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Lab Sheet - Set Associative Cache

Objectives

At the end of this lab session student should be able to:

- Understand set associative mapped cache
- Understand the behavior of set associative mapped cache by varying block size, cache size and number of sets
- Understand the behavior of fully associative mapped cache with reference to replacement algorithms

Prerequisites: Module No. 4 - Cache Memory Organization

Contents:

7.0 Performance analysis of Set Associative Mapped Cache

The following program should be used for the analysis of set associative mapped cache.

```
LDB 00, R00
LDB 16, R01
LDB 32, R02
LDB 00, R03
LDB 16, R04
LDB 20, R05
LDB 24, R06
LDB 00, R07
LDB 20, R08
LDB 28, R09
HLT
```

Press “Cache-Pipeline” tab and select cache type as “data cache” as shown in Figure 1. Press “Show Cache..” button. A new window will be opened which is as shown in Figure 2.

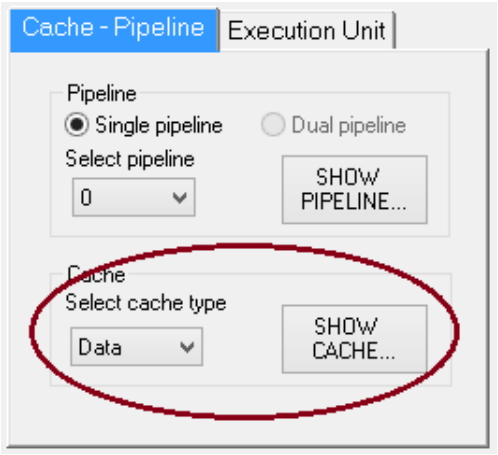


Figure 1: Cache – Pipeline setting

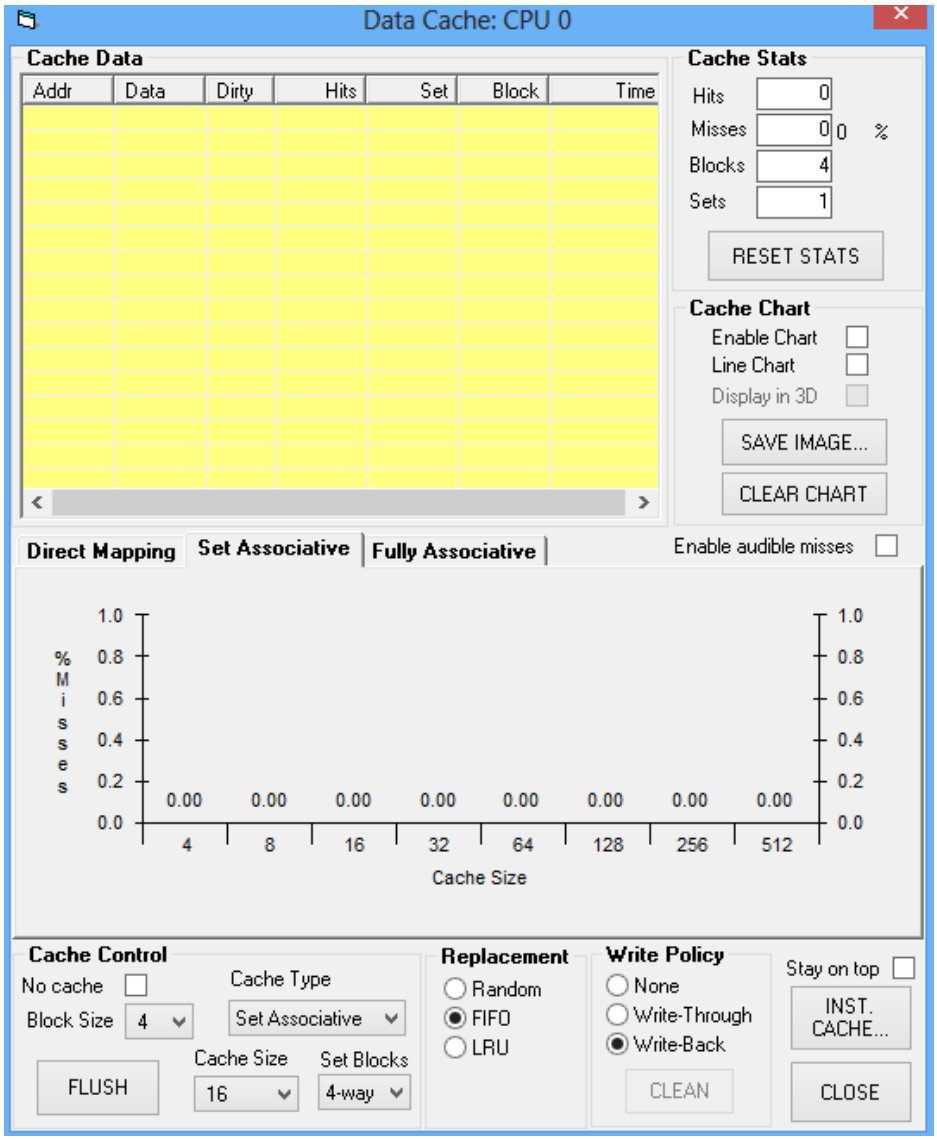


Figure 2: Data cache window

7.1 Effect of cache size on the performance of Set Associative Mapped Cache

Step 1: Set the following parameters available in cache control block of data cache window as shown in Figure 2.

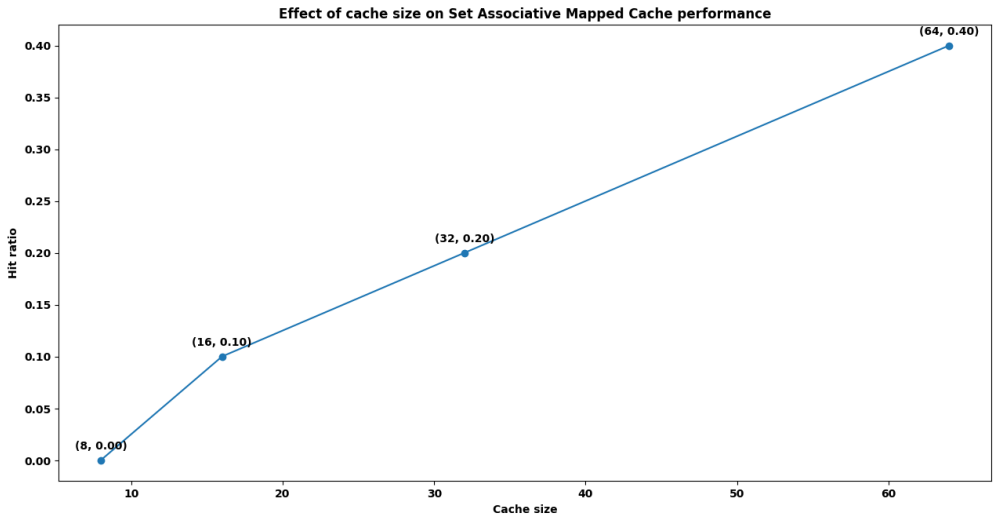
- Cache Type : Set Associative
- Number of sets (Set Blocks) : 2 way
- Block Size : 4
- Select Enable Chart check box
- Select stay on top check box
- Replacement: LRU

Step 2: Run the program in single step and observe the changes on the data cache window

Step 3: Fill in the following table with number of hits, misses and hit ratio with different cache sizes (8, 16, 32, and 64)

	Cache size = 8	Cache size = 16	Cache size = 32	Cache size = 64
Number of hit	0	1	2	4
Number of miss	10	9	8	6
Hit ratio	0	0.1	0.2	0.4

Step 4 : Plot the graph of cache size vs hit ratio and comment on the results obtained.



Based on the table and graph of cache size vs hit ratio, it is clear that increasing the cache size leads to a significant improvement in cache performance. As the cache size increases from 8 to 64, the number of hits increases from 0 to 4, and the hit ratio increases from 0 to 0.4. This suggests that larger caches are more effective at reducing cache misses and improving the overall performance of the Set Associative Mapped Cache.

However, it is worth noting that the improvement in hit ratio seems to level off beyond a cache size of 32, suggesting that there may be diminishing returns to further increasing the cache size beyond this point. Additionally, while the experiment provides valuable insights

into the effect of cache size on cache performance, it is important to keep in mind that the results may be specific to the particular parameters and conditions used in the experiment, and may not necessarily generalize to other settings.

Overall, the results obtained from the experiment suggest that cache size is an important factor to consider in optimizing the performance of a Set Associative Mapped Cache, and that larger cache sizes can significantly improve cache performance.

7.2 Effect of block size on the performance of Set Associative Mapped Cache

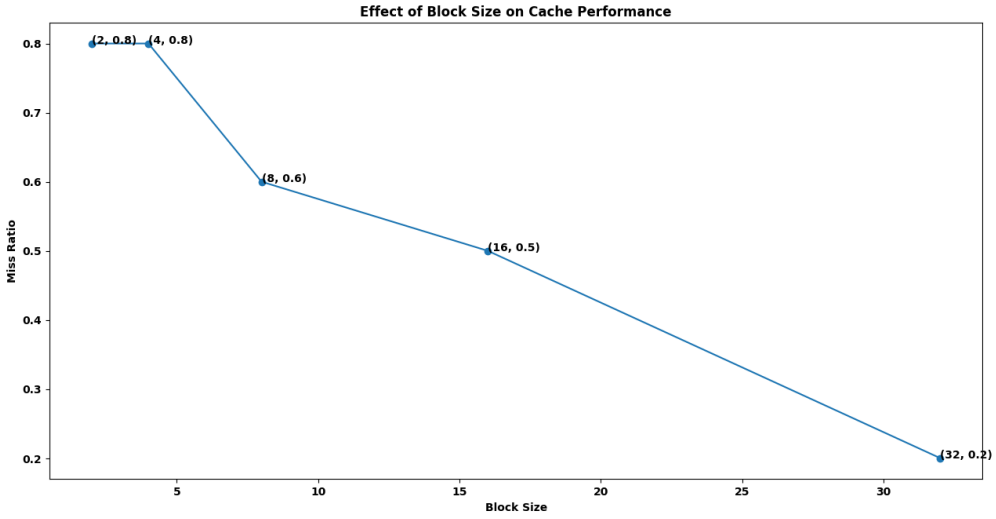
Step 1: Set the following parameters:

- Cache Type : Set Associative
- Cache Size : 32 bytes
- Set blocks : 2 way
- Select Enable Chart check box
- Select stay on top check box
- Replacement algorithm : LRU

Step 2: Execute the above program by setting block size to 2, 4, 8, 16 and 32. Record the observation in the following table.

Block Size	Miss	Hit	Miss ratio
2	8	2	0.8
4	8	2	0.8
8	6	4	0.6
16	5	5	0.5
32 (Cache Size : 64)	2	8	0.2

Step 3: Plot the graph of Cache miss ratio Vs Block size



7.3 Effect of number of sets on the performance of Set Associative Mapped Cache

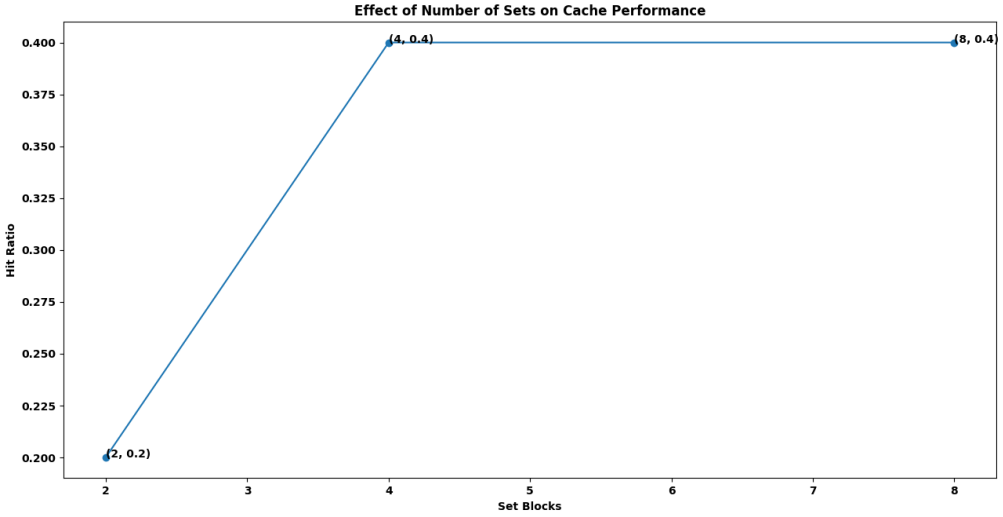
Step 1: Set the following parameters:

- Block size : 4
- Cache size : 32
- Cache Type : Set associative cache
- Select Enable Chart check box
- Select stay on top check box
- Replacement: LRU

Step 2: Execute the above program by setting set blocks to 2 way, 4 way and 8way. Record the observation in the following table.

Set Blocks	Miss	Hit	Hit ratio
2	8	2	0.2
4	6	4	0.4
8	6	4	0.4

Step 3: Plot the graph of Cache hit ratio Vs Set block size.



7.4 Performance analysis of Set Associative Mapped Cache with various replacement algorithms

Step 1 Set the following parameters:

- Block size : 4
- Cache size : 32
- Set blocks : 2 way
- Select Enable Chart check box
- Select stay on top check box

Step 2: Execute the above program by setting replacement algorithm as FIFO, Random and LRU. Record the observation in the following table.

Replacement Algorithm	Miss	Hit	Miss ratio
FIFO	8	2	0.8
LRU	8	2	0.8
Random	63	17	0.787