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**CS 465 - Homework 1 – Fall 2016**

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Team Allowed: maximum of two per team.

State clearly team member names and GMU IDs as comments in source code and each page

of submitted report.

Late submissions are not accepted.

How to submit: A zip file answering all questions from Parts 1, 2, and 3. The submission

will be made via a blackboard link available to you. For team projects, only one member of

the team should submit the zip file and the other should submit a one-page PDF file stating

the names of both members of the team.

Part 1 (40% of grade for homework 1): MIPS Programming: Triangular number

checking.

A sequence of triangular numbers is generated by adding natural numbers. The n-th

member in the sequence, Tn, is equal to the sum of the first n natural numbers: Tn = 1 + 2 +3 + ... + n. The first few triangular numbers are 1, 3, 6, 10, 15, 21, …. You can find more examples here: http://en.wikipedia.org/wiki/Triangular\_number.

You will need to write a MIPS program that accepts a positive integer and checks whether

the input is a triangular number. If input X is a triangular number, simply print “X is a

triangular number”. Otherwise, print “X is not a triangular number” and report the two

consecutive triangular numbers T1 and T2 such that T1<X<T2.

Your program cannot assume any prior knowledge of the triangular number sequence. The

sequence must be generated on the fly during the checking. You can assume that the user

input is always a positive integer that fits within a 32-bit register.

Sample runs (user input in blue):

Please enter a positive integer: 6↵

6 is a triangular number

Please enter a positive integer: 20↵

20 is not a triangular number: 15, 21

Part 2 (30% of grade for homework 1): Exercises related to chapter 1.

1. [20% of homework 1] Assume that the CPI for arithmetic, load/store, and branch

instructions of a processor is 1, 10, and 6, respectively. Also assume that on a single

processor a program requires the execution of 2.56 ∗ 109 arithmetic instructions, 1.28 ∗

109 load/store instructions, and 1.28 ∗ 108 branch instructions. Assume that each

processor has a 2 GHz clock frequency.

a. Find the total execution time (in sec) for this program on a single processor.

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b. Assume that, as the program is parallelized to run over multiple cores, the

number of arithmetic and load/store instructions per processor is divided by 0.8

∗ p (where p is the number of processors) but the number of branch instructions

per processor remains the same. Find the total execution time for this program

on 2 and 8 processors and show the relative speedup.

c. If the CPI of the arithmetic instructions was tripled, what would be the impact on

the execution time of the program on 1, 2, or 8 processors? Point out the general

trend you observe.

d. To what should the CPI of load/store instructions be reduced in order for a

single processor to match the performance of 8 processors using the original CPI

values?

2. [10% of homework 1] Consider a computer running a program that requires 320 sec,

with 90 sec spent executing floating point (FP) instructions, 100 sec executing

Load/Store (L/S) instructions, 60 sec spent executing branch (BR) instructions, and 70

sec spent executing integer (INT) instructions.

a. By how much is the total time reduced if the time for FP instructions is reduced

by 25% (assuming all other instructions are not changed)?

b. By how much is the time for INT instructions reduced if the total time is reduced

by 10% (assuming all other instructions are not changed)?

c. Can the total time be reduced by 25% by reducing only the time for branch

instructions?

Part 3 (30% of grade for homework 1): Exercises related to rotating magnetic disks.

The goal of this homework is to provide you with an understanding of (1) how rotating

magnetic disks operate and (2) their performance characteristics. If you do not understand

the basic operation of rotating magnetic disks, please read section 5.2 of the textbook. For

this homework, you will rely on the specifications of the Seagate Barracuda 7200.9 HDD

Product Manual found at www.cs.gmu.edu/~menasce/cs465/seagate.pdf. Answer the

following questions:

1. [5% of homework 1] Consider the ST3160811AS drive and answer the following

questions:

SectorSize (Number of bytes per sector):

RotSpeed: Rotational speed in RPM:

Formatted capacity (in GBytes):

Cache buffer in Mbytes1:

Sread (Average typical read seek time (in ms)):

Swrite (Average typical write seek time (in ms)):

1 Consider 1 Mbyte = 1,000,000 bytes.

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Shortest seek (aka track-to-track) read seek time (in ms):

Shortest seek (aka track-to-track) write seek time (in ms):

TransfRate (Sustained data transfer rate (in Mbytes/sec)):

2. [5% of homework 1] Consider a workload that consists of random reads2 only. What is

the average access time per sector? Show your computations first using the variable names

(e.g., RotSpeed) given above and then substitute them for their numerical values (give your

answer in seconds rounded to three decimal digits).

3. [10% of homework 1] Consider item (2) above. Suppose you are asked to reduce the

access time of your drive by 5%. You are asked to select among the following mutually

exclusive options: (a) increase the transfer rate, (b) increase the rotational speed, and (c)

decrease the average seek time. What should be the values of Sread, RotSpeed, and

TransferRate to achieve such a reduction on average access time?

4. [10% of homework 1] Consider that track 0 of the disk is the outermost track of the disk

and that initially the head is positioned on that track. Consider that the disk receives the

following workload of write requests targeted to the following tracks (in this order): 4, 5,

10, 20, 15, 15, 12, 13.

(a) Assume that after the first write request is satisfied, all other requests are in the

disk’s queue. What is the average seek time per request of this workload

considering that the disk processes the requests in the order of arrival (i.e., First

In First Out)?

(b) Consider now that the disk scheduler orders the requests by increasing order of

track number so that they can all be satisfied by moving the head in a single

direction. What is the average seek time per request in this case?

Deliverables for homework 1:

• A zip file containing:

o For part 1: Your source code file: mips\_ZZZ.asm where ZZZ is your "last names

combined". Do not submit PDF of the MIPS programs, just an .asm file! As part

of the assignment, you need to figure out how to input values and print to the

output in MIPS. As in all programming assignments, your code must be very

well commented.

o For part 1: A pseudo code of the your algorithm as a PDF file. File name:

mips\_pc\_ ZZZ.pdf

o For part 1: The output as a PDF file for the following inputs: 25, 28, 64, 70, 78,

88, and 105. File name: mips\_output\_ ZZZ.pdf.

o For part 2: A pdf file with your answers. File name: Part2\_ ZZZ.pdf

o For part 3: A pdf file with your answers. File name: Part3\_ ZZZ.pdf

2 If reads are random, the chances of finding a sector in the cache can be considered

negligible.