

CSE 775: Computer Systems Architecture
Autumn 2010
Homework #1

Instructor: Panda

Due: Monday, 11th October

1. (20 points) An n -processor parallel processing system typically consists of a *host* processor to execute the *sequential* portion of an application. The *parallel* portion gets executed on n processors. For a given application, it was observed that a 20-processor parallel system runs an application 1.5 times faster than a 10-processor system. Using Amdahl's law, determine how fast the application will run on a 40-processor system compared to the 10-processor system?
2. (30 points) On a workstation it was observed that an average program spends 40% of its execution time on disk access and 30% on memory access. With a fixed amount of budget, you have the following three options to improve the system performance:
 - (a) Improve disk access time by a factor of 2.
 - (b) Improve memory access time by a factor of 4.
 - (c) Improve disk access time by 1.5 and memory access time by 2.

Determine which option you will choose and why by carrying out a cost-performance analysis.

3. (30points) Consider a *base* machine with 2.5 GHz clock rate. A typical program on this machine has the frequency of instructions and the associated individual CPIs, as shown in the table. It was observed that 50% of the branch instructions are of the type *bneq Rx, name*. Each *bneq* instruction is preceded by the subtract instruction *subi Rx, Rx, #-1*. There is a proposal to replace these sequences of *subi* and *bneq* instructions by a new instruction *Dbneq Rx, name*, which decrements Rx by 1 and makes the jump if $Rx \neq 0$.

To incorporate this new instruction into the hardware, it is estimated that the machine clock rate needs to be reduced to 2.0 GHz. On this *enhanced* machine, the individual CPIs are affected as shown in the table.

How fast or slow will the typical program run on the *enhanced* machine compared to the *base* machine?

Instrns	Freq. (Base)	CPI (Base)	CPI (Enhanced)
load/store	50%	8	7
alu	40%	6	4
branch	10%	5	4
dbneq			6

4. (20points) The execution times (in seconds) of four programs on three computers are given below:

Program	Computer A	Computer B	Computer C
Program 1	1	10	20
Program 2	1000	100	20
Program 3	500	1000	50
Program 4	100	800	100

Assume equal probability for each program being used on the computers.

- Determine the arithmetic mean of the programs on the three computers. Based on these means, can you determine the relative performance of these computers.
- Assume 10^8 instructions were executed in each of the four programs. Calculate the MIPS rating of each program on each of the three computers. Determine the harmonic means of the programs on these computers and derive the relative performance of these computers based on the harmonic means.
- Using the geometric mean approach, rank the three computers in their relative performance.