IDX G10 CS H
Study Guide Issue S1 Midterm
By Gavin Yu, Edited by Ethan Qin

Lesson 1&2 Lead-in & The Big Picture

- A **computer** is a programmable machine that receives input, stores and manipulates data/information, and provides output in a useful format.
- **Computer Science** (abbreviated CS) is the study of the theoretical foundations of information and computation, and of practical techniques for their implementation and application in computer systems.

Computer System consists of:

- **Hardware:** The equipment associated with the computer system.
- **Software:** A set of instructions that tells the hardware what to do.
- **Network:** Helps to transmit the data.

Types of Computers

Personal computers (PCs)	The least powerful, the most widely used.
Midrange computers (Servers):	Most widely used to support or serve end users for such specific needs as retrieving data from a database or supplying access to application software.
Mainframe computers:	Occupy specially wired, air-conditioned rooms. Capable of great processing speeds and data storage.
Supercomputers:	The most powerful. These machines are special, high-capacity computers used by very large organizations.

Software Categories

- **System Software:**
  - Operating System
  - Utility, Driver
- **Application Software:** Special programming to complete special tasks.

Significant Computer Models

- **Atanasoff-Berry Computer:** The first computer (1940).
- **ENIAC:** The first electronic general-purpose computer. (1946)
- **Manchester Baby:** The first stored-program computer. (1948)

Computers are responsible for:

- Input
- Processing
- Output
- Network
- Operating System
- Application software
- Database

Lesson 3 Data Representation

- **Data** refer to the symbols that represent facts, objects, and ideas.
- **Data** become **information** when it's presented in a format that people can understand and use.

Data Representation

- **Data representation** refers to the form in which data is stored, processed and transmitted.
- **Digital Data:** Represented using two discrete states: on and off, corresponding to binary digits (0s and 1s).
- **Analog Data:** Represented using a continuous range of values.

Binary System

- Computers use 0 and 1 to represent data.
- **Bit:** A single binary digit (0 or 1).
- **Byte:** A group of 8 bits. *(KB is now equivalent to the KiB we learned in 9th grade)*
    - 1 Byte (B) = 8 bits
    - 1 Kilobyte (KB) = 1024 Bytes
    - 1 Megabyte (MB) = 1024 Kilobytes
    - 1 Gigabyte (GB) = 1024 Megabytes
    - 1 Terabyte (TB) = 1024 Gigabytes
    - 1 Petabyte (PB) = 1024 Terabytes

Character Representation

- **ASCII:** American Standard Code for Information Interchange. A commonly used standard for representing character data.
- **Unicode:** A coding scheme designed to represent characters from all global languages, and is downward-compatible with ASCII.
- **UTF** (Unicode Transformation Format): Encoding forms for Unicode (e.g., UTF-8, UTF-16, UTF-32) that use 1, 2, 3, or 4 bytes to represent one character.

Image Representation

- **Pixel:** The individual dot in a digitized image, composed of a single color.
- **Resolution:** The number of pixels used to represent a picture.

- **RGB:** Colors are made by combining Red, Green, and Blue. Values range from 0 (no contribution) to 255 (full contribution).
- **Color Depth:** The number of bits used to represent the color of a single pixel. Monochrome (black & white) has a color depth of 1, for instance.
- **True Color:** 24-bit color depth.

Sound Representation

- Sound is digitized through **Sampling** (measuring the amplitude of the sound wave at points in time) and **Quantization** (assigning a numerical value to each sample).
- The interval and accuracy of sampling and quantization determines the quality of the track.

Data Compression

- **Lossy Compression:** Uses inexact approximations and partial data discarding to represent the content (e.g., JPG). The original data cannot be perfectly reconstructed.
- **Lossless Compression:** Allows the original data to be perfectly reconstructed while saving space (e.g., Run-length encoding, Huffman encoding).
- **Huffman Encoding:** Assigns variable-length binary codes to char. based on frequency.
- **Compression Ratio =** Uncompressed Size / Compressed Size

Lesson 4 Programming Basic

Stages of Problem Solving

- Understanding the problem
- Defining the problem
- Defining boundaries
- Planning a solution
- Carry out a plan of action

Core Programming Concepts

- **Operators & Expressions:**
  - Arithmetic Operators (e.g., +, -, *, /)
  - Comparison Operators (e.g., ==, >, <)
  - Logic Operators (e.g., AND, OR, NOT)
  - Operator Precedence (the order of carrying out the operators)
- **Constant & Variable:**
  - **Variable:** A named storage location whose value can change.
  - **Constant:** A named value that is not dynamic.
  - **Naming Rules:** The syntax rules for creating names for variables and constants.
  - **Datatype:** The type of data a variable can hold (e.g., integer, string).
  - **Assignment:** The operation of storing a value in a variable.
- **Control Structures:**
  - **Conditionals (If statement):** Execute code based on condition true & false.

- **Loops (While statement):** Used to repeatedly execute a block of code as long as a condition is true.

Lesson 5 Iteration

- **Iteration** is the repetition of a process in order to generate a sequence of outcomes.
- It is implemented in programming using **loops**.

Loop types

- **Count-Controlled Loop (For Loop):** Repeats a specific number of times.
  - Example: Study for 100 hours.
- **Condition-Controlled Loop (While Loop):** Repeats until a specific condition is met.
  - Example: Study until you experience a mental breakdown.

For Loop

- Syntax: for variable in sequence:
- The loop runs once for each item in the sequence.
- range(start, stop, step): Generates numbers from start to stop-1, incrementing by step.

Loop concepts

- **Hundred Fowls Problem:** A logic puzzle requiring nested loops to find combinations of roosters, hens, and chicks that satisfy given constraints.
- **Calculating Factorial Sum:** 1! + 2! + ... + n! requires a loop to calculate each factorial and accumulate the sum.
- **Finding GCD: Using** the Euclidean algorithm, which repeatedly applies the operation m, n = n, m % n until n becomes 0.
- **Processing Input Until xxx:** Reading numbers until a specific value (e.g., -1) is entered, then calculating statistics (max, min, average).
- **Reversing a Number:** Handling negative numbers and leading zeros in the reversed result.
- **Factoring a Semiprime:** Finding the larger prime factor of a number n that is the product of two different primes.

Lesson 6 Array

- An **array** is a set of values that are logically related to each other.
- An **array** allows you to refer to these related values by the same name and to use a number, called an **index**, to tell them apart. The individual values are called the **elements** of the array.

One-Dimensional Arrays

- A single list of elements accessed by one index.
- Lists in python; indexing starts at 0.
- a = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

Example problems

- **Swapping Elements:** Exchanging the values of two elements.
- **Removing Duplicates:** Creating list that contains each unique element only once.

Two Dimensional Arrays

- An array of arrays, representing a table or grid with rows and columns.
- Accessed using two indices: array[row][column].

Example 2D Array problems

- Calculating the sum of all elements on the outer perimeter of the grid.
- Using nested loops to fill the array with sequential numbers or specific patterns.

Lesson 7 Digital Processing

- Computer programmers create programs that control digital devices. These programs are usually written in a high-level programming language.
- **Source Code:** Instructions written by a programmer in a high-level programming language.
- **Machine Language:** The low-level instructions, represented in binary (0s and 1s), that can be directly executed by a computer's processor.

Source Code to Machine Language

- **Compiler:** A program that translates all the source code of a program into machine language in a single step, creating an executable file. (.exe, .app)
- **Interpreter:** A program that translates and executes source code one instruction at a time, line by line.

Instruction Set

- An instruction set is the set of basic operations that a **microprocessor** can perform.
- A **microprocessor** is a general-purpose chip designed to perform a limited set of activities, such as addition, subtraction, counting, and comparison.

Machine Language Instruction

- A machine language instruction has two parts:
    - **Op code:** The part of the instruction that specifies the operation to be performed (e.g., ADD).
    - **Operand:** The part of the instruction that specifies the data or the address of the data to be operated on.

Processors

- A central processing unit (CPU) is an integrated circuit designed to process instructions.
- It is built from semiconducting materials, most commonly silicon.

CPU Components

- **Control Unit (CU):** The part of the CPU that contains circuitry that uses electrical signals to direct the entire computer system to carry out, or execute, program instructions. It manages other parts of the system.
- **Arithmetic Logic Unit (ALU):** The part of the CPU that contains the electronic circuitry that executes all arithmetic and logical operations.

Machine/Instruction Cycle

- **Fetch:** The control unit fetches the instruction from **memory** and puts it into a **register**.
- **Decode:** The control unit decodes the instruction and determines the memory location of the required data.
- **Execute:** The control unit moves the data from memory to registers in the ALU. The ALU executes the arithmetic or logical instruction.
- **Store:** The control unit stores the result of this operation in memory or in a register.
- The combination of I-time (Instruction time, Fetch+Decode) and E-time (Execution time, Execute+Store) is called the machine cycle or instruction cycle.

Lesson 8 Personal Computer Basics

- A **personal computer system** refer to any computer system that uses personal computers for core processing operations.
- A personal computer, software, and peripheral devices that can be connected together for use by a single individual.
- A **peripheral device** is input, output, and storage equipment that might be added to a computer system to enhance its functionality. (e.g., mouse, keyboard)

Core PC System Components

- **System Unit:** The case that holds the computer's main circuit boards, microprocessor, memory, power supply, and storage devices.
- **Keyboard:** The primary input device for most personal computer systems.
- **Mouse:** An input device designed to manipulate on-screen graphical objects and controls.
- **Hard Disk Drive:** The main storage device on a personal computer system, usually mounted inside the system unit.
- **Optical Drive:** A storage device that works with CDs, DVDs, or Blu-ray discs.

Other PC System Components

- **Solid State Storage:** Modern storage like USB flash drives and memory cards, which have replaced older technologies like floppy disk drives.
- **Sound System:** Uses a **sound card** (a circuit board) to output digital music, speech, and sound effects.
- **Display System:** Consists of a **graphics card** (circuitry that converts digital data into images) and a **display device** (monitor or screen).
- **Network and Internet:** Wired or wireless connections to a computer network.
- **Printer:** An output device that produces computer-generated text or graphical images on paper.

Internal Components

- Main board/Motherboard
- CPU/Microprocessor
- Memory (RAM)
- Power supply
- Hard disk & SATA (interface)
- Graphics Card
- Sound Card
- Network Card
- Optical drive

PC Types

- Desktop
- Laptop
- Tablet
- Smartphone
- Wearable

Compatibility

- Computers that operate in essentially the same way and use the same software are said to be **compatible**.
- Platforms: PC (Windows), Mac, and Linux.

Computer Purchasing

- Key considerations include: budget, intended uses, platform selection, form factor, and selection of peripherals, software, and accessories.