CS224 - SPRING 2023 -

Lab Report

Lab-06

Section 5

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# Report for matrix 1 size (N = 100)

a) **Direct Mapped Caches**:

(N = 100 column-major addition)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size (words) | 2 | 4 | 8 | 16 | 32 |
| Cache Size (bytes) |
| 256 | Miss Rate = 49%  Number of misses = 5035 | Miss Rate = 25%  Number of misses = 2521 | Miss Rate = 12%  Number of misses = 1262 | Miss Rate = 6%  Number of misses = 634 | Miss Rate = 3%  Number of misses = 318 |
| 512 | Miss Rate = 49%  Number of misses = 5035 | Miss Rate = 25%  Number of misses = 2521 | Miss Rate = 12%  Number of misses = 1262 | Miss Rate = 6%  Number of misses = 632 | Miss Rate = 3%  Number of misses = 318 |
| 1024 | Miss Rate = 49%  Number of misses = 5035 | Miss Rate = 25%  Number of misses = 2521 | Miss Rate = 12%  Number of misses = 1262 | Miss Rate = 6%  Number of misses = 632 | Miss Rate = 3%  Number of misses = 318 |
| 2048 | Miss Rate = 49%  Number of misses = 5035 | Miss Rate = 25%  Number of misses = 2521 | Miss Rate = 12%  Number of misses = 1262 | Miss Rate = 6%  Number of misses = 634 | Miss Rate = 3%  Number of misses = 318 |
| 4096 | Miss Rate = 49%  Number of misses = 5035 | Miss Rate = 25%  Number of misses = 2521 | Miss Rate = 12%  Number of misses = 1262 | Miss Rate = 6%  Number of misses = 632 | Miss Rate = 3%  Number of misses = 318 |

*Table 1.1: Column-major summation miss rates of matrix size N = 100*

*Figure 1.1: Graph presentation for table 1.1*

(N = 100 row-major addition)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size (words) | 2 | 4 | 8 | 16 | 32 |
| Cache Size (bytes) |
| 256 | Miss Rate = 98%  Number of misses = 10034 | Miss Rate = 98%  Number of misses = 10020 | Miss Rate = 98%  Number of misses = 10012 | Miss Rate = 98%  Number of misses = 10009 | Miss Rate = 98%  Number of misses = 10006 |
| 512 | Miss Rate = 98%  Number of misses = 10034 | Miss Rate = 98%  Number of misses = 10020 | Miss Rate = 98%  Number of misses = 10012 | Miss Rate = 98%  Number of misses = 10009 | Miss Rate = 98%  Number of misses = 10006 |
| 1024 | Miss Rate = 85%  Number of misses = 8634 | Miss Rate = 78%  Number of misses = 7920 | Miss Rate = 98%  Number of misses = 10012 | Miss Rate = 98%  Number of misses = 10007 | Miss Rate = 98%  Number of misses = 10008 |
| 2048 | Miss Rate = 49%  Number of misses = 5035 | Miss Rate = 25%  Number of misses = 2520 | Miss Rate = 77%  Number of misses = 7912 | Miss Rate = 98%  Number of misses = 10007 | Miss Rate = 98%  Number of misses = 10006 |
| 4096 | Miss Rate = 49%  Number of misses = 5034 | Miss Rate = 25%  Number of misses = 2520 | Miss Rate = 68%  Number of misses = 6940 | Miss Rate = 83%  Number of misses = 8471 | Miss Rate = 98%  Number of misses = 10006 |

*Table 1.2: Row-major summation miss rates of matrix size N = 100*

*Figure 1.2: Graph representation of table 1.2*

b) **Fully Associative Caches**:

(N = 100 row-major addition)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Good Hit Rate  Cache size = 2048 bytes  Block size = 4 words | Medium Hit Rate  Cache size = 2048 bytes  Block size = 8 words | Bad Hit Rate  Cache size = 2048 bytes  Block size = 16 words |
| Fully Associative with LRU | Miss rate = 25%  Number of misses = 2520 | Miss rate = 98%  Number of misses = 10012 | Miss rate = 98%  Number of misses = 10009 |
| Fully Associative with Random | Miss rate = 43%  Number of misses = 4347 | Miss rate = 69%  Number of misses = 7086 | Miss rate = 94%  Number of misses = 9551 |
| Direct Mapped | Miss rate = 25%  Number of misses = 2520 | Miss rate = 77%  Number of misses = 7912 | Miss rate = 98%  Number of misses = 10007 |

*Table 1.3: Comparison of fully associative cache and direct mapping on various points from table 1.2*

*Figure 1.3: Graph representation of table 1.3*

c) **N-way Set Associative Caches**:

N = 100 row-major addition

|  |  |  |  |
| --- | --- | --- | --- |
| Set size | Good Hit Rate  Cache size = 2048 bytes  Block size = 4 words | Medium Hit Rate  Cache size = 2048 bytes  Block size = 8 words | Bad Hit Rate  Cache size = 2048 bytes  Block size = 16 words |
| 2 | Miss rate = 25%  Number of misses = 2520 | Miss rate = 93%  Number of misses = 9520 | Miss rate = 98%  Number of misses = 10007 |
| 4 | Miss rate = 25%  Number of misses = 2520 | Miss rate = 98%  Number of misses = 10012 | Miss rate = 98%  Number of misses = 10009 |
| 8 | Miss rate = 25%  Number of misses = 2520 | Miss rate = 98%  Number of misses = 10012 | Miss rate = 98%  Number of misses = 10007 |
| 16 | Miss rate = 25%  Number of misses = 2520 | Miss rate = 98%  Number of misses = 10012 | Miss rate = 98%  Number of misses = 10009 |

*Table 1.4: N-way associative cache comparison on various points from table 1.2*

# Report for matrix 2 size (N = 150)

a) **Direct Mapped Caches**:

(N = 150 column-major addition)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size (words) | 2 | 4 | 8 | 16 | 32 |
| Cache Size (bytes) |
| 256 | Miss Rate = 50%  Number of misses = 11285 | Miss Rate = 25%  Number of misses = 5646 | Miss Rate = 12%  Number of misses = 2825 | Miss Rate = 6%  Number of misses = 1414 | Miss Rate = 3%  Number of misses = 711 |
| 512 | Miss Rate = 50%  Number of misses = 11285 | Miss Rate = 25%  Number of misses = 5646 | Miss Rate = 12%  Number of misses = 2825 | Miss Rate = 6%  Number of misses = 1416 | Miss Rate = 3%  Number of misses = 709 |
| 1024 | Miss Rate = 50%  Number of misses = 11285 | Miss Rate = 25%  Number of misses = 5646 | Miss Rate = 12%  Number of misses = 2825 | Miss Rate = 6%  Number of misses = 1414 | Miss Rate = 3%  Number of misses = 709 |
| 2048 | Miss Rate = 50%  Number of misses = 11285 | Miss Rate = 25%  Number of misses = 5646 | Miss Rate = 12%  Number of misses = 2825 | Miss Rate = 6%  Number of misses = 1416 | Miss Rate = 3%  Number of misses = 709 |
| 4096 | Miss Rate = 50%  Number of misses = 11285 | Miss Rate = 25%  Number of misses = 5646 | Miss Rate = 12%  Number of misses = 2825 | Miss Rate = 6%  Number of misses = 1414 | Miss Rate = 3%  Number of misses = 711 |

*Table 2.1: Column-major summation miss rates of matrix size N = 150*

*Figure 2.1: Graph presentation for table 2.1*

(N = 150 row-major addition)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size (words) | 2 | 4 | 8 | 16 | 32 |
| Cache Size (bytes) |
| 256 | Miss Rate = 99%  Number of misses = 22534 | Miss Rate = 99%  Number of misses = 22520 | Miss Rate = 99%  Number of misses = 22512 | Miss Rate = 99%  Number of misses = 22509 | Miss Rate = 99%  Number of misses = 22506 |
| 512 | Miss Rate = 99%  Number of misses = 22534 | Miss Rate = 99%  Number of misses = 22520 | Miss Rate = 99%  Number of misses = 22512 | Miss Rate = 99%  Number of misses = 22507 | Miss Rate = 99%  Number of misses = 22506 |
| 1024 | Miss Rate = 64%  Number of misses = 14584 | Miss Rate = 91%  Number of misses = 20744 | Miss Rate = 99%  Number of misses = 22512 | Miss Rate = 99%  Number of misses = 22509 | Miss Rate = 99%  Number of misses = 22506 |
| 2048 | Miss Rate = 50%  Number of misses = 11284 | Miss Rate = 59%  Number of misses = 13320 | Miss Rate = 94%  Number of misses = 21361 | Miss Rate = 99%  Number of misses = 22507 | Miss Rate = 99%  Number of misses = 22508 |
| 4096 | Miss Rate = 50%  Number of misses = 11284 | Miss Rate = 25%  Number of misses = 5720 | Miss Rate = 49%  Number of misses = 11058 | Miss Rate = 97%  Number of misses = 21986 | Miss Rate = 99%  Number of misses = 22506 |

*Table 2.2: Row-major summation miss rates of matrix size N = 150*

*Figure 2.2: Graph representation of table 2.2*

b) **Fully Associative Caches**:

N = 150 row-major addition

|  |  |  |  |
| --- | --- | --- | --- |
|  | Good Hit Rate  Cache size = 4096 bytes  Block size = 4 words | Medium Hit Rate  Cache size = 4096 bytes  Block size = 8 words | Bad Hit Rate  Cache size = 4096 bytes  Block size = 16 words |
| Fully Associative with LRU | Miss rate = 25%  Number of misses = 5720 | Miss rate = 99%  Number of misses = 22512 | Miss rate = 99%  Number of misses = 22509 |
| Fully Associative with Random | Miss rate = 41%  Number of misses = 9236 | Miss rate = 53%  Number of misses = 11969 | Miss rate = 87%  Number of misses = 19849 |
| Direct Mapped | Miss rate = 25%  Number of misses = 5720 | Miss rate = 49%  Number of misses = 11058 | Miss rate = 97%  Number of misses = 21984 |

*Table 2.3: Comparison of fully associative cache and direct mapping on various points from table 2.2*

*Figure 2.3: Graph representation of table 2.3*

c) **N-way Set Associative Caches**:

(N = 150 row-major addition)

|  |  |  |  |
| --- | --- | --- | --- |
| Set size | Good Hit Rate  Cache size = 4096 bytes  Block size = 4 words | Medium Hit Rate  Cache size = 4096 bytes  Block size = 8 words | Bad Hit Rate  Cache size = 4096 bytes  Block size = 16 words |
| 2 | Miss rate = 25%  Number of misses = 5720 | Miss rate = 61%  Number of misses = 13967 | Miss rate = 99%  Number of misses = 22509 |
| 4 | Miss rate = 25%  Number of misses = 5720 | Miss rate = 73%  Number of misses = 16626 | Miss rate = 99%  Number of misses = 22507 |
| 8 | Miss rate = 25%  Number of misses = 5720 | Miss rate = 89%  Number of misses = 20276 | Miss rate = 99%  Number of misses = 22509 |
| 16 | Miss rate = 25%  Number of misses = 5720 | Miss rate = 98%  Number of misses = 22208 | Miss rate = 99%  Number of misses = 22507 |

*Table 2.4: N-way associative cache comparison on various points from table 1.2*

# Discussion:

* Column major addition results are generally same for all cache samples since it is common array traversing.
* Obviously, if cache memory size increases, hit rate increases on the data provided on tables.
* Fully Associative Random gives beter results than Fully Associative LRU with block sizes 8 and 16 in both samples N = 100 and N = 150.
* In both samples, row addition gives best result with block size 4, and cache memory size 4096 bytes.
* Since the cache memory sizes are too low, increasing block sizes does not have a significant effect the hit rate in both samples.
* For N = 150 case, increasing the block size in the medium hit rate sample has a negative effect on hit rate since the set size must be decreased simultaneously in order to cache size remain constant.
* Fully associative with LRU, does not gives beter hit rates than direct mapping for both sample sizes N=100 and N=150.
* Generally, since increasing the block size also means that a decrease in number of sets in order to cache size remain constant, it increases the miss rate too for both samples N = 100, and N = 150.