CS224

Section 6

Spring 2024

Lab 6

Fazlı Güdül

22002785

03/05/2024

Lab Work

Preliminary Part 2

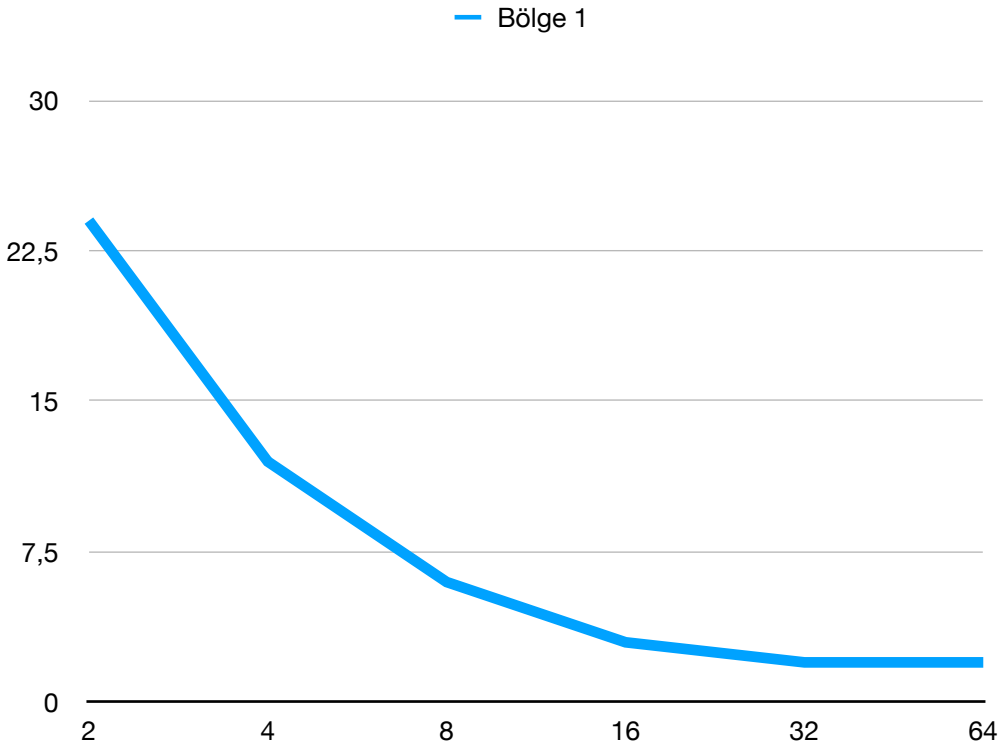
Experiments with Data Cache Parameters

Bilkent University

For matrix size N=120
Part a)

Block Size (words) ——————- Cache Size (Bytes)	4	8	16	32	64
256	Number of misses=7294 Hit Rate=%76 Miss Rate=%24	Number of misses=3648 Hit Rate=%88 Miss Rate=%12	Number of misses=1828 Hit Rate=%94 Miss Rate=%6	Number of misses=917 Hit Rate=%97 Miss Rate=%3	Number of misses=461 Hit Rate=%98 Miss Rate=%2
512	Number of misses=7293 Hit Rate=%76 Miss Rate=%24	Number of misses=3647 Hit Rate=%88 Miss Rate=%12	Number of misses=1827 Hit Rate=%94 Miss Rate=%6	Number of misses=917 Hit Rate=%97 Miss Rate=%3	Number of misses=461 Hit Rate=%98 Miss Rate=%2
1024	Number of misses=7293 Hit Rate=%76 Miss Rate=%24	Number of misses=3647 Hit Rate=%88 Miss Rate=%12	Number of misses=916 Hit Rate=%97 Miss Rate=%3	Number of misses=916 Hit Rate=%97 Miss Rate=%3	Number of misses=460 Hit Rate=%98 Miss Rate=%2
2048	Number of misses=7293 Hit Rate=%76 Miss Rate=%24	Number of misses=3647 Hit Rate=%88 Miss Rate=%12	Number of misses=916 Hit Rate=%97 Miss Rate=%3	Number of misses=916 Hit Rate=%97 Miss Rate=%3	Number of misses=460 Hit Rate=%98 Miss Rate=%2
4096	Number of misses=7293 Hit Rate=%76 Miss Rate=%24	Number of misses=3647 Hit Rate=%88 Miss Rate=%12	Number of misses=916 Hit Rate=%97 Miss Rate=%3	Number of misses=916 Hit Rate=%97 Miss Rate=%3	Number of misses=460 Hit Rate=%98 Miss Rate=%2

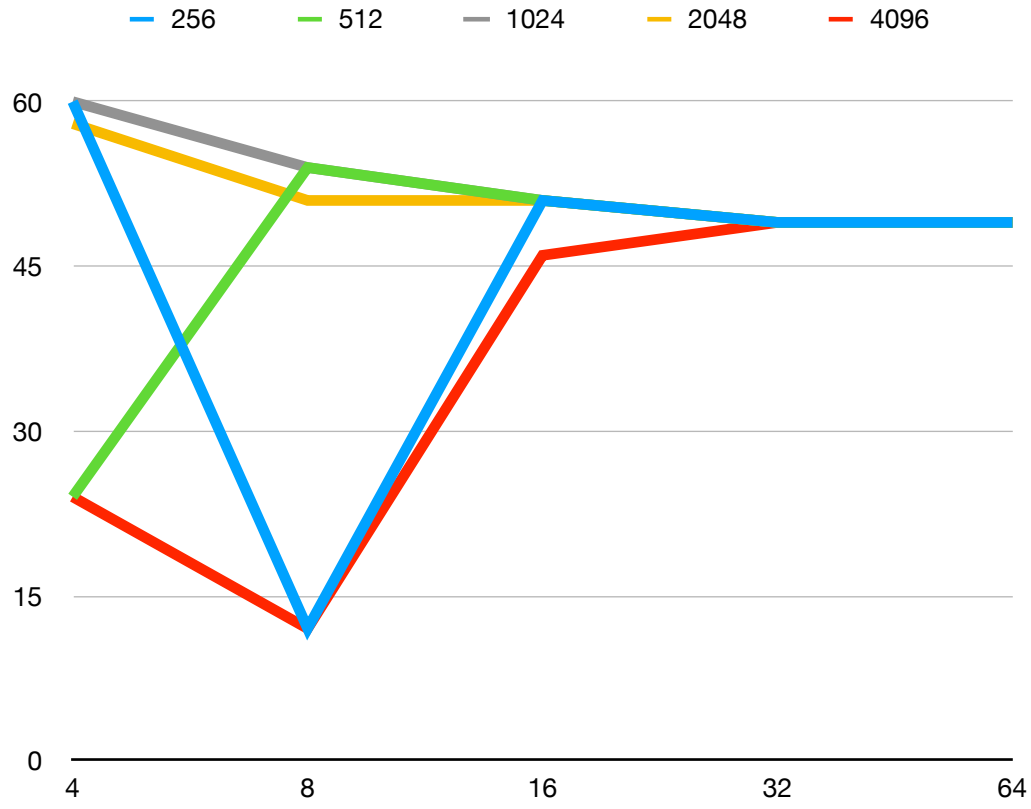
Table 1.1: Miss Rates of column-major summation for Direct Mapped Cache (N = 120)



Graph 1.1:Miss Rates(%)-block size graph column major sum
Comment: When block size (words) increase, miss rates decreases as we can see on graph. Number of sets decreases.

Block Size (words) ——————- Cache Size (Bytes)	4	8	16	32	64
256	Number of misses=18093 Hit Rate=%40 Miss Rate=%60	Number of misses=1830 Hit Rate=%88 Miss Rate=%12	Number of misses=15328 Hit Rate=%49 Miss Rate=%51	Number of misses=14868 Hit Rate=%51 Miss Rate=%49	Number of misses=14637 Hit Rate=%51 Miss Rate=%49
512	Number of misses=3658 Hit Rate=%76 Miss Rate=%24	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=15327 Hit Rate=%49 Miss Rate=%51	Number of misses=14868 Hit Rate=%51 Miss Rate=%49	Number of misses=14637 Hit Rate=%51 Miss Rate=%49
1024	Number of misses=18092 Hit Rate=%40 Miss Rate=%60	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=15327 Hit Rate=%49 Miss Rate=%51	Number of misses=14867 Hit Rate=%51 Miss Rate=%49	Number of misses=14636 Hit Rate=%51 Miss Rate=%49
2048	Number of misses=17372 Hit Rate=%42 Miss Rate=%58	Number of misses=15407 Hit Rate=%49 Miss Rate=%51	Number of misses=15327 Hit Rate=%49 Miss Rate=%51	Number of misses=14867 Hit Rate=%51 Miss Rate=%49	Number of misses=14636 Hit Rate=%51 Miss Rate=%49
4096	Number of misses=7276 Hit Rate=%76 Miss Rate=%24	Number of misses=3639 Hit Rate=%88 Miss Rate=%12	Number of misses=13773 Hit Rate=%54 Miss Rate=%46	Number of misses=14867 Hit Rate=%51 Miss Rate=%49	Number of misses=14636 Hit Rate=%51 Miss Rate=%49

Table 1.2: Miss Rates of Row-wise summation for Direct Mapped Cache N = 120



Graph 1.2:Miss Rates(%)-block size graph row major sum

Part b)

	Good Hit Rate Cache Size: 1024 Block Size: 8	**Medium Hit Rate Cache Size: 1024 Block Size: 16**	**Poor Hit Rate Cache Size: 1024 Block Size: 32**
Direct Mapped	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=15327 Hit Rate=%49 Miss Rate=%51	Number of misses=14867 Hit Rate=%51 Miss Rate=%49
Fully Associative-LRU	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=15327 Hit Rate=%49 Miss Rate=%51	Number of misses=14867 Hit Rate=%51 Miss Rate=%49
Fully Associative-Random	Number of misses=15928 Hit Rate=%47 Miss Rate=%53	Number of misses=15323 Hit Rate=%49 Miss Rate=%51	Number of misses=14867 Hit Rate=%51 Miss Rate=%49

Table 1.3: Direct Mapped, for Fully Associative-LRU and for Fully Associative- Random Table for N = 120

Result of comparison:When we compare Direct Mapped and Fully Associative caches with LRU replacement, they do perform very similar regardless of the hit rate. However, when we use Random replacement instead, there's a small boost in performance for the good hit rate, but there is no much change for the medium and poor hit rates. So, the replacement policy slightly affects performance, especially when the cache is heavily used.

Part c)

N-way set associative Set Size	**Good Hit Rate Cache Size: 1024 Block Size: 4**	**Medium Hit Rate Cache Size: 1024 Block Size: 8**	**Poor Hit Rate Cache Size: 1024 Block Size: 16**
4	Number of misses=18092 Hit Rate=%40 Miss Rate=%60	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=15327 Hit Rate=%49 Miss Rate=%51
8	Number of misses=18092 Hit Rate=%40 Miss Rate=%60	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=14868 Hit Rate=%51 Miss Rate=%49
16	Number of misses=18092 Hit Rate=%40 Miss Rate=%60	Number of misses=16247 Hit Rate=%46 Miss Rate=%54	Number of misses=15327 Hit Rate=%49 Miss Rate=%51

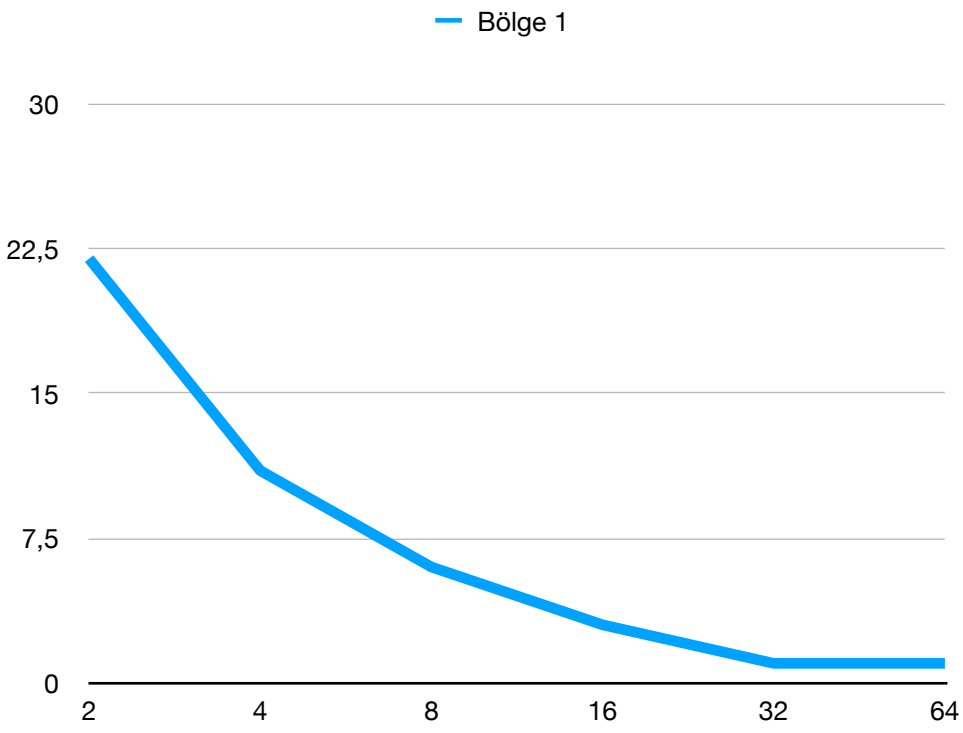
Table 1.4: Examines various hit rate performances for N-way caches (N = 120) row
Result of comparison:
For good rate, set size didn’t really change hit rate.
For medium rate, set size didn’t really change hit rate.
For poor rate, set size 8 has the best hit rate.

For matrix size N=60
Part a)

Block Size (words) ------ Cache Size (Bytes)	4	8	16	32	64
256	Number of misses=1894 Hit Rate=%78 Miss Rate=%22	Number of misses=948 Hit Rate=%89 Miss Rate=%11	Number of misses=478 Hit Rate=%94 Miss Rate=%6	Number of misses=243 Hit Rate=%97 Miss Rate=%3	Number of misses=125 Hit Rate=%99 Miss Rate=%1
512	Number of misses=1893 Hit Rate=%78 Miss Rate=%22	Number of misses=480 Hit Rate=%89 Miss Rate=%11	Number of misses=477 Hit Rate=%94 Miss Rate=%6	Number of misses=243 Hit Rate=%97 Miss Rate=%3	Number of misses=125 Hit Rate=%99 Miss Rate=%1
1024	Number of misses=1893 Hit Rate=%78 Miss Rate=%22	Number of misses=947 Hit Rate=%89 Miss Rate=%11	Number of misses=477 Hit Rate=%94 Miss Rate=%6	Number of misses=242 Hit Rate=%97 Miss Rate=%3	Number of misses=124 Hit Rate=%99 Miss Rate=%1
2048	Number of misses=1893 Hit Rate=%78 Miss Rate=%22	Number of misses=480 Hit Rate=%89 Miss Rate=%11	Number of misses=477 Hit Rate=%94 Miss Rate=%6	Number of misses=243 Hit Rate=%97 Miss Rate=%3	Number of misses=125 Hit Rate=%99 Miss Rate=%1
4096	Number of misses=1893 Hit Rate=%78 Miss Rate=%22	Number of misses=947 Hit Rate=%89 Miss Rate=%11	Number of misses=705 Hit Rate=%94 Miss Rate=%6	Number of misses=242 Hit Rate=%97 Miss Rate=%3	Number of misses=124 Hit Rate=%99 Miss Rate=%1

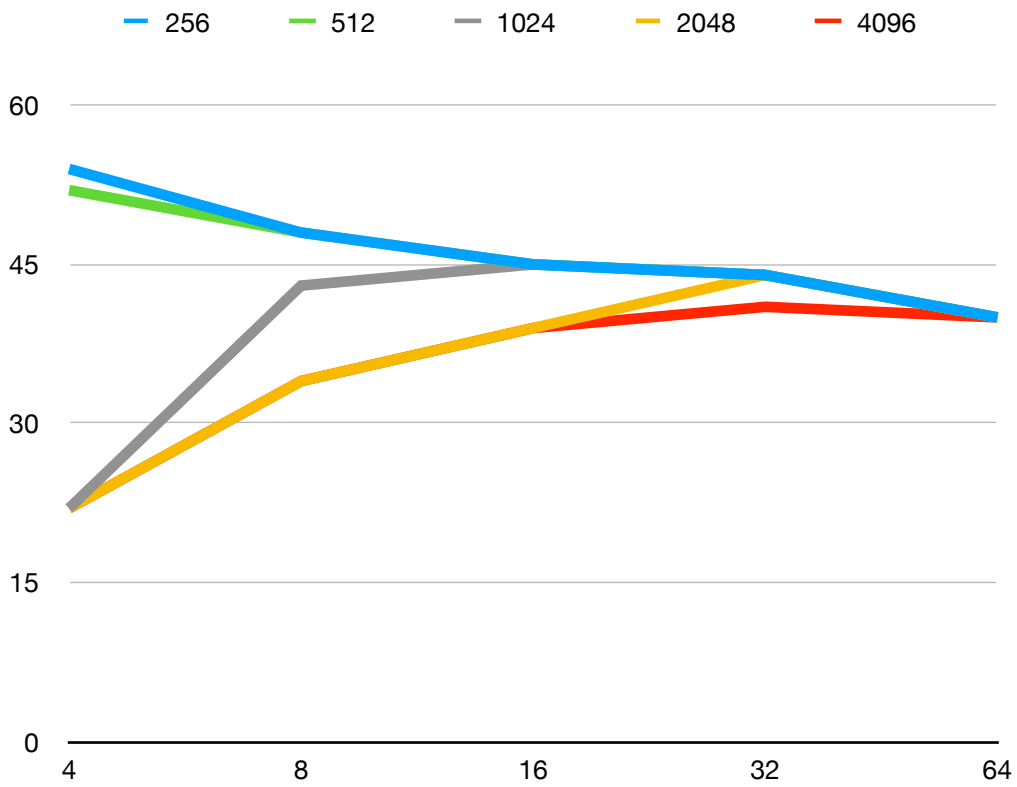
Table 2.1: Miss Rates of Column-wise summation for Direct Mapped Cache (N = 60)

Graph 2.1: Miss Rates(%)-block size graph



Block Size (words) ——————- Cache Size (Bytes)	4	8	16	32	64
256	Number of misses=4593 Hit Rate=%46 Miss Rate=%54	Number of misses=4098 Hit Rate=%52 Miss Rate=%48	Number of misses=3853 Hit Rate=%55 Miss Rate=%45	Number of misses=3731 Hit Rate=%56 Miss Rate=%44	Number of misses=3445 Hit Rate=%60 Miss Rate=%40
512	Number of misses=4412 Hit Rate=%48 Miss Rate=%52	Number of misses=4097 Hit Rate=%52 Miss Rate=%48	Number of misses=3852 Hit Rate=%55 Miss Rate=%45	Number of misses=3731 Hit Rate=%56 Miss Rate=%44	Number of misses=3445 Hit Rate=%60 Miss Rate=%40
1024	Number of misses=18090 Hit Rate=%78 Miss Rate=%22	Number of misses=3679 Hit Rate=%57 Miss Rate=%43	Number of misses=3853 Hit Rate=%55 Miss Rate=%45	Number of misses=3730 Hit Rate=%56 Miss Rate=%44	Number of misses=3444 Hit Rate=%60 Miss Rate=%40
2048	Number of misses=1885 Hit Rate=%78 Miss Rate=%22	Number of misses=2905 Hit Rate=%66 Miss Rate=%34	Number of misses=3347 Hit Rate=%61 Miss Rate=%39	Number of misses=3730 Hit Rate=%56 Miss Rate=%44	Number of misses=3444 Hit Rate=%60 Miss Rate=%40
4096	Number of misses=1876 Hit Rate=%78 Miss Rate=%22	Number of misses=2900 Hit Rate=%66 Miss Rate=%34	Number of misses=3345 Hit Rate=%61 Miss Rate=%39	Number of misses=3476 Hit Rate=%59 Miss Rate=%41	Number of misses=3444 Hit Rate=%60 Miss Rate=%40

Table 2.2: Miss Rates of Row-wise summation for Direct Mapped Cache (N = 60)



Graph 2.2: Miss Rates(%)-block size graph

Part b)

	Good Hit Rate Cache Size: 1024 Block Size: 8	**Medium Hit Rate Cache Size: 1024 Block Size: 16**	**Poor Hit Rate Cache Size: 1024 Block Size: 32**
Direct Mapped	Number of misses=3679 Hit Rate=%57 Miss Rate=%43	Number of misses=3853 Hit Rate=%55 Miss Rate=%45	Number of misses=3730 Hit Rate=%56 Miss Rate=%44
Fully Associative-LRU	Number of misses=4097 Hit Rate=%52 Miss Rate=%48	Number of misses=3852 Hit Rate=%55 Miss Rate=%45	Number of misses=3730 Hit Rate=%56 Miss Rate=%44
Fully Associative-Random	Number of misses=3426 Hit Rate=%60 Miss Rate=%40	Number of misses=3776 Hit Rate=%56 Miss Rate=%44	Number of misses=3729 Hit Rate=%56 Miss Rate=%44

Table 2.3: Direct Mapped, for Fully Associative-LRU and for Fully Associative- Random Table for N = 60

Result of comparison: Direct Mapped and Fully Associative caches with LRU replacement showed very similar results but after Random replacement there's a improvement in good hit rate meanwhile medium and poor hit rates performances maintains consistent performance.

Part c)

N-way set associative Set Size	**Good Hit Rate Cache Size: 1024 Block Size: 4**	**Medium Hit Rate Cache Size: 1024 Block Size: 8**	**Poor Hit Rate Cache Size: 1024 Block Size: 16**
4	Number of misses=2586 Hit Rate=%70 Miss Rate=%30	Number of misses=3445 Hit Rate=%60 Miss Rate=%40	Number of misses=3802 Hit Rate=%56 Miss Rate=%44
8	Number of misses=2744 Hit Rate=%68 Miss Rate=%32	Number of misses=3400 Hit Rate=%60 Miss Rate=%40	Number of misses=3759 Hit Rate=%56 Miss Rate=%44
16	Number of misses=2773 Hit Rate=%68 Miss Rate=%32	Number of misses=3419 Hit Rate=%60 Miss Rate=%40	Number of misses=3783 Hit Rate=%56 Miss Rate=%44

Table 2.4: Examines various hit rate performances for N-way caches (N = 60) row

Result of comparison:
For good rate, set size 4 has the best hit rate.
For medium rate, set size didn’t make any difference.
For poor rate, set size didn’t make any difference.