Name: Shreya Palit
Email: palits@oregonstate.edu
Project Name: The Mutex Stack Challenge

CS 575 - Project #3

1. Tell what machine you ran this on

I ran this on the flip server.

2. Tell what operating system you were using

I ran this on the flip server which uses “CentOS Linux”.

3. Tell what compiler you used

I used the GCC compiler to compile this code.

4. Include, in your writeup, the pieces of code where you implemented the mutexes

I have included the mutexes in 2 places in the code.

```
void Push(int n)
{
    if (USE_MUTEX)
    {
        omp_set_lock(&Lock);
        StackPtr++;
        Stack[StackPtr] = n;
        omp_unset_lock(&Lock);
    }
    else
    {
        StackPtr++;
        Stack[StackPtr] = n;
    }
}
```

```
int Pop()
{
    // if the stack is empty, give the Push( ) function a chance to put something on the stack:
    int t = 0;
    while (StackPtr < 0 && t < TIMEOUT)
        t++;

    // if there is nothing to pop, return;
    if (StackPtr < 0)
        return FAILED;

    if (USE_MUTEX)
    {
        omp_set_lock(&Lock);
        int n = Stack[StackPtr];
        StackPtr--;
        omp_unset_lock(&Lock);
        WasPopped[n] = true;
        return n;
    }
    else
    {
        int n = Stack[StackPtr];
        StackPtr--;

        WasPopped[n] = true;
        return n;
    }
}
```

5. Tell us what you discovered by doing this:
    a. Does the non-mutex way of doing this *ever* work? If so, how often?

From the results that I have attached below, it can be seen that when USE_MUTEX is false, NumPopErrors are always greater than 0. This means that the non-mutex way never works.

    b. Does changing NUMN make any difference in the failure percentage?

When we change NUMN, the failure percentage changes too as can be seen in the results attached below. The lowest failure percentage was for NUMN = 1024 at 15.53% whereas the highest failure percentage was for NUMN = 2048 at 43.99%. There isn't a huge difference but the failure percentage does change.

    c. Is there a difference in elapsed execution time between mutex and non-mutex? Why do you suppose this is? (Ignore the very large elapsed times -- these are a result of the TIMEOUT being used up.)

Yes, there is a difference. When USE_MUTEX is false then the elapsed time is only between 115-300 microseconds. On the other hand, when USE_MUTEX is true, the elapsed time is much

longer, ranging between 200-800 microseconds. This can be attributed to the fact that acquiring and releasing a mutex requires some amount of processing time and multiple threads may contend for the mutex, causing them to wait for a longer time.

```
flip2 ~ 1002$ bash script.bash
NUMN =   1024 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    249.99 microseconds
NUMN =   1024 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    202.13 microseconds
NUMN =   1024 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    615.06 microseconds
NUMN =   1024 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    215.95 microseconds
NUMN =   1024 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    219.39 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   318 =  31.05% , Elapsed time =    142.28 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   284 =  27.73% , Elapsed time =    127.48 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   353 =  34.47% , Elapsed time =    137.15 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   332 =  32.42% , Elapsed time =    139.47 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   159 =  15.53% , Elapsed time =    162.74 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   288 =  28.12% , Elapsed time =    115.70 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   293 =  28.61% , Elapsed time =    114.03 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   283 =  27.64% , Elapsed time =    138.64 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   357 =  34.86% , Elapsed time =    225.99 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   175 =  17.09% , Elapsed time =    132.06 microseconds
NUMN =   2048 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    440.48 microseconds
NUMN =   2048 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    459.65 microseconds
NUMN =   2048 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    250.61 microseconds
NUMN =   2048 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    320.74 microseconds
NUMN =   2048 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    272.57 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   530 =  25.88% , Elapsed time =    159.78 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   862 =  42.09% , Elapsed time =    328.23 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   590 =  28.81% , Elapsed time =    143.25 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   505 =  24.66% , Elapsed time =    202.08 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   531 =  25.93% , Elapsed time =    212.70 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   580 =  28.32% , Elapsed time =    186.65 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   576 =  28.12% , Elapsed time =    189.68 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   901 =  43.99% , Elapsed time =    274.73 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   593 =  28.96% , Elapsed time =    195.33 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   631 =  30.81% , Elapsed time =    216.44 microseconds
NUMN =   4096 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    524.16 microseconds
NUMN =   4096 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    765.91 microseconds
NUMN =   4096 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    520.61 microseconds
NUMN =   4096 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    979.94 microseconds
NUMN =   4096 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    555.18 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1700 =  41.50% , Elapsed time =    273.61 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =   662 =  16.16% , Elapsed time =    124.55 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1023 =  24.98% , Elapsed time =    331.22 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1199 =  29.27% , Elapsed time =    459.29 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1063 =  25.95% , Elapsed time =    372.68 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1026 =  25.05% , Elapsed time =    329.47 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =   956 =  23.34% , Elapsed time =    312.64 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1127 =  27.51% , Elapsed time =    336.87 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =   965 =  23.56% , Elapsed time =    286.47 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1071 =  26.15% , Elapsed time =    340.00 microseconds
NUMN =   8192 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1015.35 microseconds
NUMN =   8192 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    851.34 microseconds
NUMN =   8192 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1167.14 microseconds
NUMN =   8192 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1332.54 microseconds
NUMN =   8192 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =    979.13 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2712 =  33.11% , Elapsed time =    435.80 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2656 =  32.42% , Elapsed time =    465.07 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2493 =  30.43% , Elapsed time =    445.39 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2307 =  28.16% , Elapsed time =    791.07 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  1736 =  21.19% , Elapsed time =    447.55 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2801 =  34.19% , Elapsed time =    466.72 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  1861 =  22.72% , Elapsed time =    527.72 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  1571 =  19.18% , Elapsed time =    554.83 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  1632 =  19.92% , Elapsed time =    538.88 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2134 =  26.05% , Elapsed time =    489.65 microseconds
```

```
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2134 =  26.05% , Elapsed time =    489.65 microseconds
NUMN =  16384 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1673.57 microseconds
NUMN =  16384 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1599.84 microseconds
NUMN =  16384 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1914.95 microseconds
NUMN =  16384 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   1677.40 microseconds
NUMN =  16384 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   2033.51 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  4805 =  29.33% , Elapsed time =    775.64 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  4292 =  26.20% , Elapsed time =    946.85 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  3594 =  21.94% , Elapsed time =   1001.85 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  3963 =  24.19% , Elapsed time =    974.68 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  4811 =  29.36% , Elapsed time =    884.33 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  5041 =  30.77% , Elapsed time =   1575.58 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  3776 =  23.05% , Elapsed time =   1376.92 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  4056 =  24.76% , Elapsed time =    940.75 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  4086 =  24.94% , Elapsed time =    893.78 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  2768 =  16.89% , Elapsed time =    774.37 microseconds
NUMN =  32768 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   3284.20 microseconds
NUMN =  32768 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   3344.90 microseconds
NUMN =  32768 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =  11670.39 microseconds
NUMN =  32768 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   3596.46 microseconds
NUMN =  32768 , USE_MUTEX = true , NumPopErrors =     0 =   0.00% , Elapsed time =   3573.89 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  7737 =  23.61% , Elapsed time =   1853.19 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  7561 =  23.07% , Elapsed time =   1984.76 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 13630 =  41.60% , Elapsed time =   3069.29 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  7396 =  22.57% , Elapsed time =   1962.19 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 12436 =  37.95% , Elapsed time =   3605.59 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  7723 =  23.57% , Elapsed time =   1900.06 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  7453 =  22.74% , Elapsed time =   1948.29 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  7137 =  21.78% , Elapsed time =   1953.08 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  8775 =  26.78% , Elapsed time =   1739.56 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  8901 =  27.16% , Elapsed time =   1780.94 microseconds
flip2 ~ 1003$
```