

## CH1

### \* Turing Model

→ a mathematical model of computation that defines an abstract machine that manipulates symbols on a strip of tape according to a table of rules

### \* Five generations of computers

- less follow von Neumann model → faster, smaller, cheaper
- ① first generation (1930 ~ 1945)
  - bulky (e.g. ENIAC)
  - vacuum tubes as electronic switches
  - expensive
- ② second generation (1957 ~ 1965)
  - transistors
  - smaller, cheaper
  - FORTRAN, COBOL
- ③ third generation (1965 ~ 1975)
  - integrated circuits (IC)
  - much smaller and cheaper
  - microcomputer
  - software package
- ④ fourth generation (1975 ~ 1985)
  - microcomputer
  - desktop computer = Apple Mac (1981)
  - computer networks
- ⑤ fifth generation (1985 ~ present)
  - laptop, palmtop computer
  - CD, DVD
  - multimedia
  - virtual reality

### \* von Neumann model

→ the stored-program computer where instructions and data are stored in memory and the machine works by changing its internal state

### \* What is the role of a program in a computer that is based on the Turing model?

→ Based on the Turing model, a program is a set of instruction that tells the computer what to do

### \* What is the function of the memory subsystem in a computer?

→ automatically retrieving operands from and storing results in their associated memory modules

### \* What are the various subsystems of a computer?

→ The subsystems of the von Neumann model are memory, the arithmetic logic unit (ALU), the control units, and the input / output

#### ① memory = storage area

② ALU: calculation, logic operations

③ control unit: controls the operation of the memory, ALU, and the input / output

④ input / output: The input subsystem accepts

input data and the program from outside

the computer; the output subsystem sends

the results of the processing to the outside

### \* What is the role of a program in a computer that is based on the von Neumann model?

→ Implemented by manipulating a set of switches or by changing the wiring system

### \* Positional / nonpositional number system

① positional: use digits for the representation

② nonpositional: does not use digits for the representation instead it uses symbols for the representation

### \* Define the base or radix in a positional number system. What is the relationship between a base and the number of symbols in positional number system?

→ The base (or radix) is the total number of symbols used in a positional number system

### \* Hexadecimal system

→ The hexadecimal system is a positional system with sixteen symbols. The word hexadecimal is derived from the Greek root hex (six) and the Latin root decim (ten). To be consistent with decimal and binary, it should have been called sexadecimal, from Latin roots sex and decem. In the hexadecimal, the base is 16.

\* How many bits in the binary system are represented by one digit in the hexadecimal system?

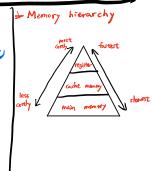
→ Four bits in binary is one hexadecimal digit

\* How many bits in the binary system are represented by one digit in the octal system?

→ Three bits in binary is one octal digit

### \* Discuss the role of the leftmost bit in sign-and-magnitude, and two's complement format.

→ In both systems, the leftmost bit represents the sign. If the leftmost bit is 0, the number is positive; if it is 1, the number is negative



### \* Can n, the bit allocation, equal 1? Why or why not?

→ The bit allocation can be 1. In this case, the data type normally represents a logical value.

### \* Overflow

→ When a calculation is run but the computer is unable to store the answer correctly.

### \* Logical Binary Operations

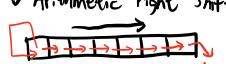
→ AND, OR, XOR

### \* What is the difference between simple and arithmetic shifts?

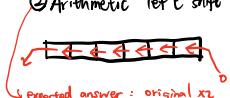
→ The logical shift operation is applied to a pattern that does not represent a signed number. The arithmetic shift operation assumes that the bit pattern is a signed number in two's complement format

### \* Arithmetic shift

#### ① Arithmetic right shift



#### ② Arithmetic left shift



→ Expected answer: original x

## CH2

### \* Define a number system

→ Shows how a number can be represented using distinct symbols

### \* Binary System

→ The binary system is a positional number system that uses two symbols (0, 1) to represent a number.

The word binary is derived from the Latin root

bini (two by two) or binarius (related to two). In the binary system, the base is 2.

### \* Why is it easy to convert from binary to hexadecimal?

→ because binary is base 2, and the hexadecimal is base 16, and 16 is a power of 2, it is easy to switch back and forth between the two number systems.

## CH3

### \* Five data types that a computer can process

→ numbers, text, audio, images and video

### \* What is the advantage of the vector graphic method over the bitmap graphic method?

What is the disadvantage?

→ Bitmap images can be resized, but you may sacrifice pixels in the process. In contrast, vector images can resize themselves without sacrificing image quality, making them more scalable in design.

\* How is bit pattern length related to the number of symbols the bit pattern can represent? → The relationship is logarithmic

\* How does the bitmap graphic method represent an image as a bit pattern? → In the bitmap graphic method each pixel is represented by a bit pattern

\* What steps are needed to convert audio data to bit patterns?

→ Sampling, quantization, encoding

\* The representation of negative integers in sign-and-magnitude, two's complement format

→ In both representations, the upper half of the range represents the negative numbers. However, the wrapping is different.

→ In addition, there are two zeros in sign-and-magnitude but only one in two's complement.

\* A simplified cycle can consist of three phases: fetch, decode, execute

\* XOR

x	y	$x \oplus y$
0	0	0
0	1	1
1	0	1
1	1	0

### \* Complementing (NOT) \* Setting (SET)

### \* Unsetting (AND) \* Flipping (XOR)

### \* Arithmetic operation / Logical operation

① arithmetic operations interpret bit pattern as numbers.

② logical operations interpret each bit as a logical value (true/false)

### \* In the addition of floating-point numbers, how do we adjust the representation of numbers with different exponents?

→ The decimal point of the number with the smaller exponent is shifted to the left until the exponents are equal

### \* What binary operation can be used to unset bits? What bit pattern should the mask have?

→ The AND operator can be used to clear bits.

Set the desired positions in the mask to 0.

- CH5** Memory addresses are defined using unsigned binary integers  
⇒ MB (megabytes) =  $2^{10}$
- \* Three subsystems that make up a computer?
    - CPU, main memory, the input/output
    - the function of the control unit?
    - controls data flow inside the processor
    - ★ purpose of cache memory
      - provides the CPU with fast access to part of data stored in main memory
    - ★ How are the surfaces of a magnetic disk and magnetic tape organized?
      - The surface of a magnetic disk is divided into circular rings called tracks. Each track is divided into sectors. The width of a magnetic tape is divided into 9 tracks. The length of the tape may be divided into blocks
  - \* CPU → ALU, control unit, registers
    - \* the function of the ALU → performs arithmetic and logical operations
    - \* the function of main memory
      - stores data and programs when the program is being executed
      - ★ SCSI, FireWire, USB controllers
        - ① SCSI: a parallel interface that provides a daisy chain connection between devices and the bus
        - ② FireWire: high speed serial interface that transfers data in packets. It can use a daisy chain or tree configuration
        - ③ USB: a serial controller that connects both low and high-speed devices to the computer bus. Multiple devices can be connected to a USB controller
    - \* Pipelining
      - Pipelining allows different types of phases belonging to different cycles to be done simultaneously. Pipelining can increase the throughput of the computer.

**CH6** A protocol defines the rules that both the sender and receiver must follow to be able to communicate effectively

- \* Each browser usually consists of a controller, interpreter, and transport layer is responsible for the logical delivery of a message between client and server processes
- \* the first principle for protocol layering that needs to be followed to make the communication bidirectional?
  - To make the communication bidirectional, each layer needs to be able to provide two opposite tasks, one in each direction
- \* Which data units is decapsulated from a user datagram?
  - A user datagram is a transport-layer data unit. It decapsulates a data unit going to the application layer. In this case, the data unit is a message.
- \* Most of the operating systems installed on personal computers come with several client processes, but normally no server processes. Why?
  - A personal computer, such as a desktop or a laptop, is normally used as a client. If a business needs to use a computer as a server, it should be more powerful to allow several connections from clients at the same time.
- \* Analog transmission
  - refers to the transmission of analog signals using a band-pass channel. Baseband digital or analog signals are converted to a complex analog signal with a range of frequencies suitable for the channel
- \* A host communicates with another host using the TCP/IP protocol suite. What is the unit of data sent or received at each of the following layers?
  - ① application layer: the unit of data is a message
  - ② network layer: the unit of data is a datagram
  - ③ data-link layer: the unit of data is a frame
- \* What are the types of address (identifiers) used in each of the following layers?
  - ① application layer: we normally use a name to define the destination - computer name and the name of the file we need to access
  - ② network layer: we use two logical address (source and destination) to define the source and destination computers. These addresses are unique universally.
  - ③ data-link layer: we use two link-layer addresses to define the source and destination connections to the link

\* How can we find the period of a sine wave when its frequency is given?  $\rightarrow T = \frac{1}{f}$

\* Two major categories of transmission media?

→ guided and unguided media
 

- ★ LAN (Local Area Network): A LAN is usually privately owned and connects some hosts in a single office, building, or campus
- ★ WAN (Wide Area Network): Point-to-point WANs and switched WANs

## CH7

\* What is the difference between an application program and an operating system?

\* An operating system is a program that facilitates the execution of application programs

\* Monoprogramming / Multiprogramming

① Monoprogramming: only a single program is in memory at any time.

② Multiprogramming: several programs are in memory at a time, but the resources of the computer are only assigned to the program that is running

\* How is demand paging more efficient than regular paging?

① Regular paging: the entire program must be in memory at the same time in order for the program to execute

② Demand paging: only some pages of a program can be in memory. This means that, in demand paging, more programs can use the computer's resources at any given time.

- \* three methods for handling the synchronization of the CPU with I/O devices
  - ① programmed I/O method: the CPU waits for the I/O device. A lot of CPU time is wasted by checking for the status of an I/O operation.
  - ② interrupt-driven I/O method: the I/O device informs the CPU of its status via an interrupt
  - ③ direct memory access (DMA): the CPU sends its I/O requests to the DMA controller which manages the entire transaction

\* IEEE Standard
 

Excess - 127	Sign	Exponent	Mantissa
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Single precision (32 bits)

Double precision (64 bits)
 

Excess - 1023	Sign	Exponent	Mantissa
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Double precision (64 bits)

\* Why is the routing the responsibility of the network layer? In other words, why can't the routing be done at the transport layer or the data-link layer?

Routing cannot be done at the transport layers, because the communication at the transport layer is one single logical path between the source port and the destination port. Routing cannot be done at the data-link layer because the communication (one single path); there is no need for routing. On the other hand, there are several possible paths for a packet between the source host and destination host at the network layer. Routing is the job of selecting one of these paths for the packet.

\* What is dial-up modem technology?

Dial-up modems use part of the bandwidth of the local loop to transfer data. The latest dial-up modems use the V-series standards such as V.90, and V.92

\* Real numbers with very large integral parts or very small fractional parts should not be stored in fixed point representation. A floating point representation of a number is made up of three parts: a sign, a shifter and a fixed-point number. The mantissa is a fractional part that, together with the sign, is treated like an integer stored in sign-and-magnitude representation. When we do arithmetic operations on numbers in a computer, we should remember that each number and the result should be in the range defined by the type definition.

\* UNIX is a multiuser, multiprocessing, portable operating system. It is designed to facilitate programming, text processing and communication.

\* Philosopher doing problem sol:

→ A philosopher must be allowed to pick up the chopsticks only if both the left and right chopsticks are available

→ Allow only four philosophers to sit at the table. That way, if all the four philosophers pick up four chopsticks, there will be one chopstick left on the table. So, one philosopher can start eating and eventually two chopsticks will be available. In this way, deadlocks can be avoided.

\* An operating system is an interface between the hardware of a computer and the user (programs or humans) that facilitates the execution of other programs and the access to hardware and software resources.

\* The operating system itself is a program that needs to be loaded into the memory and be run

\* Deadlock occurs when the operating system does not put resource restrictions on processes.

Roman number						
I	V	X	L	C	D	M
1	5	10	50	100	500	1000

In a positional number system with base  $b$ , the largest integer number that can be represented using  $k$  digits is  $b^k - 1$

\* Starvation is the opposite of deadlock. It can happen when the operating systems puts too many resource restrictions on a process

\* The computer industry uses the term "multimedia" to define information that contains numbers, text, images, video.

\* An integer is normally stored in memory using fixed-point representation.

\* Sign-and-magnitude representation: the available range for unsigned integers (0 to  $2^n - 1$ ) is divided into two equal halves.

\* An alternative way to write the two's complement of an integer is to first take the one's complement and then add 1 to it.

\* There is only one zero in this implementation notation.

