Computer Organization Lab 5

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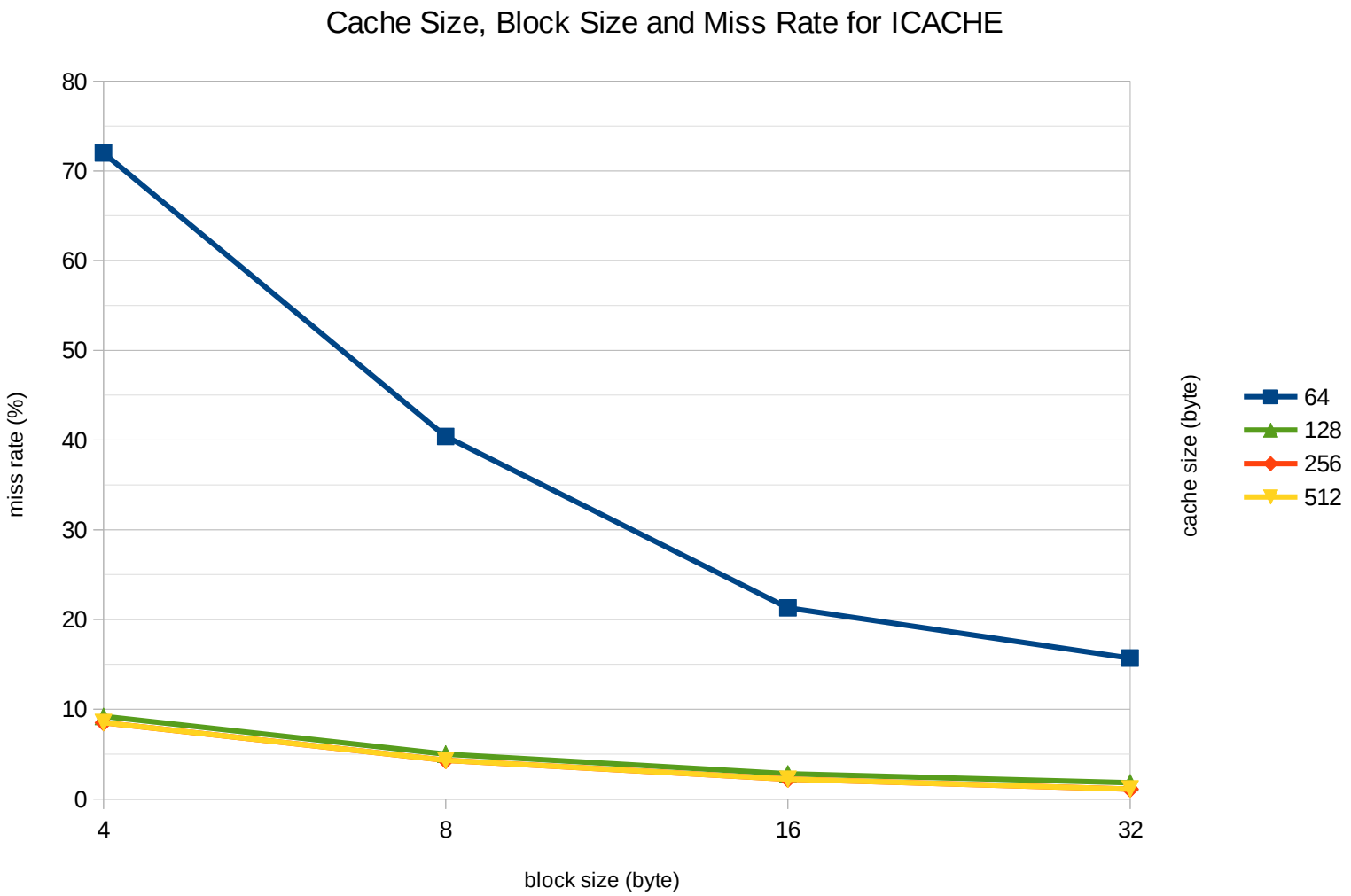
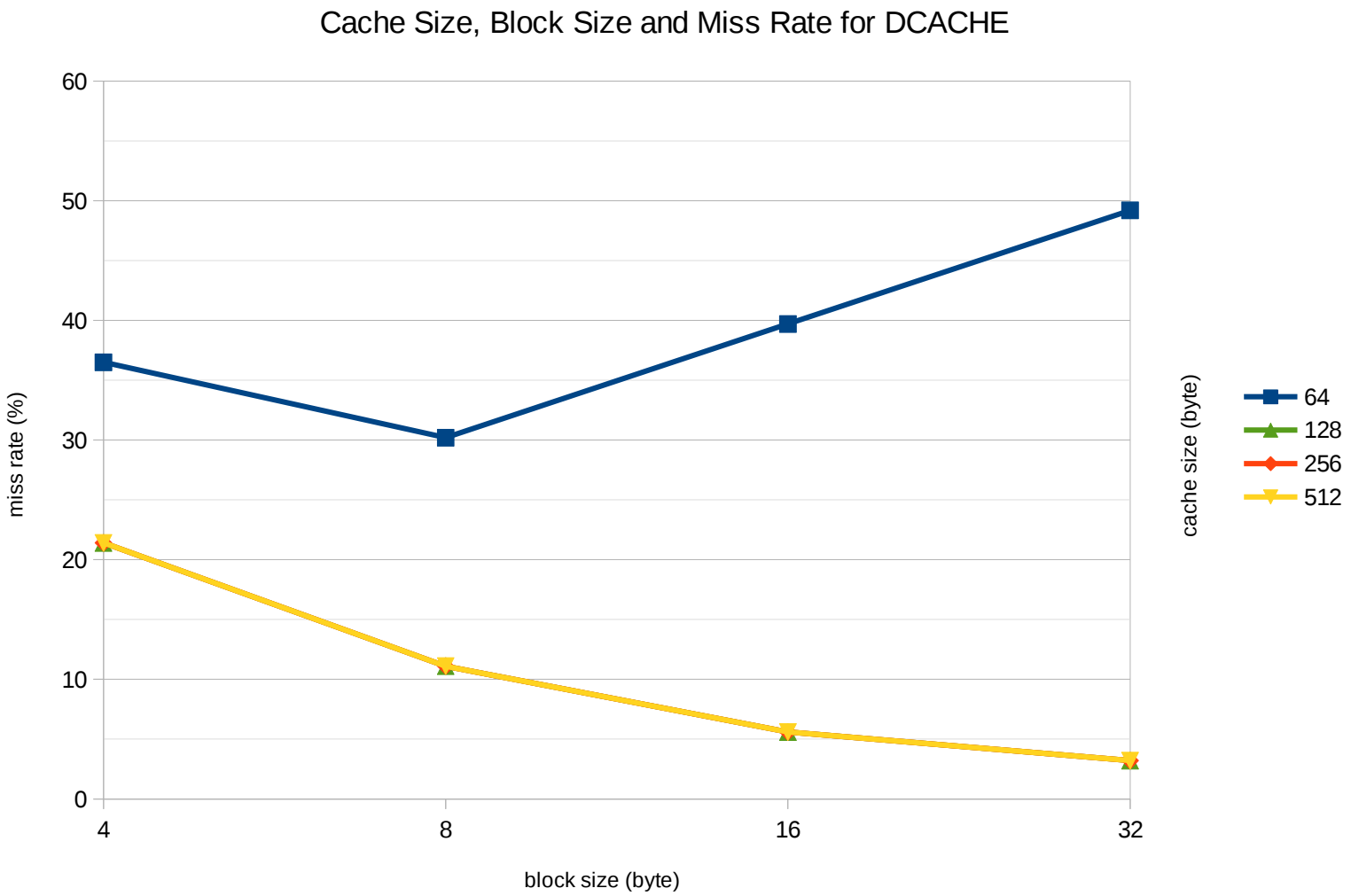
Basic Problem

```
~/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.

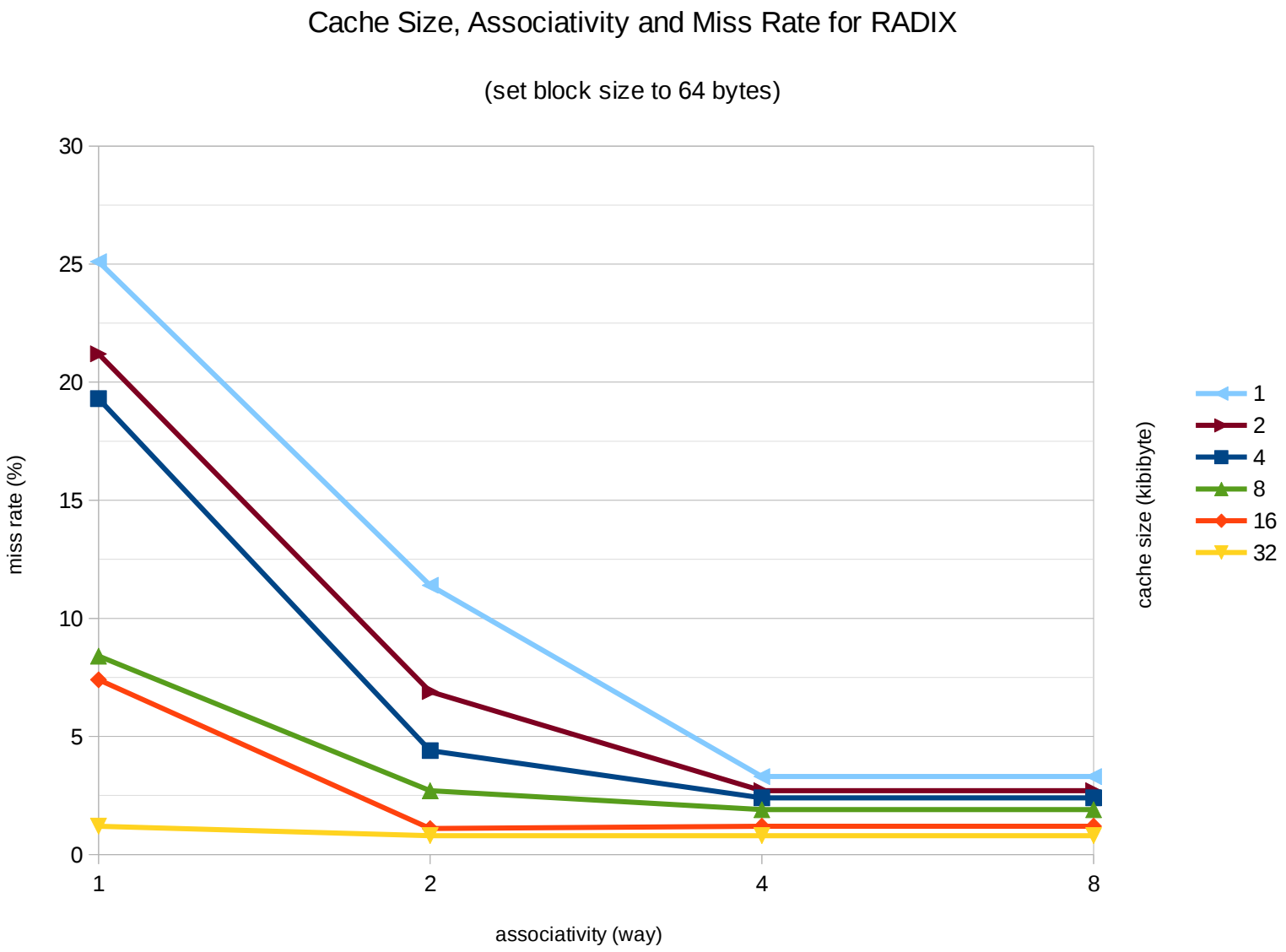


If cache size and block size are too close, the possibility to miss also increases.

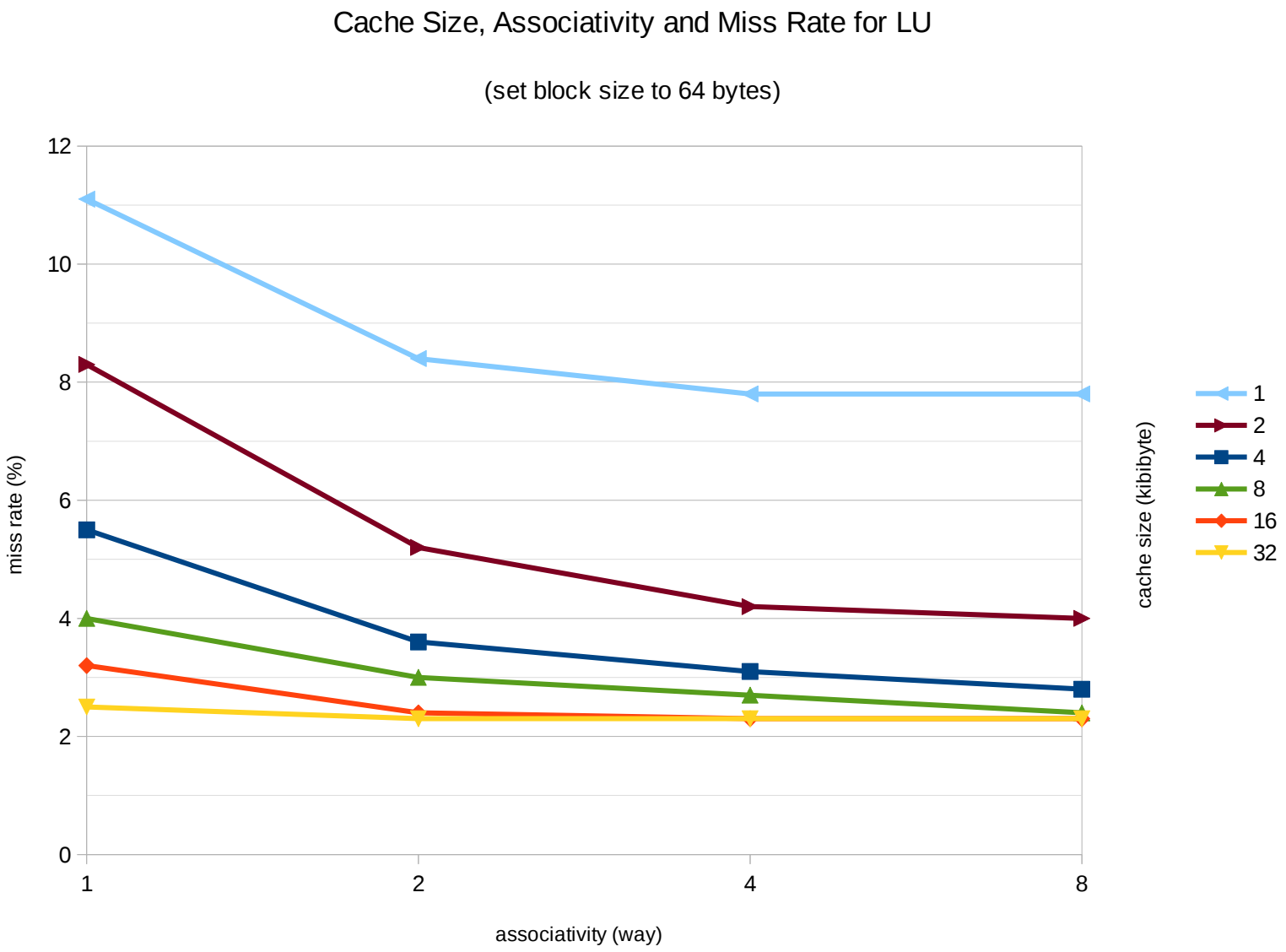
Advanced Problem

```
~/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 = 00011136 bits
cache_size = 01 kibibytes, associativity = 2 ways, total_size = 00011264 bits
cache_size = 01 kibibytes, associativity = 4 ways, total_size = 00011392 bits
cache_size = 01 kibibytes, associativity = 8 ways, total_size = 00011520 bits
cache_size = 02 kibibytes, associativity = 1 ways, total_size = 00022016 bits
cache_size = 02 kibibytes, associativity = 2 ways, total_size = 00022272 bits
cache_size = 02 kibibytes, associativity = 4 ways, total_size = 00022528 bits
cache_size = 02 kibibytes, associativity = 8 ways, total_size = 00022784 bits
cache_size = 04 kibibytes, associativity = 1 ways, total_size = 00043520 bits
cache_size = 04 kibibytes, associativity = 2 ways, total_size = 00044032 bits
cache_size = 04 kibibytes, associativity = 4 ways, total_size = 00044544 bits
cache_size = 04 kibibytes, associativity = 8 ways, total_size = 00045056 bits
cache_size = 08 kibibytes, associativity = 1 ways, total_size = 00086016 bits
cache_size = 08 kibibytes, associativity = 2 ways, total_size = 00087040 bits
cache_size = 08 kibibytes, associativity = 4 ways, total_size = 00088064 bits
cache_size = 08 kibibytes, associativity = 8 ways, total_size = 00089088 bits
cache_size = 16 kibibytes, associativity = 1 ways, total_size = 00169984 bits
cache_size = 16 kibibytes, associativity = 2 ways, total_size = 00172032 bits
cache_size = 16 kibibytes, associativity = 4 ways, total_size = 00174080 bits
cache_size = 16 kibibytes, associativity = 8 ways, total_size = 00176128 bits
cache_size = 32 kibibytes, associativity = 1 ways, total_size = 00335872 bits
cache_size = 32 kibibytes, associativity = 2 ways, total_size = 00339968 bits
cache_size = 32 kibibytes, associativity = 4 ways, total_size = 00344064 bits
cache_size = 32 kibibytes, associativity = 8 ways, total_size = 00348160 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	011,136	011,264	011,392	011,520
2K	022,016	022,272	022,528	022,784
4K	043,520	044,032	044,544	045,056
8K	086,016	087,040	088,064	089,088
16K	169,984	172,032	174,080	176,128
32K	335,872	339,968	344,064	348,160