

Algorithm & tracefile		Memsize			
RAND	50	100	150	200	
simpleloop	Hit count: 7583 Miss count: 2977 Clean evictions: 235 Dirty evictions: 2692 Total references : 10560 Hit rate: 71.8087 Miss rate: 28.1913	Hit count: 7805 Miss count: 2755 Clean evictions: 51 Dirty evictions: 2604 Total references : 10560 Hit rate: 73.9110 Miss rate: 26.0890	Hit count: 7843 Miss count: 2717 Clean evictions: 22 Dirty evictions: 2545 Total references : 10560 Hit rate: 74.2708 Miss rate: 25.7292	Hit count: 7854 Miss count: 2706 Clean evictions: 18 Dirty evictions: 2488 Total references : 10560 Hit rate: 74.3750 Miss rate: 25.6250	
Matmul	Hit count: 1972586 Miss count: 995558 Clean evictions: 956334 Dirty evictions: 39174 Total references : 2968144 Hit rate: 66.4586 Miss rate: 33.5414	Hit count: 2643917 Miss count: 324227 Clean evictions: 316545 Dirty evictions: 7582 Total references : 2968144 Hit rate: 89.0764 Miss rate: 10.9236	Hit count: 2871866 Miss count: 96278 Clean evictions: 93792 Dirty evictions: 2336 Total references : 2968144 Hit rate: 96.7563 Miss rate: 3.2437	Hit count: 2911656 Miss count: 56488 Clean evictions: 54639 Dirty evictions: 1649 Total references : 2968144 Hit rate: 98.0969 Miss rate: 1.9031	
Blocked	Hit count: 2516614 Miss count: 8402 Clean evictions: 5832 Dirty evictions: 2520 Total references : 2525016 Hit rate: 99.6672 Miss rate: 0.3328	Hit count: 2519783 Miss count: 5233 Clean evictions: 3423 Dirty evictions: 1710 Total references : 2525016 Hit rate: 99.7928 Miss rate: 0.2072	Hit count: 2520592 Miss count: 4424 Clean evictions: 2800 Dirty evictions: 1474 Total references : 2525016 Hit rate: 99.8248 Miss rate: 0.1752	Hit count: 2521155 Miss count: 3861 Clean evictions: 2342 Dirty evictions: 1319 Total references : 2525016 Hit rate: 99.8471 Miss rate: 0.1529	
My_trace_generator	Hit count: 16087 Miss count: 313 Clean evictions: 126 Dirty evictions: 137 Total references : 16400 Hit rate: 98.0915 Miss rate: 1.9085	Hit count: 16256 Miss count: 144 Clean evictions: 3 Dirty evictions: 41 Total references : 16400 Hit rate: 99.1220 Miss rate: 0.8780	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683	
FIFO	50	100	150	200	
simpleloop	Hit count: 7591 Miss count: 2969 Clean evictions: 206 Dirty evictions: 2713 Total references : 10560 Hit rate: 71.8845 Miss rate: 28.1155	Hit count: 7806 Miss count: 2754 Clean evictions: 44 Dirty evictions: 2610 Total references : 10560 Hit rate: 73.9205 Miss rate: 26.0795	Hit count: 7846 Miss count: 2714 Clean evictions: 16 Dirty evictions: 2548 Total references : 10560 Hit rate: 74.2992 Miss rate: 25.7008	Hit count: 7854 Miss count: 2706 Clean evictions: 12 Dirty evictions: 2494 Total references : 10560 Hit rate: 74.3750 Miss rate: 25.6250	
Matmul	Hit count: 1840871 Miss count: 1127273 Clean evictions: 1083235 Dirty evictions: 43988 Total references : 2968144 Hit rate: 62.0209 Miss rate: 37.9791	Hit count: 1884597 Miss count: 1083547 Clean evictions: 1061226 Dirty evictions: 22221 Total references : 2968144 Hit rate: 63.4941 Miss rate: 36.5059	Hit count: 2933734 Miss count: 34410 Clean evictions: 32946 Dirty evictions: 1314 Total references : 2968144 Hit rate: 98.8407 Miss rate: 1.1593	Hit count: 2934256 Miss count: 33888 Clean evictions: 32435 Dirty evictions: 1253 Total references : 2968144 Hit rate: 98.8583 Miss rate: 1.1417	
Blocked	Hit count: 2518547 Miss count: 6469 Clean evictions: 4164 Dirty evictions: 2255 Total references : 2525016 Hit rate: 99.7438 Miss rate: 0.2562	Hit count: 2520658 Miss count: 4358 Clean evictions: 2777 Dirty evictions: 1481 Total references : 2525016 Hit rate: 99.8274 Miss rate: 0.1726	Hit count: 2520753 Miss count: 4263 Clean evictions: 2687 Dirty evictions: 1426 Total references : 2525016 Hit rate: 99.8312 Miss rate: 0.1688	Hit count: 2521824 Miss count: 3192 Clean evictions: 1893 Dirty evictions: 1099 Total references : 2525016 Hit rate: 99.8736 Miss rate: 0.1264	
My_trace_generator	Hit count: 16119 Miss count: 281 Clean evictions: 87 Dirty evictions: 144 Total references : 16400 Hit rate: 98.2866	Hit count: 16254 Miss count: 146 Clean evictions: 0 Dirty evictions: 46 Total references : 16400 Hit rate: 99.1098	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317	

**LRU***simpleloop**Matmul**Blocked**My\_trace\_generator***CLOCK***simpleloop**Matmul**Blocked**My\_trace\_generator*

Miss rate: 1.7134	Miss rate: 0.8902	Miss rate: 0.7683	Miss rate: 0.7683
50	100	150	200
Hit count: 7775 Miss count: 2785 Clean evictions: 94 Dirty evictions: 2641 Total references : 10560 Hit rate: 73.6269 Miss rate: 26.3731	Hit count: 7877 Miss count: 2683 Clean evictions: 1 Dirty evictions: 2582 Total references : 10560 Hit rate: 74.5928 Miss rate: 25.4072	Hit count: 7880 Miss count: 2680 Clean evictions: 0 Dirty evictions: 2530 Total references : 10560 Hit rate: 74.6212 Miss rate: 25.3788	Hit count: 7880 Miss count: 2680 Clean evictions: 0 Dirty evictions: 2480 Total references : 10560 Hit rate: 74.6212 Miss rate: 25.3788
Hit count: 1926916 Miss count: 1041228 Clean evictions: 1040073 Dirty evictions: 1105 Total references : 2968144 Hit rate: 64.9199 Miss rate: 35.0801	Hit count: 1961692 Miss count: 1006452 Clean evictions: 1005272 Dirty evictions: 1080 Total references : 2968144 Hit rate: 66.0915 Miss rate: 33.9085	Hit count: 2935260 Miss count: 32884 Clean evictions: 31656 Dirty evictions: 1078 Total references : 2968144 Hit rate: 98.8921 Miss rate: 1.1079	Hit count: 2935272 Miss count: 32872 Clean evictions: 31594 Dirty evictions: 1078 Total references : 2968144 Hit rate: 98.8925 Miss rate: 1.1075
Hit count: 2519783 Miss count: 5233 Clean evictions: 2802 Dirty evictions: 2381 Total references : 2525016 Hit rate: 99.7928 Miss rate: 0.2072	Hit count: 2521184 Miss count: 3832 Clean evictions: 2648 Dirty evictions: 1084 Total references : 2525016 Hit rate: 99.8482 Miss rate: 0.1518	Hit count: 2521192 Miss count: 3824 Clean evictions: 2612 Dirty evictions: 1062 Total references : 2525016 Hit rate: 99.8486 Miss rate: 0.1514	Hit count: 2521316 Miss count: 3700 Clean evictions: 2438 Dirty evictions: 1062 Total references : 2525016 Hit rate: 99.8535 Miss rate: 0.1465
Hit count: 16197 Miss count: 203 Clean evictions: 46 Dirty evictions: 107 Total references : 16400 Hit rate: 98.7622 Miss rate: 1.2378	Hit count: 16272 Miss count: 128 Clean evictions: 0 Dirty evictions: 28 Total references : 16400 Hit rate: 99.2195 Miss rate: 0.7805	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683
50	100	150	200
Hit count: 7761 Miss count: 2799 Clean evictions: 109 Dirty evictions: 2640 Total references : 10560 Hit rate: 73.4943 Miss rate: 26.5057	Hit count: 7876 Miss count: 2684 Clean evictions: 2 Dirty evictions: 2582 Total references : 10560 Hit rate: 74.5833 Miss rate: 25.4167	Hit count: 7879 Miss count: 2681 Clean evictions: 0 Dirty evictions: 2531 Total references : 10560 Hit rate: 74.6117 Miss rate: 25.3883	Hit count: 7879 Miss count: 2681 Clean evictions: 0 Dirty evictions: 2481 Total references : 10560 Hit rate: 74.6117 Miss rate: 25.3883
Hit count: 1926905 Miss count: 1041239 Clean evictions: 1040084 Dirty evictions: 1105 Total references : 2968144 Hit rate: 64.9195 Miss rate: 35.0805	Hit count: 1966416 Miss count: 1001728 Clean evictions: 1000549 Dirty evictions: 1079 Total references : 2968144 Hit rate: 66.2507 Miss rate: 33.7493	Hit count: 2933568 Miss count: 34576 Clean evictions: 33348 Dirty evictions: 1078 Total references : 2968144 Hit rate: 98.8351 Miss rate: 1.1649	Hit count: 2935260 Miss count: 32884 Clean evictions: 31607 Dirty evictions: 1077 Total references : 2968144 Hit rate: 98.8921 Miss rate: 1.1079
Hit count: 2519280 Miss count: 5736 Clean evictions: 3268 Dirty evictions: 2418 Total references : 2525016 Hit rate: 99.7728 Miss rate: 0.2272	Hit count: 2520657 Miss count: 4359 Clean evictions: 2653 Dirty evictions: 1606 Total references : 2525016 Hit rate: 99.8274 Miss rate: 0.1726	Hit count: 2521192 Miss count: 3824 Clean evictions: 2613 Dirty evictions: 1061 Total references : 2525016 Hit rate: 99.8486 Miss rate: 0.1514	Hit count: 2521777 Miss count: 3239 Clean evictions: 1977 Dirty evictions: 1062 Total references : 2525016 Hit rate: 99.8717 Miss rate: 0.1283
Hit count: 16196 Miss count: 204 Clean evictions: 45 Dirty evictions: 109 Total references : 16400 Hit rate: 98.7561	Hit count: 16268 Miss count: 132 Clean evictions: 0 Dirty evictions: 32 Total references : 16400 Hit rate: 99.1951	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317

**OPT***simpleloop**Matmul**Blocked**My\_trace\_generator*

Miss rate: 1.2439	Miss rate: 0.8049	Miss rate: 0.7683	Miss rate: 0.7683
50	100	150	200
Hit count: 6275 Miss count: 4285 Clean evictions: 1607 Dirty evictions: 2628 Total references : 10560 Hit rate: 59.4223 Miss rate: 40.5777	Hit count: 7777 Miss count: 2783 Clean evictions: 142 Dirty evictions: 2541 Total references : 10560 Hit rate: 73.6458 Miss rate: 26.3542	Hit count: 7922 Miss count: 2638 Clean evictions: 0 Dirty evictions: 2488 Total references : 10560 Hit rate: 75.0189 Miss rate: 24.9811	Hit count: 7922 Miss count: 2638 Clean evictions: 0 Dirty evictions: 2438 Total references : 10560 Hit rate: 75.0189 Miss rate: 24.9811
Hit count: 745933 Miss count: 2222211 Clean evictions: 1831727 Dirty evictions: 390434 Total references : 2968144 Hit rate: 25.1313 Miss rate: 74.8687	Hit count: 1137560 Miss count: 1830584 Clean evictions: 1440150 Dirty evictions: 390334 Total references : 2968144 Hit rate: 38.3256 Miss rate: 61.6744	Hit count: 1267688 Miss count: 1700456 Clean evictions: 1341429 Dirty evictions: 358877 Total references : 2968144 Hit rate: 42.7098 Miss rate: 57.2902	Hit count: 1382829 Miss count: 1585315 Clean evictions: 1232636 Dirty evictions: 352479 Total references : 2968144 Hit rate: 46.5890 Miss rate: 53.4110
Hit count: 635098 Miss count: 1889918 Clean evictions: 1555278 Dirty evictions: 334590 Total references : 2525016 Hit rate: 25.1522 Miss rate: 74.8478	Hit count: 971302 Miss count: 1553714 Clean evictions: 1219126 Dirty evictions: 334488 Total references : 2525016 Hit rate: 38.4672 Miss rate: 61.5328	Hit count: 1147126 Miss count: 1377890 Clean evictions: 1084910 Dirty evictions: 292830 Total references : 2525016 Hit rate: 45.4304 Miss rate: 54.5696	Hit count: 1242982 Miss count: 1282034 Clean evictions: 996942 Dirty evictions: 284892 Total references : 2525016 Hit rate: 49.2267 Miss rate: 50.7733
Hit count: 10183 Miss count: 6217 Clean evictions: 5988 Dirty evictions: 179 Total references : 16400 Hit rate: 62.0915 Miss rate: 37.9085	Hit count: 12620 Miss count: 3780 Clean evictions: 3577 Dirty evictions: 103 Total references : 16400 Hit rate: 76.9512 Miss rate: 23.0488	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683

## *A comparison of the various algorithms used:*

**My OPT filr doesn't work that great but it should so I will write this part as if OPT is the holy grail of paging algorithms as indicated in the textbook and class.**

OPT performs the best (most of the time) out of all other algorithms used because it just flat out cheats and knows what the system is going to reference next, refer to notes on Belady's sequence to know why.

LRU and OPT (even more so) take longer than other algorithms to run, this is because of keeping track of data structures and doing more computations to update/reference them.

For some reasons (and on piazza this is the case with the results of others) the larger the trace file the better the hitrate. (Please go over this in class.)

When the memsize is increased (the size of the "cache") the hitrate increases as well, this is due to having to swap files out less because we can just hold on to many more different pages all at once.

- This (like almost everything in the world) follows the law of diminishing returns, as the cache size becomes very large the hitrate starts to almost seem like it converges to 100 very slowly.

- This also implies that there will be less page evictions (regardless of whether they are dirty or not, depending on the algorithm e.g. rand doesn't care)

### *LRU and memsize correlation:*

In general for cache's as the memsize(aka cache size) increases the hit count will increase, this implies that the hit rate will increase. This is why the hitrate will almost always increase or at least stay the same as you increase the cache size. LRU will always try to remove pages that have not been used (i.e. dirty bit is not on). This is proved as the CLOCK algorithm being a good approximation for LRU (as seen in the textbook readings). As memsize increases LRU gets a bigger "window" to look back in time, more data implies a more sound hypothesis (I'm not going to include fancy statistics in this report). By having a bigger window to look back in time LRU can get a better idea of a page that isn't really useful in the current task, therefore it is probably the best candidate for being evicted. A great piece of evidence for this is in the matmul trace. As soon as the memsize was increased from 100 to 150 the hitrate made almost a 33% raise!

LRU is great for evicting pages that are mostly improbably of being unused in the near future but it comes at a computation cost of either structure size of computation. You could use AVL trees to find the minimum quicker but this is trickier to implement and require more overhead. So an increase in cache size isn't always the best way to increase computation speeds in such magnitudes as seen in the matmul trace file.

<i>LRU</i>	<b>50</b>	<b>100</b>	<b>150</b>	<b>200</b>
<i>simpleloop</i>	Hit count: 7775 Miss count: 2785 Clean evictions: 94 Dirty evictions: 2641 Total references : 10560 Hit rate: 73.6269 Miss rate: 26.3731	Hit count: 7877 Miss count: 2683 Clean evictions: 1 Dirty evictions: 2582 Total references : 10560 Hit rate: 74.5928 Miss rate: 25.4072	Hit count: 7880 Miss count: 2680 Clean evictions: 0 Dirty evictions: 2530 Total references : 10560 Hit rate: 74.6212 Miss rate: 25.3788	Hit count: 7880 Miss count: 2680 Clean evictions: 0 Dirty evictions: 2480 Total references : 10560 Hit rate: 74.6212 Miss rate: 25.3788
<i>Matmul</i>	Hit count: 1926916 Miss count: 1041228 Clean evictions: 1040073 Dirty evictions: 1105 Total references : 2968144 Hit rate: 64.9199 Miss rate: 35.0801	Hit count: 1961692 Miss count: 1006452 Clean evictions: 1005272 Dirty evictions: 1080 Total references : 2968144 Hit rate: 66.0915 Miss rate: 33.9085	Hit count: 2935260 Miss count: 32884 Clean evictions: 31656 Dirty evictions: 1078 Total references : 2968144 Hit rate: 98.8921 Miss rate: 1.1079	Hit count: 2935272 Miss count: 32872 Clean evictions: 31594 Dirty evictions: 1078 Total references : 2968144 Hit rate: 98.8925 Miss rate: 1.1075
<i>Blocked</i>	Hit count: 2519783 Miss count: 5233 Clean evictions: 2802 Dirty evictions: 2381 Total references : 2525016 Hit rate: 99.7928 Miss rate: 0.2072	Hit count: 2521184 Miss count: 3832 Clean evictions: 2648 Dirty evictions: 1084 Total references : 2525016 Hit rate: 99.8482 Miss rate: 0.1518	Hit count: 2521192 Miss count: 3824 Clean evictions: 2612 Dirty evictions: 1062 Total references : 2525016 Hit rate: 99.8486 Miss rate: 0.1514	Hit count: 2521316 Miss count: 3700 Clean evictions: 2438 Dirty evictions: 1062 Total references : 2525016 Hit rate: 99.8535 Miss rate: 0.1465
<i>My_trace_generator</i>	Hit count: 16197 Miss count: 203 Clean evictions: 46 Dirty evictions: 107 Total references : 16400 Hit rate: 98.7622 Miss rate: 1.2378	Hit count: 16272 Miss count: 128 Clean evictions: 0 Dirty evictions: 28 Total references : 16400 Hit rate: 99.2195 Miss rate: 0.7805	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683	Hit count: 16274 Miss count: 126 Clean evictions: 0 Dirty evictions: 0 Total references : 16400 Hit rate: 99.2317 Miss rate: 0.7683