460. LFU Cache

Hard 3284 212 Add to List Share

Design and implement a data structure for a Least Frequently Used (LFU) cache.

Implement the `LFUCache` class:

- `LFUCache(int capacity)` Initializes the object with the `capacity` of the data structure.
- `int get(int key)` Gets the value of the `key` if the `key` exists in the cache. Otherwise, returns `-1`.
- `void put(int key, int value)` Update the value of the `key` if present, or inserts the `key` if not already present. When the cache reaches its `capacity`, it should invalidate and remove the **least frequently used** key before inserting a new item. For this problem, when there is a **tie** (i.e., two or more keys with the same frequency), the **least recently used** `key` would be invalidated.

To determine the least frequently used key, a **use counter** is maintained for each key in the cache. The key with the smallest **use counter** is the least frequently used key.

When a key is first inserted into the cache, its **use counter** is set to `1` (due to the `put` operation). The **use counter** for a key in the cache is incremented either a `get` or `put` operation is called on it.

The functions `get` and `put` must each run in `O(1)` average time complexity.

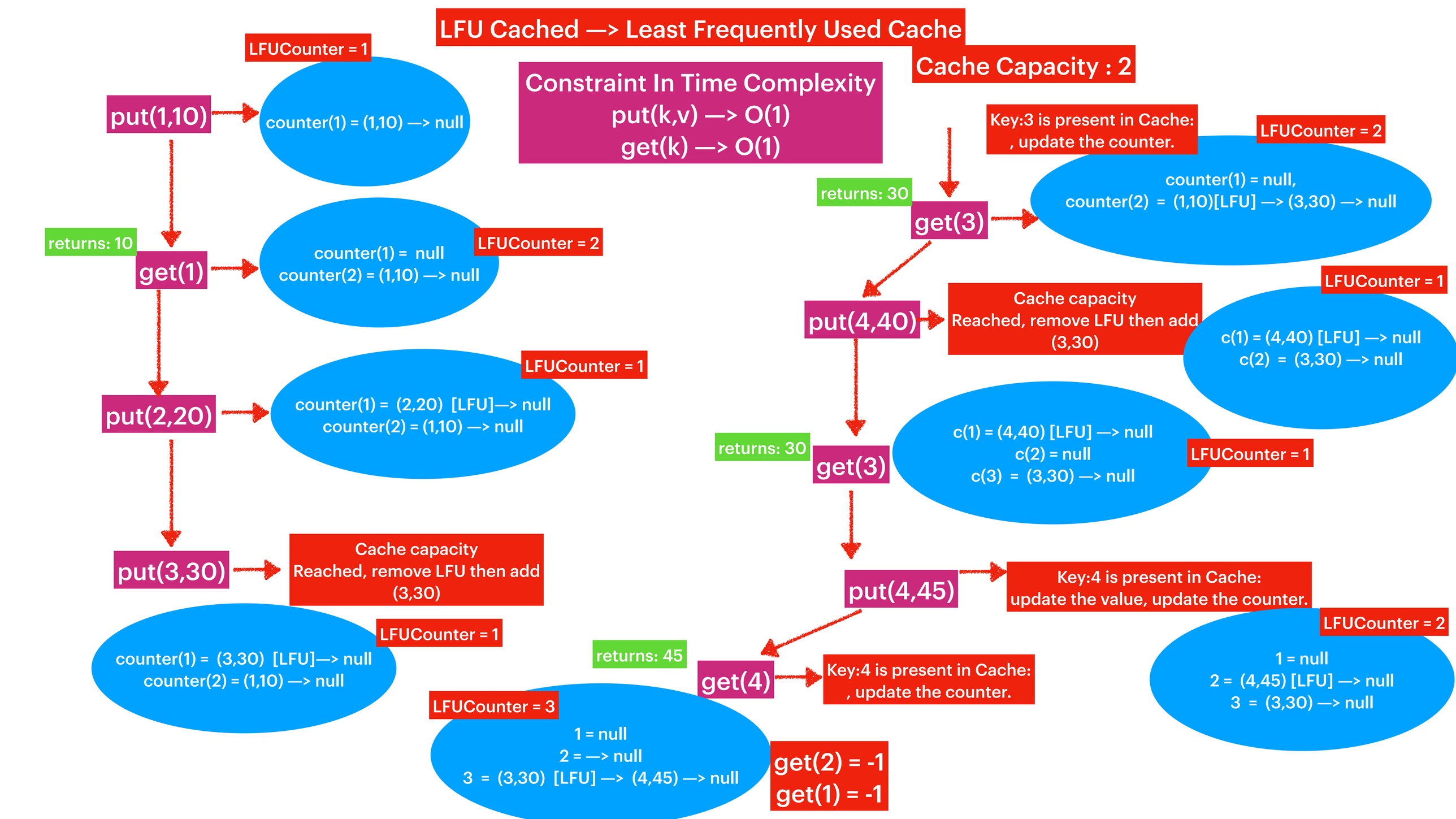
Constraints:

- $0 <= capacity <= 10^4$
- $0 <= key <= 10^5$
- $0 <= value <= 10^9$
- At most $2 * 10^5$ calls will be made to `get` and `put`.

Example 1:

```
Input
["LFUCache", "put", "put", "get", "put", "get", "get", "put", "get",
"get", "get"]
[[2], [1, 1], [2, 2], [1], [3, 3], [2], [3], [4, 4], [1], [3], [4]]
Output
[null, null, null, 1, null, -1, 3, null, -1, 3, 4]

Explanation
// cnt(x) = the use counter for key x
// cache=[] will show the last used order for tiebreakers (leftmost
element is  most recent)
LFUCache lfu = new LFUCache(2);
lfu.put(1, 1);   // cache=[1,_], cnt(1)=1
lfu.put(2, 2);   // cache=[2,1], cnt(2)=1, cnt(1)=1
lfu.get(1);      // return 1
                 // cache=[1,2], cnt(2)=1, cnt(1)=2
lfu.put(3, 3);   // 2 is the LFU key because cnt(2)=1 is the
smallest, invalidate 2.
                 // cache=[3,1], cnt(3)=1, cnt(1)=2
lfu.get(2);      // return -1 (not found)
lfu.get(3);      // return 3
                 // cache=[3,1], cnt(3)=2, cnt(1)=2
lfu.put(4, 4);   // Both 1 and 3 have the same cnt, but 1 is LRU,
invalidate 1.
                 // cache=[4,3], cnt(4)=1, cnt(3)=2
lfu.get(1);      // return -1 (not found)
lfu.get(3);      // return 3
                 // cache=[3,4], cnt(4)=1, cnt(3)=3
lfu.get(4);      // return 4
                 // cache=[4,3], cnt(4)=2, cnt(3)=3
```


LFU Cached —> Least Frequently Used Cache
Cache Capacity : 2
Constraint In Time Complexity
put(k,v) —> O(1)
get(k) —> O(1)
LFUCounter = 1
put(1,10)
counter(1) = (1,10) —> null
returns: 10
get(1)
counter(1) = null
counter(2) = (1,10) —> null
LFUCounter = 2
put(2,20)
counter(1) = (2,20) [LFU]—> null
counter(2) = (1,10) —> null
LFUCounter = 1
put(3,30)
Cache capacity
Reached, remove LFU then add
(3,30)
counter(1) = (3,30) [LFU]—> null
counter(2) = (1,10) —> null
LFUCounter = 1
returns: 45
get(4)
Key:4 is present in Cache:
, update the counter.
LFUCounter = 3
1 = null
2 = —> null
3 = (3,30) [LFU] —> (4,45) —> null
get(2) = -1
get(1) = -1
put(4,45)
Key:4 is present in Cache:
update the value, update the counter.
LFUCounter = 2
1 = null
2 = (4,45) [LFU] —> null
3 = (3,30) —> null
returns: 30
get(3)
c(1) = (4,40) [LFU] —> null
c(2) = null
c(3) = (3,30) —> null
LFUCounter = 1
put(4,40)
Cache capacity
Reached, remove LFU then add
(3,30)
c(1) = (4,40) [LFU] —> null
c(2) = (3,30) —> null
LFUCounter = 1
Key:3 is present in Cache:
, update the counter.
returns: 30
get(3)
counter(1) = null,
counter(2) = (1,10)[LFU] —> (3,30) —> null
LFUCounter = 2