Computer Sciences Department

University of Wisconsin-Madison

CS/ECE 552 – Introduction to Computer Architecture

In-Class Exercise (04/16)

Answers to all questions should be uploaded on Canvas.

1. [1 point] (Twist on Check Yourself 6.1) From the textbook: True or False: To benefit from a multiprocessor, an application must be concurrent.

   Given that the answer is false, what is one example type of application that is not concurrent but does benefit from multiprocessors.

Graphic application

2. [4 points] Consider the following piece of sequential C code.

```
char a[128], b[128]; /* each char is 1 byte (8 bits) in size */
for (int i = 0; i < 48; i++) {          // LOOP 1
    if ((a[i] % 7) == 0) {
        b[i] += a[i] + 'A';
    }
    b[i] += a[i] + 'B';
}

for (int i = 0; i < 49; i++) {          // LOOP 2
    b[i] += a[i] + 'C';
}
```

Consider running the above code on a machine with SIMD instructions with 128-bit wide registers, datapath, and ALUs capable of processing 16 8-bit packed operands in a cycle.

(a) [2 points] Will LOOP1 running on the above machine see a 15X speedup over a sequential (non-SIMD) machine? If yes, explain why. If no, explain the key impediments to achieving the speedup.

No, since it contain condition branch.

(b) [2 points] Will LOOP2 running on the above machine see a 15X speedup over a sequential (non-SIMD) machine? If yes, explain why. If no, explain the key impediments to achieving the speedup.

Yes. No condition branch.

3. [6 points] Consider your program running on a parallel processor.

    (a) [2 points] Applying Amdahl's Law, you estimate that when executing on two cores, the speedup of your entire program is 1.5x. What is the fraction of your program that can be parallelized?

        $1/((1-f)+f/2) = 1.5 => f = 2/3$

    (b) [2 points] You decide to switch to a new parallel processor equipped with six general-purpose cores and an accelerator that can speed up half of the sequential (i.e., non-parallel) portion of your program by 3x. What is the speedup of your entire program on this new processor?

        4

    (c) [2 points] If you did not have this accelerator and you only had the option to add more general-purpose cores, how many cores would you need to add (on top of the six that you already have) to achieve at least 98% of the speedup in Q2b above?

        infinite