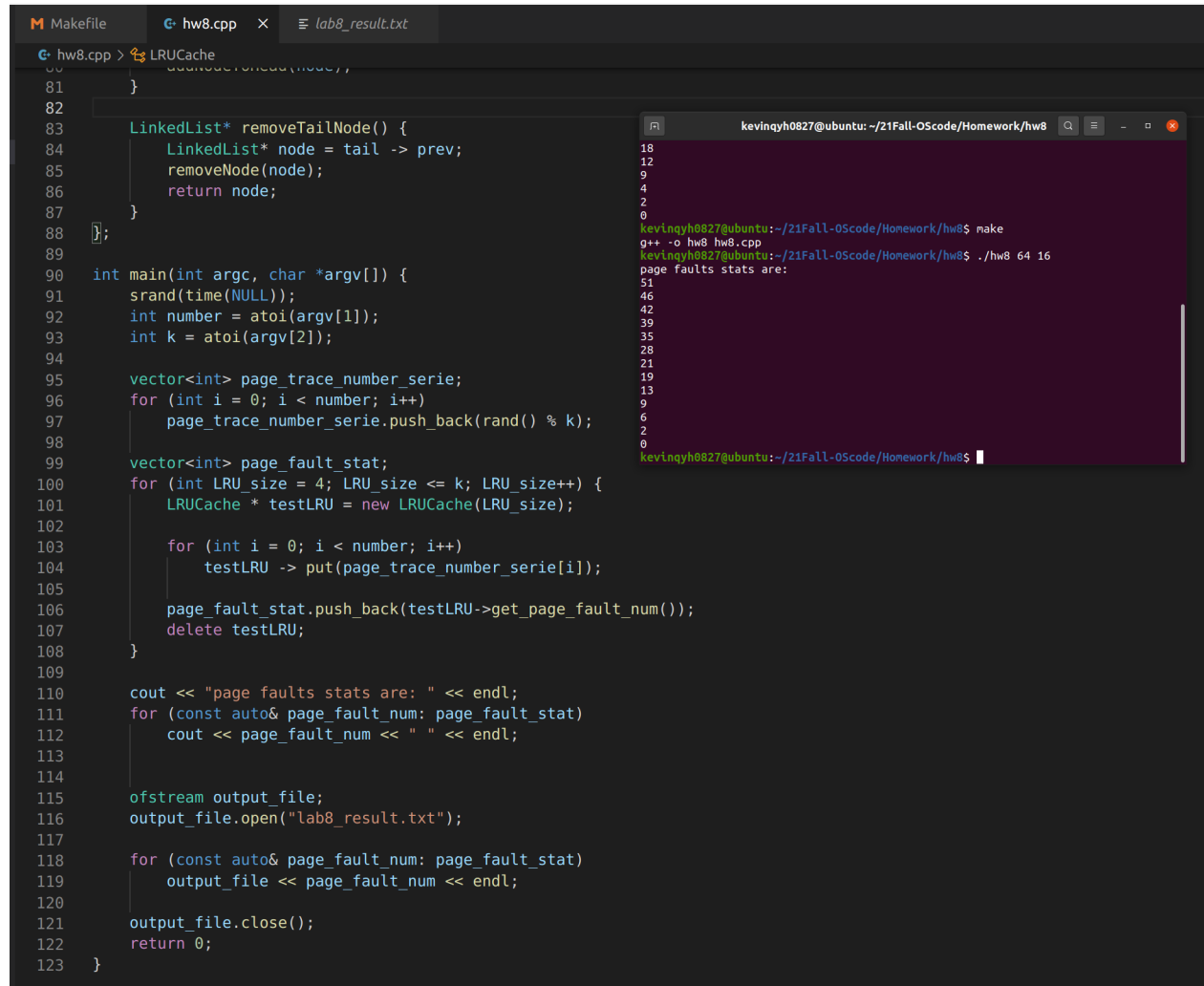


## Problem 1



The screenshot shows a code editor with a C++ file named `hw8.cpp` and a terminal window. The code implements an LRU cache and simulates page faults.

```
80     addNode(node);
81 }
82
83 LinkedList* removeTailNode() {
84     LinkedList* node = tail -> prev;
85     removeNode(node);
86     return node;
87 }
88
89
90 int main(int argc, char *argv[]) {
91     srand(time(NULL));
92     int number = atoi(argv[1]);
93     int k = atoi(argv[2]);
94
95     vector<int> page_trace_number_serier;
96     for (int i = 0; i < number; i++)
97         page_trace_number_serier.push_back(rand() % k);
98
99     vector<int> page_fault_stat;
100     for (int LRU_size = 4; LRU_size <= k; LRU_size++) {
101         LRUCache * testLRU = new LRUCache(LRU_size);
102
103         for (int i = 0; i < number; i++)
104             testLRU -> put(page_trace_number_serier[i]);
105
106         page_fault_stat.push_back(testLRU->get_page_fault_num());
107         delete testLRU;
108     }
109
110     cout << "page faults stats are: " << endl;
111     for (const auto& page_fault_num: page_fault_stat)
112         cout << page_fault_num << " " << endl;
113
114
115     ofstream output_file;
116     output_file.open("lab8_result.txt");
117
118     for (const auto& page_fault_num: page_fault_stat)
119         output_file << page_fault_num << endl;
120
121     output_file.close();
122     return 0;
123 }
```

The terminal window shows the following commands and output:

```
kevinqyh0827@ubuntu: ~/Z1Fall-05code/Homework/hw8
$ make
$ g++ -o hw8 hw8.cpp
$ ./hw8 64 16
page faults stats are:
18
12
9
4
2
0
51
46
42
39
35
28
21
19
13
9
6
2
0
kevinqyh0827@ubuntu:~/Z1Fall-05code/Homework/hw8$
```

Figure 1: Screenshot of command line and files.

Statistics of the number of page faults with the number of the allocated frames is listed below:

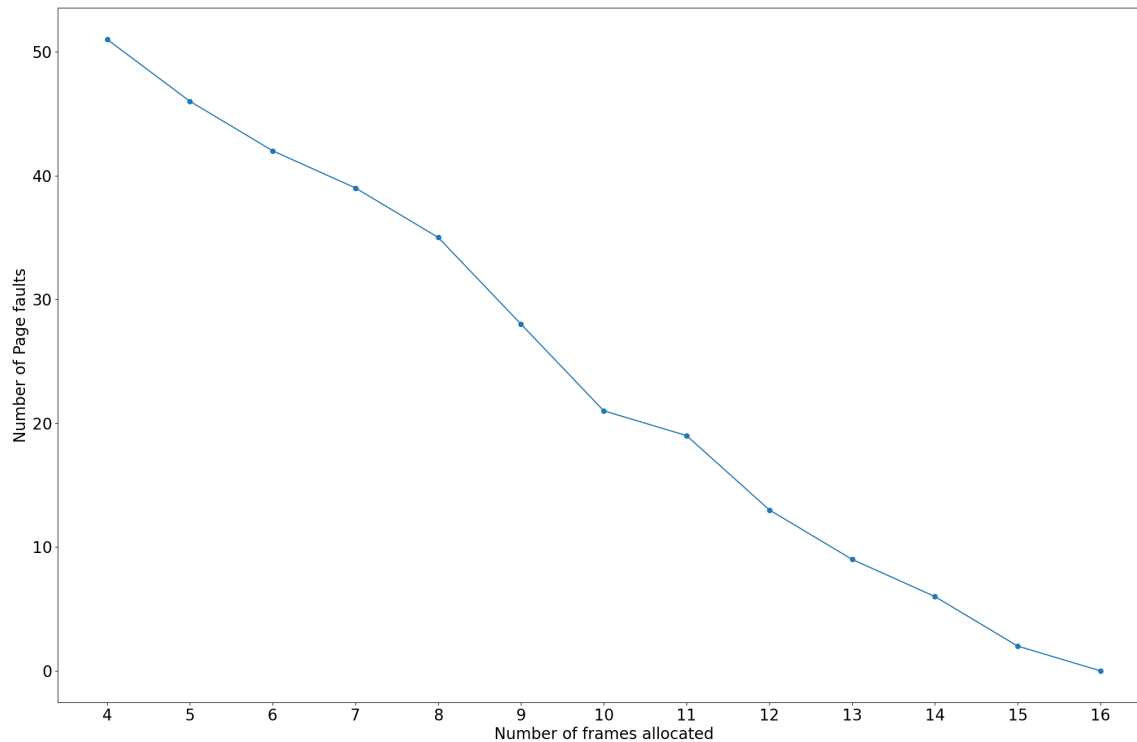


Figure 2: Screenshot of command line and files.

This statistic result cannot exhibit the Belady's anomaly since LRU is a stack algorithms not the FIFO algorithm. In stack algorithms, a set of pages in memory for  $N$  frames is always a subset of the set of pages that would be in memory if  $N + 1$  frames were used. The more the allocated frames, the less the number of page faults is.