UNIOESTE – Universidade Estadual do Oeste do Paraná
Campus de Foz do Iguaçu
Ciência da Computação - CECE
Organização e Arquitetura de Computadores - remoto
Prof. Fabiana Frata Furlan Peres

Lista de Exercícios: 04/03/2021
Data de entrega: 11/03/2021
Peso da lista: 10% da nota final de listas de exercícios (2.5 pontos)
Obs.:

- A lista deve ser desenvolvida manualmente, fotografada ou escaneada e entregue via Teams
- A entrega atrasada terá como consequência perda de 20% por cada dia de atraso, incluindo sábados e domingos.

1. We wish to compare the performance of two different computers: M1 and M2. The following measurements have been made on these computers:

Program	Time on M1	Time on M2
1	2.0 seconds	1.5 seconds
2	5.0 seconds	10.0 seconds

Which computer is faster for each program, and how many times as fast is it?

2. Suppose that M1 in Exercise 1 costs $500 and M2 costs $800. If you needed to run program 1 a large number of times, which computer would you buy in large quantities? Why?

3. Suppose you wish to run a program P with $7.5*10^9$ instructions on a 5 GHz machine with a CPI of 0.8.
   a. What is the expected CPU time?
   b. When you run P, it takes 3 seconds of wall clock time to complete. What is the percentage of the CPU time P received?
4. If the clock rates of computers M1 and M2 in Exercise 1 are 4 GHz and 6 GHz, respectively, find the clock cycles per instruction (CPI) for program 1 on both computers using the data in Exercise 1 and the following table:

Program	Instructions executed on M1	Instructions executed on M2
1	5×10^9	6×10^9

5. Assuming the CPI for program 2 on each computer in Exercise 1 is the sarne as the CPI for program 1 found in Exercise 4, find the instruction count for program 2 running on each computer using the execution times from Exercise 1.

6. Consider two different implementations, P1 and P2, of the same instruction set. There are five classes of instructions (A, B, C, D, and E) in the instruction set. P1 has a clock rate of 4 GHz. P2 has a clock rate of 6 GHz. The average number of cycles for each instruction class for P1 and P2 is as follows:

Class	CPI on P1	CPI on P2
A	1	2
B	2	2
C	3	2
D	4	4
E	3	4

   a. Assume that peak performance is defined as the fastest rate that a computer can execute any instruction sequence. What are the peak performances of P 1 and P2 expressed in instructions per second?
   b. If the number of instructions executed in a certain program is divided equally among the classes of instructions except for class A, which occurs twice as often as each of the others, how much faster is P2 than Pl?

7. Consider two different implementations, I1 and I2, of the sarne instruction set. There are three classes of instructions (A, B, and C) in the instruction set. I1 has a clock rate of 6 GHz, and I2 has a clock rate of 3 GHz. The average number of cycles for each instruction class on I1 and I2 is given in the following table:

Class	CPI on M1	CPI on M2	C1 Usage	C2 Usage	C3 Usage
A	2	1	40%	40%	50%
B	3	2	40%	20%	25%
C	5	2	20%	40%	25%

The table also contains a summary of average proportion of instruction classes generated by three different compilers. Cl is a compiler produced by the makers of I1, C2 is produced by the makers of I2, and the other compiler is a third-party product. Assume that each compiler uses the sarne number of instructions for a given ·program but that the instruction mix is as described in the table. Using CI on both I1 and I2, how much faster can the makers of I1 claim I1 is compared to I2? Using C2, how much faster can the makers of I2 claim that I2 is compared to I1? If you purchase I1, which compiler would you use? If you purchased I2, which compiler would you use? Which computer and compiler would you purchase if all other criteria are identical, including cost?

8. Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3 GHz clock rate and a CPI of 1.5. P2 has a 2.5 GHz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and has a CPI of 2.2.
   a. Which processor has the highest performance expressed in instructions per second?
   b. If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.
   c. We are trying to reduce the execution time by 30%, but this leads to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

9. Consider two different implementations of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (classes A, B, C, and D). P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3, and P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2. Given a program with a dynamic instruction count of $1.0*10^6$ instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D, which is faster: P1 or P2?
   a. What is the CPI for each implementation?
   b. Find the clock cycles required in both cases.

10. Compilers can have a profound impact on the performance of an application. Assume that for a program, compiler A results in a dynamic instruction count of $1.0*10^9$ and has an execution time of 1.1 s, while compiler B results in a dynamic instruction count of 1.2E9 and an execution time of 1.5 s.
    a. Find the average CPI for each program given that the processor has a clock cycle time of 1 ns.
    b. Assume the compiled programs run on two different processors. If the execution times on the two processors are the same, how much faster is the clock of the processor running compiler A's code versus the clock of the processor running compiler B's code?
    c. A new compiler is developed that uses only $6.0*10^8$ instructions and has an average CPI of 1.1. What is the speedup of using this new compiler versus using compiler A or B on the original processor?
    d. By how much must we improve the CPI of FP instructions if we want the program to run two times faster?
    e. By how much must we improve the CPI of L/S 160 instructions if we want the program to run two times faster?
    f. By how much is the execution time of the program improved if the CPI of INT and FP instructions is reduced by 40% and the CPI of L/S and Branch is reduced by 30%?