Computer Architecture: Assignment 1

# Q1: Classes of Computers

List and describe three types of computers. Please give a real-world example of each kind you listed.

Personal computer: the laptop you use

Embedded computer: mobile phones or other programable devices

Server: Google Cloud, AWS, or any other web servers

Supercomputers: NYU Greene, Summit, Sunway TaihuLight, Tianhe, etc.

Q2: Abstraction

Which of the following best describes the concept of abstraction in computer science?

( ) Writing code that directly manipulates hardware without any intermediary layers.

(X) Organizing data in a way that hides the implementation details and presents a simplified interface to the user.

( ) Running a program on multiple processors simultaneously to improve performance.

( ) Compressing data to save storage space and reduce transmission time.

# Q3: Performance

Consider three different processors, P1, P2, and P3, that execute the same instruction set. P1 has a 3GHz clock and a CPI of 1.5. P2 has a 2.5GHz clock rate and a CPI of 1.0. P3 has a 4GHz clock rate and has a CPI of 2.2.

## Q3.1 Which processor has the highest performance expressed in instructions per second? (explain why)

Since they execute the same instruction set, the feature, instructions per second, is equivalent to the CPU time.

CPU Time of P1 = (IC x CPI)/Clock rate = IC x 1.5/ (3GHz) = IC x 0.5 x 10-9

CPU Time of P2 = IC x 1/2.5GHz = IC x 0.4 x 10-9

CPU Time of P3 = IC x 2.2/4GHz = IC x 0.55 x 10-9

So, P2 is the fastest processor among the three.

Alternatively, we know that CPU time = (Instruction count x CPI) / Clock rate. Since the number of instructions per second = Instruction count / CPU time, we have the number of instructions per second = Clock rate / CPI.

## Q3.2 If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

Number of cycles = CPU Clock rate \* time

P1 number of cycles = 3 x 109 x 10 = 3 x 1010

P2 number of cycles = 2.5 x 1010

P3 number of cycles = 4 x 1010

Number of instructions in 10 seconds = Number of cycles in 10 seconds / CPI

P1: 3 x 1010 / 1.5 = 2 x 1010

P2: 2.5 x 1010/1 = 2.5 x 1010

P3: 4 x 1010/2.2 = 1.83 x 1010

## Q3.3 We are trying to reduce the execution time by 30%, but this has led to an increase of 20% in the CPI. What clock rate should we have to get this time reduction? (explain why)

Clock rate = CPU Time/(IC x CPI) ⇒

old clock rate/new clock rate = old CPU time / (IC x old CPI) / new CPU time / (IC x new CPI) = (old CPU time x new CPI) / (new CPU time x old CPI)

P1: 1.2/0.7\*3=5.143GHz

P2: 1.2/0.7\*2.5=4.286GHz

P3: 1.2/0.7\*4 =6.857GHz

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