

High Performance Computing

Homework #1

Due: Monday September 11 2017 before 11:59 PM (Midnight)

Email-based help Cutoff: 5:00 PM on Sun, Sept 10 2017

Maximum Points: 15

Submission Instructions

This homework assignment must be turned-in electronically via Canvas. Type in your responses to each question (right after the question in the space provided) in this MS-Word document. You may use as much space as you need to respond to a given question. Once you have completed the assignment upload:

1. The MS-Word document (duly filled) and saved as a PDF file named with the convention MUid.pdf (example: **raodm.pdf**)

Note that copy-pasting from electronic resources is plagiarism. Consequently, you must suitably paraphrase the material in your own words when answering the following questions.

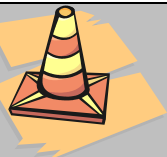
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Objective

The objective of this homework is to review the necessary background information about computer architecture, related concepts, and terminology. The terminology will be often used in the course.

Read Chapters 5 and 6 of the E-book titled "[How Computers Work](#)" (all students have free access to the electronic book) and then answer the first set of questions.

Once you have answered the first set of questions, read chapters 1, and 2 of the E-book titled "[C++ How to Program](#)" (all students have free access to the electronic book) and then answer the following questions.



Although the Safari E-books are available to all students there are only a limited number of concurrent licenses to access the books. Consequently, do not procrastinate working on this homework or you may not be able to access the E-books due to other users accessing books.

1. Briefly describe (1 or 2 sentences will suffice) each one of the following terms: **[3 points]**

a. ALU

The ALU is the Arithmetic Logic Unit is a component of the Central Processing Unit that completes mathematical operations for the computer.

b. Address line

An electric line or circuit associated with a location in RAM

c. CISC

The complex instruction set computing unit is where single, simple instructions can be executed such as an arithmetic operation through assembly language.

d. RISC

The reduced instruction set computer that allows programs to run at lower cycles per instruction.

e. Register

A register is a set of transistors in a process where data is temporarily stored while the processor is making calculations

- f. Using the image in section titled “How the Processor Uses Registers” in Chapter 6, mention name of three registers (such as: MDR/ACCUMULATOR) and write one line description of the function of each one of the 3 registers.

Accumulation registers :where the processor places the results of an operation after execution

Program counter register: holds the memory address of the next value the process will fetch prior to executing it

Address registers: this collects the contents of different addresses in Ram or in the Processors inboard cache

2. Provide suitable response to each of the following questions regarding a modern PC.

a. What is the expansion of the acronym RAM? What is RAM? **[1 points]**

RAM stands for Random Access Memory, or the active memory of a computer that stores current programs and data structures that are currently being used by the computer. The memory of RAM is volatile and is deleted if the computer is turned off.

b. What is the expansion of the acronym ROM? What is the difference between RAM and ROM? **[1 points]**

ROM is an acronym for Read Only Memory. RAM is volatile memory (information is lost when power is turned off) to which data can be read and written. On the other hand ROM is non-volatile memory from which data can only be read (but cannot be written).

c. What is a microprocessor aka CPU? List at least 3 major subcomponents of a CPU? **[2 points]**

ALU- arithmetic logic unit which performs mathematical operations in the CPU
CU- clock unit which keeps track of time in the CPU
Cache memory- stores values for later use

d. What is a CPU core? What is a dual-core or multi-core CPU? **[1 point]**

A cpu core is the basic computation unit of a CPU. It can support running one task or multiple if has implemented threading. Multi cores have the ability to tread and execute moer than one instruction concurrently

e. What is the difference between a CPU Core and an ALU? **[1 point]**

A CPU core is primarily focused on scheduling tasks and mainting program states while the ALU

Ensure you have read chapters 1 and 2 of the E-book titled “[C++ How to Program](#)” (all students have free access to the electronic book) and then answer the following questions.

3. What are command-line arguments and illustrate their use with a short C++ program [2 points]

Command line arguments are arguments given to the code by the user and are handled only by the main method

```
Int main(int argc, char *argv[]) {  
  
    for(int i = 0; i < argv.length(); i++){  
        printf("The command-line-arg is %s\n", argv[i]);  
    }  
    return 0;  
}
```

4. What is the significance of the main function in a C++ program returning the value of zero? [1 point]

A return value of zero shows that the main method has complete totally with no errors.

5. High Performance Computing (HPC) aims to improve efficiency of programs by (1) reducing program runtime, (2) reducing memory (or resource) usage, and (3) efficiently utilize energy. However, depending on the nature of the application, programmers have to balance the priority (or order of importance) of these three key components of efficiency. In each of the following scenario discuss/justify which one of the factors plays the most significant role. A solution is already provided for the first question to illustrate an example. [3 points]

- a. A HPC programmer (i.e., *yours truly*) is optimizing a program to run on Ohio's Supercomputer (<https://www.osc.edu/supercomputing/computing/oakley>) for forecasting the spread of Zika virus (see: <http://in.reuters.com/article/health-zika-who-idINKCN0V61JD>) to inform multinational policies. Which one of the aforementioned 3 efficiency factors should the programmer primarily focus on?

In this situation getting results quickly is critical to combat the ongoing epidemic that is affecting > 10 million people. Since the program is running on a Supercomputer memory is not an issue. Energy concerns is unequivocally superseded by the need to quickly help millions of people.

Decision: In this situation, the programmer must strive to minimize runtime of the program while trading off memory and energy.

- b. A HPC programmer is developing a program to run on a bridge monitoring device. The device has special accelerometers to quickly measure vibrations and compactly store it permanently in a large flash memory. Since the bridge is in a remote location a small battery will be used to power the device. Which one of the aforementioned 3 efficiency factors should the programmer primarily focus on?

The programmer should focus on effectively utilizing energy of the small battery in this case since it is in a remote location which already has flash energy and the special accelerometers are already trying to give the program feedback quickly.

- c. A HPC programmer is developing a program for a car collision avoidance system to rapidly (in microseconds) respond to head on collision situations. The program is run on a dedicated (different from navigation/entertainment system) Intel Atom CPU (@2.5 Ghz) with 8 GB of RAM. Which one of the aforementioned 3 efficiency factors should the programmer primarily focus on?

There is no power or memory issues and the programmer should focus on decreasing the runtime of the program so it can quickly respond to head on collisions.

- d. A HPC programmer is developing a program to report temperature (requires 1 second to report temperature) once an hour on an embedded device based on ATmega328 (<http://www.atmel.com/devices/atmega328.aspx?tab=parameters>). The device is powered from the main power supply. Which one of the aforementioned 3 efficiency factors should the programmer primarily focus on?

In this case, the microprocessor does not have a large amount of on-board storage and assuming none is added, the programmer should focus on using as little memory as possible.