

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

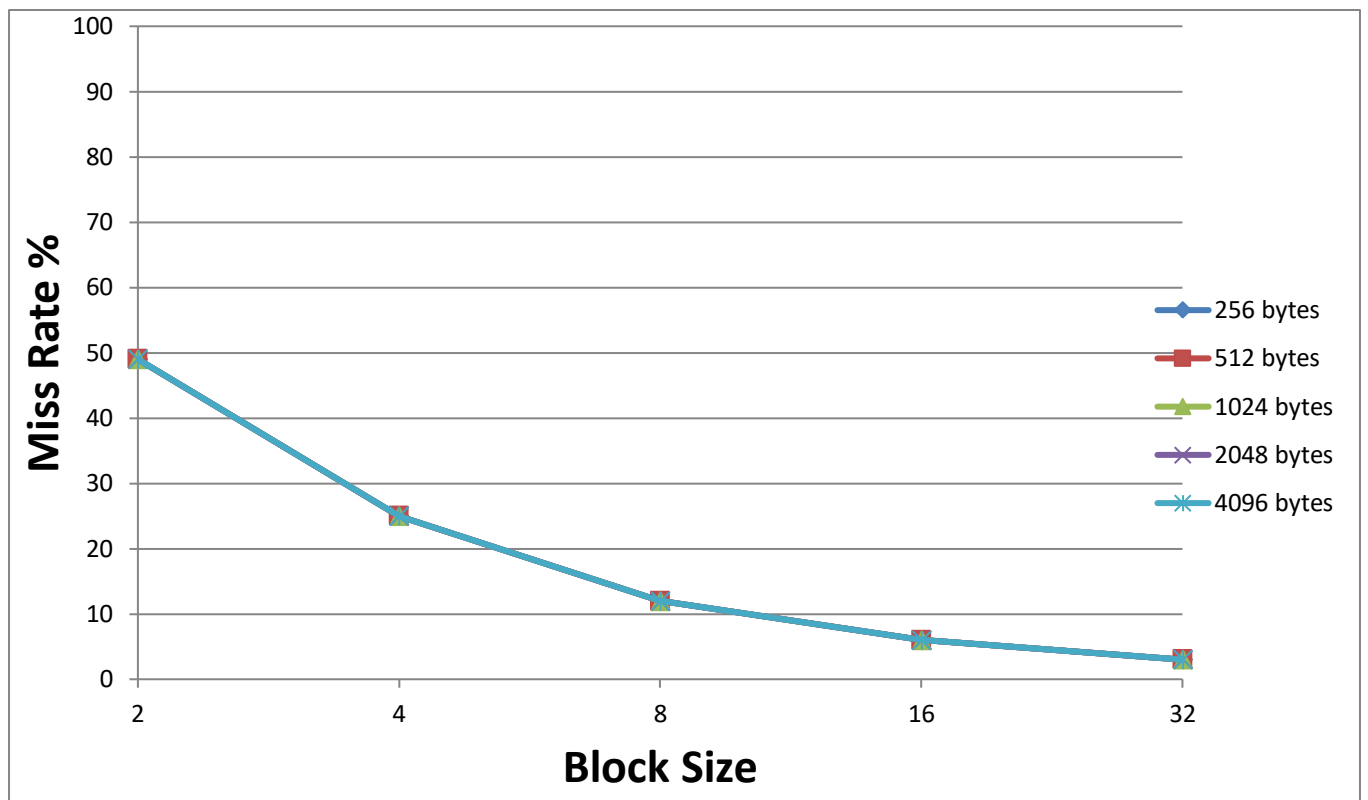


Figure 1.1: Graph presentation for table 1.1

(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

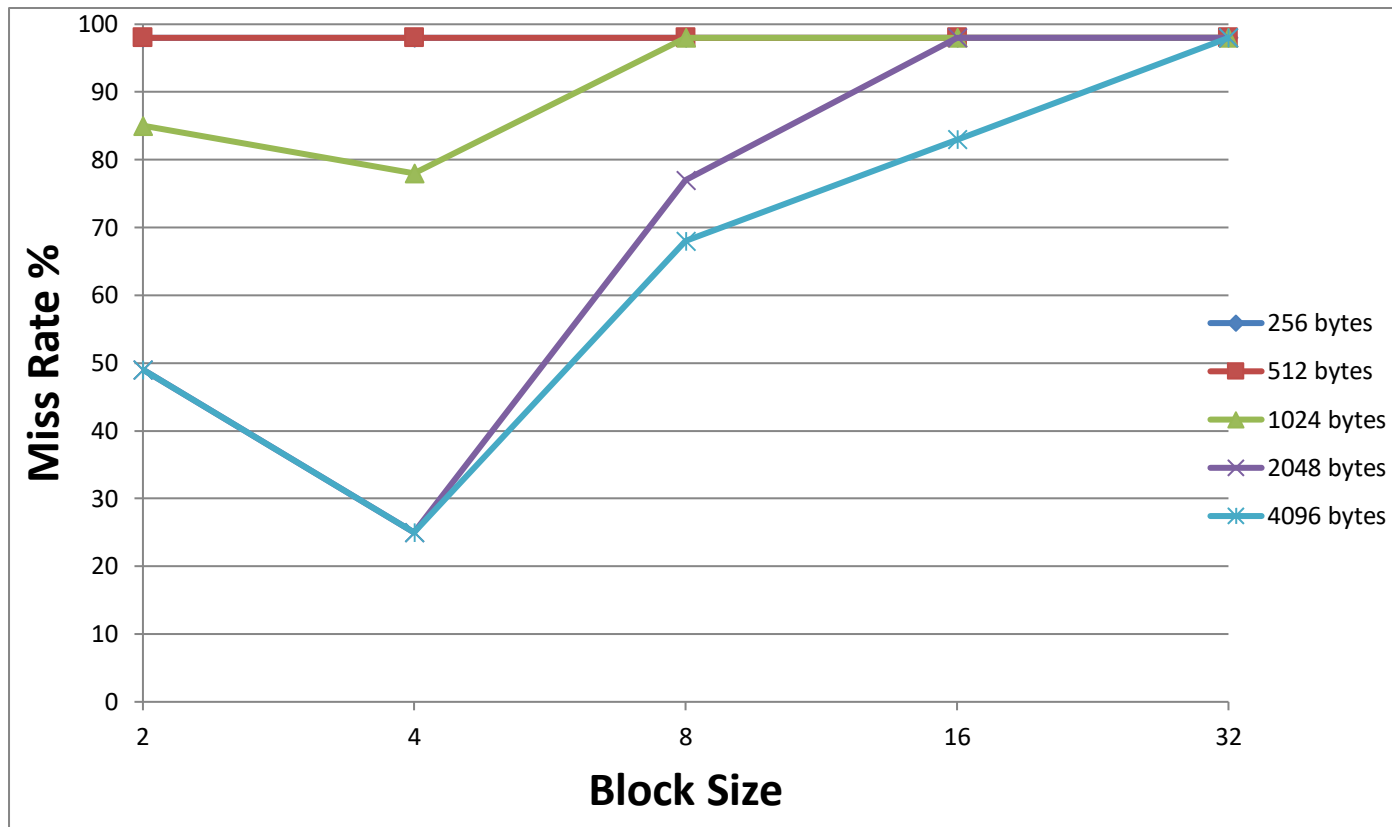


Figure 1.2: Graph representation of table 1.2

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

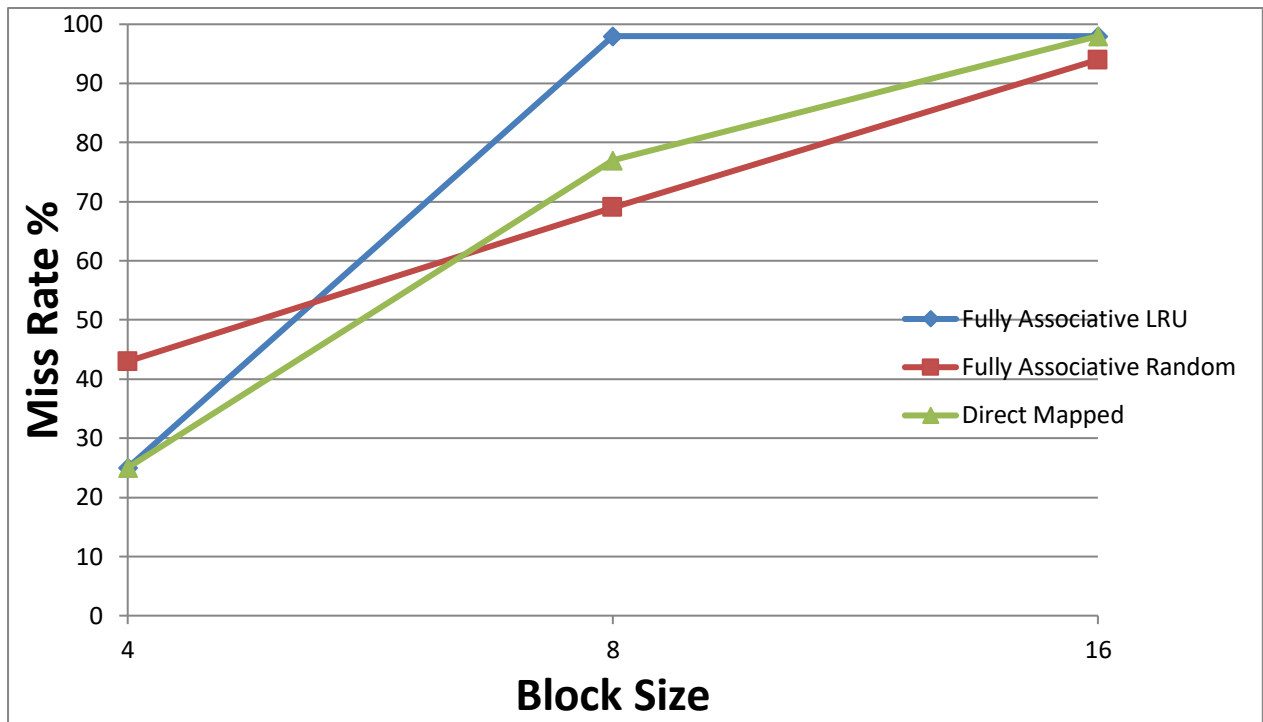


Figure 1.3: Graph representation of table 1.3

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

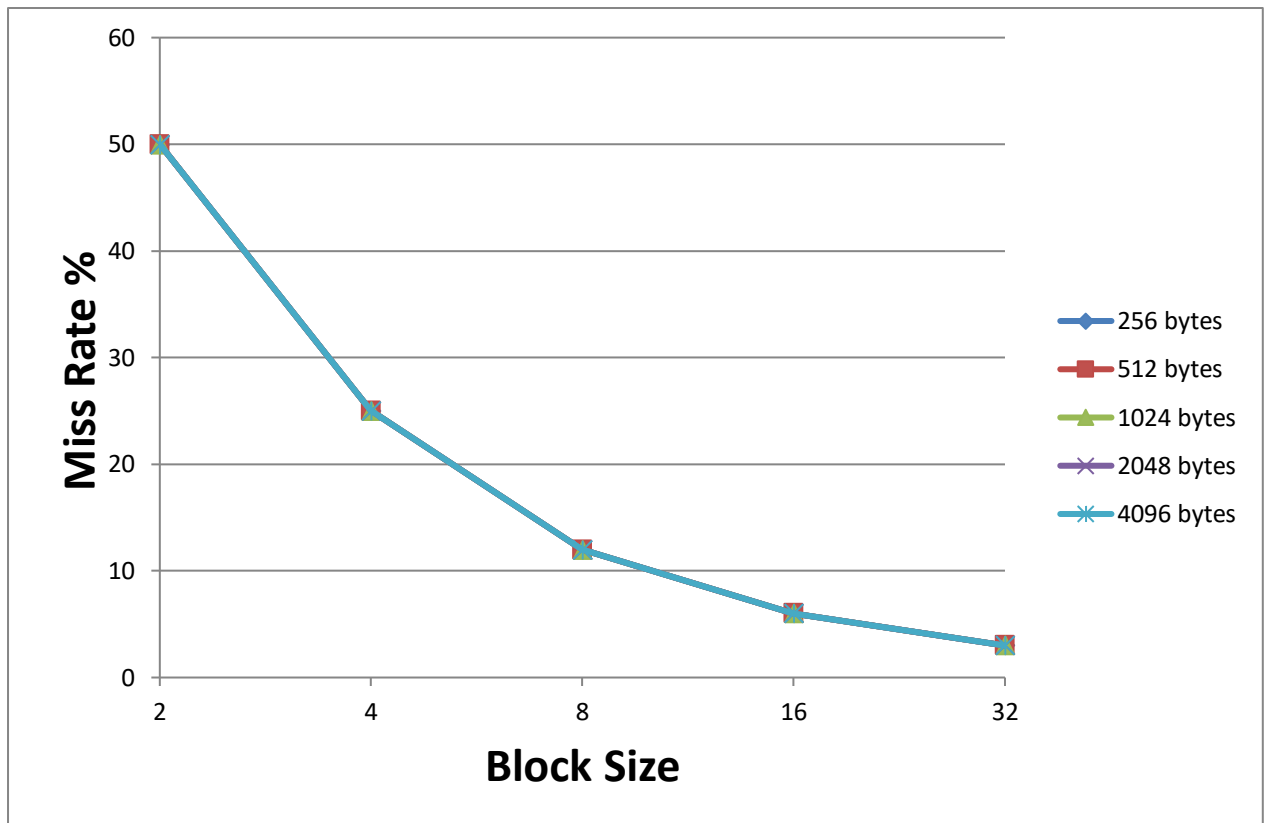


Figure 2.1: Graph presentation for table 2.1

(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

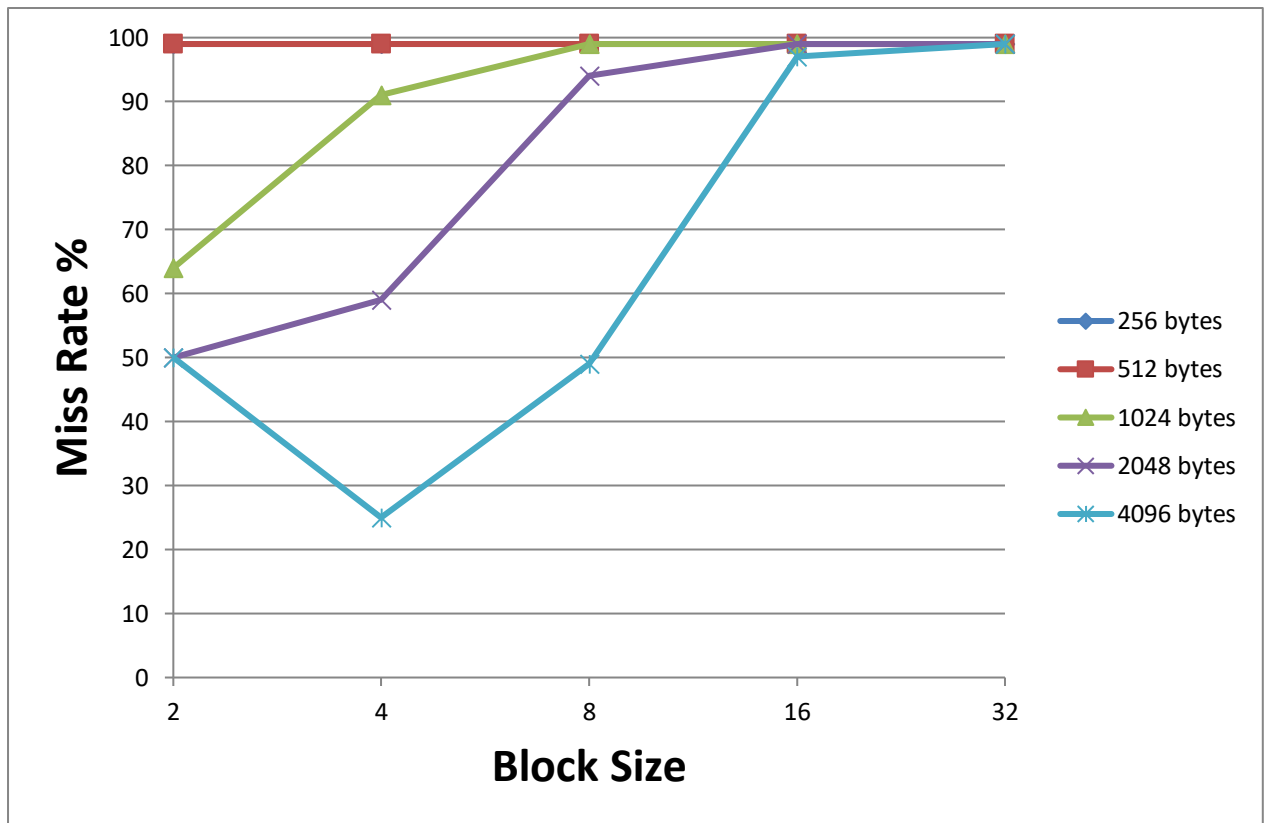


Figure 2.2: Graph representation of table 2.2

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

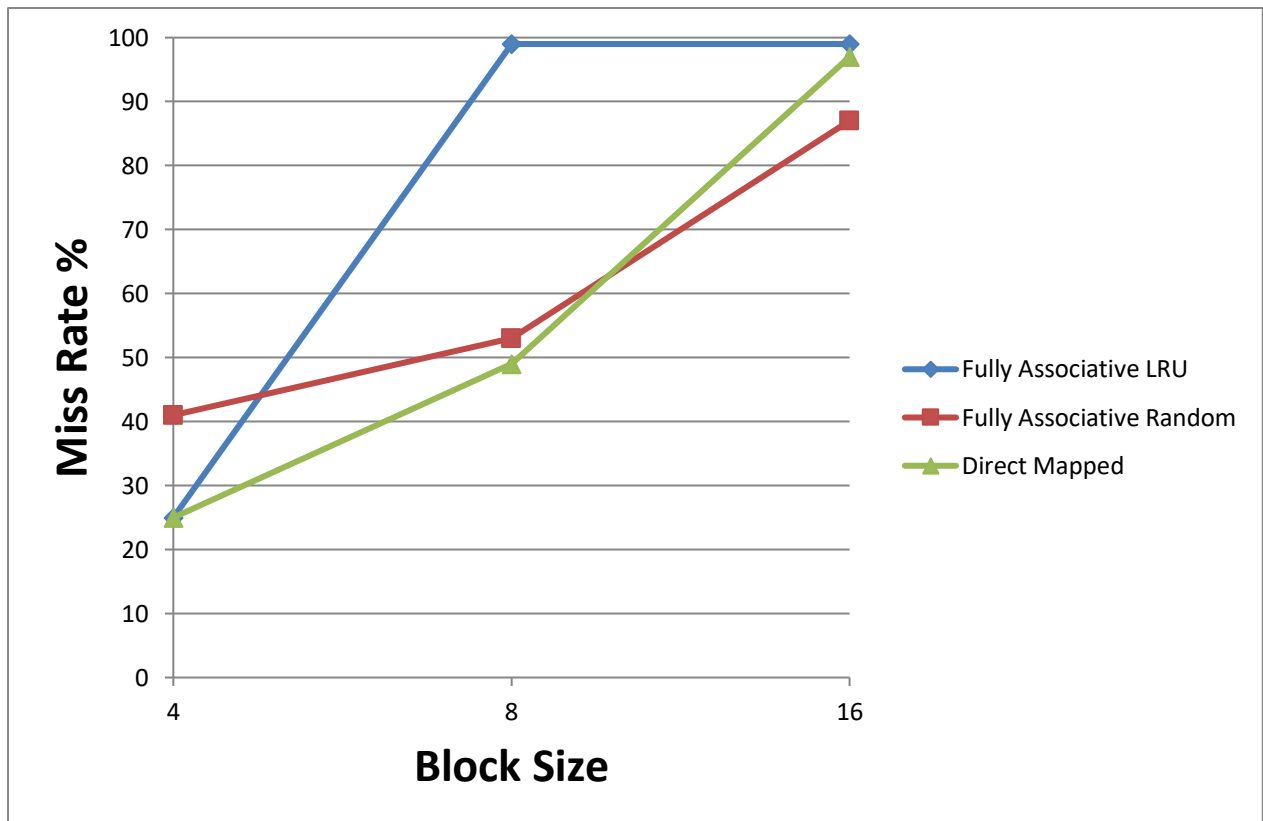


Figure 2.3: Graph representation of table 2.3

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 better 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 give better 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 $N = 150$.