Computer Architecture–Homework I

107 Fall semester, Chapter 2

2.12 Early examples of CISC and RISC design are the VAX 11/780 and the IBM RS/6000, respectively. Using a typical benchmark program, the following machine characteristic result:

Processor	Clock frequency	Performance	CPU time
VAX 11/780	10 MHz	2 MIPS	$11x$ second
IBM RS/6000	20 MHz	16 MIPS	x second

The final column shows that the VAX required 11 times longer than the IBM measured in CPU time.

(a) What is the relative size of the instruction count of the machine code for this benchmark program running on the two machines?

(b) What are the CPI values for the two machines?

2.15 To clarify the result of the preceding problem, we look at a simpler example.[1]

Benchmark	Processor		
	X	Y	Z
1	40	20	80
2	80	160	40

(a) Compute the arithmetic mean value for each system using X as the reference machine and then using Y as the reference machine. Argue that intuitively the three machines have roughly equivalent performance and that the arithmetic mean gives misleading results.

(b) Compute the geometric mean value for each system using X as the reference machine and then using Y as the reference machine. Argue that the results are more realistic than with the arithmetic mean.

[1] The conclusion of the preceding problem is that arithmetic means are worthless in some context.

2.16 Consider the example in Section 2.5 for the calculation of average CPI and MIPS rate, which yielded the result of CPI 2.24 and MIPS rate 178.[2] Now assume that the program can be executed in eight parallel tasks or threads with a roughly equal number of instructions executed in each task. Execution is on an 8-core system with each core (processor) having the same performance as the single processor originally used. Coordination and synchronization between the parts adds an extra 25,000 instruction executions to each task. Assume the same instruction mix as in the example for each task, but increase the CPI for memory reference with cache miss to 12 cycles due to contention for memory.

(a) Determine the average CPI.

(b) Determine the corresponding MIPS rate.

(c) Calculate the speedup factor.

(d) Compare the actual speedup factor with the theoretical speedup factor determined by Amdhal's law.

2.18 The owner of a shop observes that on average 20 customers per hour arrive and there are typically 5 customers in the shop. What is the average lenght of time each customer spends in the shop?

[2]The example in Section 2.5: Consider the execution of a program which results in the execution of 2 million instructions on a 400-MHz processor. The program consists of four major types of instructions, where

(a) 60% of instructions are *arithmetic and logic*, each of which takes 1 clock cycle. (CPI=1)

(b) 18% of instructions are *load/store with cache hit*, each of which takes 2 clock cycle. (CPI=2)

(c) 12% of instructions are *branch*, each of which takes 4 clock cycle. (CPI=4)

(d) 10% of instructions are *memory reference with cache miss*, each of which takes 8 clock cycle. (CPI=8)

The average CPI is 2.24 when the program is executed on uniprocessor; the corresponding MIPS rate is approximately 178.