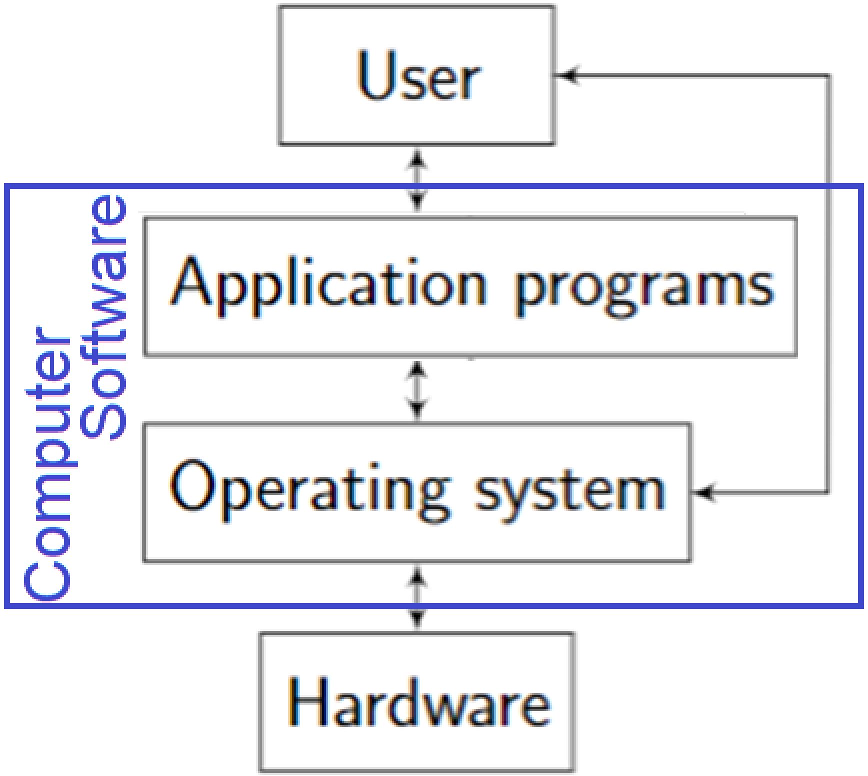
- Most similar to natural languages (i.e., English)
- Platform (machine) independent
- A chunk of code in a high-level language is called source code
- Source code must be compiled or interpreted before it is run on a computer
  - Compiled: Source code -> Compiler -> Machine code -> CPU
  - Interpreted: Source code -> Interpreter -> CPU

Example

- A statement in a high level language to add 6 to a stored number might look like this: x = x + 6;

Computer Software

- System Software
  - Examples:
    - Operating System
    - Device Drivers
    - Compilers and more
- Application Software
  - Examples:
    - Science, Business, Graphics, Games



Operating system (OS)

- Most important program
- Manages and controls a computer
- All application programs must run on top of an OS

Example

- Some popular operating systems are Windows, Mac OS, and Linux

Main functions of the OS

- Controls system activities
  - I/O and access to storage go through the OS
  - OS ensures programs don't interfere with each other
  - Security is managed by the OS

- Allocates resources to programs
  - CPU time, memory space, disk use, I/O, etc.

- Schedules operations to make efficient use of resources
  - Multiprogramming, Multithreading, Multiprocessing

More Practice

- List the key terms in the lecture
- Define each key term
- Name the different parts of a computer
- Explain how a computer works