CPSC 3300

Homework 1

Due 11:59PM, Sept 3rd

Submit your answers to canvas

Please provide sufficient space on your homework solutions

so that your calculations and answers are easily readable and so

that grading will be easier. Furthermore, except for the simplest questions, giving only the answer without showing your work is not acceptable. For the best chance at partial credit, show the generic equation you are starting with and any derivations needed to handle the information as given in the question, then plug in the values from the question. You may, of course, use a calculator for the homework. (Unlike the exams, the values in the homework questions are not necessarily chosen for ease of hand calculation.)

1. Moore’s law

Read the following three articles. (You may use other published sources to answer the questions; please cite those sources if you do.)

* "Exponential Growth," Wikipedia: The Free Encyclopedia,

accessed Aug. 22, 2015. [Online] en.wikipedia.org/wiki/

Exponential\_growth

* “moore’s law,” Wikipedia: The free Encyclopedia. [Online]

https://en.wikipedia.org/wiki/Moore%27s\_law

* Chris Mack, "The Multiple Lives of Moore’s Law”. [Online]

www.quora.com/

http://spectrum.ieee.org/semiconductors/processors/the-multiple-lives-of-moores-law

(5 points each of the following subquestions)

(a) Define exponential growth.

(b) What did the original Moore’s Law observe and project?

(c) In your opinion, why has Moore’s prediction been accurate over

the years?

(d) What is Dennard Scaling and why is it important in processor

technology evolvement.

(e) According to Dr. Mack, scaling down or miniaturization marked the Moore’s Law 2.0 era. Scaling down reduces the size of transistors.

List the feature sizes over the years to today.

(f) In your opinion, why are people discussing whether Moore’s law is dead or not.

1. (30pt)A processor P has a 4.0 GHz clock rate and has a CPI of 2.2.
2. If the processor executes a program in 20 seconds, find the number of cycles and the number of instructions.
3. What is the MIPS rate for the processor?
4. 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?

1. (20pt)Consider two different implementation of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (class A, B, C, and D). P1 has a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3.

Given a program with a dynamic instruction count of 1.0E6 instructions divided into classes as follows: 20% class A, 10% class B, 50% class C, and 20% class D.

1. What is the global CPI?
2. Find the clock cycles required to run the program on P1.
3. (20pt)Assume for a given processor the CPI of arithmetic instructions is 1, the CPI of load/store instructions is 10, and the CPI of branch instructions is 3. Assume a program has the following instruction breakdowns: 600 million arithmetic instructions, 250 million load/store instructions, 150 million branch instructions.
4. Suppose we find a way to double the performance of the arithmetic instructions. What is the overall speedup of our machine?
5. If we find a way to improve the performance of the arithmetic instructions by 10 times, what is the overall speedup of our machine?
6. (50pt) Use perf and time tool to profile program execution. Run all experiments on one of the school linux machines.

download the whetstone <http://www.netlib.org/benchmark/whetstone.c> benchmark to your home directory.

compile whetstone. You may need to explicitly specify the math lib folder and link to it, e.g.,

gcc -o whetstone whetstone.c -lm

#link the math with -lm

On the same machine (one in the lab), examine how compiler optimization levels and options change the number of instructions for the program whetstone and the number of CPU cycles to execute the program. Use gcc to compile your program.

1. use perf to profile the execution of whetstone. For information

about perf usage, type command

perf

you will see the commands that perf supports. You are encouraged to find online articles on perf and read them.

1. Use utility time to profile the execution of whetstone that loops 200,000 times

time ./whetstone 200000

Explain the timing output and the definitions.

If the timings from perf and time are different, explain the cause.

1. Examine the following levels/options:
   1. -O0
   2. -O1
   3. -O2
   4. -O3
   5. -O3 -funroll-loops

Use a table to show the instruction count, #cycles, IPC, and time for each of the experiments, and calculate the speedup based on the execution time with -O0. Paste your screen shot at the end.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | IC | #Cycles | IPC | Time | Speedup |
| -O0 |  |  |  |  |  |
| -O1 |  |  |  |  |  |
| -O2 |  |  |  |  |  |
| -O3 |  |  |  |  |  |
| -O3 -funroll-loops |  |  |  |  |  |