

CSCI 564: Homework 2

Name: _____ CWID: _____

For each of the following questions, please show all of your work, and explain your answers.

1. Cache performance is a factor of several parameters. For each of the following, describe the issues that arise if the value is either too small or too large:

(a) (3 points) Cache size

(b) (3 points) Line size

(c) (3 points) Associativity

2. Consider the `matrix_add` function shown below:

```
1 int matrix_add(int a[128][128], int b[128][128], int c[128][128]) {
2     int i, j;
3     for(i = 0; i < 128; i++)
4         for(j = 0; j < 128; j++)
5             c[i][j] = a[i][j] + b[i][j];
6     return 0;
7 }
```

In each iteration, the compiled code will load `a[i][j]` first, and then load `b[i][j]`. After performing the sum of those two values, the result will be stored in `c[i][j]`.

The processor has a 64 KiB, 2-way, 64 byte-block L1 data cache, and the cache uses an LRU policy for determining which cache line to evict if a set is full. The L1 data cache is write-back and write-allocate.

For the following questions, assume that the addresses of the `a`, `b`, and `c` arrays are `0x10000`, `0x20000`, and `0x30000`, respectively, and that the cache starts out completely empty. **Explain all of your answers.**

- (a) (12.5 points) What is the L1 data cache miss rate for the `matrix_add` function? How many misses are contributed by compulsory miss? How many misses are conflict misses?

- (b) (12.5 points) If the L1 hit time is 1 cycle, and the L1 miss penalty is 20 cycles. What is the average memory access time?

3. (16 points) You are given a cache that has 16 byte blocks, 512 sets, and is 2-way set associative. Integers are 4 bytes. Give the C code for a loop that has a 100% miss rate in this cache but whose hit rate rises to almost 100% if you double the size of the cache. **Do not assume the starting indexes of any arrays.**