

**CS 2021: Practice Exam 3**

Spring 2021

University of Minnesota

Exam period: 20 minutes

Points available: 40

**Problem 1 (10 pts):** Below is an initial memory/cache configuration along with several memory load operations. Indicate whether these load operations result in cache hits or misses and show the state of the cache after these loads complete.

MAIN MEMORY					DIRECT-MAPPED Cache, 8-byte lines 4 Sets, 8-bit Address = 3-bit tag					
Addr	Addr Bits			Value	INITIAL CACHE STATE					
10	000	10	000	10				Blocks/Line		
14	000	10	100	11	Set	V	Tag	0-3	4-7	
18	000	11	000	12						
1C	000	11	100	13						
20	001	00	000	20	00	1	010	200	201	
24	001	00	100	21	01	1	001	22	23	
28	001	01	000	22	10	1	000	10	11	
2C	001	01	100	23	11	0	-	-		
30	001	10	000	100						
34	001	10	100	101						
38	001	11	000	102						
3C	001	11	100	103						
40	010	00	000	200						
44	010	00	100	201						
48	010	01	000	202						
4C	010	01	100	203						
					HITS OR MISSES?					
					OPEARTION		HIT/MISS?			
					1. Load 0x48					
					2. Load 0x4C					
					3. Load 0x24					
					FINAL CACHE STATE					
					Set	V	Tag	Blocks/Line		
								0-3	4-7	Changed?
					00					
					01					
					10					
					11					

**Problem 3 (15 pts):** Nearby is the definition for `base_scalvec()` which scales a vector by multiplying each element by a number. Write an optimized version of this function in the space provided. Mention in comments why you performed certain transformations.

```

1 int vget(vector_t vec, int idx){
2     return vec.data[idx];
3 }
4 void vset(vector_t vec, int idx, int x){
5     vec.data[idx] = x;
6 }
7 void base_scalevec(vector_t *vec, int *scale){
8     for(int i=0; i < vec->len; i++){
9         int cur = vget(*vec,i);
10        int new = cur * (*scale);
11        vset(*vec,i,new);
12    }
13 }

```

**Problem 4 (10 pts):** Examine the two functions below which add elements of a row or column vector to all corresponding rows or columns of a matrix. Consider the benchmark timing of these two provided.

1. Explain which of these two functions is faster and **why**.
2. Suggest a way to increase the speed of the slower function with only moderate changes to the code.

```

1 // add given row to each row of mat
2 void matrix_addrow_vec(matrix_t mat,
3     vector_t row) {
4     for(int i=0; i<mat.rows; i++){
5         for(int j=0; j<mat.cols; j++){
6             int elij = MGET(mat,i,j);
7             int vecj = VGET(row,j);
8             MSET(mat,i,j, elij + vecj);
9         }
10    }
11 }
12 // add given col to each column of mat
13 void matrix_addcol_vec(matrix_t mat,
14     vector_t col) {
15     for(int j=0; j<mat.cols; j++){
16         for(int i=0; i<mat.rows; i++){
17             int elij = MGET(mat,i,j);
18             int veci = VGET(col,i);
19             MSET(mat,i,j, elij + veci);
20         }
21    }
22 }
23 // BENCHMARK TIMING:
24 //   SIZE      addrow      addcol
25 //   512 2.9040e-03 5.5230e-03
26 //  1024 5.9290e-03 1.3160e-02
27 //  2048 1.3809e-02 9.9269e-02
28 //  4096 5.0853e-02 3.6760e-01
29 //  8192 2.0867e-01 1.4719e+00

```