CS 1541
Project 2
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Experiment 1:

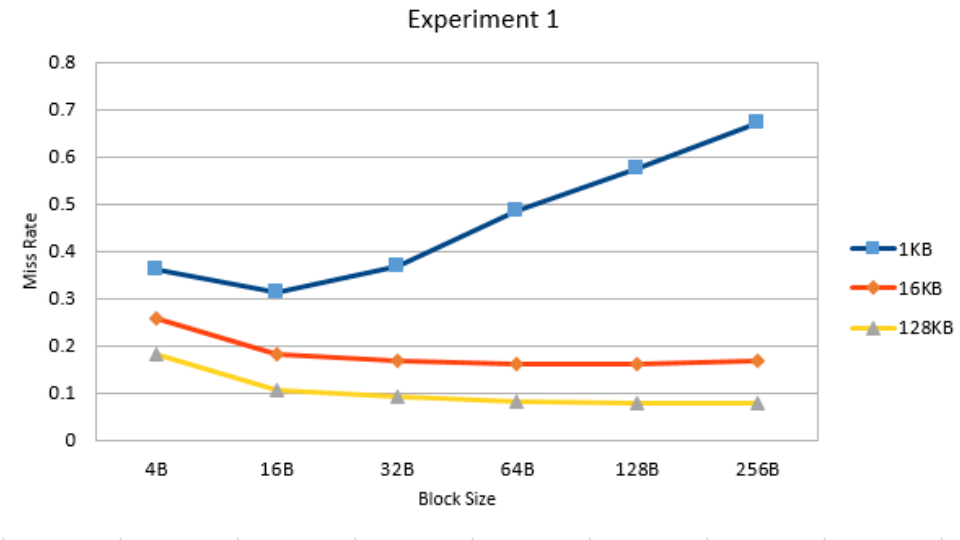
To examine the effect of the block size, consider 3 cache sizes (1KB, 16KB and 128KB) with 4-way set associativity and LRU replacement. Compare the miss rate for block sizes of 4B, 16B, 32B, 64B, 128B and 256B. Produce two plots similar to the one on page 391 of the text book, one for each of the long traces. Produce two corresponding graphs to express the number of bytes written back (the y axis being the number of bytes written back instead of the miss rate).

The result of running our simulation with trace_view_on = 0 for each long trace file and the parameters specified in this experiment can be found in exp1.txt.

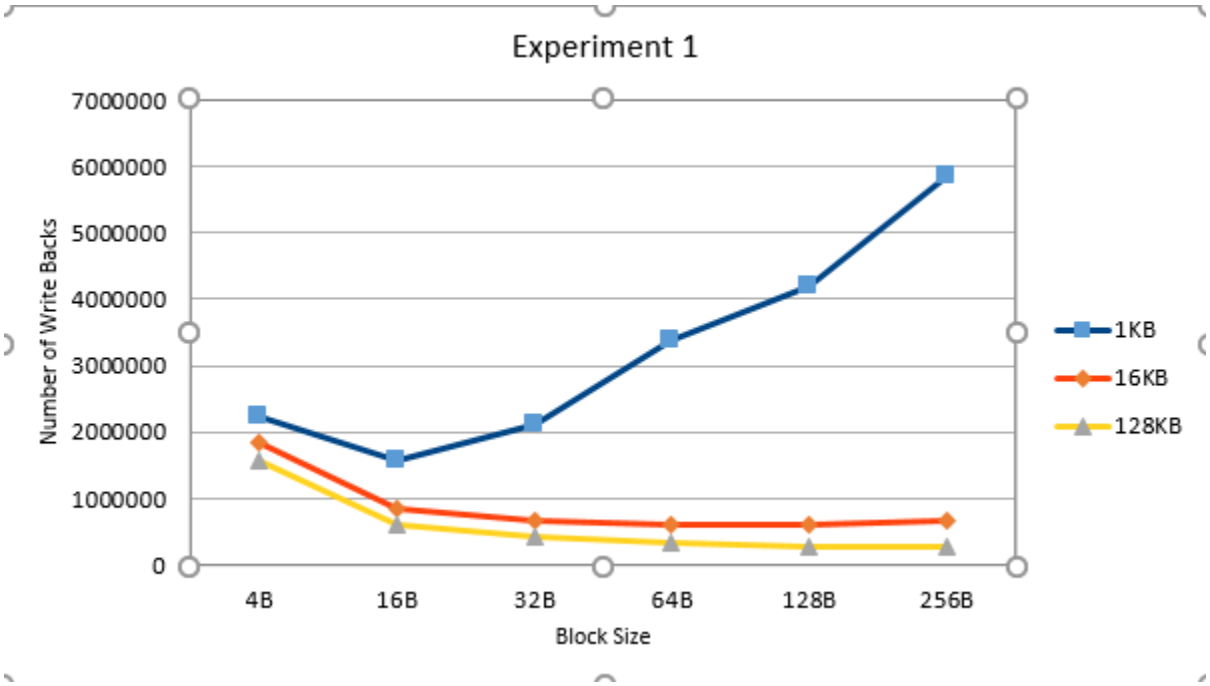
The data we gathered from running all of the simulations with sample_large1.tr:

sample_large1	4-way associativity	LRU		Experiment 1	write back		
Experiment 1 Miss Rate	1KB	16KB	128KB	Experiment 1	1KB	16KB	128KB
4B	0.360056	0.258945	0.18221	4B	2224202	1838108	1584935
16B	0.311524	0.180966	0.106475	16B	1585103	834206	601420
32B	0.367343	0.167206	0.091184	32B	2102724	670681	421101
64B	0.485552	0.16108	0.083014	64B	3367378	597168	327138
128B	0.57605	0.160954	0.078926	128B	4197343	593396	280388
256B	0.671623	0.17006	0.077254	256B	5844825	676720	259844

Miss Rate for sample_large1.tr:



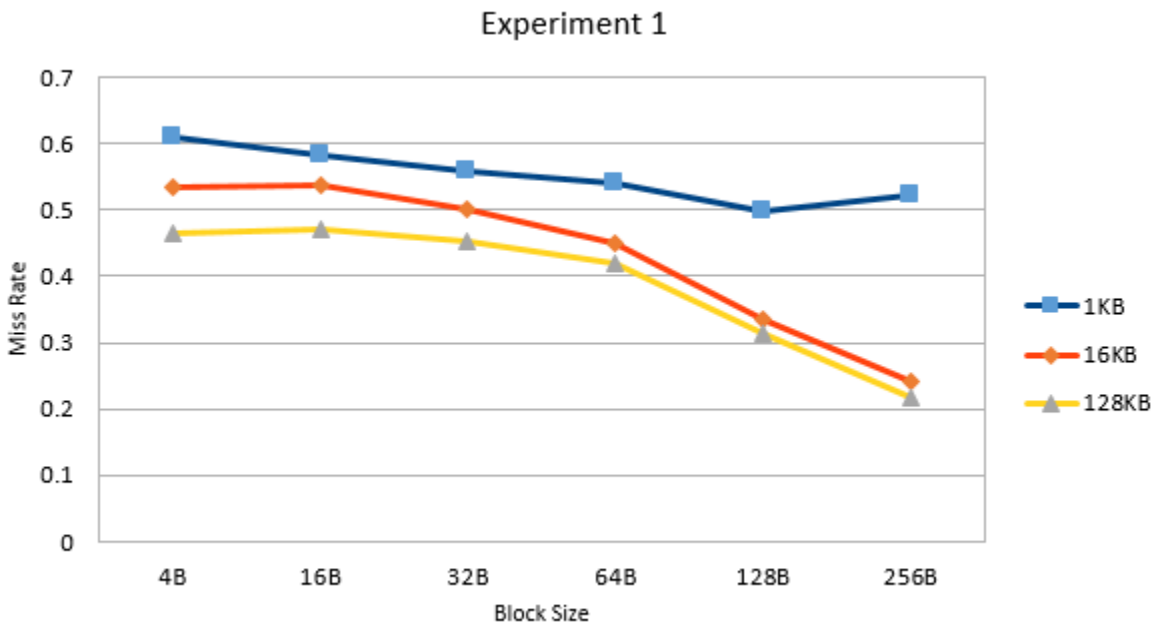
Write Backs for sample_large1.tr:



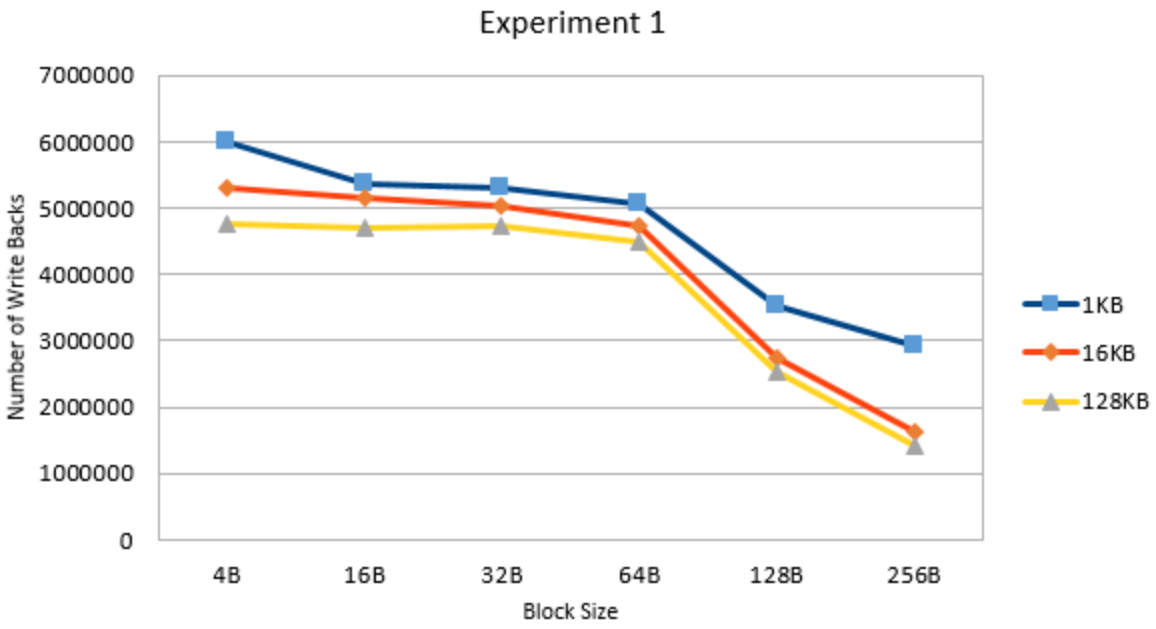
The data we gathered from running all of the simulations with sample_large2.tr:

Experiment 1							
sample_large2	1KB	16KB	128KB	Experiment 1	1KB	16KB	128KB
4B	0.609105	0.534324	0.465606	4B	6009564	5309638	4756396
16B	0.581492	0.537675	0.471912	16B	5370681	5150207	4711749
32B	0.557979	0.501522	0.453878	32B	5300659	5041223	4718167
64B	0.538503	0.449821	0.418687	64B	5070575	4720719	4476674
128B	0.497953	0.333996	0.313868	128B	3512642	2731109	2519399
256B	0.520479	0.242393	0.218507	256B	2916571	1632553	1422492

Miss Rate for sample_large2.tr:



Number of Write Backs for sample_large2.tr :



From the data gathered in experiment 1 we can conclude that increasing block size generally decreases the number misses and write backs if you have a decent size cache (> 1KB). We can see that increasing the block size in the 1 KB cache there is an increase in misses and write backs for sample1. We see the best benefits from increasing the block size come from the larger cache sizes (16 KB and 128KB) when the number of misses and write backs decrease the most with increasing block size. Overall it is hard to predict the pattern of increasing block size for a 1KB cache as both samples show contradicting behavior. However for the 16KB and 128KB we can see a general decrease in misses when you increase the block size.

Experiment 2:

To examine the effect of the replacement policy, consider a 4KB cache with 32B blocks and 4-way associativity. Use a bar graph to plot the miss rate for each of the two long traces and 2 replacement policies (FIFO and LRU). Your plot should have 4 bars.

The result of running our simulation with trace_view_on = 0 for each long trace file and the parameters specified in this experiment:

The data we gathered from running all of the simulations:

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large1.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 4-way set associative
+ Replacement Policy : LRU
+ number of accesses : 30438865
+ number of reads : 20813032
+ number of writes : 9625833
+ number of hits : 23924859
+ number of misses : 6514006
+ number of misses with write back : 967763
+ rate of misses : 0.214003

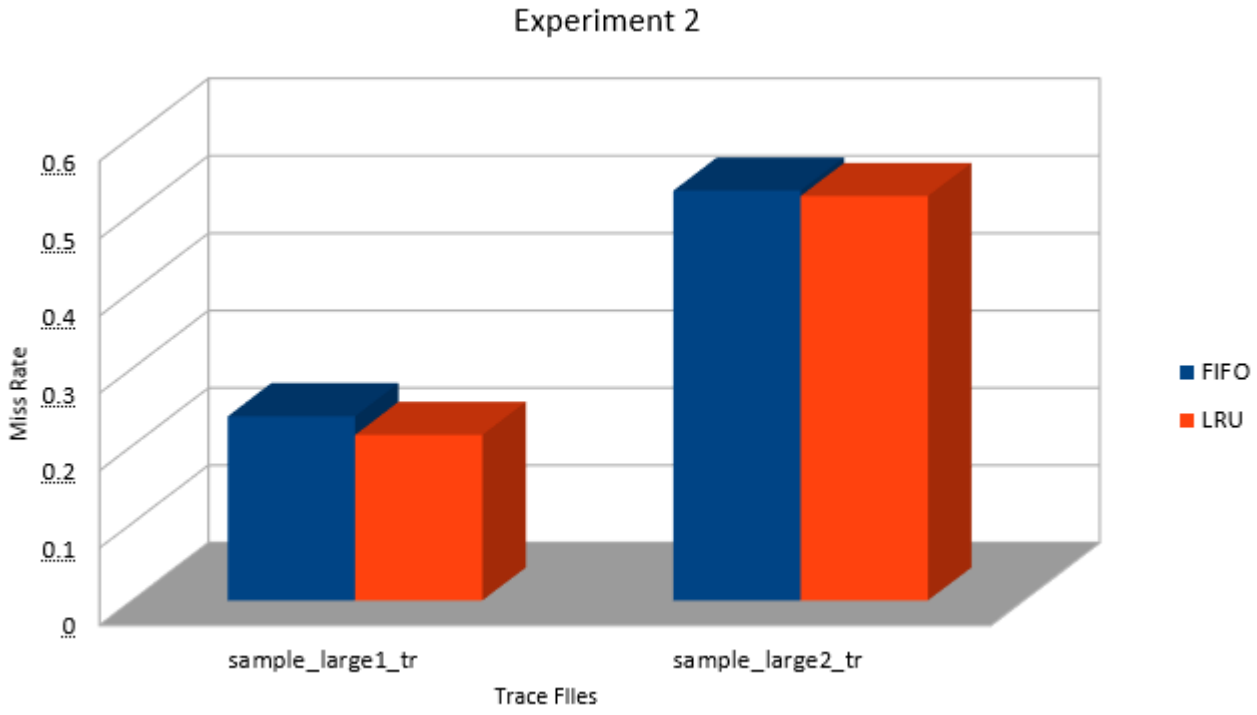
** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large1.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 4-way set associative
+ Replacement Policy : FIFO
+ number of accesses : 30438865
+ number of reads : 20813032
+ number of writes : 9625833
+ number of hits : 23190552
+ number of misses : 7248313
+ number of misses with write back : 1158049
+ rate of misses : 0.238127

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large2.tr
+ Cache Size : 4KB

+ Block Size : 32B
+ 4-way set associative
+ Replacement Policy : LRU
+ number of accesses : 36084985
+ number of reads : 29411338
+ number of writes : 6673647
+ number of hits : 17219663
+ number of misses : 18865322
+ number of misses with write back : 5158821
+ rate of misses : 0.522803

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large2.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 4-way set associative
+ Replacement Policy : FIFO
+ number of accesses : 36084985
+ number of reads : 29411338
+ number of writes : 6673647
+ number of hits : 16965726
+ number of misses : 19119259
+ number of misses with write back : 5196034
+ rate of misses : 0.529840

Experiment 2	FIFO	LRU
sample_large1_tr	0.238127	0.214003
sample_large2_tr	0.52984	0.522803



From this experiment we can see that in both cases LRU has better performance then FIFO. We can also observe that for a longer running program with more instructions the difference in performance is not as great.

Experiment 3:

To examine the effect of associativity, consider a 4KB cache with 32B blocks and LRU replacement. Use a bar graph to plot the miss rate for associativity = 1, 4 and 8. This plot will have 6 bars, three for each long trace

The result of running our simulation with trace_view_on = 0 for each long trace file and the parameters specified in each experiment.

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large1.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 1-way set associative
+ Replacement Policy : LRU
+ number of accesses : 30438865
+ number of reads : 20813032
+ number of writes : 9625833
+ number of hits : 20771557
+ number of misses : 9667308
+ number of misses with write back : 1969379
+ rate of misses : 0.317598

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large1.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 4-way set associative
+ Replacement Policy : LRU
+ number of accesses : 30438865
+ number of reads : 20813032
+ number of writes : 9625833
+ number of hits : 23924859
+ number of misses : 6514006
+ number of misses with write back : 967763
+ rate of misses : 0.214003

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large1.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 8-way set associative
+ Replacement Policy : LRU
+ number of accesses : 30438865
+ number of reads : 20813032
+ number of writes : 9625833
+ number of hits : 24100584

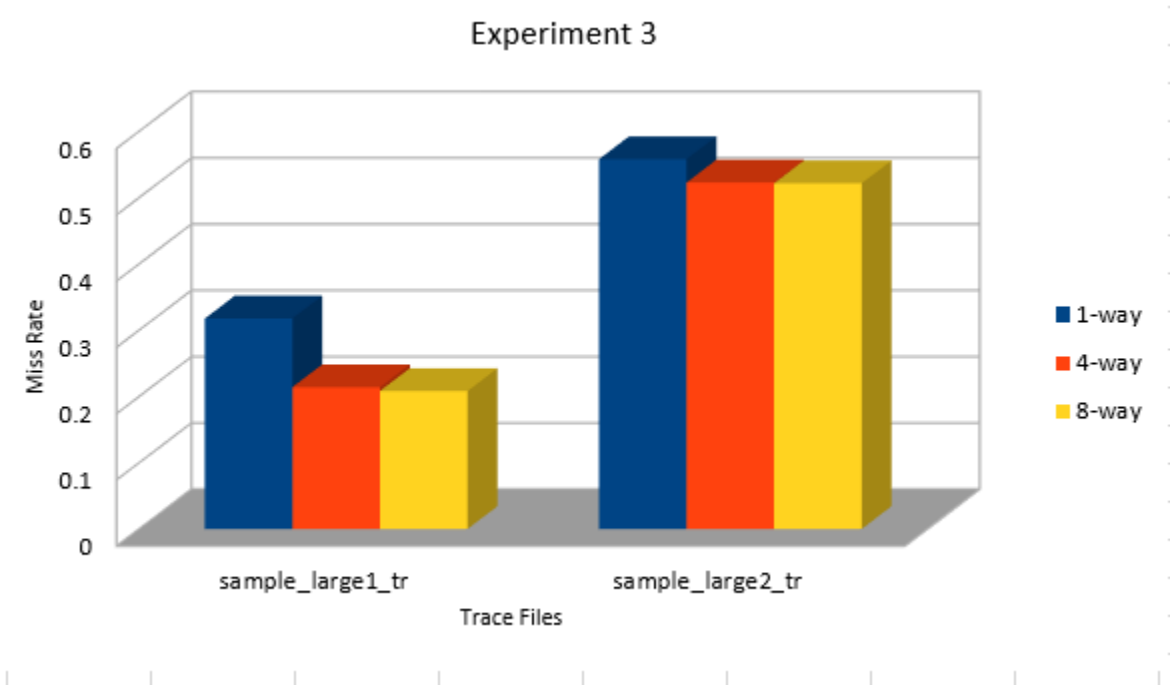
+ number of misses : 6338281
+ number of misses with write back : 933434
+ rate of misses : 0.208230

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large2.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 1-way set associative
+ Replacement Policy : LRU
+ number of accesses : 36084985
+ number of reads : 29411338
+ number of writes : 6673647
+ number of hits : 15952062
+ number of misses : 20132923
+ number of misses with write back : 5213762
+ rate of misses : 0.557931

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large2.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 4-way set associative
+ Replacement Policy : LRU
+ number of accesses : 36084985
+ number of reads : 29411338
+ number of writes : 6673647
+ number of hits : 17219663
+ number of misses : 18865322
+ number of misses with write back : 5158821
+ rate of misses : 0.522803

** opening file /afs/cs.pitt.edu/courses/1541/long_traces/sample_large2.tr
+ Cache Size : 4KB
+ Block Size : 32B
+ 8-way set associative
+ Replacement Policy : LRU
+ number of accesses : 36084985
+ number of reads : 29411338
+ number of writes : 6673647
+ number of hits : 17260684
+ number of misses : 18824301
+ number of misses with write back : 5157055
+ rate of misses : 0.521666

Experiment 3	associativity		
Experiment 3	1-way	4-way	8-way
sample_large1_tr	0.317598	0.214003	0.20823
sample_large2_tr	0.557931	0.522803	0.521666



We can clearly see that for this experiment having 4-way associativity is great improvement from 1-way but 8-way is not as much of an improvement. Additionally, like in experiment 2, we can see that for a longer running program with more instructions the difference in performance is not as great.