2nd MEETING

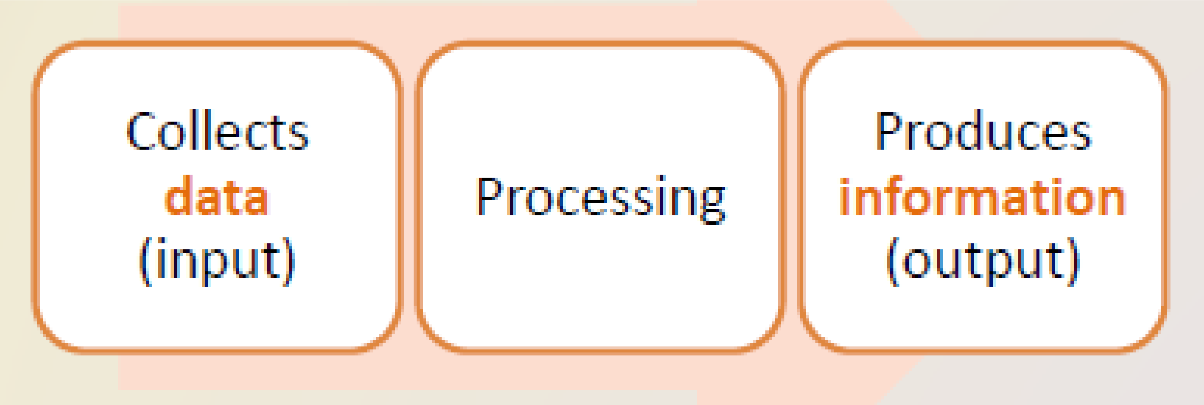
Basic Introduction to Computers

The Computer Defined

- A device that computes
- Electronic device
- Converts data into information
- Modern computers are digital
  - Two digits combine to make data (1s and 0s)
- Older computers were analog
  - A range of values made data

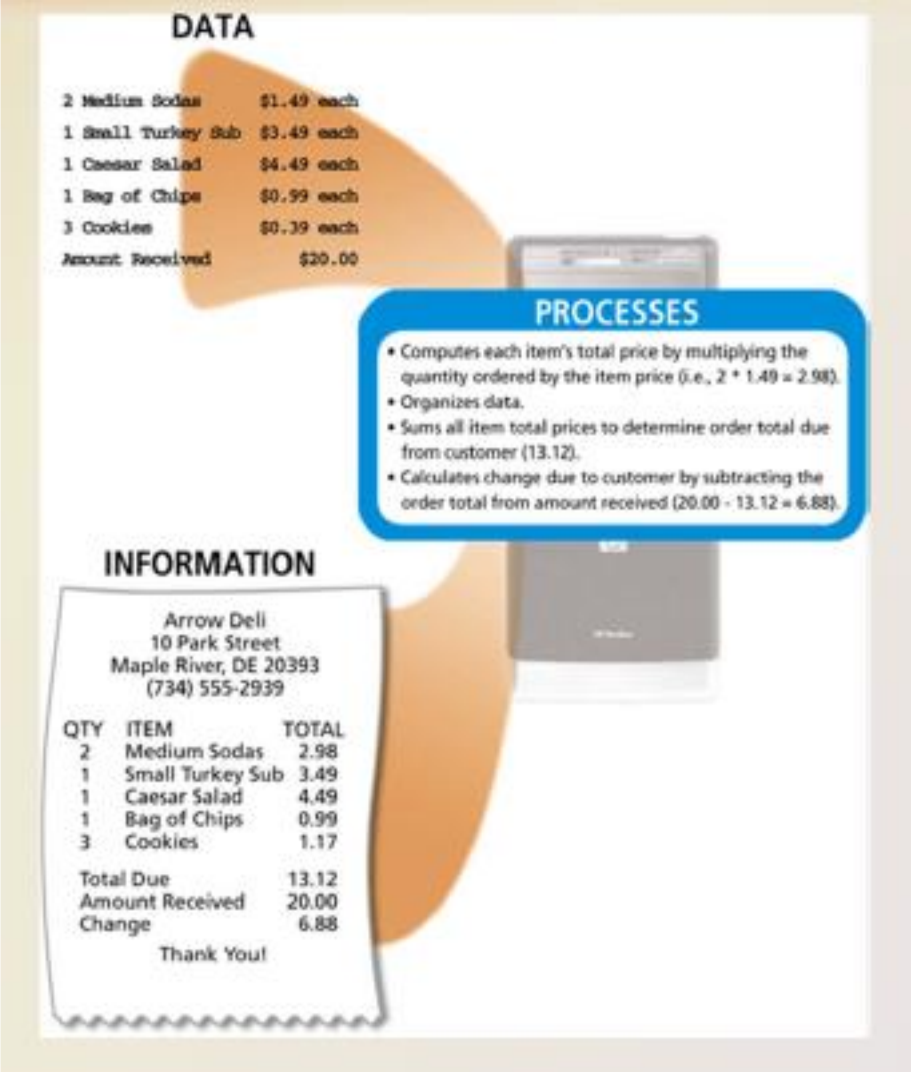
What is a computer?

a device that computes


Collects **data** (input)

Processing

Produces **information** (output)


DATA

2 Medium Sodas	$1.49 each
1 Small Turkey Sub	$3.49 each
1 Caesar Salad	$4.49 each
1 Bag of Chips	$0.99 each
3 Cookies	$0.39 each
Amount Received	$20.00

PROCESSES

- Computes each item's total price by multiplying the quantity ordered by the item price (i.e., 2 * 1.49 = 2.98).
- Organizes data.
- Sums all item total prices to determine order total due from customer (13.12).
- Calculates change due to customer by subtracting the order total from amount received (20.00 - 13.12 = 6.88).

INFORMATION

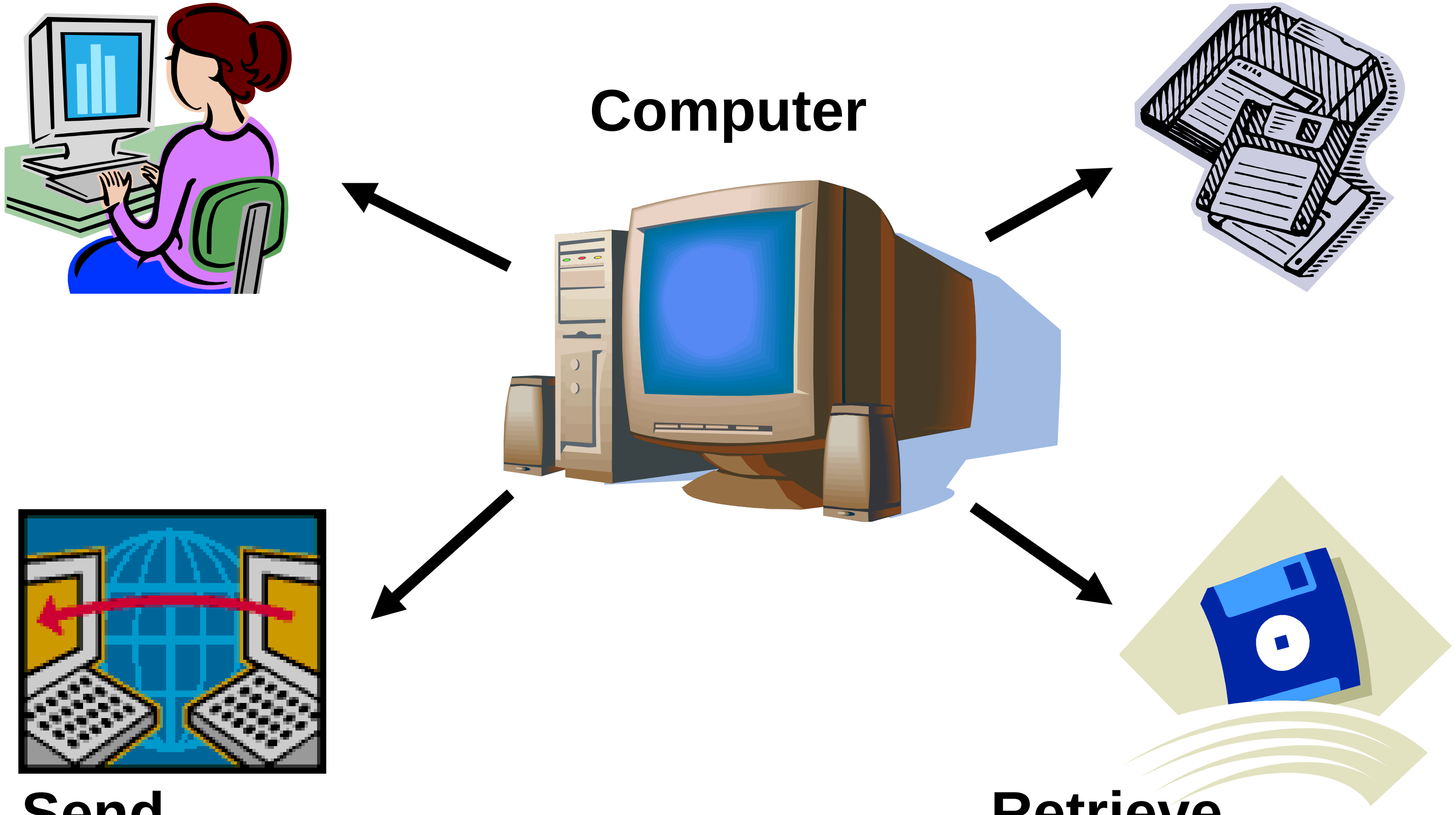
Arrow Deli
10 Park Street
Maple River, DE 20393
(734) 555-2939

QTY	ITEM	TOTAL
2	Medium Sodas	2.98
1	Small Turkey Sub	3.49
1	Caesar Salad	4.49
1	Bag of Chips	0.99
3	Cookies	1.17

Total Due	13.12
Amount Received	20.00
Change	6.88

Thank You!

What is a computer?



Record, Processing

Store

Computer

Send, Receive

Retrieve

What is Processing?

- Conversion of Data into Information
- Data
  - The raw facts and figures that are processed into information
- Information
  - Data that has been summarized or otherwise manipulated for use in decision making

The Components of a Computer

- A computer contains many electric, electronic, and mechanical components known as **hardware**

Input Device

- Allows you to enter data and instructions into a computer

Output Device

- Hardware component that conveys information to one or more people

System Unit

- Case that contains the electronic components of the computer that are used to process data

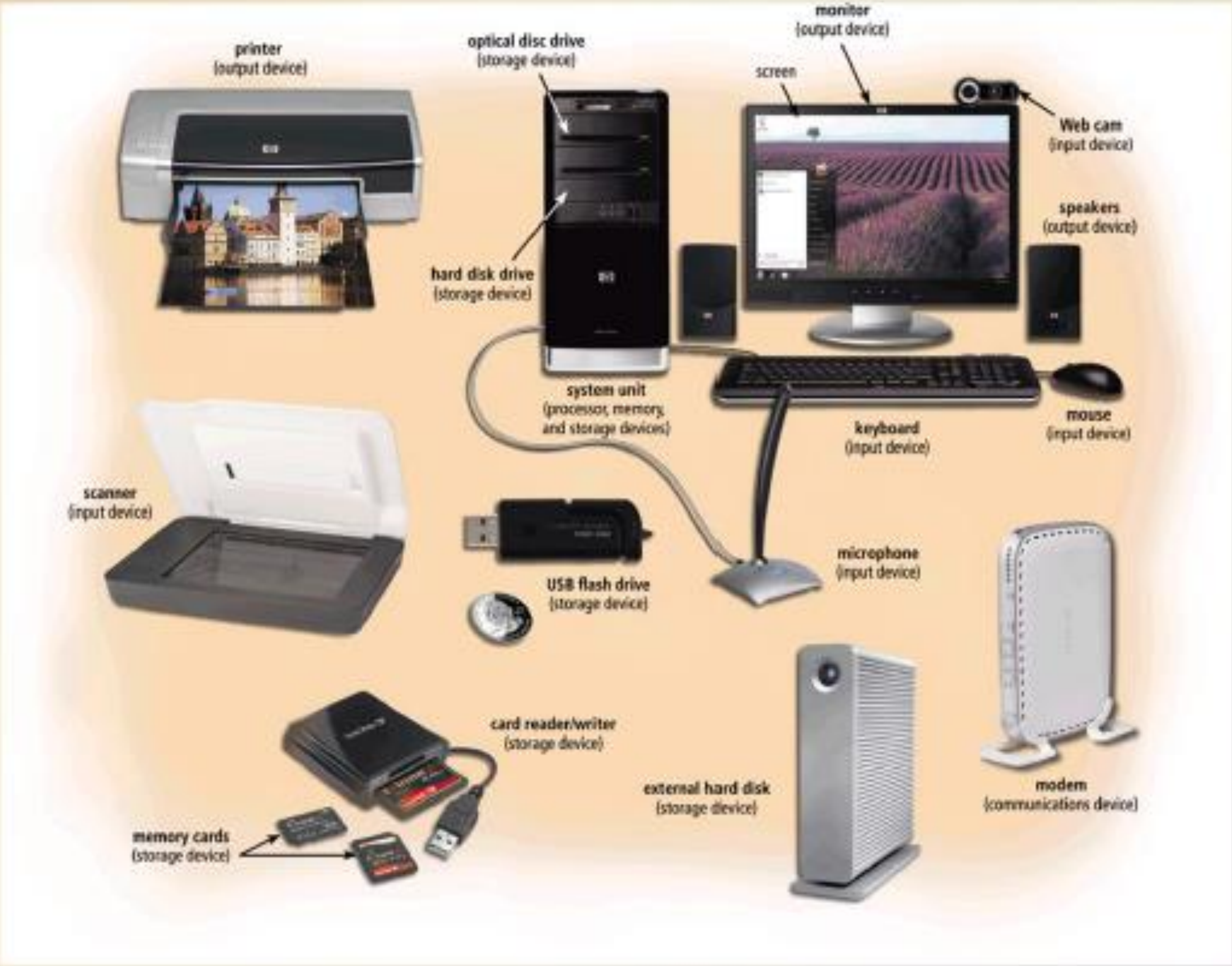
Storage Device

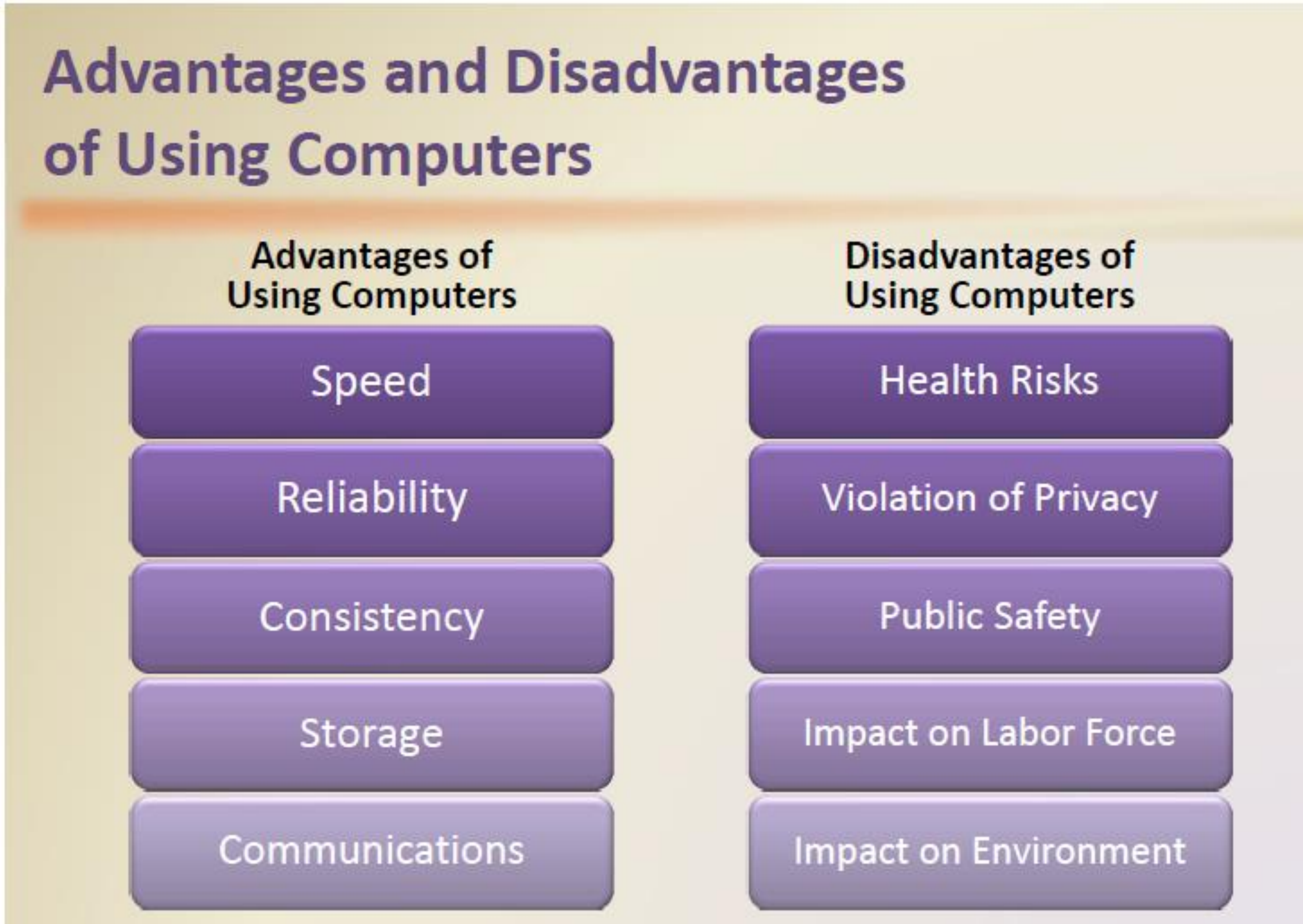
- Records (writes) and/or retrieves (reads) items to and from storage media

Communications Device

- Enables a computer to send and receive data, instructions, and information to and from one or more computers or mobile devices

The Components of a Computer





Advantages and Disadvantages of Using Computers

Advantages of Using Computers

- Speed
- Reliability
- Consistency
- Storage
- Communications

Disadvantages of Using Computers

- Health Risks
- Violation of Privacy
- Public Safety
- Impact on Labor Force
- Impact on Environment

Hardware

Digital Computers

- The computers that we use are digital, not analogue computers
- Analogue technology
  - The signal is directly analogous to the information it represents
  - The signal is continuous and in direct proportion to the source of the information

Digital Technology

- Digital technology
  - The information is broken down into pieces, and each piece is represented separately
  - How music is stored on a compact disc - the disc stores numbers representing specific voltage levels sampled at specific times
  - Can be used to digitize sound, video, graphics, etc.
- Our computers work with digital technology, hence the term digital computers

Storage of Programs and Data

- Sampling is only one way to digitize information
- Since our computers work ONLY with numbers, everything (not just analogue information such as sound and video) must be converted to numbers
  - Text (letters and special characters) gets converted to numbers (A = 65), using a standard coding convention called ASCII
  - Graphics (images), gets broken down into pieces (pixels) and each colour gets a number

Binary Numbers

- Devices that store and move information are cheaper and more reliable if they have to represent only two states
  - A circuit conducts current (1) or does not (0)
  - A position on a diskette is magnetized in one direction (1) or the opposite direction (0)
  - A position on a CD is pitted (1) or is not (0)
- Once information is digitized, it is represented and stored in memory using the *binary number system*
- A single binary digit (0 or 1) is called a *bit*
- A single bit can represent two possible states, like a light bulb that is either on (1) or off (0)
- Permutations of bits are used to store values. All information is represented as combinations of the two digits 0 and 1.

Binary Numbers

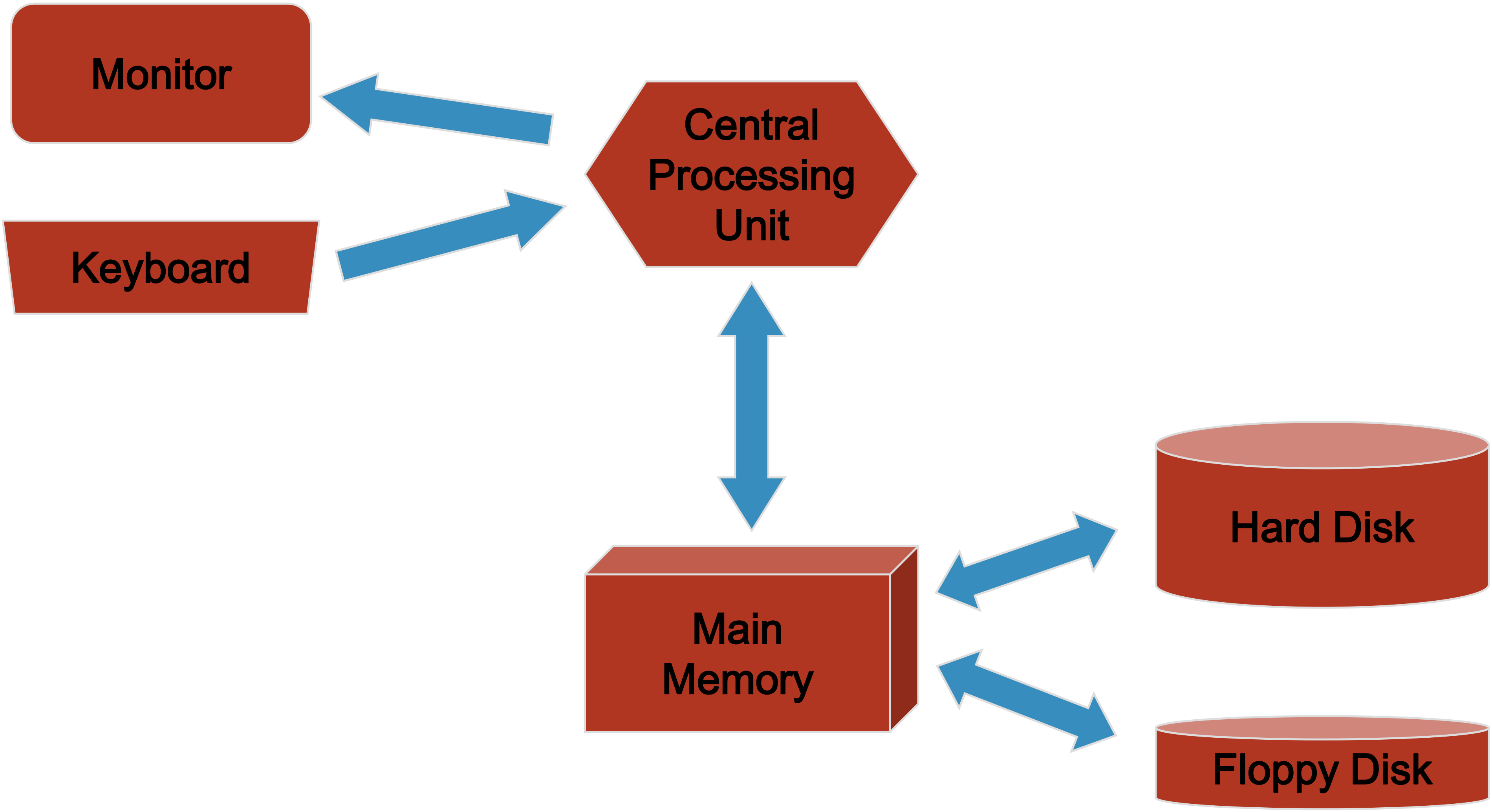
1 bit	2 bits	3 bits	4 bits	
0	00	000	0000	1000
1	01	001	0001	1001
	10	010	0010	1010
	11	011	0011	1011
		100	0100	1100
		101	0101	1101
		110	0110	1110
		111	0111	1111

- Each permutation can represent a particular item
- 1 bit = 2 choices, a 0 or a 1
- 8 bits = 1 byte = 256 different combinations of 0’s and 1’s
- There are 2^N permutations of N bits
- Therefore, N bits are needed to represent 2^N unique items

Binary Numbers

- So how do we convert decimal numbers to binary numbers?
  - i.e. if we enter the number 9 into the computer, how is it changed to 1001 for computer storage and processing?
- Or when we want to display or output information from the computer, how do we convert binary numbers to decimal numbers?
- See the slides titled Number Systems in the Additional Material at the end of this lecture

A simplified view of a computer system



Hardware Devices

- Input Devices (Get information)
  - Keyboard
  - Mouse
  - Scanner

- Output Devices (Give information)
  - Screen/monitor
  - Printer

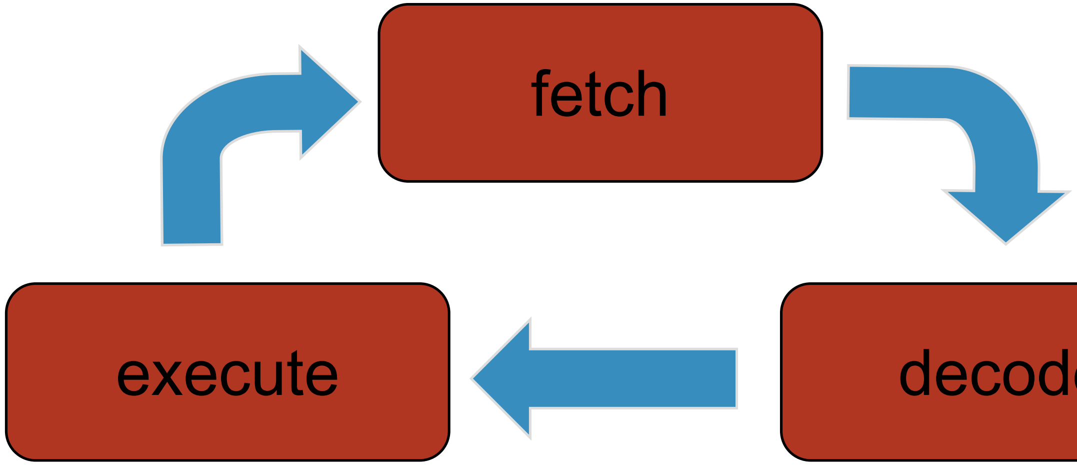
Hardware Devices

- Processing Device (Arithmetic/logic/repetition)
  - Central Processing Unit (CPU)
  - Has three basic parts
    - Arithmetic Logic Unit (ALU)
      - executes all the arithmetic and logic instructions
    - Control Unit
      - decodes instructions and determines which is next to be executed
    - Buses/Registers
      - Buses are paths for information entering/exiting the CPU
      - Registers are memory for processing information

The Central Processing Unit

- The CPU continuously follows the *fetch-decode-execute cycle:*

Retrieve an instruction from main memory



fetch

decode

execute

Carry out the instruction

Determine what the instruction is

Hardware Devices

- Storage
  - Two types
    - Primary and secondary
- Primary Storage (main memory)
  - On board memory (located on the motherboard)
  - Very fast, but expensive
  - Two types
    - RAM – Random Access Memory
    - ROM – Read Only Memory

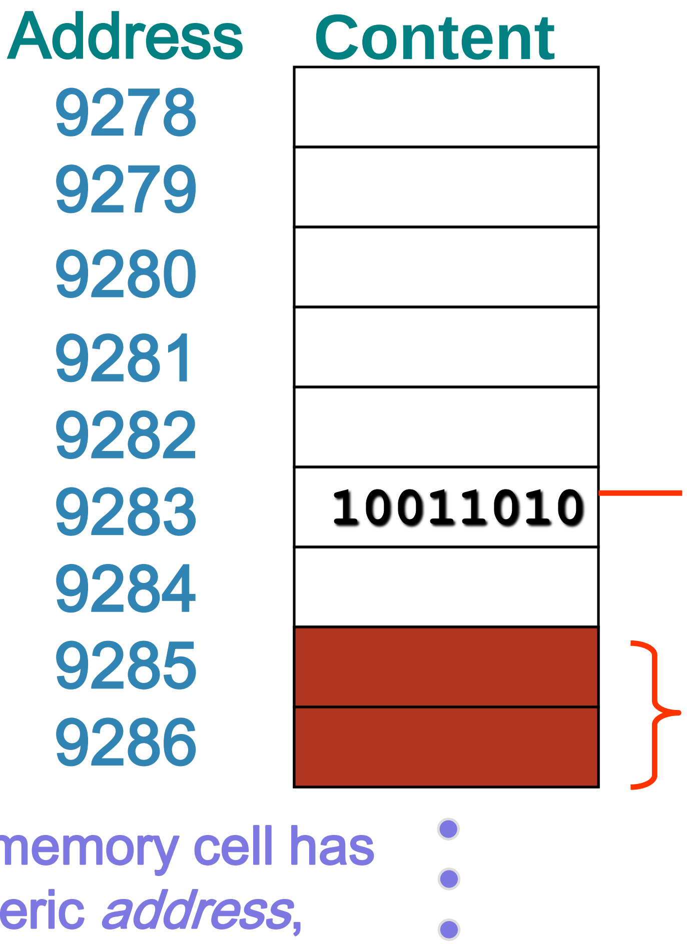
Hardware Devices

- RAM - Random Access Memory
  - Read/write capability
  - Contents lost when computer is turned off (volatile)
  - **A program must be in RAM for it to execute**
  - 128 to 256MB for a typical desktop computer

Hardware Devices

- ROM - Read Only Memory
  - Read but not write capability
  - Permanent (non volatile)
  - Stores the preliminary instructions to be executed when the computer is turned on, for example
    - To check RAM
    - To check communications with peripheral devices
    - Bootstrap loader program

Hardware Devices



Address	Content
9278	
9279	
9280	
9281	
9282	
9283	10011010
9284	
9285	🟥
9286	🟥
	⋮

Main memory is divided into many memory locations (or *cells*)

Each memory cell stores a set number of bits (usually 8 bits, or one *byte*)

Large values are stored in consecutive memory locations

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

Hardware Devices

- Secondary Storage (secondary memory)
  - External devices (not on the motherboard); either inside or outside the computer
  - Store programs and data permanently
  - Slower, but cheaper
    - RAM - nanoseconds, Drive - milliseconds
  - Different sizes/styles
    - Floppy Disk - 1.4MB (portable)
    - Zip Drive - 100-750MB (portable)
    - CD - 650MB (portable)
    - Hard Disk Drive >=20GB (not portable)
    - Flash drives (portable)

Hardware Devices

- Other devices
  - Port
    - For connecting peripheral devices
    - USB, Parallel and serial ports
  - Modem (internal or external)
    - For communicating over telephone lines

Software

Software

- A computer program is a series of instructions
  - each instruction is expressed in a format consistent with a predefined set of rules
  - a computer processes data under the direction of the instructions in a program
  - there are instructions to input, process, store and output data
  - the user of a program (as distinct from its creator) has no need to be aware of the details of its construction
  - the user is only interested in the services that the program is able to provide

Software

- Programming Languages
  - 1st generation
    - machine language
    - instructions coded using combinations of 0’s & 1’s
  - 2nd generation
    - assembly languages (low-level symbolic languages)
    - instructions coded using letters & numbers
    - one assembly language instruction is translated into one machine language instruction

Software

Programming Languages

- 3rd generation
  - high-level symbolic languages
  - one instruction generates multiple machine language instructions
- 4th generation programming languages
  - non-procedural languages
  - code “what” not “how”

Software

Translation Software

- Interpreters
  - translate each instruction as it is entered
    - Advantage: easier to find/correct mistakes
    - Disadvantage: redundant translation
- Compilers
  - translate a group of instructions
    - Advantage: generally faster
    - Disadvantage: all errors are given at one time

Software

- A file is a unit for storing information
- All information on a computer is stored in files
  - Data Files
    - created by the user of the computer
      - My_Thesis.doc, Assign1.xls
  - Program Files
    - created by a programmer
      - Word, Excel, Windows98
  - Naming Convention
    - [File Name].[Extension]
      - the extension, (usually 3 letters long), describes the type of program used for that file
        - doc(Word), xls(Excel), ppt(PowerPoint)

Software categories

- Operating System
  - controls all machine activities
  - provides the user interface to the computer
  - manages resources such as the CPU and memory
  - Windows XP, Unix, Linux, Mac OS
- Application program
  - generic term for any other kind of software
  - word processors, games, . . .
- Most operating systems and application programs have a *graphical user interface* (GUI)

Software

Operating Systems

- The most important software on a computer
  - always running to perform the following tasks
    - create and manage files
    - run programs
    - control information going to/from the peripherals
  - Eg: MS-DOS
    - create and manage files - several programs
    - run programs - COMMAND.COM
    - peripherals - IO.SYS, MSDOS.SYS

Disk Operating System (DOS)

- Example of command line interface (DOS prompt in bold; user entries in italics)

```
c:\  a:
a:\  format
a:\  Format another (Y/N)? n
a:\  c:
c:\  cd csi1301\lectures
c:\csi1301\lectures  copy lecture2 a:
c:\csi1301\lectures  a:
a:\  dir /p
```

Windows

- An operating system that has four advantages over MS-DOS
  - Graphical user interface (GUI)
    - uses pictures & symbols (not just text & numbers)
    - replaces the DOS command line interface
  - Multitasking
    - allows running or opening 2 or more programs simultaneously
    - click on the taskbar to switch between open programs

Starting (Booting) the Computer

- Turn on the power
  - CPU loads the instructions from ROM into RAM, including the bootstrap loader program
  - CPU executes the bootstrap loader program which
    - Starts drive a: (diskette drive)
    - Reads the boot record (bootstrap program) from the diskette in drive a: and loads it into RAM; if no diskette is in drive a:, reads the boot record from the c: drive (hard drive) and loads it into RAM
  - CPU executes the bootstrap program which
    - Loads a portion of the operating system into RAM

Additional Material

Number Systems

Number Systems

- The base value of a number system determines
  - The number of symbols in the system
  - The place value of each digit

- Decimal (base 10)
  - Symbols (10): 0,1,2,....9
  - Place: …..,10^4,10^3,10^2,10^1,10^0
  - 132: $(1x10^2)+(3x10^1)+(2x10^0)$

Number Systems

- Octal (base 8)
  - Symbols (8): 0,1,2,….7
  - Place: …..,8^3,8^2,8^1,8^0

  To convert decimal 132 to octal:

  $(2x8^2)+(0x8^1)+(4x8^0)$ or 204_8

- Hexadecimal (base 16)
  - Symbols (16): 0,1,2,…9,A,B,C,D,E,F
  - Place: …..,16^3,16^2,16^1,16^0

  To convert decimal 132 to hexadecimal:

  $(8x16^1)+(4x16^0)$ or 84_{16}

Number Systems

- Binary (base 2)
  - Symbols (2): 0,1
  - Place: …..,2^3,2^2,2^1,2^0

  To convert decimal 132 to binary:

  $(1x2^7)+(0x2^6)+(0x2^5)+(0x2^4)+(0x2^3)+(1x2^2)+(0x2^1)+(0x2^0)$ or 10000100_2

Number Systems

- To convert from any base to decimal
  1. Write the number in its expanded form
  2. Sum each term
  - 1001_2
    - $(1 \text{x} 2^3) + (0 \text{x} 2^2) + (0 \text{x} 2^1) + (1 \text{x} 2^0)$
    - $8 + 0 + 0 + 1 = 9$
  - 84_{16}
    - $(8 \text{x} 16^1) + (4 \text{x} 16^0)$
    - $128 + 4 = 132$
  - 35_8
    - $(3 \text{x} 8^1) + (5 \text{x} 8^0)$
    - $24 + 5 = 29$

Number Systems

- To convert from decimal to any base
  1. Write the place representation for the base using 1 as the multiplier for each term
  2. Calculate the value of each term
  3. Determine the number required for each term
- Decimal (57_{10}) to binary

$(1x2^6)$	+	$(1x2^5)$	+	$(1x2^4)$	+	$(1x2^3)$	+	$(1x2^2)$	+	$(1x2^1)$	+	$(1x2^0)$
64		32		16		8		4		2		1
0		1		1		1		0		0		1

57_{10} = 111001_2

Number Systems

- Decimal (57_{10}) to octal

$(1x8^2) + (1x8^1) + (1x8^0)$

64 8 1

0 7 1

57_{10} = 71_8

- Decimal (57_{10}) to hexadecimal

$(1x16^2) +(1x16^1) + (1x16^0)$

256 16 1

0 3 9

57_{10} = 39_{16}

Number Systems

Decimal	Binary	Octal	Hex
101	1100101	145	65
5	101	5	5
65	1000001	101	41
257	100000001	401	101

Exercice 1

1. Convert the following decimal numbers into Binary (base 2), Octal (base 8) and Hexadecimal (Base 16)
   - 17 – 85 – 172 – 220

2. Convert the following numbers into their decimal equivalent
   - 110_2 – 110_3 – 110_5 – 110_8 – 110_{16}

Any Questions