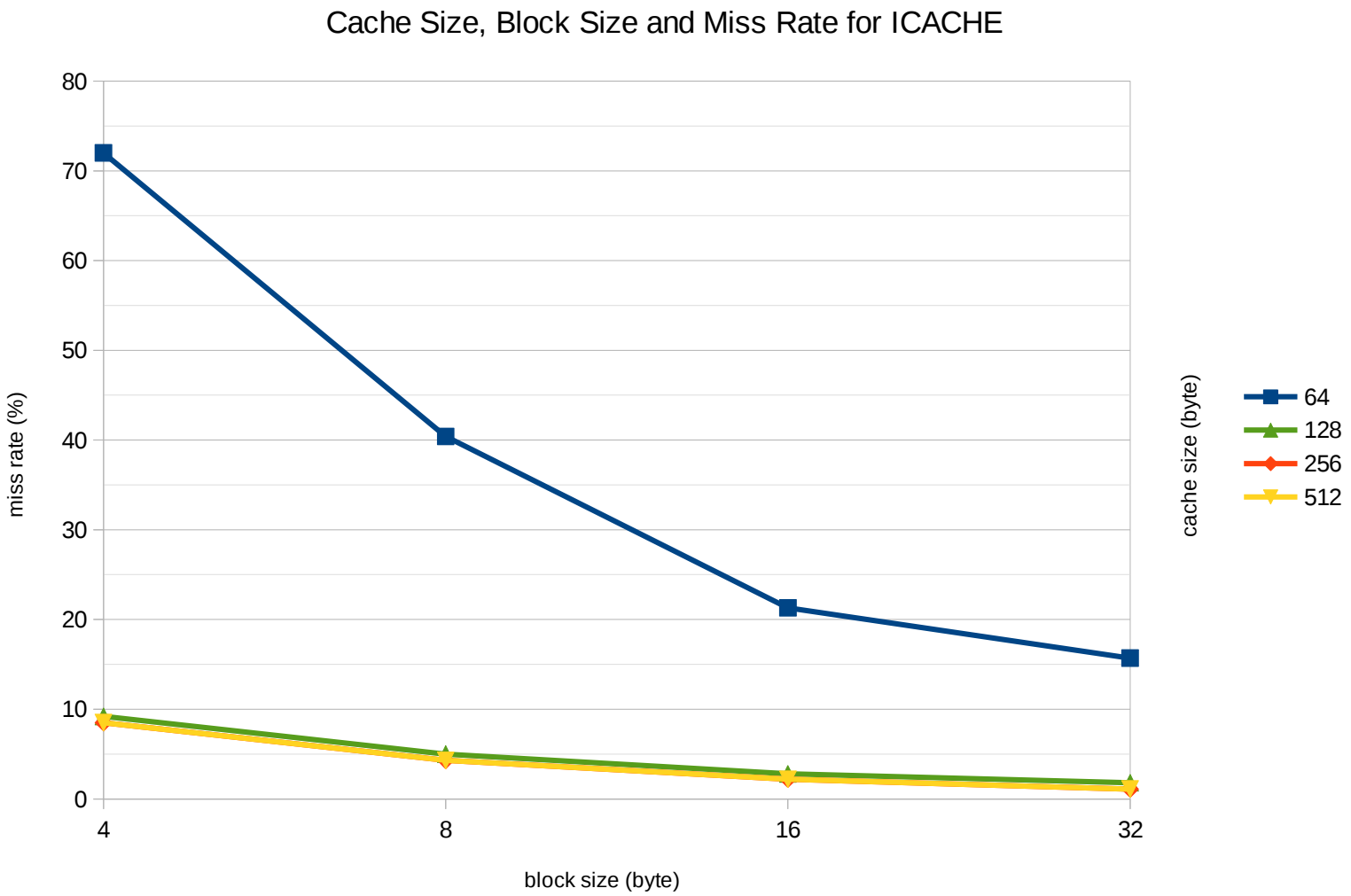
Computer Organization Lab 5

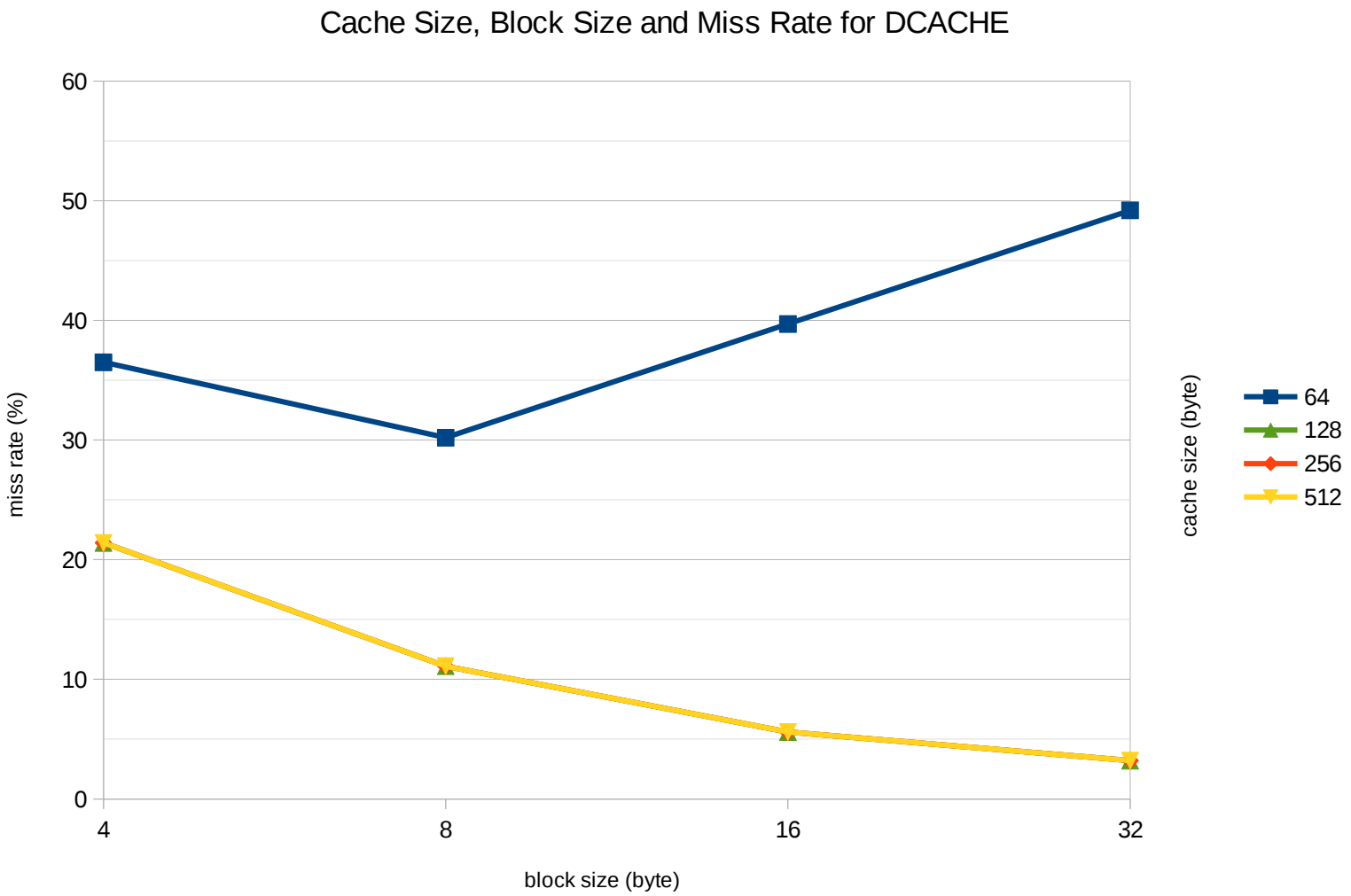
0113110 Po-han Chen (#1, 2, 3), 0316213 Yu-wen Pwu (#1, 4, 5)

Basic Problem

```
~/Documents/co-lab/lab05  master  g++ -Wall --std=c++11 direct_mapped_cache.cpp -o direc
~/Documents/co-lab/lab05  master  ./direct_mapped_cache.out
cache_size = 064 bytes, block_size = 04 bytes, memory_trace = ICACHE.txt, miss_rate = 72.0%
cache_size = 064 bytes, block_size = 08 bytes, memory_trace = ICACHE.txt, miss_rate = 40.4%
cache_size = 064 bytes, block_size = 16 bytes, memory_trace = ICACHE.txt, miss_rate = 21.3%
cache_size = 064 bytes, block_size = 32 bytes, memory_trace = ICACHE.txt, miss_rate = 15.7%
cache_size = 128 bytes, block_size = 04 bytes, memory_trace = ICACHE.txt, miss_rate = 09.2%
cache_size = 128 bytes, block_size = 08 bytes, memory_trace = ICACHE.txt, miss_rate = 05.0%
cache_size = 128 bytes, block_size = 16 bytes, memory_trace = ICACHE.txt, miss_rate = 02.8%
cache_size = 128 bytes, block_size = 32 bytes, memory_trace = ICACHE.txt, miss_rate = 01.8%
cache_size = 256 bytes, block_size = 04 bytes, memory_trace = ICACHE.txt, miss_rate = 08.5%
cache_size = 256 bytes, block_size = 08 bytes, memory_trace = ICACHE.txt, miss_rate = 04.3%
cache_size = 256 bytes, block_size = 16 bytes, memory_trace = ICACHE.txt, miss_rate = 02.2%
cache_size = 256 bytes, block_size = 32 bytes, memory_trace = ICACHE.txt, miss_rate = 01.1%
cache_size = 512 bytes, block_size = 04 bytes, memory_trace = ICACHE.txt, miss_rate = 08.5%
cache_size = 512 bytes, block_size = 08 bytes, memory_trace = ICACHE.txt, miss_rate = 04.3%
cache_size = 512 bytes, block_size = 16 bytes, memory_trace = ICACHE.txt, miss_rate = 02.2%
cache_size = 512 bytes, block_size = 32 bytes, memory_trace = ICACHE.txt, miss_rate = 01.1%
cache_size = 064 bytes, block_size = 04 bytes, memory_trace = DCACHE.txt, miss_rate = 36.5%
cache_size = 064 bytes, block_size = 08 bytes, memory_trace = DCACHE.txt, miss_rate = 30.2%
cache_size = 064 bytes, block_size = 16 bytes, memory_trace = DCACHE.txt, miss_rate = 39.7%
cache_size = 064 bytes, block_size = 32 bytes, memory_trace = DCACHE.txt, miss_rate = 49.2%
cache_size = 128 bytes, block_size = 04 bytes, memory_trace = DCACHE.txt, miss_rate = 21.4%
cache_size = 128 bytes, block_size = 08 bytes, memory_trace = DCACHE.txt, miss_rate = 11.1%
cache_size = 128 bytes, block_size = 16 bytes, memory_trace = DCACHE.txt, miss_rate = 05.6%
cache_size = 128 bytes, block_size = 32 bytes, memory_trace = DCACHE.txt, miss_rate = 03.2%
cache_size = 256 bytes, block_size = 04 bytes, memory_trace = DCACHE.txt, miss_rate = 21.4%
cache_size = 256 bytes, block_size = 08 bytes, memory_trace = DCACHE.txt, miss_rate = 11.1%
cache_size = 256 bytes, block_size = 16 bytes, memory_trace = DCACHE.txt, miss_rate = 05.6%
cache_size = 256 bytes, block_size = 32 bytes, memory_trace = DCACHE.txt, miss_rate = 03.2%
cache_size = 512 bytes, block_size = 04 bytes, memory_trace = DCACHE.txt, miss_rate = 21.4%
cache_size = 512 bytes, block_size = 08 bytes, memory_trace = DCACHE.txt, miss_rate = 11.1%
cache_size = 512 bytes, block_size = 16 bytes, memory_trace = DCACHE.txt, miss_rate = 05.6%
cache_size = 512 bytes, block_size = 32 bytes, memory_trace = DCACHE.txt, miss_rate = 03.2%
```



Lowering cache size and block size will increase the possibility to miss.

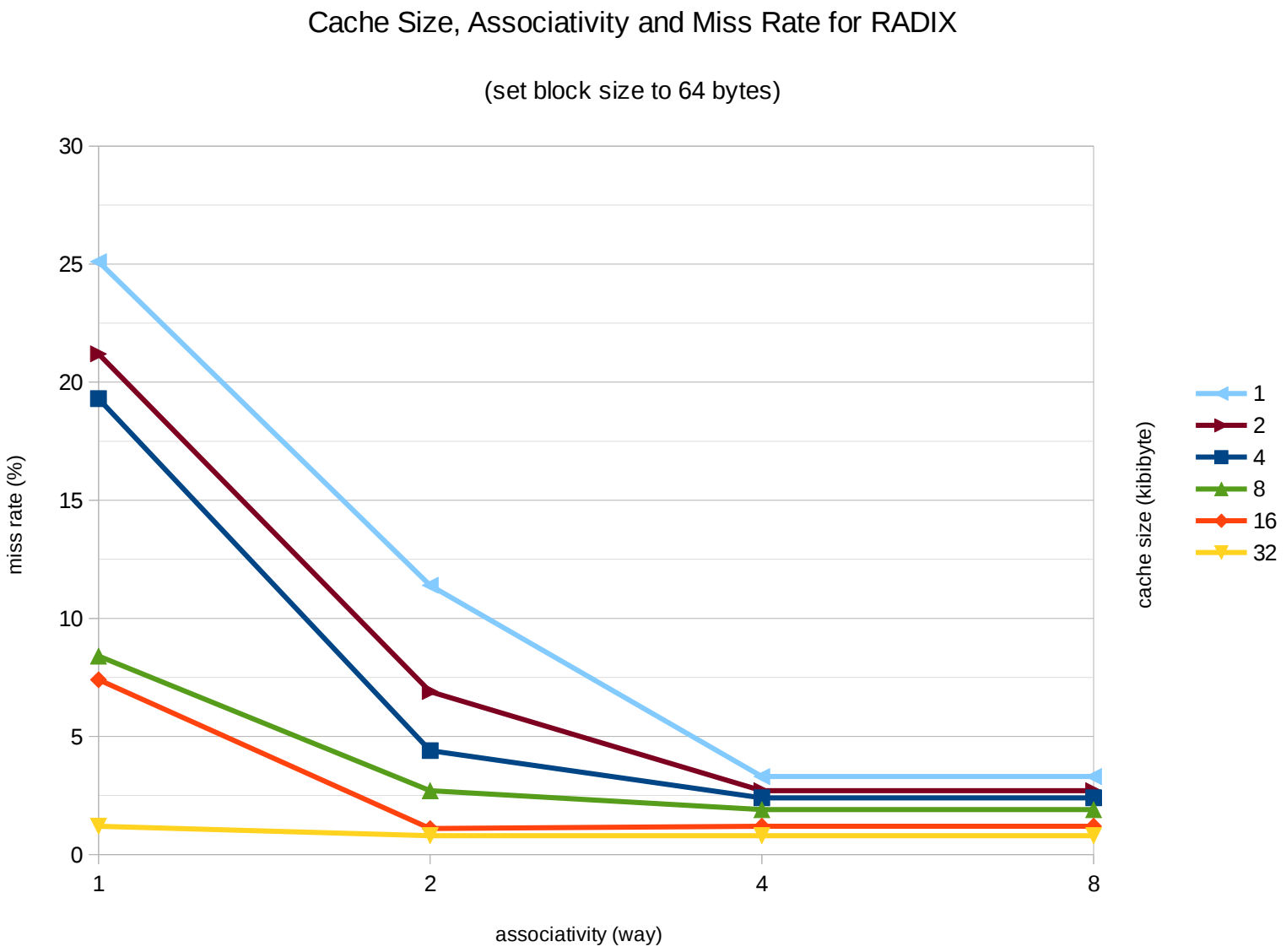


If cache size and block size are too close, the possibility to miss also increases.

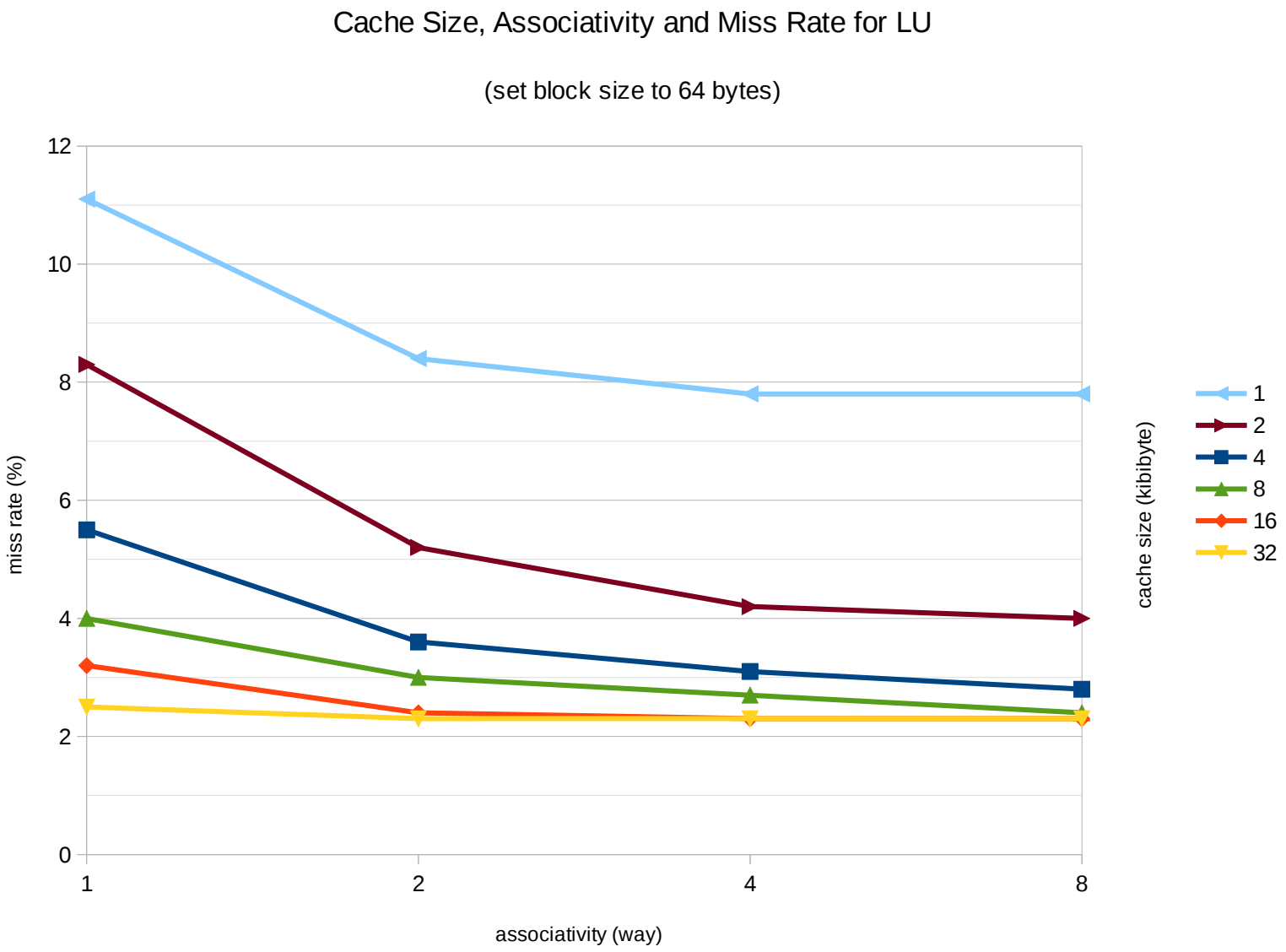
Advanced Problem

```
~/Documents/co-lab/lab05  master  g++ -Wall --std=c++11 direct_mapped_cache_lru.cpp -o dir
~/Documents/co-lab/lab05  master  ./direct_mapped_cache_lru.out
cache_size = 01 kibibytes, associativity = 1 ways, memory_trace = RADIX.txt, miss_rate = 25.1%
cache_size = 01 kibibytes, associativity = 2 ways, memory_trace = RADIX.txt, miss_rate = 11.4%
cache_size = 01 kibibytes, associativity = 4 ways, memory_trace = RADIX.txt, miss_rate = 03.3%
cache_size = 01 kibibytes, associativity = 8 ways, memory_trace = RADIX.txt, miss_rate = 03.3%
cache_size = 02 kibibytes, associativity = 1 ways, memory_trace = RADIX.txt, miss_rate = 21.2%
cache_size = 02 kibibytes, associativity = 2 ways, memory_trace = RADIX.txt, miss_rate = 06.9%
cache_size = 02 kibibytes, associativity = 4 ways, memory_trace = RADIX.txt, miss_rate = 02.7%
cache_size = 02 kibibytes, associativity = 8 ways, memory_trace = RADIX.txt, miss_rate = 02.7%
cache_size = 04 kibibytes, associativity = 1 ways, memory_trace = RADIX.txt, miss_rate = 19.3%
cache_size = 04 kibibytes, associativity = 2 ways, memory_trace = RADIX.txt, miss_rate = 04.4%
cache_size = 04 kibibytes, associativity = 4 ways, memory_trace = RADIX.txt, miss_rate = 02.4%
cache_size = 04 kibibytes, associativity = 8 ways, memory_trace = RADIX.txt, miss_rate = 02.4%
cache_size = 08 kibibytes, associativity = 1 ways, memory_trace = RADIX.txt, miss_rate = 08.4%
cache_size = 08 kibibytes, associativity = 2 ways, memory_trace = RADIX.txt, miss_rate = 02.7%
cache_size = 08 kibibytes, associativity = 4 ways, memory_trace = RADIX.txt, miss_rate = 01.9%
cache_size = 08 kibibytes, associativity = 8 ways, memory_trace = RADIX.txt, miss_rate = 01.9%
cache_size = 16 kibibytes, associativity = 1 ways, memory_trace = RADIX.txt, miss_rate = 07.4%
cache_size = 16 kibibytes, associativity = 2 ways, memory_trace = RADIX.txt, miss_rate = 01.1%
cache_size = 16 kibibytes, associativity = 4 ways, memory_trace = RADIX.txt, miss_rate = 01.2%
cache_size = 16 kibibytes, associativity = 8 ways, memory_trace = RADIX.txt, miss_rate = 01.2%
cache_size = 32 kibibytes, associativity = 1 ways, memory_trace = RADIX.txt, miss_rate = 01.2%
cache_size = 32 kibibytes, associativity = 2 ways, memory_trace = RADIX.txt, miss_rate = 00.8%
cache_size = 32 kibibytes, associativity = 4 ways, memory_trace = RADIX.txt, miss_rate = 00.8%
cache_size = 32 kibibytes, associativity = 8 ways, memory_trace = RADIX.txt, miss_rate = 00.8%
cache_size = 01 kibibytes, associativity = 1 ways, memory_trace = LU.txt, miss_rate = 11.1%
cache_size = 01 kibibytes, associativity = 2 ways, memory_trace = LU.txt, miss_rate = 08.4%
cache_size = 01 kibibytes, associativity = 4 ways, memory_trace = LU.txt, miss_rate = 07.8%
cache_size = 01 kibibytes, associativity = 8 ways, memory_trace = LU.txt, miss_rate = 07.8%
cache_size = 02 kibibytes, associativity = 1 ways, memory_trace = LU.txt, miss_rate = 08.3%
cache_size = 02 kibibytes, associativity = 2 ways, memory_trace = LU.txt, miss_rate = 05.2%
cache_size = 02 kibibytes, associativity = 4 ways, memory_trace = LU.txt, miss_rate = 04.2%
cache_size = 02 kibibytes, associativity = 8 ways, memory_trace = LU.txt, miss_rate = 04.0%
cache_size = 04 kibibytes, associativity = 1 ways, memory_trace = LU.txt, miss_rate = 05.5%
cache_size = 04 kibibytes, associativity = 2 ways, memory_trace = LU.txt, miss_rate = 03.6%
cache_size = 04 kibibytes, associativity = 4 ways, memory_trace = LU.txt, miss_rate = 03.1%
cache_size = 04 kibibytes, associativity = 8 ways, memory_trace = LU.txt, miss_rate = 02.8%
cache_size = 08 kibibytes, associativity = 1 ways, memory_trace = LU.txt, miss_rate = 04.0%
cache_size = 08 kibibytes, associativity = 2 ways, memory_trace = LU.txt, miss_rate = 03.0%
cache_size = 08 kibibytes, associativity = 4 ways, memory_trace = LU.txt, miss_rate = 02.7%
cache_size = 08 kibibytes, associativity = 8 ways, memory_trace = LU.txt, miss_rate = 02.4%
cache_size = 16 kibibytes, associativity = 1 ways, memory_trace = LU.txt, miss_rate = 03.2%
```

```
cache_size = 16 kibibytes, associativity = 2 ways, memory_trace = LU.txt, miss_rate = 02.4%
cache_size = 16 kibibytes, associativity = 4 ways, memory_trace = LU.txt, miss_rate = 02.3%
cache_size = 16 kibibytes, associativity = 8 ways, memory_trace = LU.txt, miss_rate = 02.3%
cache_size = 32 kibibytes, associativity = 1 ways, memory_trace = LU.txt, miss_rate = 02.5%
cache_size = 32 kibibytes, associativity = 2 ways, memory_trace = LU.txt, miss_rate = 02.3%
cache_size = 32 kibibytes, associativity = 4 ways, memory_trace = LU.txt, miss_rate = 02.3%
cache_size = 32 kibibytes, associativity = 8 ways, memory_trace = LU.txt, miss_rate = 02.3%
cache_size = 01 kibibytes, associativity = 1 ways, total_size = 008560 bits
cache_size = 01 kibibytes, associativity = 2 ways, total_size = 008576 bits
cache_size = 01 kibibytes, associativity = 4 ways, total_size = 008592 bits
cache_size = 01 kibibytes, associativity = 8 ways, total_size = 008608 bits
cache_size = 02 kibibytes, associativity = 1 ways, total_size = 017088 bits
cache_size = 02 kibibytes, associativity = 2 ways, total_size = 017120 bits
cache_size = 02 kibibytes, associativity = 4 ways, total_size = 017152 bits
cache_size = 02 kibibytes, associativity = 8 ways, total_size = 017184 bits
cache_size = 04 kibibytes, associativity = 1 ways, total_size = 034112 bits
cache_size = 04 kibibytes, associativity = 2 ways, total_size = 034176 bits
cache_size = 04 kibibytes, associativity = 4 ways, total_size = 034240 bits
cache_size = 04 kibibytes, associativity = 8 ways, total_size = 034304 bits
cache_size = 08 kibibytes, associativity = 1 ways, total_size = 068096 bits
cache_size = 08 kibibytes, associativity = 2 ways, total_size = 068224 bits
cache_size = 08 kibibytes, associativity = 4 ways, total_size = 068352 bits
cache_size = 08 kibibytes, associativity = 8 ways, total_size = 068480 bits
cache_size = 16 kibibytes, associativity = 1 ways, total_size = 135936 bits
cache_size = 16 kibibytes, associativity = 2 ways, total_size = 136192 bits
cache_size = 16 kibibytes, associativity = 4 ways, total_size = 136448 bits
cache_size = 16 kibibytes, associativity = 8 ways, total_size = 136704 bits
cache_size = 32 kibibytes, associativity = 1 ways, total_size = 271360 bits
cache_size = 32 kibibytes, associativity = 2 ways, total_size = 271872 bits
cache_size = 32 kibibytes, associativity = 4 ways, total_size = 272384 bits
cache_size = 32 kibibytes, associativity = 8 ways, total_size = 272896 bits
```



Lowering cache size and associativity will increase the possibility to miss.



Same as above.

Total Size in Bits

associativity cache size	1-way	2-way	4-way	8-way
1K	008,560	008,576	008,592	008,608
2K	017,088	017,120	017,152	017,184
4K	034,112	034,176	034,240	034,304
8K	068,096	068,224	068,352	068,480
16K	135,936	136,192	136,448	136,704
32K	271,360	271,872	272,384	272,896