CS213M: Assignment 1
Problem 2: Memory simulation

Due Date: 25/01/2015

The memory of a computer is divided into fixed sized frames, while applications are divided into fixed sized pages such that each page can fit in a frame. However, only a few pages can reside in memory at a given time. A page accessed by an application thus may or may not be present in the memory. If the page is present in the memory, we call it a "HIT" else we call it a "MISS". In case of a miss, we bring the referenced page into the memory. If the memory is already full then we choose a candidate page and replace that with the referenced page.

The Least Frequently Used (LFU) policy replaces the least frequently used page in the memory with the referenced page. The frequency is the number of times a particular page has been referenced since it was brought into memory. If the frequency of two or more pages in the memory is the same, then we choose the candidate using Least Recently Used (LRU) technique to break the tie.

Example 1:
Consider a memory of 3 frames. If the reference string (the order in which the pages are accessed in memory) is 2,5,3,3,3,2,5,6,4,1 and we have processed up to 7th reference at present, pages {3, 2, 5} are in memory. Now, if we refer to 6 there will be a miss as the memory can hold any three pages. Pages 5 and 2 are both referenced 2 times and page 3 is referenced 4 times in the past. Pages 5 and 2 thus have a tie which will be resolved by looking at which was least recently used. As page 5 was referenced more recently than page 2, page 2 will become candidate for replacement. After replacement the contents of the memory will become {3, 6, 5}. Had the frequency been different for all 3 pages then the one with lowest frequency would have become the candidate for replacement.

Example 2:
Consider a memory of 3 frames as shown below.
Let the reference string be 1,1,2,3,7.

```
|_|_|_|3|3|
|_|_|2|2|7|
|1|1|1|1|1|
——time——>
```

At 5th page reference, you will replace either page 3 or page 2 with page 7 since page 1 is not the least frequently used (it has been referenced twice). There is a tie between page 2 and page 3. In the case of tie we will follow LRU technique and replace page 2 with page 7.

Write a program that simulates this policy and prints out the number of hits and misses. Assume that initially the memory is empty. Name the file `mem_sim.cpp`. You may use C++ STL lists if needed for this problem.

Input:
First line will be N, maximum ID of the pages. ($0 < N < 100000$)
Second line will be P, the number of page frames in memory ($0 < P < 100000$)
Third line will be M, the number of page references ($0 < M < 100000$)
Next, M lines will follow, with one integer K on each line, $0 <= K < N$

Output:

First line is the number of hits
Second line is the number of misses