CS224
Section No: 5
Spring 2021
Lab No: 6
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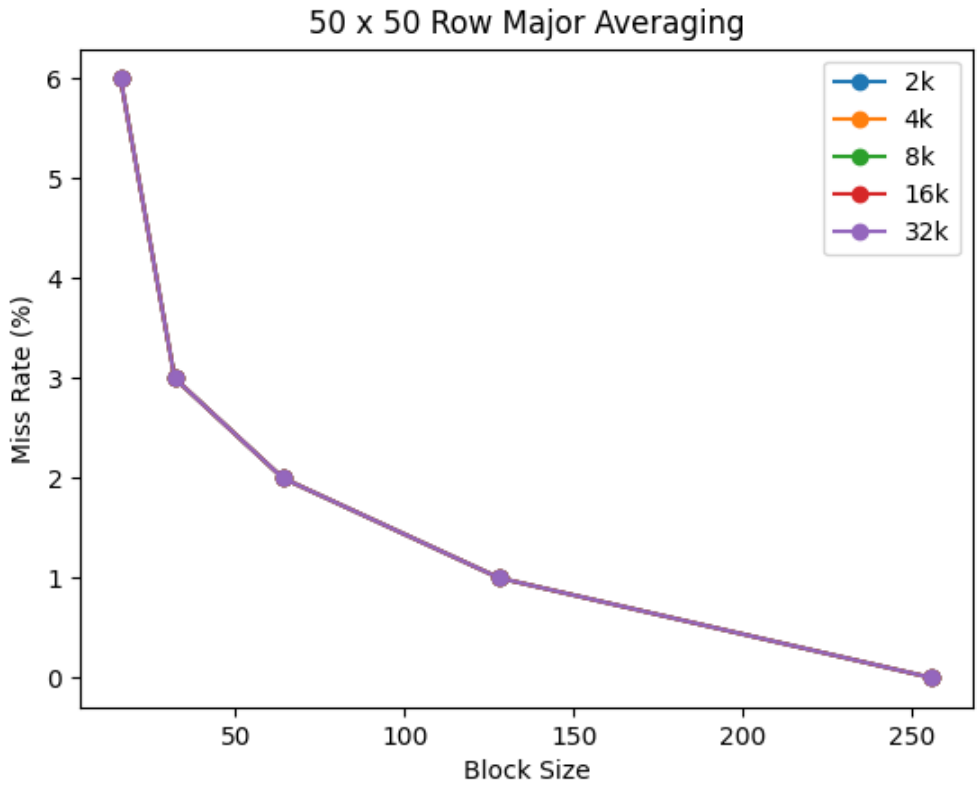
A. Direct Mapped Caches

Row Major Averaging

Matrix Size: 50 x 50

	Block Size (number of words)				
Cache Size (bytes)	16	32	64	128	256
2048	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 11
4096	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 11
8192	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 11
16384	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 11
32768	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 11

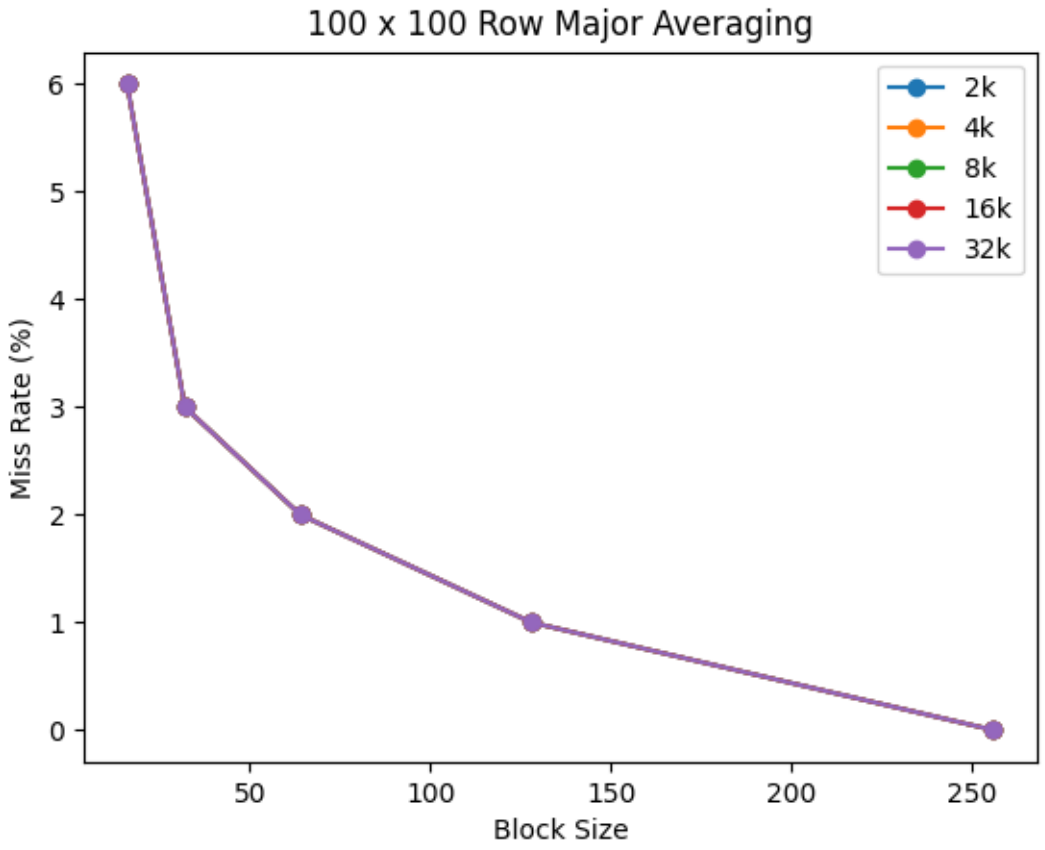
Graph:



Matrix Size: 100 x 100

	Block Size (number of words)				
Cache Size (bytes)	16	32	64	128	256
2048	Miss Rate: 6% Miss #: 631	Miss Rate: 3% Miss #: 317	Miss Rate: 2% Miss #: 160	Miss Rate: 1% Miss #: 80	Miss Rate: 0% Miss #: 41
4096	Miss Rate: 6% Miss #: 631	Miss Rate: 3% Miss #: 317	Miss Rate: 2% Miss #: 160	Miss Rate: 1% Miss #: 80	Miss Rate: 0% Miss #: 41
8192	Miss Rate: 6% Miss #: 631	Miss Rate: 3% Miss #: 317	Miss Rate: 2% Miss #: 160	Miss Rate: 1% Miss #: 80	Miss Rate: 0% Miss #: 41
16384	Miss Rate: 6% Miss #: 631	Miss Rate: 3% Miss #: 317	Miss Rate: 2% Miss #: 160	Miss Rate: 1% Miss #: 80	Miss Rate: 0% Miss #: 41
32768	Miss Rate: 6% Miss #: 631	Miss Rate: 3% Miss #: 317	Miss Rate: 2% Miss #: 160	Miss Rate: 1% Miss #: 80	Miss Rate: 0% Miss #: 41

Graph:

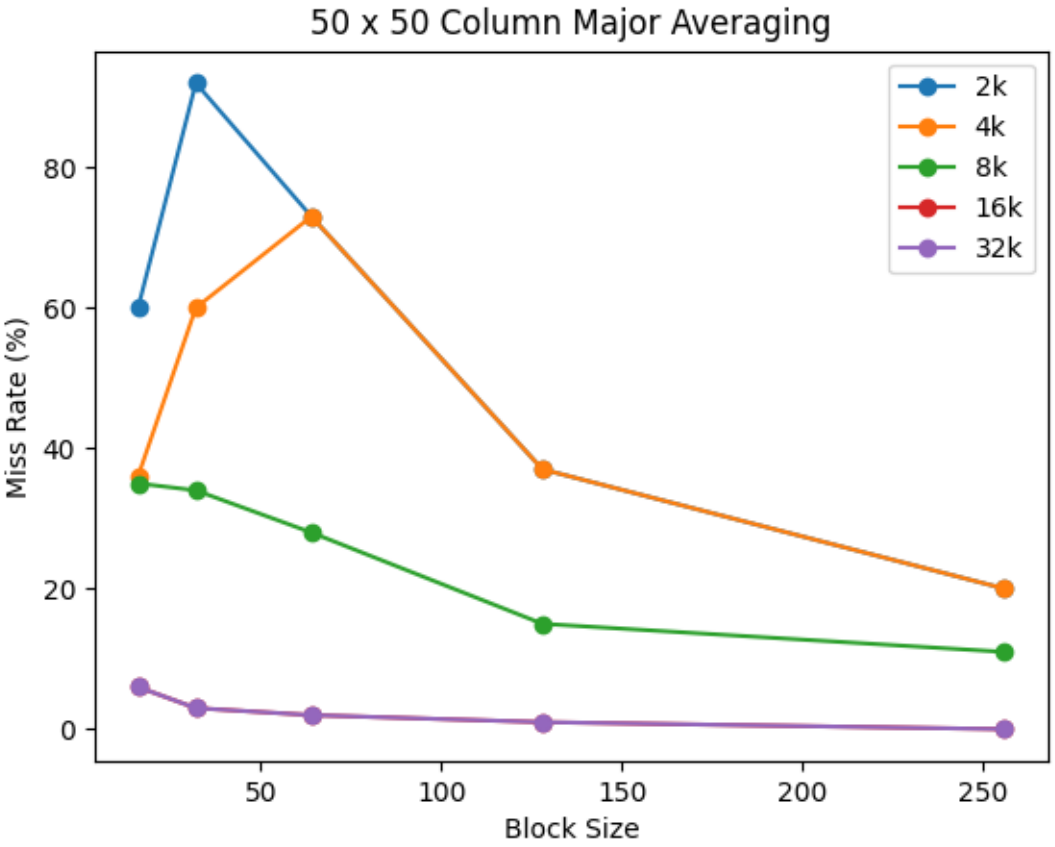


Column Major Averaging

Matrix Size: 50 x 50

	Block Size (number of words)				
Cache Size (bytes)	16	32	64	128	256
2048	Miss Rate: 60% Miss #: 1619	Miss Rate: 92% Miss #: 2503	Miss Rate: 73% Miss #: 1966	Miss Rate: 37% Miss #: 1001	Miss Rate: 20% Miss #: 551
4096	Miss Rate: 36% Miss #: 977	Miss Rate: 60% Miss #: 1637	Miss Rate: 73% Miss #: 1966	Miss Rate: 37% Miss #: 1001	Miss Rate: 20% Miss #: 551
8192	Miss Rate: 35% Miss #: 950	Miss Rate: 34% Miss #: 926	Miss Rate: 28% Miss #: 754	Miss Rate: 15% Miss #: 413	Miss Rate: 11% Miss #: 306
16384	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 12
32768	Miss Rate: 6% Miss #: 162	Miss Rate: 3% Miss #: 82	Miss Rate: 2% Miss #: 42	Miss Rate: 1% Miss #: 21	Miss Rate: 0% Miss #: 12

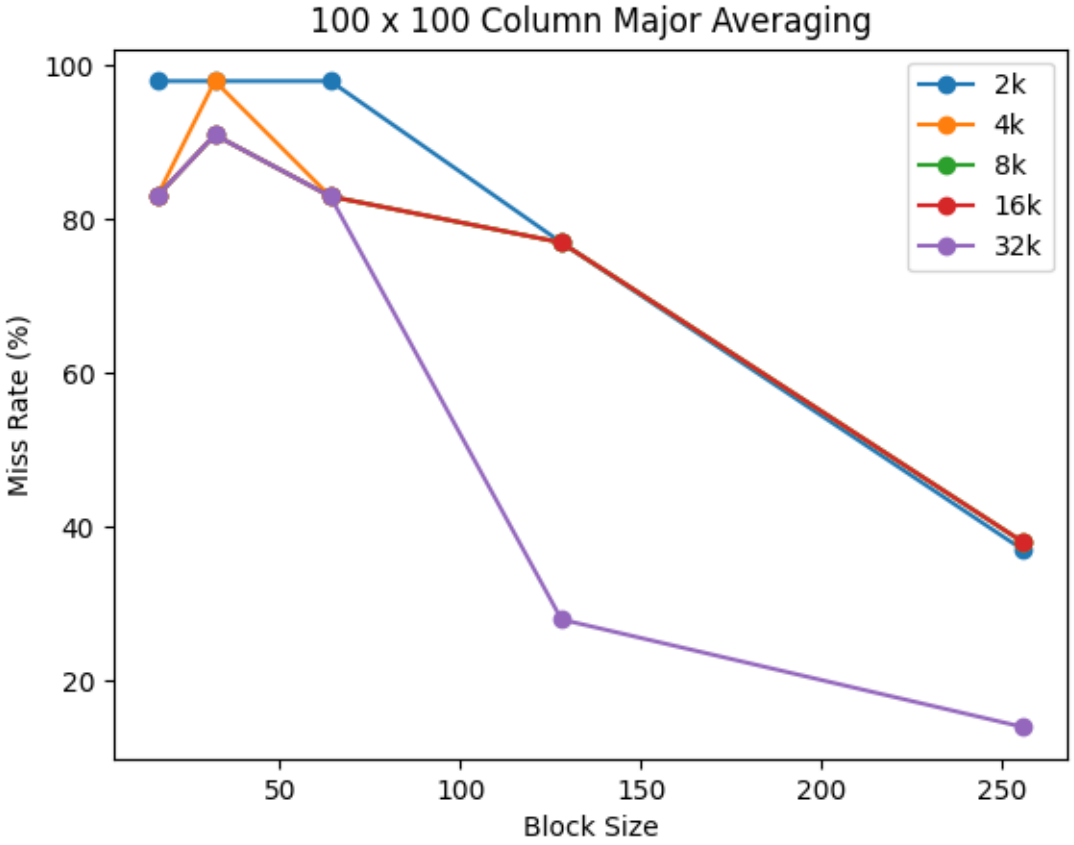
Graph:


50 x 50 Column Major Averaging
Miss Rate (%)
Block Size
2k
4k
8k
16k
32k
0
20
40
60
80
50
100
150
200
250

Matrix Size: 100 x 100

	Block Size (number of words)				
Cache Size (bytes)	16	32	64	128	256
2048	Miss Rate: 98% Miss #: 10005	Miss Rate: 98% Miss #: 10003	Miss Rate: 98% Miss #: 10005	Miss Rate: 77% Miss #: 7817	Miss Rate: 38% Miss #: 3917
4096	Miss Rate: 83% Miss #: 8487	Miss Rate: 98% Miss #: 10003	Miss Rate: 83% Miss #: 8487	Miss Rate: 77% Miss #: 7817	Miss Rate: 38% Miss #: 3917
8192	Miss Rate: 83% Miss #: 8487	Miss Rate: 91% Miss #: 9245	Miss Rate: 83% Miss #: 8487	Miss Rate: 77% Miss #: 7817	Miss Rate: 38% Miss #: 3917
16384	Miss Rate: 83% Miss #: 8487	Miss Rate: 91% Miss #: 9245	Miss Rate: 83% Miss #: 8487	Miss Rate: 77% Miss #: 7817	Miss Rate: 38% Miss #: 3917
32768	Miss Rate: 83% Miss #: 8487	Miss Rate: 91% Miss #: 9245	Miss Rate: 83% Miss #: 8487	Miss Rate: 28% Miss #: 2882	Miss Rate: 14% Miss #: 1457

Graph:


100 x 100 Column Major Averaging
Miss Rate (%)
Block Size
100
80
60
40
20
50
100
150
200
250
2k
4k
8k
16k
32k

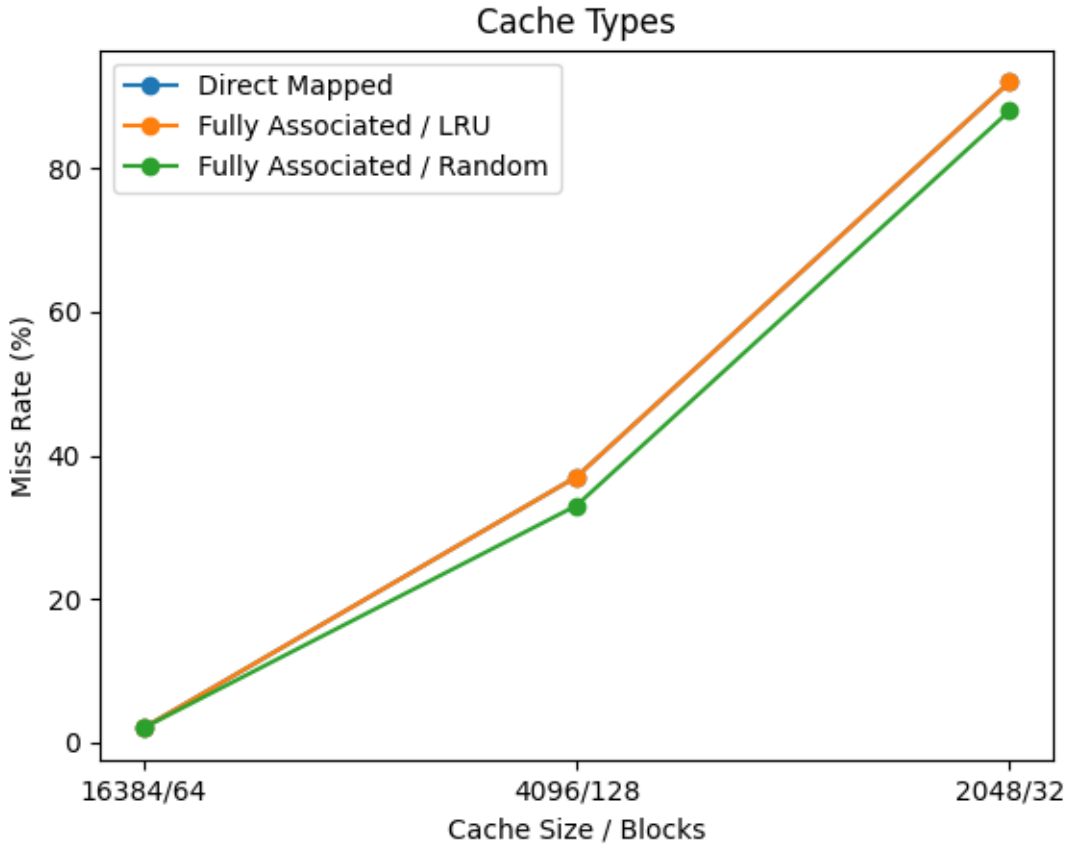
B. Fully Associative Caches

Column Major Averaging

Matrix Size: 50 x 50

Cache Size/Block Size	Cache Type		
	Direct Mapped	Fully Associative / LRU	Fully Associative / Random
16384 / 64 (Good)	2%	2%	2%
4096 / 128 (Medium)	37%	37%	33%
2048 / 32 (Poor)	92%	92%	88%

Graph:

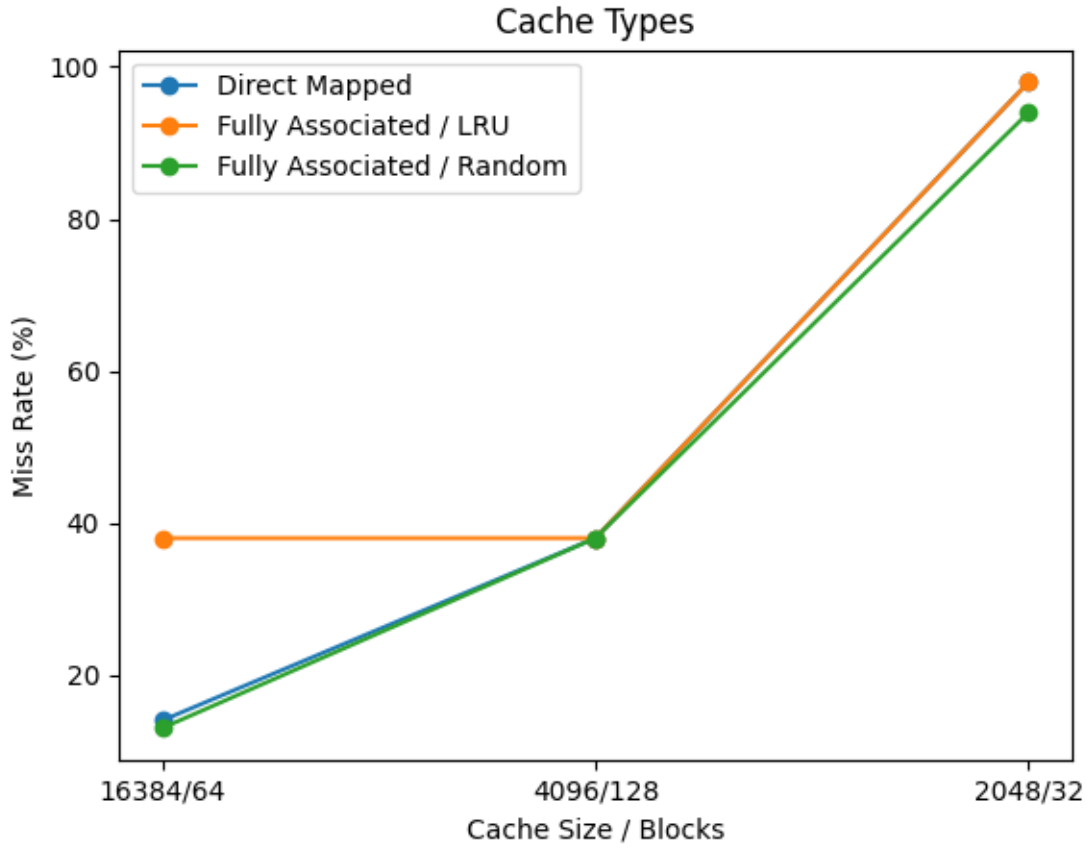


As seen in the graph, results are exactly same for all three caches (Fully associative / Random is a little better due to randomness.). Change from direct mapped to fully associative cache does not make a difference because while doing column by column reading neighboring integers are placed in cache too and cache is large enough to get same miss rate for every cache. That means for “good” cache, there is enough cache size in direct mapped therefore fully associative is not needed and for “medium” and “poor” caches, most of the misses are not conflict misses but capacity miss therefore fully associativity does not help.

Matrix Size: 100 x 100

Cache Size/Block Size	Cache Type		
	Direct Mapped	Fully Associative / LRU	Fully Associative / Random
32768 / 256 (Good)	14%	38%	13%
2048 / 256 (Medium)	38%	38%	38%
2048 / 16 (Poor)	98%	98%	94%

Graph:



This graph's conclusion is same as 50 x 50 matrix's graph except for "good". For "good" configuration, fully associative / LRU cache type is not same for miss rate as other but worse. This is because there wasn't much conflict misses from the direct mapping and fully associativity brings capacity misses. Therefore it is not helping and making performance worse.

C. N-way Set Associative Caches

Column Major Averaging
Matrix Size: 50 x 50

Cache Size/Block Size: 4096 / 128 (Medium)

N-way Cache	1	2	4	8
Hit Rate	63	63	63	63
Miss Rate	37	37	37	37
Miss Count	1001	1001	1001	1001

Cache Size/Block Size: 16384 / 64 (Good)

N-way Cache	4	8	16	32
Hit Rate	98	98	98	98
Miss Rate	2	2	2	2
Miss Count	42	42	42	42

Cache Size/Block Size: 2048 / 32 (Poor)

N-way Cache	2	4	8	16
Hit Rate	8	8	8	8
Miss Rate	92	92	92	92
Miss Count	2503	2503	2503	2503

For all three cases, miss rate does not change as the N increases or decreases because as in Part B, misses are not conflict misses but capacity misses. Therefore making cache more divided by increasing N, does not do any good other than wasting resources.