Operating Systems Programming Assignment #5

Page Replacement Simulation: LRU and LFU

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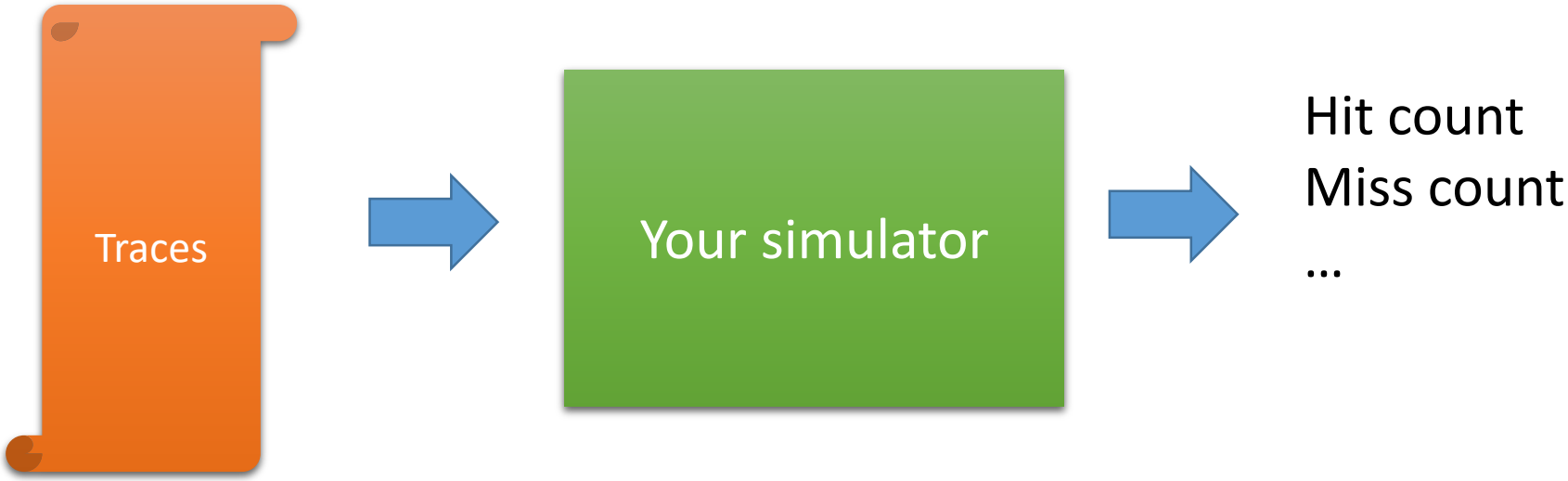
Simulation



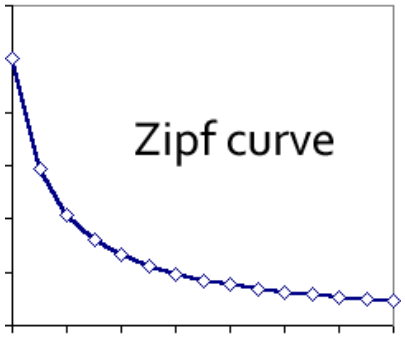
Trace File Format

- Page number of referenced pages

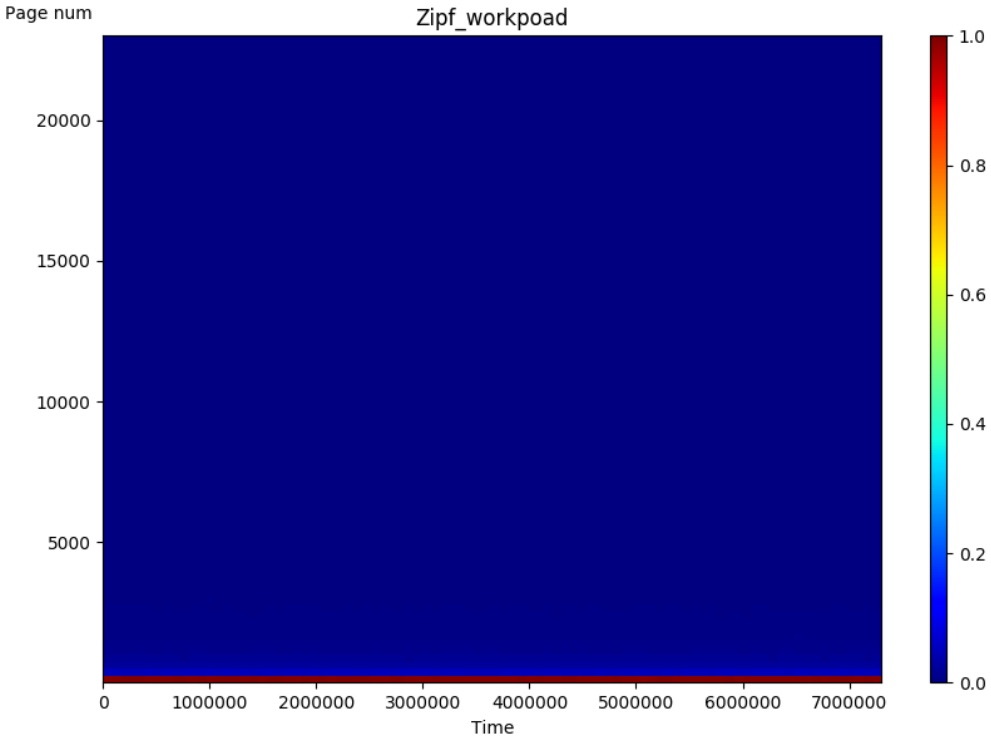
```
1003
1003
9340
1243
1108
1786
1066
1312
1000
1000
1213
1249
2116
```

Unsigned integer

Test Workload (I)

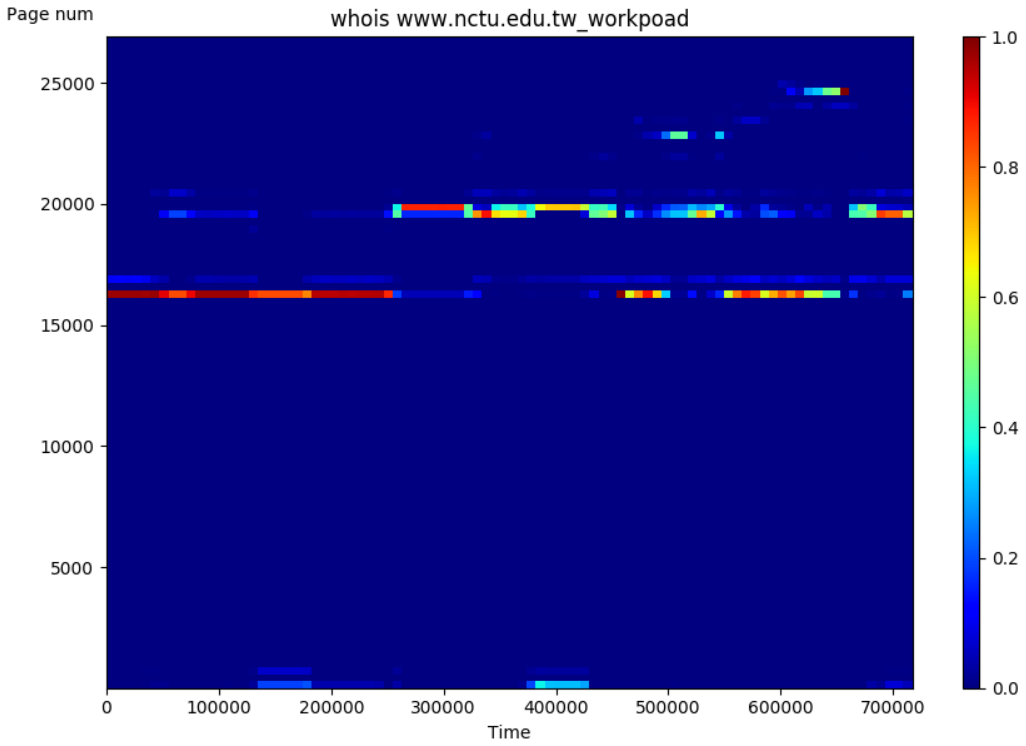


- Zipfian distribution



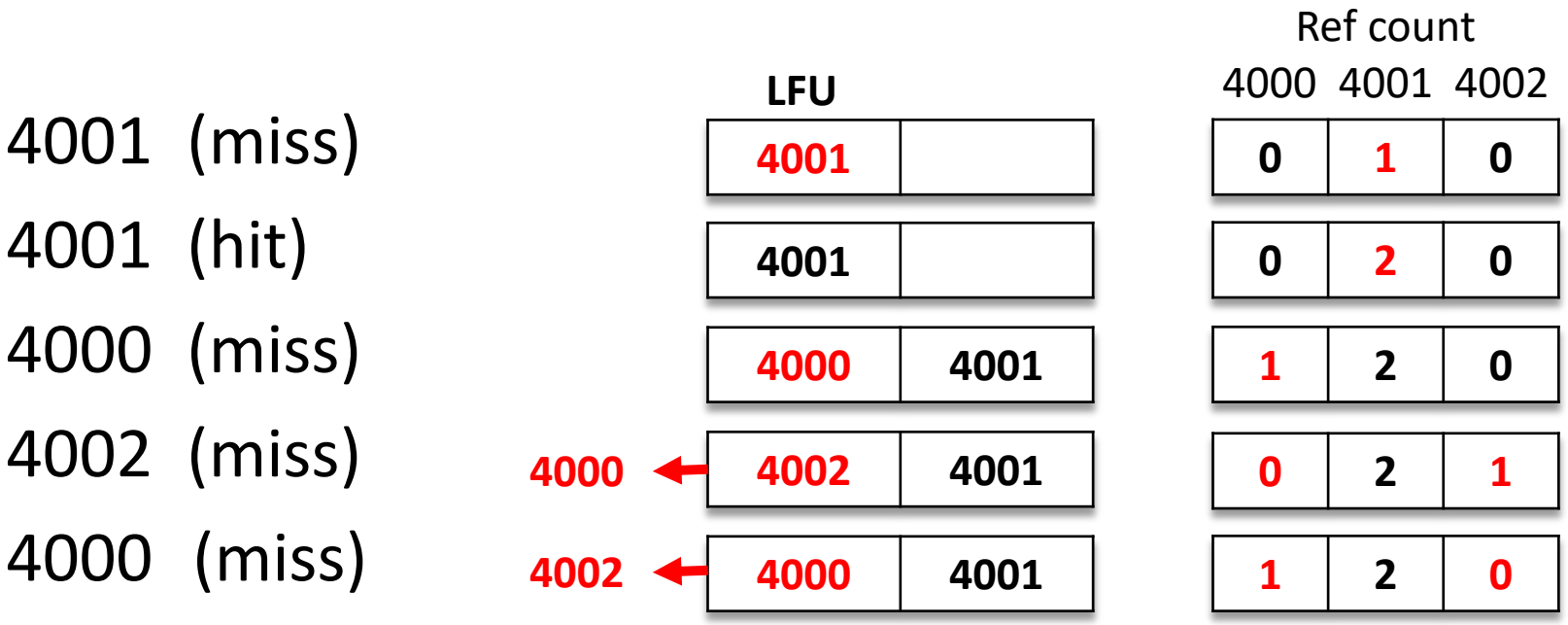
Test Workload (II)

- “whois www.nctu.edu.tw”

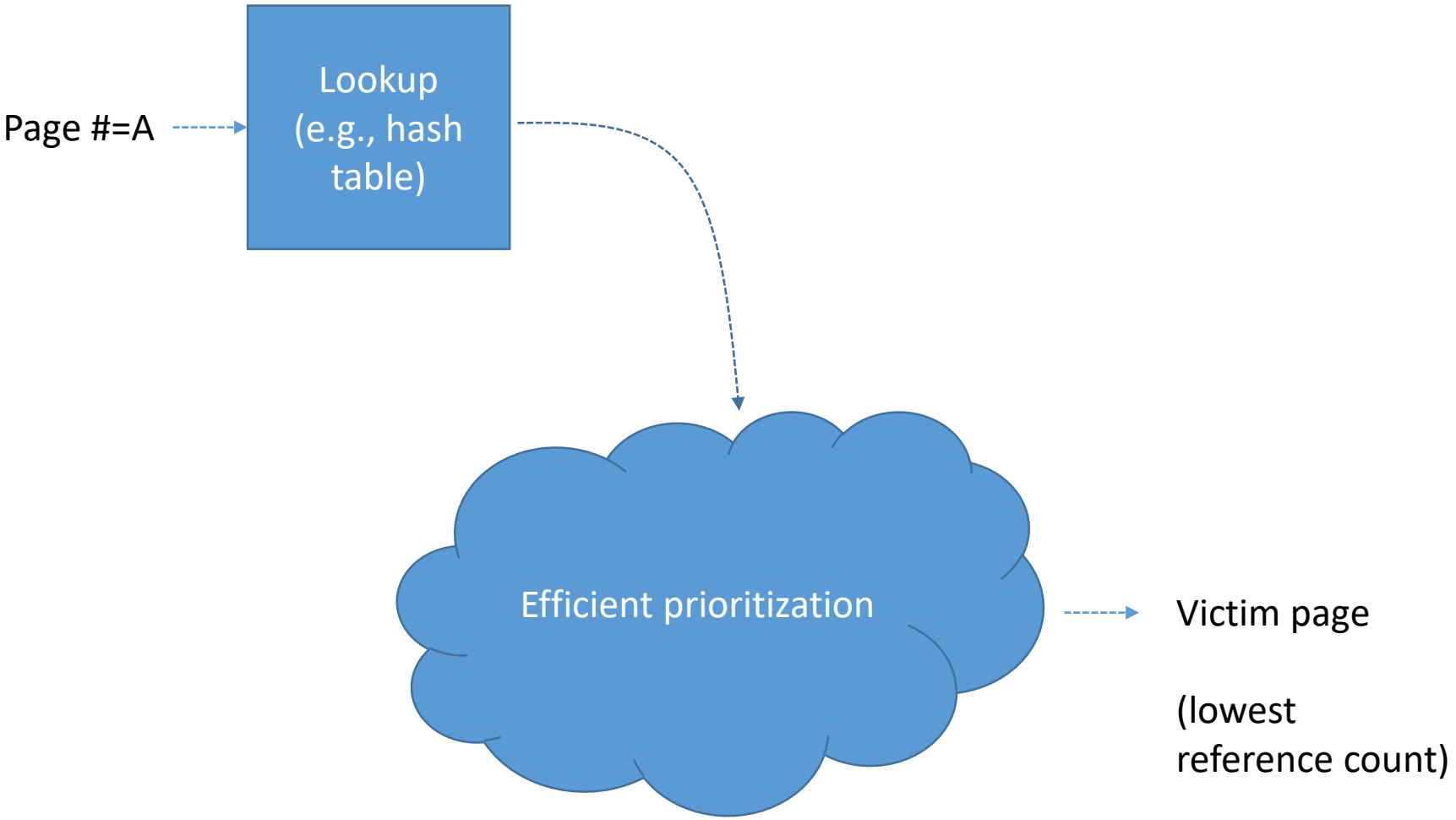


Page Replacement(LFU)

- Example: Frame #=2



Simulator Structure (LFU)



Page Replacement(LRU)

- Example: Frame #=2

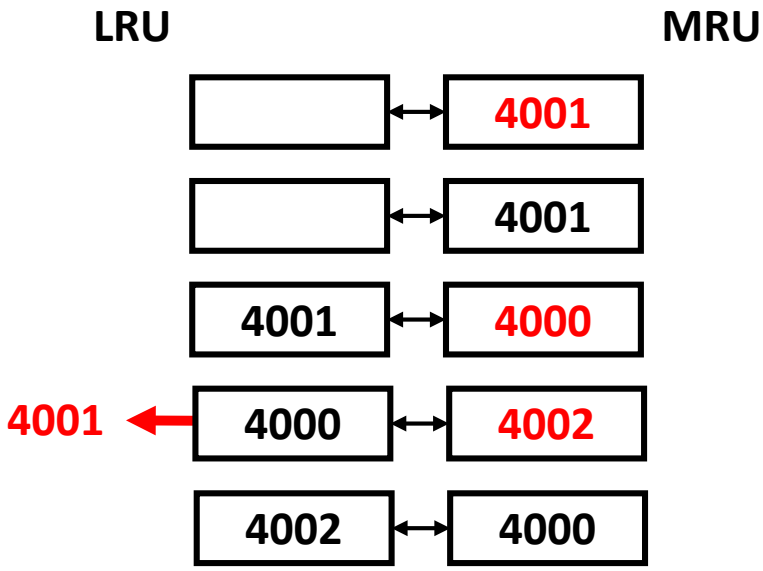
4001 (miss)

4001 (hit)

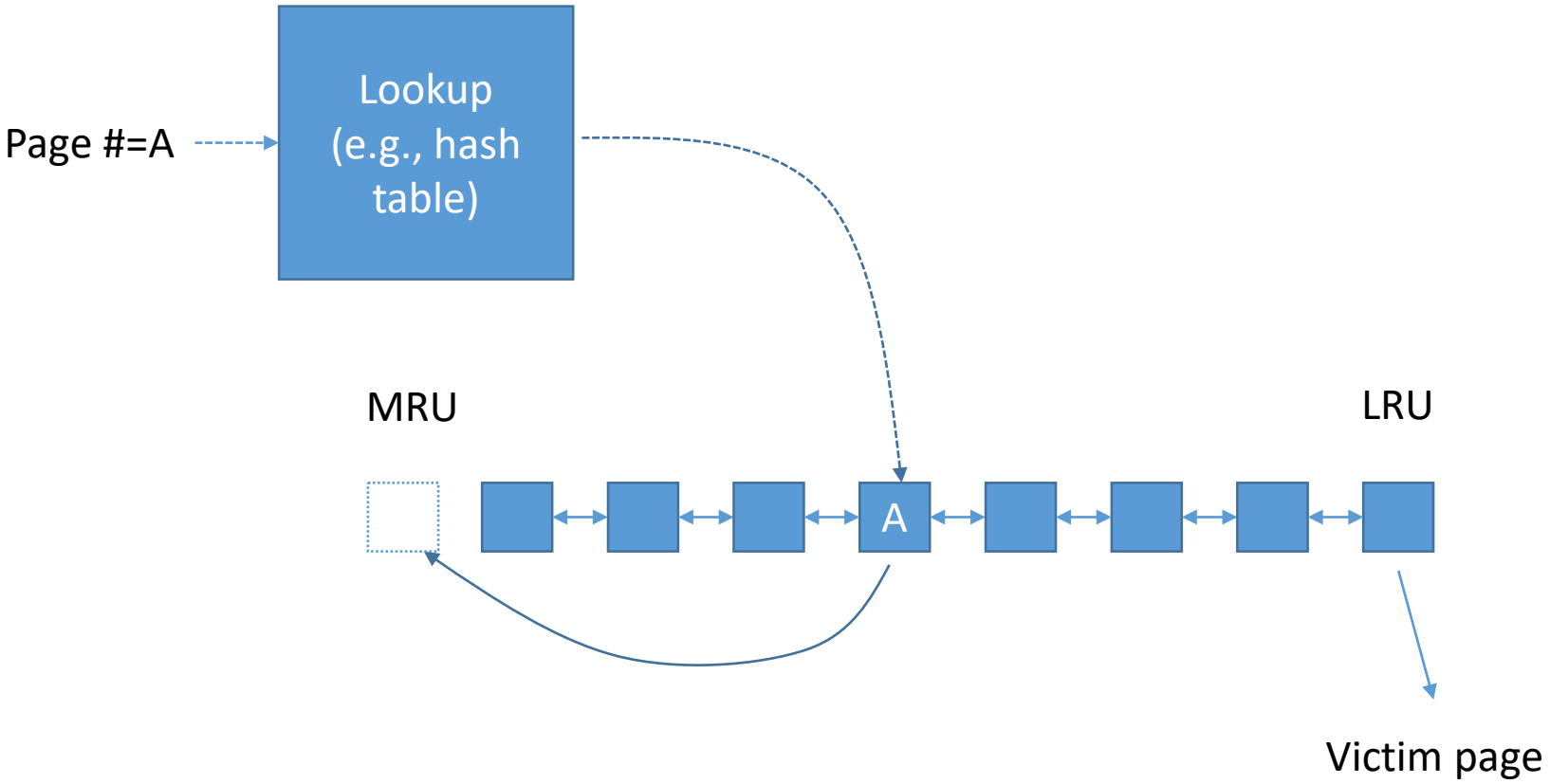
4000 (miss)

4002 (miss)

4000 (hit)



Simulator Structure (LRU)



Page Cache Operations

- Page lookup
  - Check whether or a new reference is a hit or a miss
  - Hash tables, binary search trees, skip lists….

- Do not use linear search!!!
  - You will receive a grade penalty if you do
  - Implement your own search, or reuse any existing libraries/classes for searching
  - TAs will examine your code
  - Duplication in this part does not count

Victim selection

- LFU
  - The least frequently used page
  - If two pages have the same access count, the page having a smaller reference sequence number is replaced
  - You may need to store the reference sequence number when a page is added to the page cache
- LRU
  - The least recently used page

Procedure

1. Algorithm=LFU
2. For (frame # = 64, 128, 256, and 512) do
   - Read the trace file
   - Run simulation
   - Print out the hit count, miss count, page fault ratio
3. Print out the total elapsed time of Step 2

4. Algorithm=LRU
5. For (frame # = 64, 128, 256, and 512) do
   - Read the trace file
   - Run simulation
   - Print out the hit count, miss count, page fault ratio
6. Print out the total elapsed time of Step 5

The scenario of program

Output format

LFU policy: (\n)

Frame	(\t)	Hit	(\t\t)	Miss	(\t\t)	Page fault ratio(\n)
64	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)
128	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)
256	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)
512	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)

Total elapsed time %.4f sec(\n) (\n)

LRU policy: (\n)

Frame	(\t)	Hit	(\t\t)	Miss	(\t\t)	Page fault ratio(\n)
64	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)
128	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)
256	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)
512	(\t)	%d	(\t\t)	%d	(\t\t)	%.10f(\n)

Total elapsed time %.4f sec(\n)

The scenario of program

- Your output should be exactly the same as follows
- Test case : whois www.nctu.edu.tw

```
ubuntu@ubuntu:~/C-project/OS/oshw5$ ./osSummerHW5 ./testcase/whois.txt
LFU policy:
Frame   Hit             Miss            Page fault ratio
64      689115          83143           0.1076622062
128     729104          43154           0.0558802887
256     771124          1134            0.0014684212
512     771921          337             0.0004363827
Total elapsed time 0.1785 sec

LRU policy:
Frame   Hit             Miss            Page fault ratio
64      771056          1202            0.0015564746
128     771663          595             0.0007704679
256     771909          349             0.0004519215
512     771921          337             0.0004363827
Total elapsed time 0.1916 sec
```

- Your output should be exactly the same as follows
- Test case : zipfian

```
ubuntu@ubuntu:~/C-project/OS/oshw5$ ./osSummerHW5 ./testcase/zipf.txt
LFU policy:
Frame     Hit             Miss            Page fault ratio
64        7880135         2119865         0.2119865000
128       8382340         1617660         0.1617660000
256       8807903         1192097         0.1192097000
512       9134227         865773          0.0865773000
Total elapsed time 2.5885 sec

LRU policy:
Frame     Hit             Miss            Page fault ratio
64        7215568         2784432         0.2784432000
128       7880805         2119195         0.2119195000
256       8425224         1574776         0.1574776000
512       8871063         1128937         0.1128937000
Total elapsed time 2.0990 sec
```

Correctness

- The TAs will prepare another workload to validate your implementation
- Except the total elapsed time, your results should be exactly the same as ours
- Do not use linear search in anywhere of your program; otherwise, you will receive a score penalty

More details

- Total request # <= 10 millions
- Max page # == 0xfffff
- The path+file name of the trace file is an argument of your program (see the screen shot), do not hard-coding the pathname of thee trace file
- For each iteration, you should open the file, run the simulation, print the result and close the file
- Do not store the trace data to speed up the next iteration
- Use gettimeofday() to get the total elapsed time

Header of your .c or .cpp

/*

Student No.: <your student id>

Student Name: <your name>

Email: <your email>

SE tag: xnxcxtxuxoxsx

Statement: I am fully aware that this program is not supposed to be posted to a public server, such as a public GitHub repository or a public web page.

*/

Testing OS Environment

- Ubuntu 18.04
- Install as a VM or on a physical machine