ENSC 254 Lab #4: Cache Design Exploration

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Cache Configurations for CSIZE = 2KB

$$CSIZE = (Block\ Size) \times 2^s \times E,\ where\ E\ is\ a\ power\ of\ 2$$

$$2048\ Bytes = (64\ Bytes) \times 2^s \times E \Rightarrow 32\ Bytes = 2^s \times E$$

$32\ Bytes = 2^5$, Therefore the value of 's' can range from 0 to 5, meaning there are 6 possible configurations with each one being either LRU or LFU, which leads to 12 total configurations.

CSIZE = 2KB (real1.trace)

Config	s	E	LRU/LFU	Hits	Misses	Hit rate
1	0	32	LRU	281840	5124	0.9821441017
			LFU	254770	32194	0.8878117116
2	1	16	LRU	281584	5380	0.9812520037
			LFU	261432	25532	0.9110271672
3	2	8	LRU	273928	13036	0.954572699
			LFU	264992	21972	0.9234329045
4	3	4	LRU	269203	17761	0.938107219
			LFU	266793	20171	0.929708953
5	4	2	LRU	269087	17877	0.9377029871
			LFU	267668	19296	0.932758116
6	5	1	LRU	266033	20931	0.9270605372
			LFU	266033	20931	0.9270605372

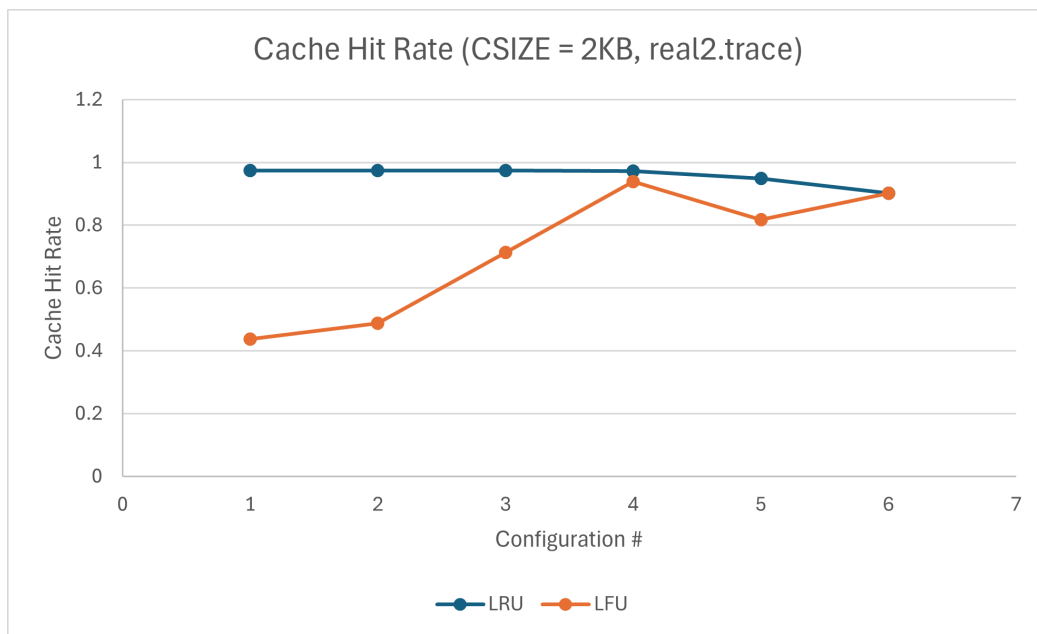Cache Hit Rate (CSIZE = 2KB, real1.trace)
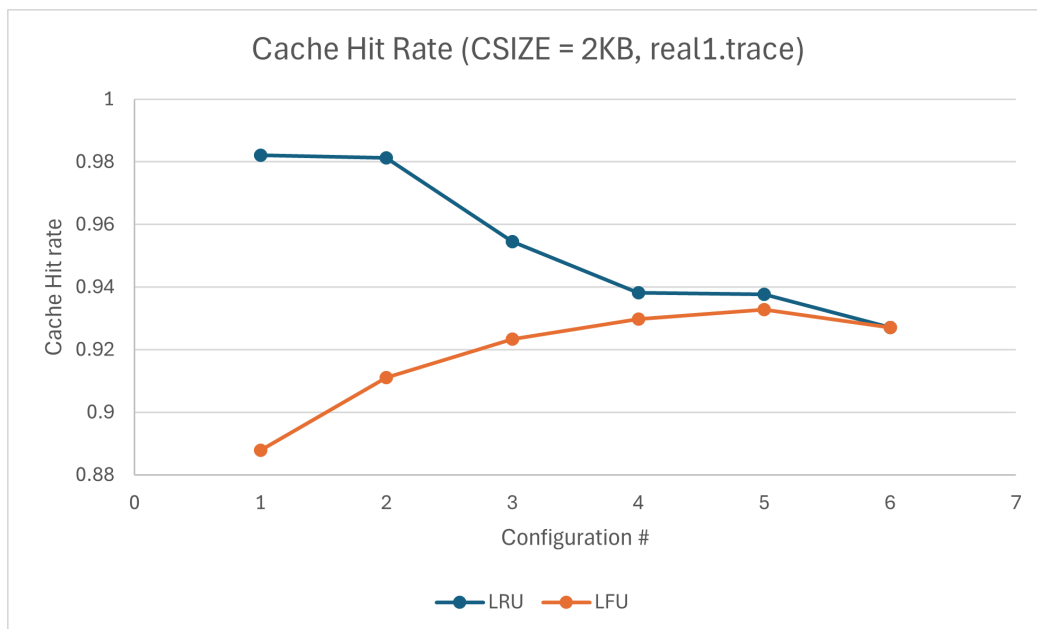
Best configuration for CSIZE = 2KB (real1.trace) is: s=0, E=32, LRU, with a hit rate of 0.9821441017.

LRU performs significantly better with a hit rate of 0.982 compared to LFU's 0.888, indicating LRU is more efficient for a smaller number of cache sets 's' and higher cache associativity 'E'.

CSIZE = 2KB (real2.trace)

Config	s	E	LRU/LFU	Hits	Misses	Hit rate
1	0	32	LRU	284145	7557	0.9740934241
			LFU	127787	163915	0.4380737876
2	1	16	LRU	284127	7575	0.9740317173
			LFU	142230	149472	0.4875866466
3	2	8	LRU	284226	7476	0.9743711048
			LFU	208115	83587	0.7134507134
4	3	4	LRU	283663	8039	0.9724410529
			LFU	273592	18110	0.9379160925
5	4	2	LRU	276964	14738	0.9494758349
			LFU	238681	53021	0.8182357337
6	5	1	LRU	263226	28476	0.902379826
			LFU	263226	28476	0.902379826

Cache Hit Rate (CSIZE = 2KB, real2.trace)

Best configuration for CSIZE = 2KB (real2.trace) is: s=2, E=8, LRU, with a cache hit rate of 0.9743711048.

LRU drastically outperforms LFU, with a hit rate of 0.974 versus 0.438, showing that LFU is particularly inefficient for these parameters.

Best configuration for CSIZE = 2KB (both traces) is: s=0, E=32, LRU
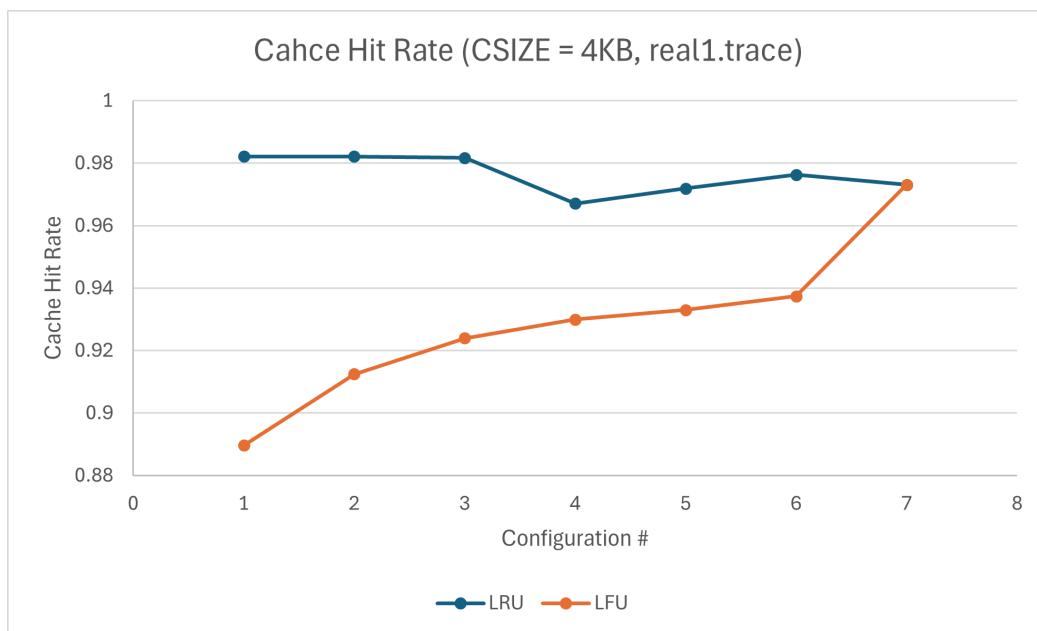
Cache Configurations for CSIZE = 4KB

$CSIZE = (Block\ Size) \times 2^s \times E$, where E is a power of 2

$4096\ Bytes = (64\ Bytes) \times 2^s \times E \Rightarrow 64\ Bytes = 2^s \times E$

$64\ Bytes = 2^6$, Therefore the value of 's' can range from 0 to 5, meaning there are 7 possible configurations with each one being either LRU or LFU, which leads to 14 total configurations

CSIZE = 4KB (real1.trace)

| Config	s	E	LRU/LFU	Hits	Misses	Hit rate
1	0	64	LRU	281840	5124	0.9821441017
			LFU	255311	31653	0.8896969655
2	1	32	LRU	281840	5124	0.9821441017
			LFU	261842	25122	0.9124559178
3	2	16	LRU	281712	5252	0.9816980527
			LFU	265145	21819	0.9239660724
4	3	8	LRU	277512	9452	0.9670620705
			LFU	266857	20107	0.9299319775
5	4	4	LRU	278896	8068	0.9718849751
			LFU	267728	19236	0.9329672015
6	5	2	LRU	280166	6798	0.9763106174
			LFU	269011	17953	0.9374381456
7	6	1	LRU	279243	7721	0.973094186
			LFU	279243	7721	0.973094186

Best configuration for CSIZE = 4KB (real1.trace) is a tie between:
(s=0, E=64, LRU) and (s=1, E=32, LRU), both with cache hit rates of 0.9821441017.

LRU and LFU show high hit rates, but LRU is still slightly better, with a hit rate of 0.982 compared to LFU's 0.890.

CSIZE = 4KB (real2.trace)

Config	s	E	LRU/LFU	Hits	Misses	Hit rate
1	0	64	LRU	287570	4132	0.9858348589
			LFU	136127	155575	0.4666646098
2	1	32	LRU	287601	4101	0.9859411317
			LFU	143747	147955	0.4927871595
3	2	16	LRU	287541	4161	0.9857354423
			LFU	251324	40378	0.8615779117
4	3	8	LRU	287207	4495	0.9845904382
			LFU	276816	14886	0.9489684678
5	4	4	LRU	286544	5158	0.9823175707
			LFU	241822	49880	0.8290035721
6	5	2	LRU	285088	6614	0.9773261753
			LFU	282240	9462	0.9675627867
7	6	1	LRU	265431	26271	0.9099389103
			LFU	265431	26271	0.9099389103

Cahce Hit Rate (CSIZE = 4KB, real2.trace)
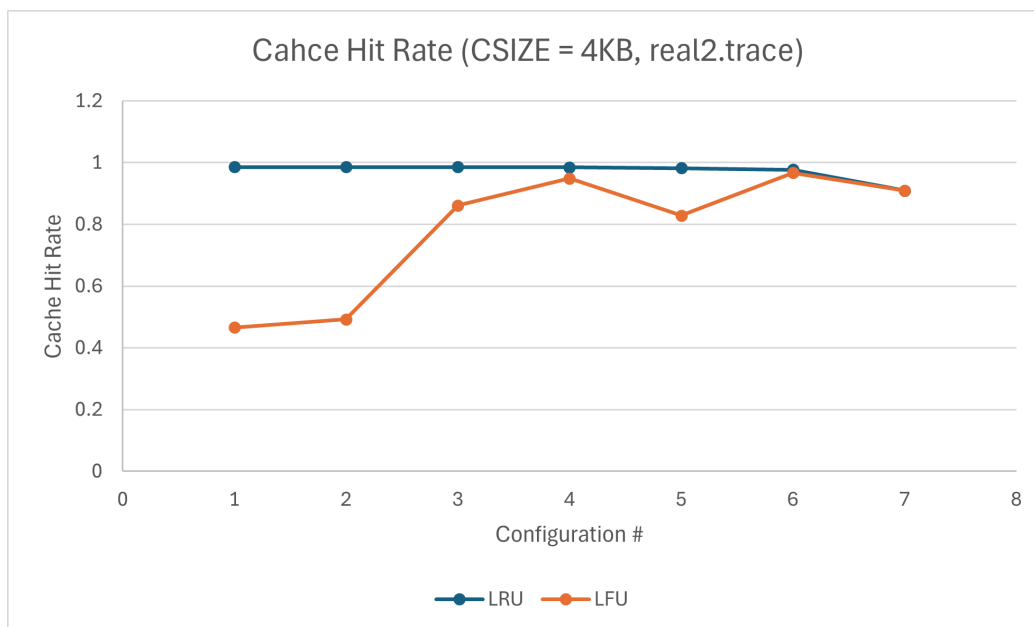
Best configuration for CSIZE = 4KB (real2.trace) is: s=1, E=32, LRU, with a cache hit rate of 0.9859511317.
LRU maintains significantly higher performance with a hit rate of 0.986, while LFU falls behind at 0.467, further emphasizing LFU's inefficiency with these configurations.

Best configuration for CSIZE = 4KB (both traces) is: s=1, E=32, LRU