

# CS 4100 Computer Architecture

## Quiz 1

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1. (20 points) Give the five components of a computer.

Input, Output, Datapath, Memory, Processor

2. (20 points) Give the equation for Amdahl's law; you can also express it as speedup.

$$\text{Execution time} = \frac{\text{可以被 affect 的部分 (execution time)}}{\text{affect factor}} + \text{無法被 affect 的部分 (execution time)}$$

3. (60 points) Consider an instruction set whose instructions are divided into four classes: A, B, C, and D. Suppose P1 and P2 are two different processors implementing this instruction set. P1 has a clock rate of 4GHz and has CPIs of 4, 3, 2, and 1 for instructions respectively in classes A, B, C, and D, while P2 has a clock rate of 2GHz and has CPIs of 3, 4, 1, and 2 for instructions respectively in classes A, B, C, and D. There is a program with an instruction count of  $10^{10}$  and its instruction mix is as follows: 20% class A, 30% class B, 20% class C, and 30% class D.

- (a) (20 points) What is the average CPI of this program on each processor?

$$P1: 4 \times 0.2 + 3 \times 0.3 + 2 \times 0.2 + 1 \times 0.3 = 0.8 + 0.9 + 0.4 + 0.3 = 2.4 \text{ CPI}$$

$$P2: 3 \times 0.2 + 4 \times 0.3 + 1 \times 0.2 + 2 \times 0.3 = 0.6 + 1.2 + 0.2 + 0.6 = 2.6 \text{ CPI}$$

- (b) (20 points) What is the number of clock cycles of this program on each processor?

$$P1: 2.4 \times 10^{10} \text{ clock cycles}$$

$$P2: 2.6 \times 10^{10} \text{ clock cycles}$$

- (c) (20 points) Which processor is faster when running this program? Why?

Execution time

$$P1 = \frac{2.4 \times 10^{10}}{4 \times 10^9} = 6 \text{ s}$$

$$P2 = \frac{2.6 \times 10^{10}}{2 \times 10^9} = 13 \text{ s}$$

P1 is faster because it has a lower execution time.  
(lower CPI, higher clock rate)