



香港中文大學

The Chinese University of Hong Kong

CSCI2510 Computer Organization

Tutorial 10: Direct Mapping vs Associate Mapping

Yuhong LIANG

yhliang@cse.cuhk.edu.hk





- Direct Mapping vs Associate Mapping
- Hint for assignment3

Direct Mapping vs Associate Mapping



Number of Cache Hits (0~99 are randomly generated 1000 times)

Cache Size	Direct	Associate (LRU)	Associate (FIFIO)
4	51	36	35
8	89	81	86
16	175	159	160
32	323	300	292

Increasing the cache size, the hit rate increases

Hints for Assignment 3



- A computer system uses 32-bit memory addresses and it has a main memory consisting of 1Gbytes. It has a **4K-byte** cache organized in the block-set-associative manner, with **2 blocks** per set and **32 bytes** per block.
 - (a) Calculate the number of bits in each of the Tag, Set, and Word fields of the memory address.
 - (b) Assume that the cache is initially empty. Suppose that the processor fetches **1032 words of four bytes** each from successive word locations starting at location 0. It then repeats this fetch sequence **four** more times. If the cache is **10** times faster than the memory, estimate the improvement factor resulting from the use of the cache. Assume that **the LRU algorithm** is used for block replacement.

Hints for Assignment 3



(a)

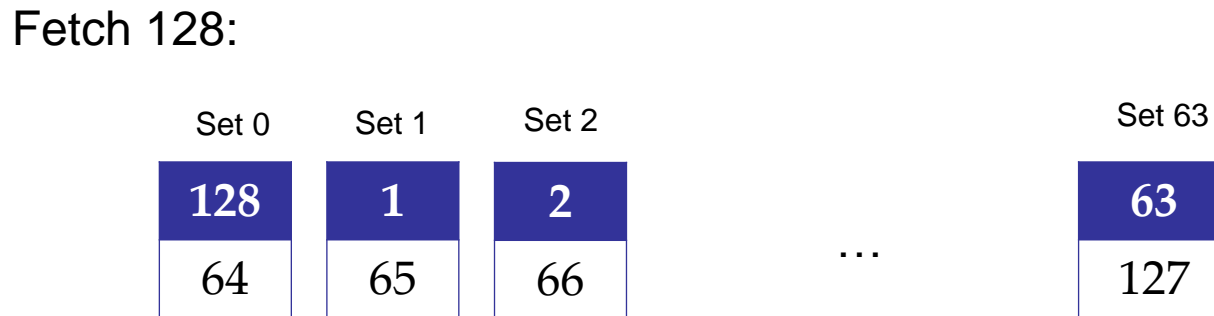
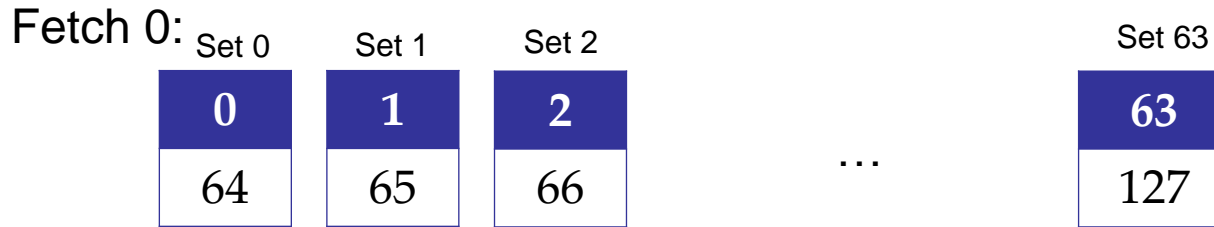
- A block has 32 bytes and it's byte-addressable; hence the Word field is 5 bits long.
- With $2 \times 32 = 64$ bytes in a set, there are $4K/64 = 64$ sets, requiring a Set field of 6 bits.
- This leaves $32 - 5 - 6 = 21$ bits for the Tag field.

Hints for Assignment 3



(b) LRU: Replace the least recently used cache block in its set

First round: 1032 words of four bytes constitute 129 blocks (32 bytes per block)



Let t be the access time of the cache.

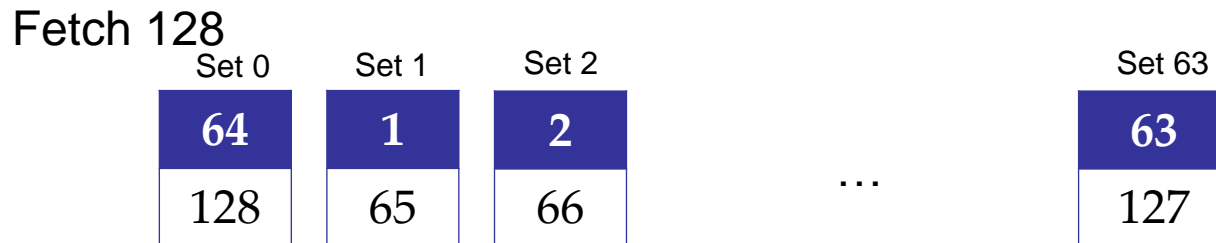
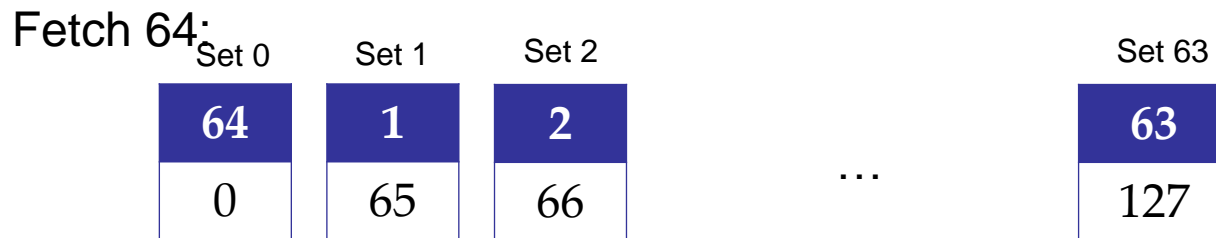
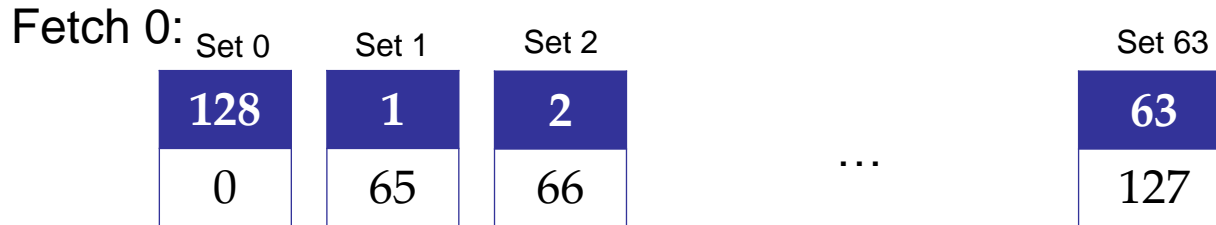
$$1 \times 129 \times 11t$$

Hints for Assignment 3



(b) LRU: Replace the least recently used cache block in its set

Second round:



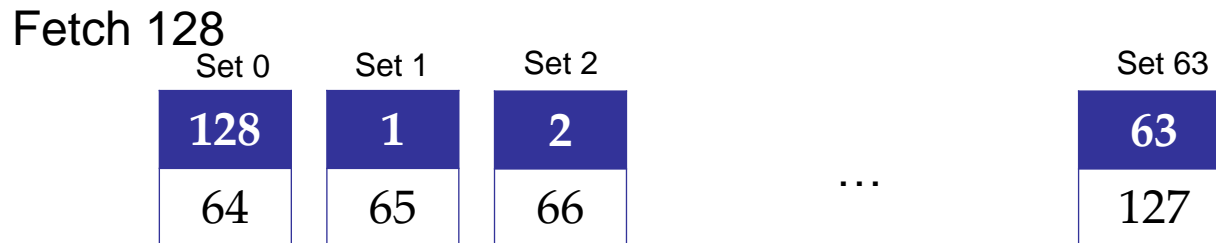
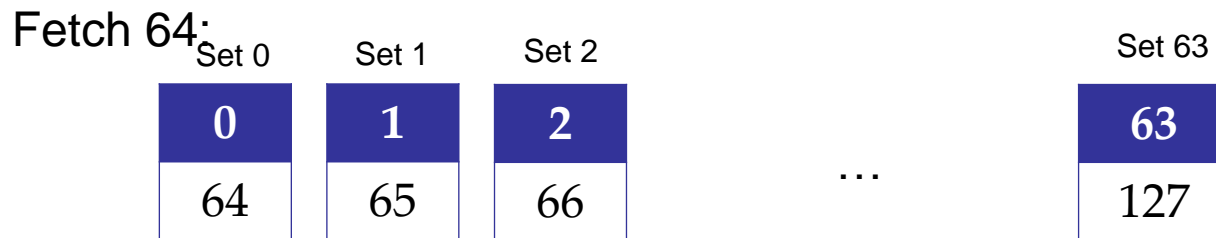
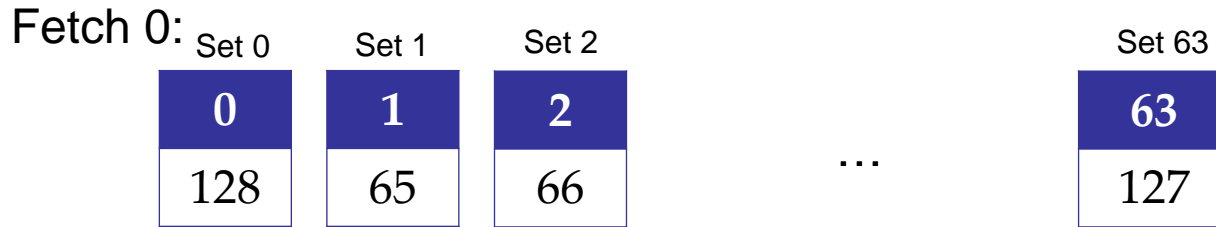
$$3 \times 11t + 126 * t$$

Hints for Assignment 3



(b) LRU: Replace the least recently used cache block in its set

Third round:



$$3 \times 11t + 126 * t$$

Hints for Assignment 3



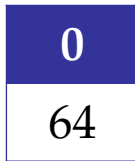
(b)

As execution proceeds, all memory blocks that occupy the first set of the 64 cache sets are always overwritten before they can be used on a succeeding round.

Memory blocks 0, 64, 128 continually displace each other as they compete for the 2 block positions in cache set 0.

First round:

Fetch 0: Set 0

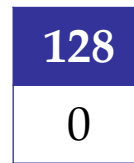


Fetch 128:

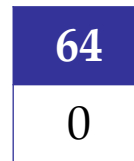


Second round:

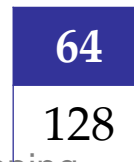
Fetch 0: Set 0



Fetch 64: Set 0



Fetch 128: Set 0

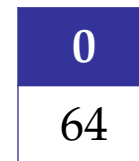


Third round:

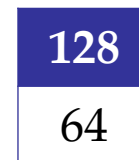
Fetch 0: Set 0



Fetch 64: Set 0



Fetch 128: Set 0

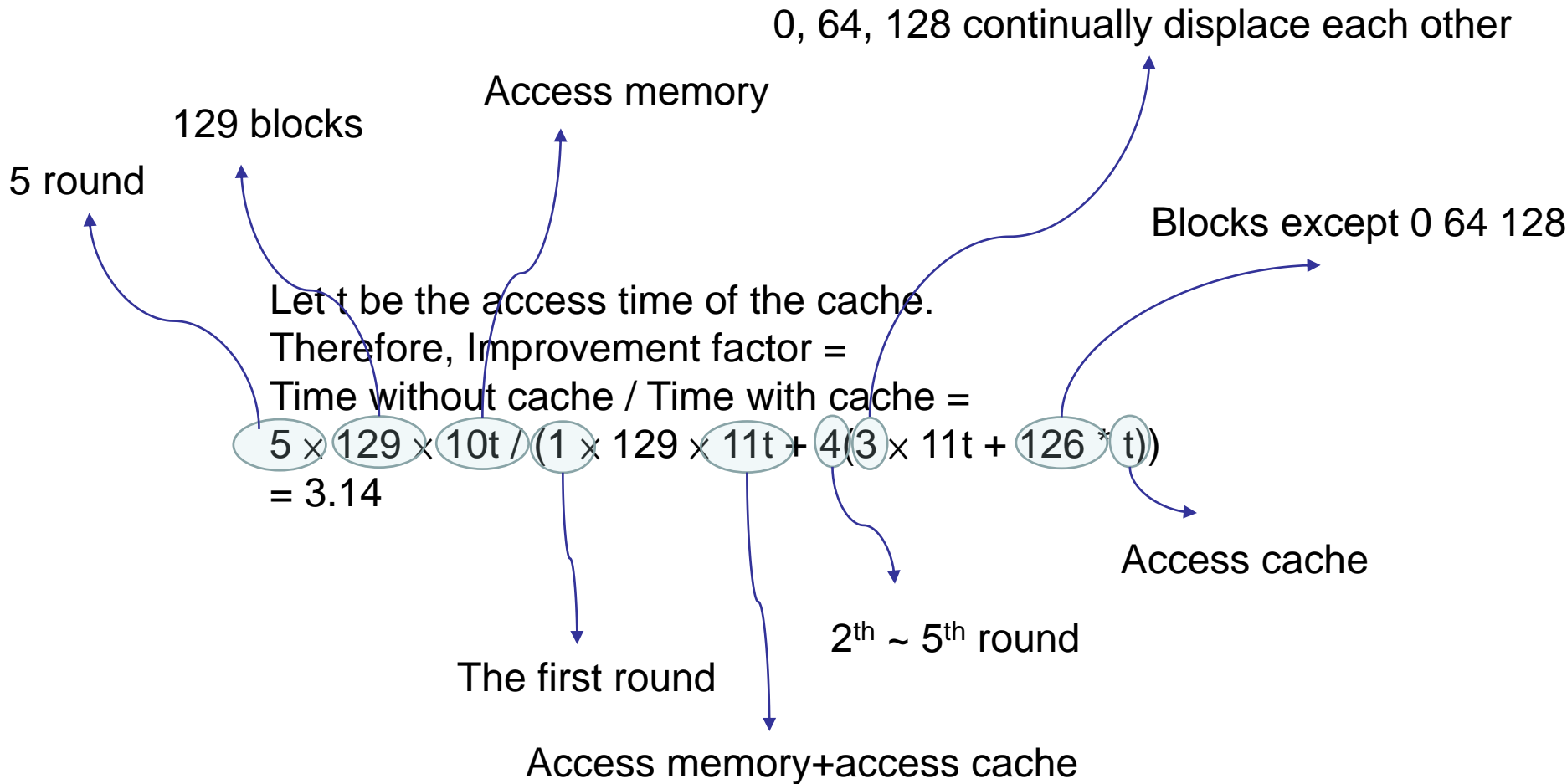


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Hints for Assignment 3



(b)





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