Tutorial #1

CSE 321a: Computer Organization (I)

Third Year, Computer and Systems Engineering

Problem 2.10:

A benchmark program is run on a40 MH 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 = 40MHz I_c = 100000

$CPI_{effective}$ =(45000*1 + 32000*2 + 15000*2 + 8000*2)/100000

CPI=1.55

MIPS = f / ($CPI_{effective}$ * 10^6) = 40/1.55 = 25.8

T_p (execution time for this program) =(I_c * $CPI_{effective}$)/ f = 100000*1.55 / 40 *10^6 = 3.875 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

a. 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.

b. Repeat part (a) using M as the reference machine.

c. Which machine is the slowest based on each of the preceding two calculations?

Solution:

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

a. 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:

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 μs
(b) 7.2 μs
(c) 12.3 μs
(d) 6.7 μs
(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 μs

(b) 6.375 μs

(c) 5.6 μs

(d) 5.1 μs

(e) None of the above.