CE450 – Computer Architecture I

Homework: Chapter 1b

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Questions

1) How to measure a computer performance?

The performance of a computer is measured based on its execution time. The execution time is usually recorded in seconds. However, time can be defined as elapsed time (or total response time), or as CPU time. Elapsed time indicates system performance, CPU time indicates the CPU performance. The longer the time is taken, the lower performance the computer has.

2) Suppose we have a program runs in 100 seconds on a computer, and the multiplication work takes 40 seconds. If we want the program to run 30% faster, how many seconds do we have to improve the multiplication work?

Using Amdahl's law: $T_{improved} = \frac{T_{affected}}{\text{improvement factor}} + T_{unaffected}$

We have:

$$70\% \times 100s = \frac{40s}{n} + 60s.$$

$$70s = \frac{40s}{n} + 60s$$

$$10n = 40$$

$$\Rightarrow n = 4 = \text{improvement factor}$$

So multiplication has to reduce from 40s to 10s (4 times lesser)
It has to improve 30sec in the multiplication work

3) There are 2 computers. Computer A clock cycle time is 350ps, CPI is 3. Computer B clock cycle time is 400ps, CPI is 2.5. Which computer runs faster on same program?

We have CPU T = Instruction Count × CPI × Cycle Time.

$$\frac{T_A}{T_B} = \frac{IC_A \times CPI_A \times CT_A}{IC_B \times CPI_B \times CT_B} = \frac{CPI_A \times CT_A}{CPI_B \times CT_B}$$

(Assume the same program has similar instruction counts)

$$\Rightarrow \frac{T_A}{T_B} = \frac{3 \times 350 \times 10^{-12}}{2.5 \times 400 \times 10^{-12}} = \frac{1050}{1000} = 1.05$$

⇒ Computer A runs 5% faster than computer B on the same program.

4) There are 3 instructions types A B C, each instruction type CPI is A:4, B:2, C:3. If we have two programs, program 1 has 2 of A type instructions, 3 of B type instructions, 4 of C type instructions; program 2 has 3 of A type instructions, 4 of B type instruction, 3 C type instruction. Which program runs faster on the same computer?

	A	B	C
CPI	4	2	3
Ins / Program 1	2	3	4
Ins / Program 2	3	4	3

Clock cycles of Prg 1 = $4 \times 2 + 2 \times 3 + 3 \times 4 = 26$ cycles.

Clock cycles of Prg 2 = $4 \times 3 + 2 \times 4 + 3 \times 3 = 29$ cycles.

Since the 2 programs run on the same computer, the cycle time is the same. So program 1 runs faster as it has lesser cycles to execute.

5) Why does the computer microprocessor vendors switch to multi-processors?

As Moore's law has reached its limit, microprocessor can't shrink forever without 2 problems, power usage & generated heat. Hence, multi-processor are a way to extend Moore's law so the user gets more performance out of a piece of silicon.

6) What are the software factors which will affect the program performance?

(a) Algorithm affects instruction count and possibly CPI

(b) Programming language affects ins count & CPI.

(c) Compiler affects the Ins & CPI.

(d) Instruction set architecture affects IC, CPI, T_c.