

hw0

ECE 3803

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Contents

1	Introduction	1
2	Assignment	1
2.1	Part 1: C review	1
2.2	Part 2: Parallelism	3
3	Rules	4
3.1	Academic integrity	4
4	Submission	4

1 Introduction

This assignment will review material from previous semesters and familiarize you with the CUDA tool chain.

2 Assignment

Write your answers in a plain text file (not Word, not PDF) named `hw0.txt`. Number each answer according to the number of the corresponding question.

2.1 Part 1: C review

1. The following code is supposed to do the following: create an integer pointer, sets the value to which it points to 3, adds 2 to this value, and print said value. However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code.

```
void test1() {  
    int* a = 3;  
    *a = *a + 2;  
    printf("%d\n", *a);  
}
```

2. The following code is supposed to do the following: create two integer pointers and set the values to which they point to 2 and 3, respectively. However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code.

```
void test2() {
    int* a, b;
    a = (int *) malloc(sizeof (int));
    b = (int *) malloc(sizeof (int));

    if (!(a && b)) {
        printf("Out of memory\n");
        exit(1);
    }
    *a = 2;
    *b = 3;
}
```

3. The following code is supposed to do the following: allocate an array of 1000 integers, and for $i = 0, \dots, 999$, set the i th element to the value i . However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code.

```
void test3() {
    int i;
    int* a = (int *) malloc(1000);

    if (!a) {
        printf("Out of memory\n");
        exit(1);
    }
    for (i = 0; i < 1000; i++)
        *(i + a) = i;
}
```

4. The following code is supposed to do the following: create a two-dimensional array of size 3×100 , and sets element (1, 1) (assuming zero-indexed array) to the value 5. However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code.

```
void test4() {
    int **a = (int **) malloc(3 * sizeof (int *));
    a[1][1] = 5;
}
```

5. The following code is supposed to do the following: set the value pointed to by **a** to an input, checks if the value pointed to by **a** is 0, and prints a message if it is. However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code.

```
void test5() {
    int *a = (int *) malloc(sizeof (int));
```

```

scanf("%d", a);
if (!a)
    printf("Value is 0\n");
}

```

6. The following code is supposed to do the following: calculate the sum of $5 + 9$, then print out the sum and the address that stores that value. However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code.

```

void test6() {
    int x = 5 + 9;
    printf("The sum of 5 + 9 is ", x);
    printf("The address of x is ", &x);
}

```

7. The following code is supposed to do the following: take as parameters a two-dimensional array (passed as a pointer to a sequence of floats with row-major ordering), along with its width and height, and return the sum of its middle row. However, the provided code is wrong. Describe in a few sentences what is wrong with the code, and provide corrected code. Don't change the type or number of parameters of the function.

```

float test7(float *array, int width, int height) {
    float sum = 0;
    int i;
    for (i = 0; i < width; i++)
        sum += array[height / 2][i];
    return sum;
}

```

2.2 Part 2: Parallelism

8. You are tasked with improving the performance of a computer program by using parallelism. Upon inspection, you discover that 50% of the program can benefit from parallelism. Your boss insists that the improved program run at least three times faster than the original version. Your boss wants to know how many parallel processors will you need to add in order to achieve this goal. What will you tell your boss? Use Amdahl's law. Show your work.
9. A goal of many computer scientists is to introduce "automatic parallelization," where a sequential program can, through automated, algorithmic means, be converted into a program that takes advantage of hardware parallelism (either multithreading, SIMD, distributed computing, or something else) to improve performance. For example, given the following sequential for loop:

```

for (int i = 0; i < N; i++)
    array[i] ++;

```

the program could be converted into a form that executes N increments *concurrently*, thus making the program run faster. In this case, the conversion to parallel form is trivial: simply run `array[i] ++` on each available processor until no more processors are available, then

repeat. This parallelized form of the program is *equivalent*, in that it always produces identical results as the sequential version.

However, although some progress has been made in automatic parallelization, it has not yet been made general, i.e. our algorithms are not yet smart enough to convert *any* sequential program into an equivalent (i.e. producing identical results) parallel program. Why is that? Try to think of an example of a `for` loop that could not be correctly parallelized by the method described above. Give the code (or pseudocode), and explain why the obvious approach to parallelization wouldn't work, by producing results inconsistent with the sequential version.

3 Rules

3.1 Academic integrity

You should write this assignment entirely on your own. You are specifically prohibited from submitting code written or inspired by someone else, including code written by other students. Code may not be developed collaboratively. Do not use any artificial intelligence resource at any point in your completion of this assignment. Please read the course syllabus for detailed rules and examples about academic integrity.

4 Submission

Submit your work on Gradescope. Remember to submit all files before the due date. Do not submit binary executable files. Do not submit data files.