CS 421 – Fall 2017
Project #2

100 Points **Due: Tuesday, 10/31/17 at 11:59PM in D2L**

Consider the following concurrency problem: Santa Claus sleeps in his shop up at the North Pole, and can only be wakened by either all nine reindeer being back from their year long vacation on the beaches of some tropical island in the South Pacific, or by some elves who are having some difficulties making the toys. One elf's problem is never serious enough to wake up Santa (otherwise, he may never get any sleep), so, the elves visit Santa in a group of three. When three elves are having their problems solved, any other elves wishing to visit Santa must wait for those elves to return. If Santa wakes up to find three elves waiting at his shop's door, along with the last reindeer having come back from the tropics, Santa decides that the elves can wait until after Christmas, because it is more important to get his sleigh ready as soon as possible. The last reindeer to arrive must wake up Santa while the others wait in a warming hut before being harnessed to the sleigh.

Simulate this problem using the `PThreads` library in C, and locks and condition variables.

Your simulation should have:

- One thread for Santa who either sleeps, delivers presents (for a random amount of time) or helps a group of 3 elves (for a random amount of time).
- Nine threads to model the 9 reindeer who each either deliver presents (for the same random amount of time for the entire group of 9 reindeer and Santa), holiday on a tropical island (for a random amount of time for each reindeer) or wait in the warming shed (until all 9 reindeer arrive).
- Ten threads for 10 elves who either busily work on making toys (for a random amount of time for each elf), wait for help from Santa (waiting to get a quorum of 3, or for Santa to return from delivering presents), get help from Santa (for a random amount of time for the group of 3 elves and Santa), or wait for Santa to finish helping a current group of 3 elves (again, for the random amount of time for that group of 3 elves and Santa; this may also include time spent by that group waiting for Santa to return from delivering presents).

In your simulation:

1. Your program will create all threads on startup and the threads will keep executing, in an infinite loop, until terminated.
2. Each thread should print out a message stating which state it is about to enter, just before it enters that state.
3. Set all random times to vary from `100ms` to `2000ms`. (Define these as constants so I can easily modify them.)
4. In comments at the start of your code, please explain the number of locks, condition variables, and all other concurrency variables that you use, and their purposes so I can follow the logic of your code.

To further ensure I can understand your code, please pay special attention to making it well designed, with variable and function names that are germane to this particular application domain (Locks and condition variables, etc. should be named with respect to what they are modelling). The design must also be modular and well documented. To grade your program, I will have to read the code as well as run it, so please bear this in mind.

Submission

To complete this assignment, simply submit your C code files, along with a make file, zipped up in a single folder, to the D2L submission drop box folder **Project 2** by the deadline specified.