Lecture 04: Performance

Name: ________

ID: ________

EX-1

If computer A runs a program in 10 seconds and computer B runs the same program in 15 seconds, how much faster is A than B?

Solution:

EX-1

If computer A runs a program in 10 seconds and computer B runs the same program in 15 seconds, how much faster is A than B?

Solution:

The performance ratio is $\frac{15}{10} = 1.5$, so A is 1.5 times faster than B.

EX-2: Improving Performance Example

A program runs on computer A with a 2 GHz clock in 10 seconds. What clock rate must a computer B has to run this program in 6 seconds? Unfortunately, to accomplish this, computer B will require 1.2 times as many clock cycles as computer A to run the program.

Solution:

EX-2: Improving Performance Example

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Solution:

We denote x as clock cycle # on computer A, y as clock rate on computer B.

$$\begin{cases} x & = 10 \times 2 \times 10^9, \\ 1.2x & = 6 \times y. \end{cases}$$

$\rightarrow y = 4 \times 10^9 = 4$ GHz.

EX-3: Using the Performance Equation

Computers A and B implement the same ISA. Computer A has a clock cycle time of 250 ps and an effective CPI of 2.0 for some program and computer B has a clock cycle time of 500 ps and an effective CPI of 1.2 for the same program. Which computer is faster and by how much?

Solution:

EX-3: Using the Performance Equation

Computers A and B implement the same ISA. Computer A has a clock cycle time of 250 ps and an effective CPI of 2.0 for some program and computer B has a clock cycle time of 500 ps and an effective CPI of 1.2 for the same program. Which computer is faster and by how much?

Solution: Assume each computer executes I instructions, so

$$\text{CPU time}_A = I \times 2.0 \times 250 = 500 \times I \text{ ps}$$
$$\text{CPU time}_B = I \times 1.2 \times 500 = 600 \times I \text{ ps}$$

A is faster by the ratio of execution times:

$$\frac{\text{performance}_A}{\text{performance}_B} = \frac{\text{execution\_time}_B}{\text{execution\_time}_A} = \frac{600 \times I}{500 \times I} = 1.2$$

EX-4

Op	Freq	CPI_i	Freq x CPI_i
ALU	50%	1	
Load	20%	5	
Store	10%	3	
Branch	20%	2	
			$\sum =$

- How much faster would the machine be if a better data cache reduced the average load time to 2 cycles?
- How does this compare with using branch prediction to shave a cycle off the branch time?
- What if two ALU instructions could be executed at once?

Determinates of CPU Performance

$$\text{CPU time} = \text{Instruction count} \times \text{CPI} \times \text{clock cycle}$$

	Instruction_ count	CPI	clock_cycle
Algorithm			
Programming language			
Compiler			
ISA			
Core organization			
Technology			

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	Instruction_ count	CPI	clock_cycle
Algorithm	X	X	
Programming language	X	X	
Compiler	X	X	
ISA	X	X	X
Core organization		X	X
Technology			X