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CDA 3103 Computer Organization

Homework #1: Chapter 1 Problem Set

1. **What are the main components of a computer?**

1) A processor to interpret and execute programs
2) Memory to store both data and programs
3) Mechanism for transferring data to and from the outside world

2**. What role did Charles Babbage play in computing history? How about Ada Lovelace?**

-Charles Babbage, known as the "father of computing", developed a mechanical calculating machine called the "Difference Engine" based upon a calculating technique known as the method of differences used to solve polynomial functions, he also designed the first general purpose calculator called the "Analytical Engine" that was capable of performing any mathematical operation and featured components that are considered early predecessors to modern APU, Memory, and I/O devices.

-Ada Lovelace is noted as having suggested to Charles Babbage on how best to use the "Analytical Engine" through the implementation of pre-defined "algorithms" to calculate numbers; this is why Ada Lovelace is considered the first computer programmer.

3. **What is Moore's Law? How about Rock's Law?**

-Moore's Law is an assertion by Intel founder Gordon Moore that relates the advancement of technology to the density of transistors in integrated circuits, he states "the density of silicon chips will double every 18 months".

-Rock's Law asserts that the operating cost for building semiconductors will double every four years.

4**. What is the fetch-decode-execute cycle? What is happening in the "decode" part of this cycle?**

-The fetch-decode-execute cycle, also known as the "von Neumann execution cycle", describes how the stored-data program computer architecture functions.

-In the decode portion of the von Neumann execution cycle, the program instruction received from the system's main memory by the control unit is decoded into a language the ALU (arithmetic logic unit) can understand.

Questions from Chapter 1 Exercises

2.A) How many milliseconds are in 1 second?

-10^3 = *1,000 milliseconds*

2.B) How many microseconds are in 1 second?

-10^6 = *1,000,000 microseconds*

2.C) How many nanoseconds are in 1 millisecond?

-10^9 to 10^3 = 10^6 = *1,000,000 nanoseconds*

2.D) How many microseconds are in 1 millisecond?

-10^6 to 10^3 = 10^3 = *1,000 microseconds*

2.E) How many nanoseconds are in 1 microsecond?

-10^9 to 10^6 = 10^3 = *1,000 nanoseconds*

2.F) How many kilobytes (KB) are in 1 gigabyte (GB)?

-2^{10} to 2^{30} = 2^{20} = *1,048,576 kilobytes*

2.G) How many kilobytes are in 1 megabyte (MB)?

-2^{10} to 2^{20} = 2^{10} = *1,024 kilobytes*

2.H) How many megabytes are in 1 gigabyte (GB)?

-2^{20} to 2^{30} = 2^{10} = *1,024 megabytes*

2.I) How many bytes are in 20 megabytes?

-20 * 2^{20} = *20,971,520 bytes*

2.J) How many kilobytes are in 2 gigabytes?

-2^{10} to (2 * 2^{30}) = 2 * 2^{20} = *2,097,152 kilobytes*

7) Briefly explain two breakthroughs in the history of computing.

-The first breakthrough in computing was the creation of the "transistor", a device that recreates the triode in solid-state form. The decreasing size of transistors made it possible to construct integrated circuits with exponentially large transistor counts.

-The second breakthrough in computing was the storage of program instructions in machines, known as the "von Neumann architecture", making it possible to carry out sequential instruction processing given a single path between the main memory system and the control unit of the CPU.

10) List five applications of personal computers. Is there a limit to the applications of computers? Do you envision any radically different and exciting applications in the near future?

-Personal finance, word processing, web browsers, email clients, and games.

-Yes, there is a limit to the applications of computers, namely the processing speed and consequently the number of instructions executed per clock cycle. Thus, given a modern high-end computer some graphical intensive applications (3D rendering, folding, and data mining) still require an exponential amount of "processing power".

-Yes, specifically for PC gaming, Advanced Micro Devices (AMD) have developed a new API, called "Mantle" that mimics the efficient low-level communication between hardware seen on consoles and translates that to the x 86 architecture to offer substantially better communication between the VGA and CPU/System components.

11) In the von Neumann model, explain the purpose of the:

a) processing unit

b) program counter

a) The processing unit contains the ALU, Control Unit, Program Counter, and Registers; carries out sequential instruction processing.

b) Determines where the next program instruction is located in main memory.

12) Under the von Neumann architecture, a program and its data are both stored in memory. It is therefore possible for a program, thinking a memory location holds a piece of data when it actually holds a program instruction, to accidentally (or on purpose) modify itself. What implication does this present to you as a programmer?

- As a programmer, security comes to mind, as malicious users will try to exploit the von Neumann architecture vulnerability and cause program crashes/lockups. A potential hazard if the program is connected to a server with users' personal information stored. This requires the programmer to be familiar with validating memory access by program variables, arrays, vectors, templates, classes, etc...

13) Explain why modern computers consist of multiple levels of virtual machines.

-For a computer to be able to solve a wide range of complex problems, it must address the semantic gap first by using a "divide and conquer" approach (creation of "levels"). Each level to computer organization of modern computers has a specific function and therefore exists as a hypothetical, distinct machine.