

Question 1. [100 points] Start by executing the following commands in a terminal:

```
wget http://ycpcs.github.io/cs365-spring2015/assign/CS365_Exam02.zip
unzip CS365_Exam02.zip
cd CS365_Exam02
```

Use a text editor to open the file `parhist.c` in the `CS365_Exam02` directory.

Your task is to complete the program so that it uses `pthread`s to compute a histogram of the data values in a large array of `uint16_t` elements. All of the data values are in the range 1..40,000 inclusive. Each bucket of the histogram counts how many values were found in a range containing 4,000 elements. The first bucket counts the number of elements between 1 and 4000 (inclusive), the second counts the number of elements between 4001 and 8000, etc.

To compile the program, run the command `make`. To run the program, use the command `./parhist /usr/local/data/normal.dat`.

This is the expected output of the program on the provided input is:

```
1.. 4000: 0
4001.. 8000: 9
8001..12000: 13201
12001..16000: 1002332
16001..20000: 7348613
20001..24000: 7381198
24001..28000: 1018460
28001..32000: 13394
32001..36000: 9
36001..40000: 0
```

A sequential implementation of the program is provided as `seqhist.c`. (Run it with the command `./seqhist /usr/local/data/normal.dat`.) You may use the sequential code in your implementation of the parallel version of the program (but you don't have to.)

The parallel version of the program (`parhist.c`) should use the number of threads specified by the `NUM_THREADS` constant. This is set to 2, although you should assume that I might test your program with other values.

Hints:

- Store the counts in the `histogram` array
- In the `main` function, `arr` is the array of values, and `num_elements` indicates the number of elements
- **Extremely important:** make sure that multiple threads do not modify the histogram array simultaneously
- If you use a mutex for synchronization, avoid using the mutex in a manner that would cause contention to significantly reduce the efficiency of the computation