CS61 Homework 7

READING: Chapter 3 (complete)

Read ahead for Week 7: Chapter 4 (complete) & Chapter 5.1

HOMEWORK SET 7 (5 questions): Complete the following exercises.

Questions 1-5: Chapter 4, exercises 4.1 through 4.4 (1 point each) and 4.5 (2 points)

4.1) Name the five components of the von Neumann model. For each component, state its purpose.

CPU (Central Processing Unit): The CPU is in charge of executing instructions and conducting calculations. It reads instructions and data from memory, decodes the instructions, conducts the required operations, and returns the results to memory.

Memory: Memory is the term used to describe the storage area utilized to keep both data and instructions. Instruction memory, also known as program memory, and data memory are the two basic categories. While programs are being executed, data is being stored and accessed while instructions are being received from instruction memory and executed by the CPU.

Control Unit: In order to manage and coordinate the CPU's activities, the control unit is in charge. It manages the flow of commands, chooses the order in which tasks are completed, and governs the transfer of data between various parts of the system.

ALU(Arithmetic and Logic Unit): The ALU's function is to execute arithmetic and logical operations (such as comparisons and boolean operations) as directed by the CPU. Examples of arithmetic operations are addition, subtraction, multiplication, and division. It works with data to compute and manipulate it.

I/O (Input/Output) Devices: I/O devices serve to facilitate communication between the computer and the outside world. They make it possible to input information and commands into the system and to output results to the user. Keyboards, mice, screens, printers, and network interfaces are a few examples of I/O devices.

4.2) Briefly describe the interface between the memory and the processing unit. That is, describe the method by which the memory and the processing unit communicate.

The CPU communicates with the memory using bus lines on the system bus. There are three bus lines that are used, Address Bus, Data Bus, Control Bus. The address bus, as its name suggests, carries the memory addresses from the CPU to the memory. The CPU as a result knows where to read to and where to write to. The data bus carries the actual data that needs to be sent to memory or received from memory. The control bus carries control signals and commands that coordinate the operations between the CPU and the memory.

4.3) What is misleading about the name program counter? Why is the name instruction pointer more insightful?

The name "program counter" can be misleading because the name implies that it only counts the instructions being executed. The name "instruction pointer" is a better term for this because it accurately suggests its purpose, which is to point to the memory address of the current instruction being fetched and executed.

4.4) What is the word length of a computer? How does the word length of a computer affect what the computer is able to compute? That is, is it a valid argument, in light of what you learned in Chapter 1, to say that a computer with a larger word size can process more information and therefore is capable of computing more than a computer with a smaller word size?

The word length of a computer is the number of bits that the computer can process as a single unit. It is the max size of values that can be represented and changed by the CPU. The word length does not impact computational capabilities. A computer with a shorter word length will take longer to achieve what a higher word length computer can achieve but if one can finish a task so can the other. A valid argument will compute the same in the end but the shorter word length computer will take longer.

4.5) The following table represents a small memory. Refer to this table for the following questions.

Address	Data
0000	0001 1110 0100 0011
0001	1111 0000 0010 0101
0010	0110 1111 0000 0001
0011	0000 0000 0000 0000
0100	0000 0000 0110 0101
0101	0000 0000 0000 0110
0110	1111 1110 1101 0011
0111	0000 0110 1101 1001

a. What binary value does location 3 contain? Location 6?

The location 3 in the table represents address 0011 and the binary value at that location 3 is 0000 0000 0000 0000

b. The binary value within each location can be interpreted in many ways. We have seen that binary values can represent unsigned numbers, 2's complement signed numbers, floating point numbers, and so forth.

(1) Interpret location 0 and location 1 as 2's complement integers.

The 2's complement of the value at location 0 is 7,747.

The 2's complement of the value at location 1 is -4,059.

(2) Interpret location 4 as an ASCII value.

The hexadecimal value of the binary value at location 4 is 0x65h. The ASCII value corresponding to the hex value 0x65h is lower case alphabet e.

(3) Interpret locations 6 and 7 as an IEEE floating point number.

Location 6 contains number[15:0]. Location 7 contains Number[31:16].

The IEEE floating point number at 6 combined with 7 is 110110011111111011010011

(4) Interpret location 0 and location 1 as unsigned integers.

The unsigned integer at location 0 is 7,747 and the one at location 1 is 61,477.

c. In the von Neumann model, the contents of a memory location can also be an instruction. If the binary pattern in location 0 were interpreted as an instruction, what instruction would it represent?

The binary value 111 in the target register field is R7 and the binary value 001 in the left operand register field is R1. The binary value 011 in the right operand register field is R3. We can conclude from what's given that the instruction formed by the value at location 0 is ADD R7, R1, R3.

d. A binary value can also be interpreted as a memory address. Say the value stored in location 5 is a memory address. To which location does it refer? What binary value does that location contain?

The decimal value corresponding to the binary value 0000 0000 0000 0110(in location 5) is 6. The value stored by location 5 points at location 6. The binary value stored at location 6 (0110) is 1111 1110 1101 0011 which is what we were looking for.