

ICS Homework 9

April 22, 2021

1 Organization

1.1 Cache I

The following table gives the parameters for a number of different caches. Fill in the missing fields in the table for each cache. Recall that m is the number of memory address bits, C is the cache size (number of data bytes), B is the block size in bytes, E is the associativity, S is the number of cache sets, t is the number of tag bits, s is the number of set index bits, and b is the number of block offset bits.

Cache	C	S	E	B	m	t	s	b
A	1024	16		4	64		4	2
B	32768	128	8			20		
C	2048	32			32		5	6
D			2	8	64	53	8	3

ANS:

Cache	C	S	E	B	m	t	s	b
A	1024	16	16	4	64	58	4	2
B	32768	128	8	32	32	20	7	5
C	2048	32	1	64	32	21	5	6
D	4096	256	2	8	64	53	8	3

1.2 Cache II

Bob has a machine with 4-way cache. The cache line size is 64 bytes. There are 4 sets in the cache. Alice executes the code below on this machine. Suppose **sum**, **i**, **j**, **k** are stored in registers and **sizeof(int)** will return 4.

```
1  #define M 16
2  #define N 16
3
4  int a[M][N];
5
6  int sum()
7  {
8      int i, j;
9      int sum = 0;
10
11     for (i = 0; i < M; i++)
```

```

12         for (j = 0; j < N; j++)
13             sum += a[i][j];
14
15     return sum
16 }

```

1. How many memory accesses in total are there in the loop between line 11 and 13?

ANS:

$$16 \times 16 = 256$$

2. How many cache misses in the loop in total?

ANS:

16, one cache miss on each iteration of the outer loop.

3. Suppose the latency of cache hit is 4 cycles. An access to main memory requires 200 cycles for 64 bytes. What is the average latency of accessing array elements in cycles when executing the loop between line 11 and 13?

ANS:

$$4 \times \frac{15}{16} + (200 + 4) \times \frac{1}{16} = 16.5$$

4. Bob wants to execute this program on a new machine, whose cache doubles in size to get better performance. The larger cache comes in different styles. Which one(s) of the followings will help?

(a) Double the associativity of a set

(b) Double the number of sets

(c) Double the size of cache line

ANS:

Only the c will reduce the miss rate into half.

2 System Software

11.3.2 (textbook) shows examples of multiple domain names mapped to the same IP address, and also a domain name mapped to multiple IP addresses.

1. Think about the benefits of mapping a domain names to multiple IP addresses.

ANS:

For example, to obtain good availability of your server, you might want multiple servers, each with a different IP address, to serve the same web page to your clients.

2. In shared web hosting case, many websites can reside on one web server (sharing a single IP address) connected to the Internet. How does this server decide which website to show the user?

ANS:

HTTP request includes the host name (refer to telnet), the server can use this information to decide which domain to serve.