**Logo

Description automatically generated San Francisco Bay University**

**EE488 - Computer Architecture**

**Homework Assignment #1**

**Due day: 2/7/2023**

**Instruction:**

1. **Push the answer sheet to Github in word file**
2. **Overdue homework submission could not be accepted.**
3. **Takes academic honesty and integrity seriously (Zero Tolerance of Cheating & Plagiarism)**

**1. Assuming that a web server with the architecture spends 20% on processing, 30% on disk access, and 50% on network transfer, you have a base system consisting of a 500MHz processor and a disk with 20Mbytes/sec data transfer rate. This system costs $5K and can support 10,000 average web page accesses/sec. considering the following three options to enhance system performance:**

**Answers:**

**(1) Determine what will be the new performance (in terms of average web page accesses per second) with each of the enhancement options**

**a. Answer: Option-1:**

i) If processing time f = 0.3 and Speed up factor k = 40Mbytes/sec/20Mbytes/sec=2

Then, Speed=1/ ((1-f) +f/k) =1/ (0.7+0.15) =1.1765

Average web page acc. = 1.176\*10000 = 11760 web page/sec

Additional cost 1000

**web page access cost performance analysis:**

ii) it is achieved improvement by 1760 for $1000 and 1.76 per dollar

**b. Answer: Option-2:**

**i)** If processing time f = 0.3 and the speed up factor K=800 MHz/500MHz=1.6.

Then, Speed = 1/ ((1-f) +f/k) = 1/(0.8+0.2/1.6 )= 1.0811

Average web page acc. = 1.081\*10000 = 10810 web page/sec

Additional cost $800

**ii) Web page access cost performance analysis:**

It is achieved improvement by 810 for $800 and 1.013 per dollar

**c. Answer: Option-3:** i) By combining option 1&2,

k=800/500=1.6 and f=0.5

Speed = 1/ (1-sum (f)) + fn /k + f/k) =1/ ((1-0.5) +0.2/1.6+0.3/2)=1.2903

Average web page acc. = 1.2903\*10000 = 12903 web page/sec

Additional cost $1500

**iii) Web page access cost performance analysis:**

It is achieved improvement by 2903 for $1500 and 1.935 per dollar

**2) Cost-performance analysis:**

If we look at the data set closely, it is clear that Option-C is gaining 50% enhancement whereas option a&b enchantment gain is around 20%. Hence, Option-C produces formidable cost-performance ratio compare to its counterparts.

**End of answer of question-1**

1. The Amdahl’s law is based on the assumption that when an enhancement is performed to some part of the system, the enhancement doesn’t have any negative impact on the non-enhanced part. However, in the real life, it could lead to negative impact on these parts. Thus, the Amdahl’s law can be modified to take care of this situation.

Consider a computer system with two components A and B which can be enhanced. There is interdependency between these components. And enhancement in one component affects the other. There exist three options for enhancement as suggested below. All options involve the same amount of cost.

* 1. Option-A: Let us assume that , the fraction of instructions using component A, can be sped up by 10 times. However, due to the dependency of A on B, another fraction 2 will be get slowed down by 5 times
  2. Option-B: The instructions using component B, fraction , can be sped up by 20 times. The dependency forces another fraction 0.5 to get slow down by 2 times
  3. Option-C: A fraction of instructions using the component A, can be sped up by a factor of 4. Unfortunately, the dependency forces another fraction to get slowed down by 1.8 times.
     1. Derive the parameterized speed-up equations (in terms of ) for each of the above three options
     2. As a beginner architect, which option will be preferred and why? Give convincing reasoning. Assuming for a reasonable enhancement, you need to have and

**Answer:**

1. **Derive the parameterized speed-up equations (in terms of) for each of the above three options below:**

Option-A:

10 times speed enhancement by component A = f\_A \* 10.

5 times slowed by component A = 2f\_A \* 1/5.

Hence, speed-up= f\_A \* 10 + (1 - f\_A - f\_B) \* 1 – 2f\_A \* (1/5)

Option-B:

20 times speed enhancement by component B = f\_B \* 20.

2 times slowed down by component B = 0.5f\_B \* 2 = f\_B

Hence, Speed-up = f\_B \* 20 + (1 - f\_A - f\_B) \* 1 - 0.5 f\_B \* (1/2)

Option-C:

4 times speed enhancement by component A = f\_A \* 4

Component A slows down by 1.8 times = f\_A \*1/ 1.8

Hence, f\_A \* 4 + (1 - f\_A - f\_B) \* 1 – f\_A \* (1/1.8)

**Answer:** Option-b component speed up by 20 time while other fraction slowed down by 2 times and its nearly the fraction of option-c but 4 times speed up by their one fraction. Meanwhile option-a slowed down by 5 times while fraction raised up by 10 times. Therefore, to start with as an architect, I will definitely go for option-b.

**End of Answers of Question-2**

1. A set of three systems are being evaluated to be used in a laboratory environment. This environment uses three types of programs with a relative usage of 45% (Program 1), 35% (Program 2), and 20% (Program 3) respectively. Each of these three programs has been benchmarked on these three systems individually and their execution times are shown as follows.

|  |  |  |  |
| --- | --- | --- | --- |
| **Programs** | **System 1** | **System 2** | **System 3** |
| Programs 1 | 1.0 sec | 2.0 sec | 1.5 sec |
| Programs 2 | 10.0 sec | 7.0 sec | 5.0 sec |
| Programs 3 | 5.0 sec | 3.0 sec | 4.0 sec |

* 1. Determine which of the above three systems will provide the best performance for the laboratory.
  2. The three systems cost as follows: $8,000 (System 1), $5,000 (System 2), and $6,500 (System 3). By doing a cost-performance analysis, indicate which one of these systems you will choose and why?

**Answers:**

**a.** Let’s find the best system based on their performances by doing below calculations:

**Average Execution Time** = (Program 1 execution time \* relative usage of Program 1) + (Program 2 execution time \* relative usage of Program 2) + (Program 3 execution time \* relative usage of Program 3)

By following the above formula for average execution time for three systems are:

System 1 = (1.0 \* 0.45) + (10.0 \* 0.35) + (5.0 \* 0.20) = 4.95 seconds

Performance=1/execution time=1/4.95=0.202

System 2 = (2.0 \* 0.45) + (7.0 \* 0.35) + (3.0 \* 0.20) = 3.95 seconds

Performance=1/execution time=1/3.95=0.253

System 3 = (1.5 \* 0.45) + (5.0 \* 0.35) + (4.0 \* 0.20) = 3.22 seconds

Performance=1/execution time=1/3.22=0.310

For the laboratory, System 3 offers the highest performance, if we compare the average execution time among all three systems.

**b**. To determine the best system based on cost-performance analysis, we need to find the performance per dollar spent on each system.

**System performance per dollar spent** = average execution time/system cost

System 1 = 4.95 sec / $8,000 = 0.00061875 sec/dollar

System 2 = 3.95 sec / $5,000 = 0.00079 sec/dollar

System 3 = 3.22 sec / $6,500 = 0.000495385 sec/dollar

By doing a cost-performance analysis, it is seen that system-3(0.000495385 sec/dollar) can be selected as the best system.

**End of Answers of Question-3**