

## Review Questions

1) Justin is reconstructing his house and he has a piece of wood with some number of nails on it. A vector `<int> w` is representing the piece of wood and each element is a nail and the value of the element is the height of the nail. Justin has a broken hammer which can only pull up `k` nails to any height he wishes. His objective is to pull up `k` nails such that there are as many nails of the same height as possible. For example, `w = {6, 9, 7, 9, 7, 9}` and `k = 2`, he can pull any 2 of the `{6, 7, 7}` to height 9 so that there are 5 nails of height 9 in total.

Write a function to calculate the maximum number of nails of the same height after justin pull up `k` nails with the hammer. In the previous example, the function should return 5. Assume that `k >= 0`.

```
#include <algorithm>
```

```
#include <vector>
```

```
int sameHeight(const vector<int> &w, int k) {
```

```
}
```

2) The age of Artificial Intelligence has come. There is an evil AI called SkyNut trying to conquer humanity by interrupting network communications. However, due to the lack of research fundings of the developers for SkyNut, it is not very smart. It does not have the ability to change the content of what people send, but it does know how to corrupt different network layers in any one computer or the internet system to interfere network communication. Your job is to identify which network layer it has corrupted in the following scenarios.

- a) When the users enter any website link in the browser, it always redirects to [www.skynutwins.com](http://www.skynutwins.com). Which layers (or layer) did Skynut interrupt? And more specifically, which part of that layer?
  
- b) After part a is fixed, users can now send each other data across the internet. However, once a while, even though the contents the users send are delivered to the correct destination on time, some of the contents would sometime be out of order or missing. Which layers (or layer) did Skynut interrupt? And more specifically, which part of that layer?
  
- c) Again, that previous part is now fixed by our genius UW CSE folks. We found another problem, however. We trace the packages that are sent to various destinations, all of which somehow would route to the Skynut's camping location, regardless of how far or close the destination is from the source. This could potentially be dangerous. Which layers (or layer) did Skynut interrupt?
  
- d) Again, that previous parts are all fixed, and we realize there is one last problem. Sometimes the content of the files are messed up because the bits are randomly flipped. Which layers (or layer) did Skynut interrupt?

3. It's the payday! It's time for UW to pay each of the 333 TAs their monthly salary. Each of the TA's bank account is inside the `bank_accounts[]` array and the person who is in charge of

paying the TAs is a 333 student and decided to use pthreads to pay the TAs by adding 1000 into each bank account. Here is the program the student wrote:

```
// Assume it includes all the necessary libraries and files
const int NUM_TAS = 10;

static int bank_accounts[NUM_TAS];
static pthread_mutex_t sum_lock;

void *thread_main(void *arg) {
    int *TA_index = reinterpret_cast<int*>(arg);

    pthread_mutex_lock(&sum_lock);
    bank_accounts[*TA_index] += 1000;
    pthread_mutex_unlock(&sum_lock);

    delete TA_index;
    return NULL;
}

int main(int argc, char** argv) {
    pthread_t thds[NUM_TAS];
    pthread_mutex_init(&sum_lock, NULL);

    for (int i = 0; i < NUM_TAS; i++) {
        int *num = new int(i);
        if (pthread_create(&thds[i], NULL, &thread_main, num) != 0) {
            /*report error*/
        }
    }

    for (int i = 0; i < NUM_TAS; i++) {
        cout << bank_accounts[i] << endl;
    }

    pthread_mutex_destroy(&sum_lock);
    return 0;
}
```

a) Does the program increase the TAs' bank accounts correctly? Why or why not?

b) Assumes that the all the problems, if any, are now fixed. The student discovers that the program she wrote is kinda slow even though its a multithreaded program. Why might it be the case? And how would you fix that?

4.

a) List some reasons why it's better to use multiple threads within the same process over multiple processes of the same program

b) Which registers will for sure be different between 2 threads that are executing different functions?

c) How does the OS distinguish the threads?