Lab3 Questions

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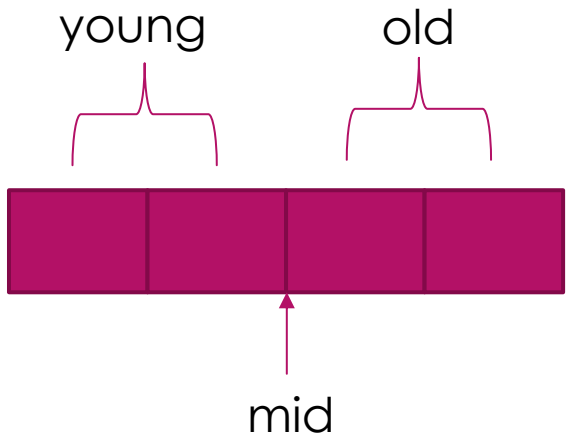
Lab3.A: LRU Cache

- In our lab, we haved learned a modified LRU algorithm that is used in database buffer pool. Now, Let's implement it.
- Building your own data structure to solve the problem is recommended. But feel free to use LinkedList, LinkedHashMap or other containers if you want to.
- A reference of real-world database buffer pool: https://dev.mysql.com/doc/refman/5.7/en/innodb-buffer-pool.html.

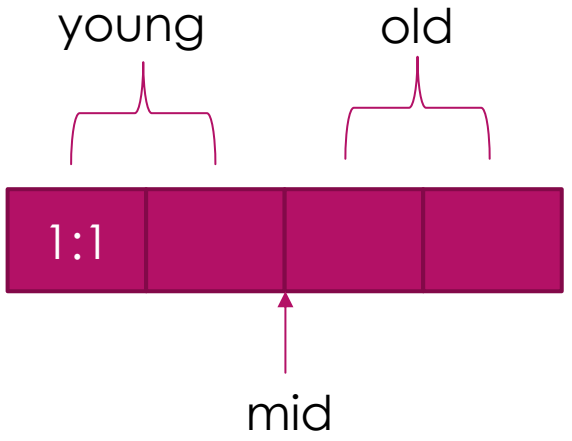
Sample Input 1

```
2 2
10
put 1 1
put 2 2
get 1
put 3 3
put 4 4
print
put 5 5
get 3
put 5 4
print
```

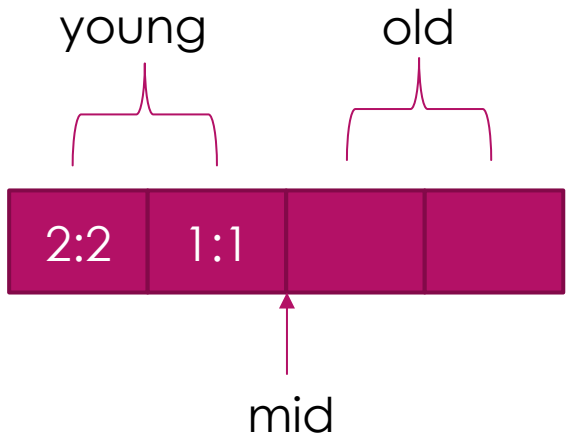
Initial:



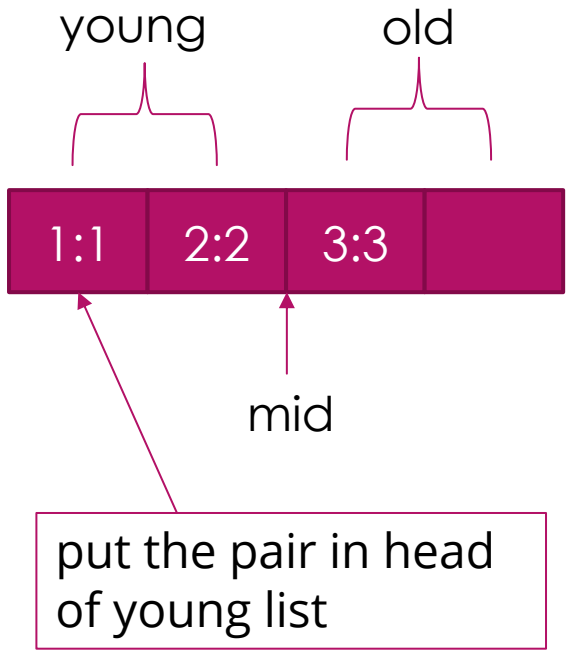
put 1 1:



put 2 2:

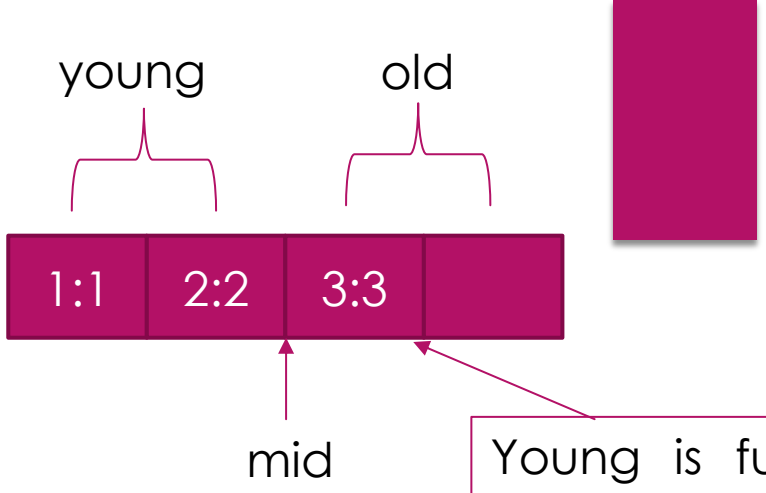


get 1:

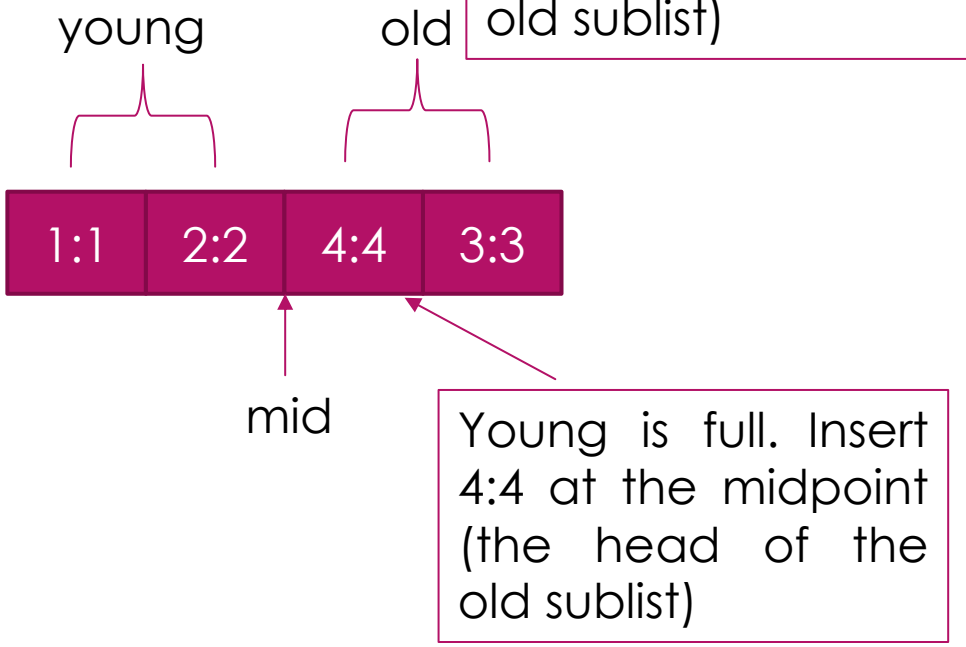


Remember print 1

put 3 3:

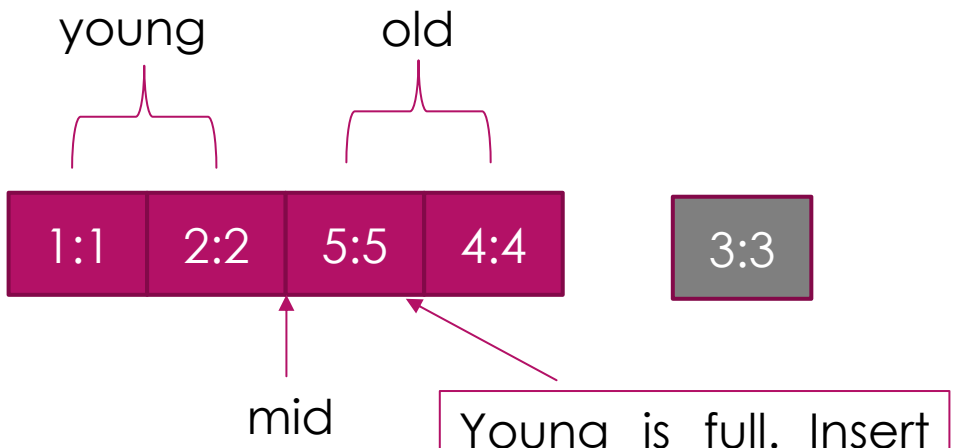


put 4 4:



print: 1:1 2:2 4:4 3:3

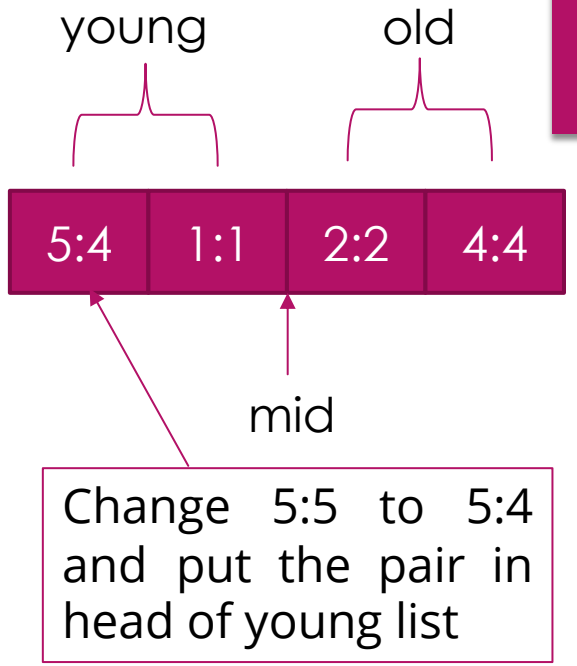
put 5 5:



get 3: No pair in the LRU, do nothing

Remember print -1

put 5 4:



print: 5:4 1:1 2:2 4:4

Lab3.B: Dream

- One day FluffyBunny finds herself trapped in a dream. In her dream, there are N rooms and M one-way corridors. Each corridor is defined as (x_i, y_i, z_i), which means there is a corridor from x_i to y_i, which takes z_i seconds.
- However, naughty Satori is casting spells at the same time so that the time required to move between rooms is constantly changing. Specifically, every time after FluffyBunny moves on one corridor, the time spent on **all** corridors changes from z_i to $f(z_i)$, in which $f(x) = \frac{1+x}{1-x} \ mod \ p, x \in (1, p-1)$.
- It is guaranteed that p is a prime number and $f(z_i)$ is defined in any time.
- FluffyBunny, of course, wants to escape from the dream. She notices that the exit is room N and she is currently at room 1. Please tell her the minimum time required to get to room N.

$$f(x) = \frac{1+x}{1-x} \; mod\; p, x \in (1, p-1)$$

$$f(x) = (1+x) * inv(1-x) \; mod\; p, x \in (1, p-1)$$

$$f(x) = (1+x) * (1+p-x)^{p-2} mod\; p, x \in (1, p-1)$$

p is prime

Fermat's Little Theorem

$$a^{p-1} \equiv 1 (mod\; p)$$
$$a^{p-2} \equiv inv(a) (mod\; p)$$
$$inv(a) = a^{p-2} (mod\; p)$$

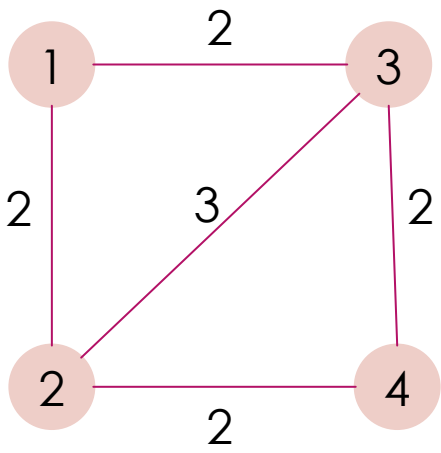
$$inv(1-x) = (1-x)^{p-2} \; mod\; p$$

$$inv(1-x) = (1+p-x)^{p-2} \; mod\; p$$

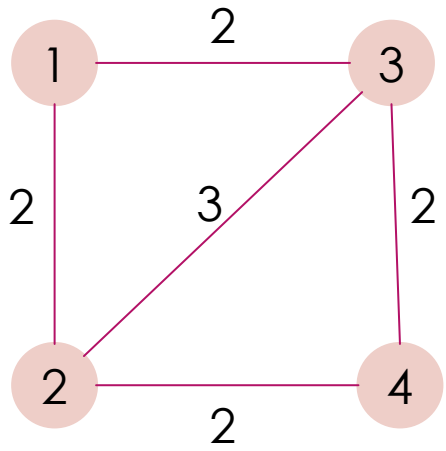
Sample Input

4 5 5
1 2 2
3 4 2
1 3 2
2 4 2
2 3 3

$f(2) = 2$
$f(3) = 3$

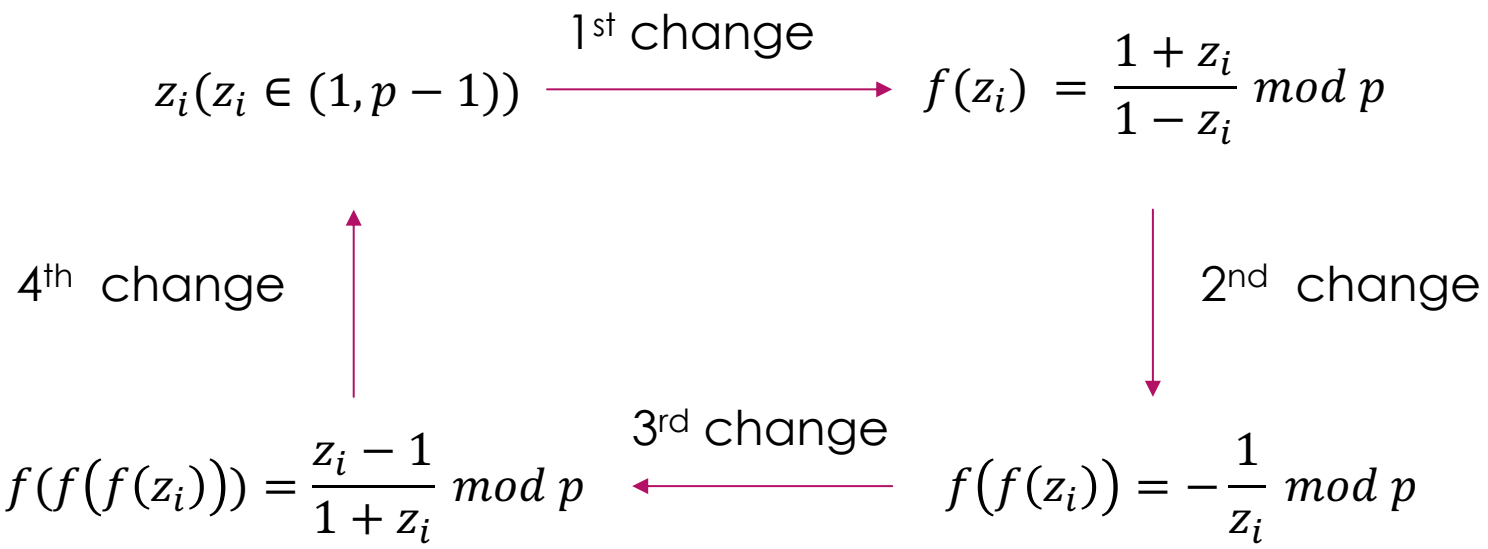


next



Sample Output
4

Hint


$z_i(z_i \in (1, p-1))$
1st change
$f(z_i) = \frac{1+z_i}{1-z_i} \; mod \; p$
2nd change
$f(f(z_i)) = -\frac{1}{z_i} \; mod \; p$
3rd change
$f(f(f(z_i))) = \frac{z_i - 1}{1+z_i} \; mod \; p$
4th change