

Tutorial #1

CSE 301: Computer Engineering (I)
Third Year, Communication Engineering

Problem 2.10:

A benchmark program is run on a 40 MHz processor. The executed program consists of 100,000 instruction executions, with the following instruction mix and clock cycle count:

Instruction Type	Instruction Count	Cycles per Instruction
Integer arithmetic	45,000	1
Data transfer	32,000	2
Floating point	15,000	2
Control transfer	8000	2

Determine the effective CPI, MIPS rate, and execution time for this program.

Solution:

$$f = 40\text{MHz} \quad I_c = 100000$$

$$\text{CPI}_{\text{effective}} = (45000 \cdot 1 + 32000 \cdot 2 + 15000 \cdot 2 + 8000 \cdot 2) / 100000$$

$$\text{CPI} = 1.55$$

$$\text{MIPS} = f / (\text{PI}_{\text{effective}} \cdot 10^6) = 40 / 1.55 = 25.8$$

$$T_p (\text{execution time for this program}) = (I_c \cdot \text{PI}_{\text{effective}}) / f = 100000 \cdot 1.55 / 40 \cdot 10^6 = 3.875 \text{ s}$$

Problem 2.14:

The following table shows the execution times, in seconds, for five different benchmark programs on three machines.

Benchmark	Processors		
	R	M	Z
E	417	244	134
F	83	70	70
H	66	153	135
I	39449	35527	66000
K	772	368	369

- Compute the speed metric for each processor for each benchmark, normalized to machine R. That is, the ratio values for R are all 1.0. Other ratios are calculated using Equation (2.5) with R treated as the reference system.
- Repeat part (a) using M as the reference machine.
- Which machine is the slowest based on each of the preceding two calculations?

Solution:

$$r_x = T_{\text{ref}} / T_{\text{sut}}$$

- The following table, using the equation above, shows the speed ratios as R is the reference machine

Benchmark	Processors	
	M	Z
E	1.7	3.12
F	1.2	1.2
H	0.4	0.5
I	1.1	0.6
K	2.1	2.1

To compare the two machines M and Z with reference to machine R, the geometric mean is computed

For machine M: $r_g = (1.7*1.2*0.4*1.1*2.1)^{1/5} = 1.1352$

For machine Z: $r_g = (3.12*1.2*0.5*0.6*2.1)^{1/5} = 1.2$

So machine Z is faster than machine M.

b. The following table shows the speed ratios as R is the reference machine

Benchmark	Processors	
	R	Z
E	0.6	1.8
F	0.84	1
H	2.32	1.13
I	0.9	0.54
K	0.48	1

To compare the two machines M and Z with reference to machine R, the geometric mean is computed

For machine R: $r_g = (0.6*0.84*2.32*0.9*0.48)^{1/5} = 0.8723$

For machine Z: $r_g = (1.8*1*1.13*0.54*1)^{1/5} = 1.019$

So machine Z is faster than machine R.

c. From the previous calculation in part a and b machine R is the slowest one

External Problem:

Given that 30% of a certain program could be executed in parallel, calculate the speed up factor due to executing that program on 8 processors/cores instead of a single processor.

Solution:

$$\text{Speed Up} = 1 / ((1-f) + (f/N)) = 1 / ((1-0.3) + (0.3 / 8)) = 1.4$$

CSE 321a – Midterm Exam– Fall 2014

A processor runs on a 1 GHz clock to execute a program that contains 1000 instructions classified as follows: 25% “multiply” instructions (whose CPI is 10), 30% “add” instructions (whose CPI is 5), 45% other instructions (whose CPI on average is 6). The processor supports another instruction called “multiply-add” (whose CPI is 12). A single “multiply-add” is equivalent to a “multiply” instruction followed by an “add” instruction. Suppose that the program is to be modified to use the “multiply-add” instructions whenever is possible. Suppose further that 80% of the “multiply” instructions in the original program are followed by “add” instructions and hence can be replaced by “multiply-add” instructions.

12. What is the average CPI of the original program (i.e., before using “multiply-add” instructions)?

- (a) 16.3
- (b) 7.2
- (c) 12.3
- (d) 6.7**
- (e) None of the above.

13. How much time does it take to execute the original program?

- (a) 16.3 μ s
- (b) 7.2 μ s
- (c) 12.3 μ s
- (d) 6.7 μ s**
- (e) None of the above.

14. What is the length of the modified program (i.e., after using “multiply-add” instructions)?

- (a) 800 instructions**
- (b) 750 instructions
- (c) 1200 instructions
- (d) 700 instructions
- (e) None of the above.

15. What is the average CPI of the modified program?

(a) 9.5

(b) 7.625

(c) 7

(d) 6.375

(e) None of the above.

16. How much time does it take to execute the modified program?

(a) 6.1 μ s

(b) 6.375 μ s

(c) 5.6 μ s

(d) 5.1 μ s

(e) None of the above.