Project Title: The Mutex Stack Challenge

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I compiled and executed my program on the Rabbit server because I am unable to run it locally on my Mac. I uploaded the file to my university network account (using Citrix Workspace, Windows) and accessed it using the Rabbit server (using Mac terminal, ssh), which has access to those files.

In my implementation, I used Mutex in the Push() and Pop() functions. I wrapped the following lines of code with Mutex to ensure thread safety:

Push():

```
    if( USE_MUTEX )
        omp_set_lock( &Lock );
    StackPtr++;
    Stack[StackPtr] = n;
    if( USE_MUTEX )
        omp_unset_lock( &Lock );
```

Pop():

```
    if( USE_MUTEX )
        omp_set_lock( &Lock );
    int n = Stack[StackPtr];
    StackPtr--;
    WasPopped[n] = true;
    if( USE_MUTEX )
        omp_unset_lock( &Lock );
```

In my experience, the non-mutex approach (USE_MUTEX = false) did not work reliably. This is expected because both threads are using the shared variable (StackPtr), which introduces a high risk of data corruption. By locking the code sections where the shared variable is accessed, I can ensure the correct output.

The percentage of PopErrors does not show a significant change as the size of the array increases. According to my output, the percentage of PopErrors varies from 14% to 56%, but I haven't observed a clear correlation with the array size. While the number of PopErrors may increase with the array size, there doesn't seem to be a direct impact on the percentage.

However, the elapsed execution time does exhibit a noticeable difference between the mutex and non-mutex cases. The elapsed time without using mutex is significantly lower compared to using mutex. This is because mutex introduces synchronization mechanisms that cause threads to wait for each other, leading to increased execution time.

Output results after execution:

```
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    719.47 microseconds
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    408.80 microseconds
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    205.13 microseconds
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    327.07 microseconds
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    471.22 microseconds
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    202.19 microseconds
NUMN =   1024 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    646.78 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   368 =  35.94% , Elapsed time =    109.70 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   254 =  24.80% , Elapsed time =    148.78 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   504 =  49.22% , Elapsed time =    179.69 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   370 =  36.13% , Elapsed time =    125.96 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   438 =  42.77% , Elapsed time =    114.12 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   266 =  25.98% , Elapsed time =    171.82 microseconds
NUMN =   1024 , USE_MUTEX = false , NumPopErrors =   263 =  25.68% , Elapsed time =    118.82 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    604.39 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    506.58 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   1361.44 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    634.07 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    549.76 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    595.29 microseconds
NUMN =   2048 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    590.35 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   534 =  26.07% , Elapsed time =    165.76 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   626 =  30.57% , Elapsed time =    131.11 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   632 =  30.86% , Elapsed time =    177.67 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   905 =  44.19% , Elapsed time =    164.86 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   841 =  41.06% , Elapsed time =    274.15 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   688 =  33.59% , Elapsed time =    157.02 microseconds
NUMN =   2048 , USE_MUTEX = false , NumPopErrors =   947 =  46.24% , Elapsed time =    298.34 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    637.67 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    729.98 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   1251.58 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2383.34 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   1297.99 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    799.57 microseconds
NUMN =   4096 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =    817.03 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =   898 =  21.92% , Elapsed time =    211.74 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  2038 =  49.76% , Elapsed time =    455.55 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1376 =  33.59% , Elapsed time =    267.83 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1277 =  31.18% , Elapsed time =    253.74 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1180 =  28.81% , Elapsed time =    261.98 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  2226 =  54.35% , Elapsed time =    444.03 microseconds
NUMN =   4096 , USE_MUTEX = false , NumPopErrors =  1222 =  29.83% , Elapsed time =    200.20 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   1773.17 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2132.18 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   4794.29 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   4145.04 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2184.25 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2089.93 microseconds
NUMN =   8192 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2528.22 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2430 =  29.66% , Elapsed time =    365.99 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  3490 =  42.60% , Elapsed time =   1061.18 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  4026 =  49.15% , Elapsed time =    883.13 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  4258 =  51.98% , Elapsed time = 571320.59 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  3392 =  41.41% , Elapsed time =   1088.92 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2753 =  33.61% , Elapsed time =    437.76 microseconds
NUMN =   8192 , USE_MUTEX = false , NumPopErrors =  2917 =  35.61% , Elapsed time =    855.55 microseconds
NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   4172.07 microseconds
NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   5427.49 microseconds
NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2934.69 microseconds
```

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NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   4154.86 microseconds
NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2796.68 microseconds
NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   2826.96 microseconds
NUMN =  16384 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   3096.71 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  7679 =  46.87% , Elapsed time =   1840.33 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  5015 =  30.61% , Elapsed time =    838.40 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  2613 =  15.95% , Elapsed time =   1331.48 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  9121 =  55.67% , Elapsed time =   1400.82 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  7374 =  45.01% , Elapsed time =   1456.83 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  9147 =  55.83% , Elapsed time =   1632.86 microseconds
NUMN =  16384 , USE_MUTEX = false , NumPopErrors =  4943 =  30.17% , Elapsed time =    731.21 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   8100.18 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   6110.39 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =  18838.34 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   6120.97 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   7995.09 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =  16917.90 microseconds
NUMN =  32768 , USE_MUTEX =  true , NumPopErrors =     0 =   0.00% , Elapsed time =   8601.34 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 15128 =  46.17% , Elapsed time =   2949.45 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 13938 =  42.54% , Elapsed time =   3280.63 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 18488 =  56.42% , Elapsed time =   2786.79 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 17762 =  54.21% , Elapsed time =   2795.52 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors =  4737 =  14.46% , Elapsed time =    520.02 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 16304 =  49.76% , Elapsed time =   1447.12 microseconds
NUMN =  32768 , USE_MUTEX = false , NumPopErrors = 10621 =  32.41% , Elapsed time =   1423.88 microseconds
```