**Report for Matrix (with N=100)**

Part A:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size(words)  Cache Size (Bytes) | 2 | 4 | 8 | 16 | 32 |
| 256(0.26KB) | Miss rate:  47%  Hit rate: 53%  # of misses: 10220 | Miss rate:  24%  Hit rate:  76%  # of misses:  5113 | Miss rate:  12%  Hit rate:  88%  # of misses:  2559 | Miss rate:  6%  Hit rate:  94%  # of misses:  1283 | Miss rate:  3%  Hit rate:  97%  # of misses:  647 |
| 512(0.5KB) | Miss rate: 47%  Hit rate:  53%  # of misses:  10218 | Miss rate:  24%  Hit rate:  76%  # of misses:  5112 | Miss rate:  12%  Hit rate:  88%  # of misses:  2559 | Miss rate:  6%  Hit rate:  94%  # of misses:  1283 | Miss rate:  3%  Hit rate:  97%  # of misses:  326 |
| 1024(1KB) | Miss rate: 47%  Hit rate:  53%  # of misses: 10218 | Miss rate:  24%  Hit rate:  76%  # of misses:  5112 | Miss rate:  12%  Hit rate:  88%  # of misses:  2558 | Miss rate:  6%  Hit rate:  94%  # of misses:  1282 | Miss rate:  3%  Hit rate:  97%  # of misses:  646 |
| 2048(2 KB) | Miss rate:  47%  Hit rate:  53%  # of misses:  10217 | Miss rate:  24%  Hit rate:  76%  # of misses:  5112 | Miss rate:  12%  Hit rate:  88%  # of misses:  2558 | Miss rate:  6%  Hit rate:  94%  # of misses:  1282 | Miss rate:  3%  Hit rate:  97%  # of misses:  646 |
| 4096(4 KB) | Miss rate:  47%  Hit rate:  53%  # of misses:  10218 | Miss rate:  24%  Hit rate:  53%  # of misses:  2239 | Miss rate:  12%  Hit rate:  88%  # of misses:  2558 | Miss rate:  6%  Hit rate:  94%  # of misses:  1282 | Miss rate:  3%  Hit rate: 97%  # of misses:  646 |

Table-01: Miss rate, hit rate and # of misses of column-wise summation for Direct Mapped Cache (N=100)

Graph-01: Direct Mapped Cache with N=100 for column-wise summation

**COMMENT:**  #of sets = Cache size / 1\*Block size = 256 / 1\*2\*32 = 4

#of sets = 256 / 4\*32 = 2 sets

As we increase the block size, number of sets will be decreased.

#of sets = Cache size / 1\*Block size = 512/ 1\*4\*32 = 4 sets

Therefore, miss rates will decrease.

Code for this problem involves lines

lw $t1, 0($s2)

add $s7, $s7, $t1 #update the sum column by column

add $s2, $s2, 4

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size(words)  Cache Size (Bytes) | 2 | 4 | 8 | 16 | 32 |
| 256(0.26KB) | Miss rate:  70%  Hit rate: 30%  # of misses: 15218 | Miss rate:  58%  Hit rate:  42%  # of misses:  12613 | Miss rate:  52%  Hit rate:  48%  # of misses:  11310 | Miss rate:  49%  Hit rate:  51%  # of misses:  10659 | Miss rate:  48%  Hit rate:  52%  # of misses:  10334 |
| 512(0.5KB) | Miss rate: 70%  Hit rate:  30%  # of misses:  15216 | Miss rate:  58%  Hit rate:  42%  # of misses:  12612 | Miss rate:  52%  Hit rate:  48%  # of misses:  11310 | Miss rate:  49%  Hit rate:  51%  # of misses:  10659 | Miss rate:  48%  Hit rate:  52%  # of misses:  10334 |
| 1024(1KB) | Miss rate: 64%  Hit rate:  36%  # of misses: 13816 | Miss rate:  49%  Hit rate:  51%  # of misses:  10052 | Miss rate:  48%  Hit rate:  52%  # of misses:  10333 | Miss rate:  49%  Hit rate:  51%  # of misses:  10658 | Miss rate:  48%  Hit rate:  52%  # of misses:  10333 |
| 2048(2 KB) | Miss rate:  31%  Hit rate:  69%  # of misses:  10718 | Miss rate:  24%  Hit rate:  76%  # of misses:  5099 | Miss rate:  43%  Hit rate:  57%  # of misses:  9204 | Miss rate:  50%  Hit rate:  50%  # of misses:  10655 | Miss rate:  33%  Hit rate:  67%  # of misses:  10650 |
| 4096(4 KB) | Miss rate:  31%  Hit rate:  69%  # of misses:  10716 | Miss rate:  24%  Hit rate:  76%  # of misses:  5099 | Miss rate:  29%  Hit rate:  71%  # of misses:  9489 | Miss rate:  42%  Hit rate:  58%  # of misses:  9117 | Miss rate:  47%  Hit rate:  53%  # of misses:  10331 |

Table-02: Miss rate, hit rate and # of misses of row-wise summation for Direct Mapped Cache (N=100)

Graph-02: Direct Mapped Cache with N=100 for row wise summation

PART B:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Hit Rate(Good)  Cache Size(bytes):2048  Block Size(words):4 | Hit Rate(Medium)  Cache Size(bytes):2048  Block Size(words):16 | Hit Rate(Bad)  Cache Size(bytes):256  Block Size(words):2 |
| Fully Associative (LRU) | Cache hit rate: 52%  Miss rate: 48%  # of misses: 10332 | Cache hit rate: 50%  Miss rate: 50%  #of misses: 10655 | Cache hit rate: 29%  Miss rate: 71%  # of misses: 15199 |
| Fully Associative (Random) | Cache hit rate: 67%  Miss rate: 33%  # of misses: 7022 | Cache hit rate: 52%  Miss rate: 48%  #of misses: 10227 | Cache hit rate: 30%  Miss rate: 70%  #of misses: 14970 |
| Direct Mapped | Miss rate:24%  Hit rate:76%  # of misses:5099 | Miss rate:50%  Hit rate:50%  # of misses: 10655 | Miss rate:70%  Hit rate: 30%  # of misses: 15218 |

Table-03: Examines hit rate performances for various cache designs(N=100) for row major operation

Comparison of the results:

* The Direct Mapped good result versus the Fully Associative good result:

Hit rate increased, miss rate decreased when we apply Fully associative map (LRU).

When we apply random replacement, hit rate increases more compared to LRU.

* The Direct Mapped medium result versus the Fully Associative medium result:

Hit rate and miss rate did not changed when we apply Fully associative map(LRU).

When we apply random replacement, hit rate increased compared to LRU.

* The Direct Mapped poor result versus the Fully Associative poor result:

Hit rate decreased 1%, miss rate increased 1% when we apply Fully associative map(LRU).

When we apply random replacement, hit rate and miss rate did not changed.

Fully associative (random) made significant change on Direct Mapped (with good rate).

Graph-03: Miss rates of good, medium and high rates according to Fully(LRU), Fully(Random) and DirectMapped

PART C:

|  |  |  |  |
| --- | --- | --- | --- |
| N-way Set Associative  Cache Set Size | Hit Rate(Good)  Cache Size(bytes):2048  Block Size(words):4 | Hit Rate(Medium)  Cache Size(bytes):2048  Block Size(words):16 | Hit Rate(Bad)  Cache Size(bytes):256  Block Size(words):2 |
| 4 | Cache hit rate: 70%  Miss rate: 30%  # of misses: 6406 | Cache hit rate: 52%  Miss rate: 48%  # of misses: 10298 | Cache hit rate: 29%  Miss rate: 71%  # of misses: 15191 |
| 8 | Cache hit rate: 70%  Miss rate: 30%  # of misses: 6653 | Cache hit rate: 52%  Miss rate: 48%  # of misses: 10248 | Cache hit rate: 29%  Miss rate: 71%  # of misses: 15191 |
| 2 | Cache hit rate: 72%  Miss rate: 28%  # of misses: 5947 | Cache hit rate: 43%  Miss rate: 57%  # of misses: 12158 | Cache hit rate: 29%  Miss rate: 71%  # of misses: 15198 |
| 16 | Cache hit rate: 68%  Miss rate: 32%  # of misses: 6977 | Cache hit rate: 52%  Miss rate: 48%  # of misses: 10213 | Cache hit rate: 29%  Miss rate: 71%  # of misses: 15187 |

Table-04: Examines hit rate performances for n-way caches(N=100) for row major operation

Comparison of results:

* For the medium rate, set size = 4, 8 and 16 give the best hit rate.
* For the good rate, set size=2 gives the best hit rate.
* For the poor rate, set size did not change the hit rate.

**Report for Matrix (with N=50):**

Part A:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size(words)  Cache Size (Bytes) | 2 | 4 | 8 | 16 | 32 |
| 256(0.26KB) | Miss rate:  41%  Hit rate: 59%  # of misses: 2720 | Miss rate:  21%  Hit rate:  79%  # of misses:  2029 | Miss rate:  10%  Hit rate:  90%  # of misses:  685 | Miss rate:  5%  Hit rate:  95%  # of misses:  347 | Miss rate:  3%  Hit rate:  97%  # of misses:  179 |
| 512(0.5KB) | Miss rate: 41%  Hit rate:  59%  # of misses:  2718 | Miss rate:  20%  Hit rate:  80%  # of misses:  1362 | Miss rate:  10%  Hit rate:  90%  # of misses:  685 | Miss rate:  5%  Hit rate:  95%  # of misses:  347 | Miss rate:  3%  Hit rate:  97%  # of misses:  179 |
| 1024(1KB) | Miss rate: 41%  Hit rate:  59%  # of misses: 2718 | Miss rate:  20%  Hit rate:  80%  # of misses:  1362 | Miss rate:  10%  Hit rate:  90%  # of misses:  684 | Miss rate:  5%  Hit rate:  95%  # of misses:  346 | Miss rate:  3%  Hit rate:  97%  # of misses:  178 |
| 2048(2 KB) | Miss rate:  41%  Hit rate:  59%  # of misses:  2718 | Miss rate:  20%  Hit rate:  59%  # of misses:  1362 | Miss rate:  10%  Hit rate:  90%  # of misses:  684 | Miss rate:  5%  Hit rate:  95%  # of misses:  346 | Miss rate:  3%  Hit rate:  97%  # of misses:  178 |
| 4096(4 KB) | Miss rate:  41%  Hit rate:  59%  # of misses:  2718 | Miss rate:  20%  Hit rate:  59%  # of misses:  1362 | Miss rate:  10%  Hit rate:  90%  # of misses:  684 | Miss rate:  5%  Hit rate:  95%  # of misses:  346 | Miss rate:  3%  Hit rate: 97%  # of misses:  178 |

Table-05: Miss rate, hit rate and # of misses of column-wise summation for Direct Mapped Cache (N=50)

Graph-04: Direct Mapped Cache with N=50 for column-wise summation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block Size(words)  Cache Size (Bytes) | 2 | 4 | 8 | 16 | 32 |
| 256(0.26KB) | Miss rate:  54%  Hit rate: 46%  # of misses: 3618 | Miss rate:  49%  Hit rate:  51%  # of misses:  3238 | Miss rate:  43%  Hit rate:  57%  # of misses:  2873 | Miss rate:  41%  Hit rate:  59%  # of misses:  2691 | Miss rate:  39%  Hit rate:  61%  # of misses:  2600 |
| 512(0.5KB) | Miss rate:  41%  Hit rate:  59%  # of misses:  2716 | Miss rate:  38%  Hit rate:  62%  # of misses:  2503 | Miss rate:  53%  Hit rate:  57%  # of misses:  2873 | Miss rate:  41%  Hit rate:  59%  # of misses:  2691 | Miss rate:  39%  Hit rate:  61%  # of misses:  2600 |
| 1024(1KB) | Miss rate:  41%  Hit rate:  59%  # of misses:  2711 | Miss rate:  28%  Hit rate:  72%  # of misses:  1828 | Miss rate:  29%  Hit rate:  71%  # of misses:  1896 | Miss rate:  40%  Hit rate:  60%  # of misses:  2690 | Miss rate:  39%  Hit rate:  61%  # of misses:  2599 |
| 2048(2 KB) | Miss rate:  41%  Hit rate:  59%  # of misses:  2711 | Miss rate:  27%  Hit rate:  73%  # of misses:  1814 | Miss rate:  21%  Hit rate:  79%  # of misses:  1380 | Miss rate:  27%  Hit rate:  73%  # of misses:  1803 | Miss rate:  39%  Hit rate:  61%  # of misses:  2599 |
| 4096(4 KB) | Miss rate:  41%  Hit rate:  59%  # of misses:  2711 | Miss rate:  27%  Hit rate:  73%  # of misses:  1814 | Miss rate:  20%  Hit rate:  80%  # of misses:  1339 | Miss rate:  17%  Hit rate:  83%  # of misses:  1141 | Miss rate:  26%  Hit rate: 74%  # of misses:  1726 |

Table-06: Miss rate, hit rate and # of misses of row-wise summation for Direct Mapped Cache (N=50)

Graph-05: Direct Mapped Cache with N=50 for row-wise summation

|  |  |  |  |
| --- | --- | --- | --- |
|  | Hit Rate(Good)  Cache Size(bytes):4096  Block Size(words):16 | Hit Rate(Medium)  Cache Size(bytes):1024  Block Size(words):16 | Hit Rate(Bad)  Cache Size(bytes):256  Block Size(words):4 |
| Fully Associative (LRU) | Miss rate: 6%  Hit rate: 94%  # of misses: 386 | Miss rate: 41%  Hit rate: 59%  # of misses: 2687 | Miss rate: 50%  Hit rate: 50%  # of misses: 3229 |
| Fully Associative (Random) | Miss rate: 8%  Hit rate: 92%  # of misses: 1029 | Miss rate: 49%  Hit rate: 51%  # of misses: 6367 | Miss rate: 49%  Hit rate: 51%  # of misses: 6367 |
| Direct Mapped | Miss rate:17%  Hit rate:83%  # of misses:1141 | Miss rate:41%  Hit rate:59%  # of misses:5264 | Miss rate:49%  Hit rate:51%  # of misses:3238 |

Table-07: Examines hit rate performances for various cache designs(N=50) for row major operation

Comparison of the results:

* The Direct Mapped good result versus the Fully Associative good result:

Hit rate increased, miss rate decreased when we apply Fully associative map (LRU).

When we apply random replacement, hit rate increases more compared to LRU.

* The Direct Mapped medium result versus the Fully Associative medium result:

Hit rate and miss rate did not changed when we apply Fully associative map(LRU).

When we apply random replacement, hit rate increased compared to LRU.

* The Direct Mapped poor result versus the Fully Associative poor result:

Hit rate decreased 1%, miss rate increased 1% when we apply Fully associative map(LRU).

When we apply random replacement, hit rate and miss rate did not changed.

Fully associative (random) made significant change on Direct Mapped (with good rate).

Graph-06: MissRates of Good, Medium and High Rates according to Fully(LRU), Fully(Random), DirectMapped

|  |  |  |  |
| --- | --- | --- | --- |
| N-way Set Associative  Cache Set Size | Hit Rate(Good)  Cache Size(bytes):4096  Block Size(words):16 | Hit Rate(Medium)  Cache Size(bytes):1024  Block Size(words):16 | Hit Rate(Bad)  Cache Size(bytes):256  Block Size(words):4 |
| 4 | Miss rate: 11%  Hit rate: 89%  # of misses: 697 | Miss rate: 40%  Hit rate: 60%  # of misses: 2606 | Miss rate: 51%  Hit rate: 49%  # of misses: 3174 |
| 8 | Miss rate: 11%  Hit rate: 89%  # of misses: 683 | Miss rate: 40%  Hit rate: 60%  # of misses: 2580 | Miss rate: 29%  Hit rate: 71%  # of misses: 3154 |
| 16 | Miss rate: 10%  Hit rate: 90%  # of misses: 635 | Miss rate: 40%  Hit rate: 60%  # of misses: 2573 | Miss rate: 48%  Hit rate: 52%  # of misses: 3131 |
| 2 | Miss rate: 18%  Hit rate: 82%  # of misses: 1137 | Miss rate: 40%  Hit rate: 60%  # of misses: 2607 | Miss rate: 49%  Hit rate: 51%  # of misses: 3178 |

Table-08: Examines hit rate performances for various N-way caches(N=50) for row major operation

Comparison of results:

* For good rate, set size=16 gives the best hit rate. Hit rate increased by 7% compared to direct mapped.
* For medium rate, set size did change the rates. Compared to direct mapped, hit rate increased by 20% but set size did not affect the result on N-way associative cache.
* For poor rate, set size = 8 gives the best hit rate.

Set size = 8 gives significant affect compared to direct mapped hit result.