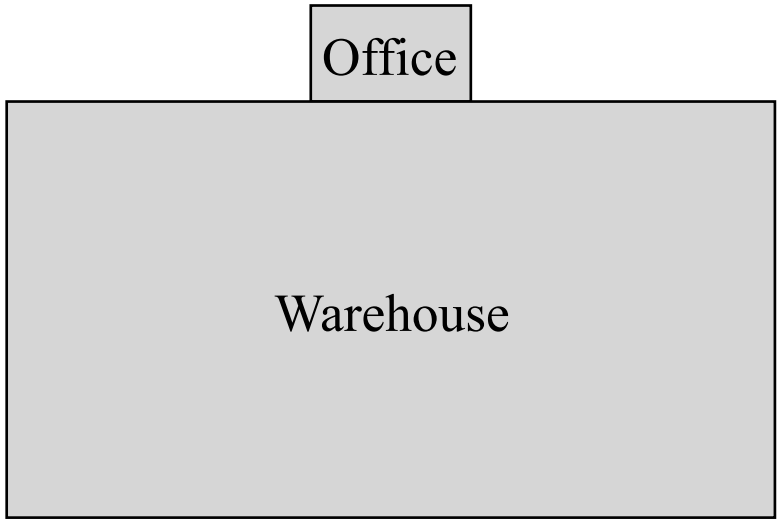
Movie Rental Store

- You have a huge warehouse with EVERY movie ever made (hits, training films, etc.).
- Getting a movie from the warehouse takes 15 minutes.
- You can't stay in business if every rental takes 15 minutes.
- You have some small shelves in the front office.

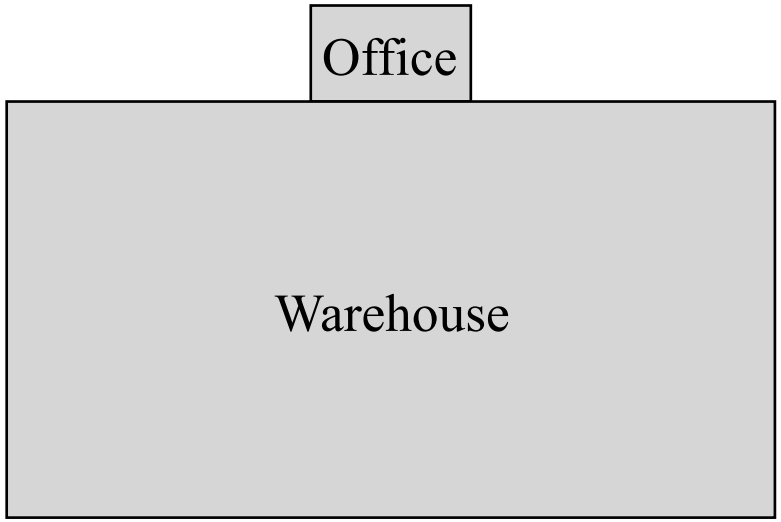


Here are some suggested improvements to the store:

1. Whenever someone rents a movie, just keep it in the front office for a while in case someone else wants to rent it.
2. Watch the trends in movie watching and attempt to guess movies that will be rented soon – put those in the front office.
3. Whenever someone rents a movie in a series (Star Wars), grab the other movies in the series and put them in the front office.
4. Buy motorcycles to ride in the warehouse to get the movies faster

Extending the analogy to locality for caches, which pair of changes most closely matches the analogous cache locality?

Selection	Spatial	Temporal
A	2	1
B	4	2
C	4	3
D	3	1
E	None of the above	



- Answer D

A simple cache 1

address string:

4	00000100
8	00001000
12	00001100
4	00000100
8	00001000
20	00010100
4	00000100
8	00001000
20	00010100
24	00011000
12	00001100
8	00001000
4	00000100

the *tag* identifies the address of the cached data

tag	data

4 blocks, each block holds one word, any block can hold any word.

- A cache that can put a line of data anywhere is called _____

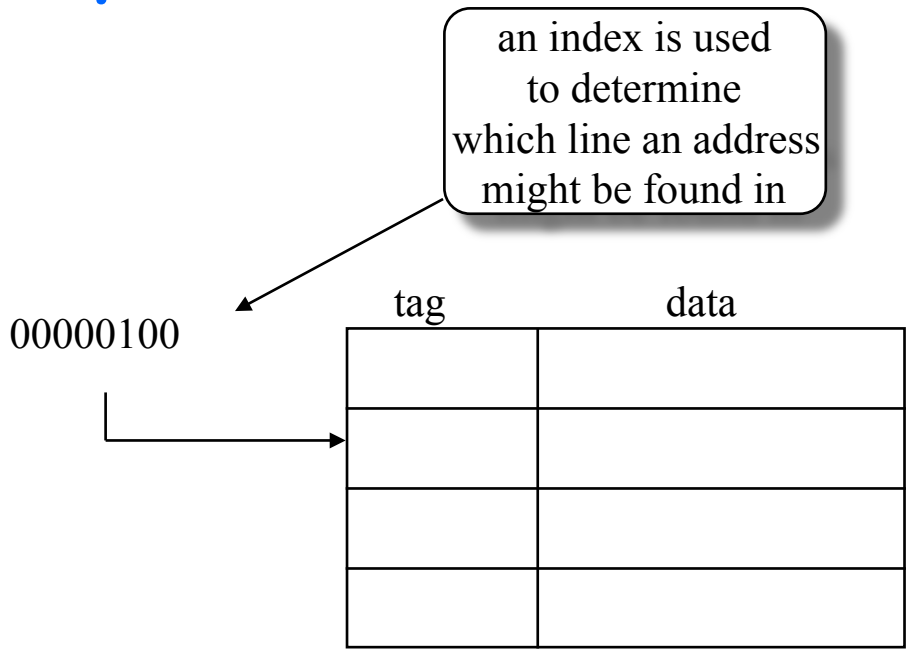
Selection	Name
A	Direct mapped
B	Set Associative
C	Fully Associative
D	None

- Answer fully associative

A simpler cache II

address string:

4	00000100
8	00001000
12	00001100
4	00000100
8	00001000
20	00010100
4	00000100
8	00001000
20	00010100
24	00011000
12	00001100
8	00001000
4	00000100



4 blocks, each block holds one word, each word in memory maps to exactly one cache location.

- A cache that can put a line of data in exactly one place is called _____.

Selection	Name
A	Direct mapped
B	Set Associative
C	Fully Associative
D	None

- Answer direct mapped

Direct Mapped Cache

addresses				A	B	C	D
4	00 00	01	00	M	M	M	M
8	00 00	10	00	M	M	M	H
12	00 00	11	00	M	M	M	M
4	00 00	01	00	H	H	H	H
8	00 00	10	00	H	H	H	H
20	00 01	01	00	M	M	M	M
4	00 00	01	00	M	M	H	H
8	00 00	10	00	H	H	H	H
20	00 01	01	00	H	M	H	H
24	00 01	10	00	M	M	M	M
12	00 00	11	00	H	H	M	H
8	00 00	10	00	H	M	H	H
4	00 00	01	00	H	M	M	M

E None are correct

	tag	data
00		
01		
10		
11		

4 blocks, each block holds one word, each word in memory maps to exactly one cache location.

- Answer B

2-way Set Associative Cache

addresses				A	B	C	D
4	00 000	1	00	M	M	M	M
8	00 001	0	00	M	M	M	H
12	00 001	1	00	M	M	M	M
4	00 000	1	00	H	H	H	H
8	00 001	0	00	H	H	H	H
20	00 010	1	00	M	M	M	M
4	00 000	1	00	H	M	M	H
8	00 001	0	00	H	H	H	H
20	00 010	1	00	H	M	H	H
24	00 011	0	00	M	M	M	M
12	00 001	1	00	M	H	M	H
8	00 001	0	00	H	M	H	H
4	00 000	1	00	M	M	M	M

E None are correct

	tag	data	tag	data
0				
1				

4 entries, each block holds one word, each word in memory maps to one of a set of *n* cache lines

- Answer A

Cache Performance

- Instruction cache miss rate of 4%, data cache miss rate of 10%, BaseCPI = 1.0 (no data or control hazards), 20% of instructions are loads and stores, miss penalty = 12 cycles, CPI = ?

Selection	CPI (rounded if necessary)
A	1.24
B	1.34
C	1.48
D	1.72
E	None of the above

- Answer D

```
for(int i = 0; i<10,000,000;i++)
        sum+=A[i];
```

Assume each element of A is 4 bytes and sum is kept in a register. Assume a baseline direct-mapped 32KB cache with 32 byte blocks. Which changes would help the hit rate of the above code?

Selection	Change
A	Increase to 2-way set associativity
B	Increase block size to 64 bytes
C	Increase cache size to 64 KB
D	A and C combined
E	A, B, and C combined

- Answer B