

Homework #5

We had 2 parts for this assignment. The first part had us write two versions of win32 and posix code. One version required us to update our existing posix and win32 code from homework 4 to use a one-dimensional global array to hold all of the character counts. This allows us to increment the same array without using synchronization. The second version required that we protect the increment of the global array using a mutex.

Part 1:

Win32

-First I compiled both programs...

The screenshot shows the Visual Studio IDE with two source files open: `win32.1.race.c` and `win32.1.sync.c`. Both files contain C++ code for a program that counts the frequency of ASCII characters in a file. The `win32.1.race.c` file uses a mutex for synchronization, while `win32.1.sync.c` does not. A Visual Studio Command Prompt window is open in the foreground, showing the compilation and execution of the programs. The command prompt shows the following commands and output:

```

C:\Program Files (x86)\Microsoft Visual Studio 12.0>cd C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>cl win32.1.race.c
Microsoft (R) C/C++ Optimizing Compiler Version 18.00.31101 for x86
Copyright (C) Microsoft Corporation. All rights reserved.

win32.1.race.c
c:\users\eric\documents\codeblocks\project 4 without synchronization\win32.1.race.exe
Microsoft (R) Incremental Linker Version 12.00.31101.0
Copyright (C) Microsoft Corporation. All rights reserved.

/out:win32.1.race.exe
win32.1.race.obj
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>cl win32.1.sync.c
Microsoft (R) C/C++ Optimizing Compiler Version 18.00.31101 for x86
Copyright (C) Microsoft Corporation. All rights reserved.

win32.1.sync.c
c:\users\eric\documents\codeblocks\project 4 without synchronization\win32.1.sync.exe
Microsoft (R) Incremental Linker Version 12.00.31101.0
Copyright (C) Microsoft Corporation. All rights reserved.

/out:win32.1.sync.exe
win32.1.sync.obj
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>
  
```

-Next I executed the two programs using the same test.txt file. The test file has random input as well as website source code to see a difference in counts...

(win32.1.race.c)

```
Visual Studio Command Prompt
72 occurrences of H
116 occurrences of I
53 occurrences of J
86 occurrences of K
75 occurrences of L
103 occurrences of M
74 occurrences of N
135 occurrences of O
62 occurrences of P
60 occurrences of Q
73 occurrences of R
124 occurrences of S
96 occurrences of T
57 occurrences of U
39 occurrences of V
57 occurrences of W
29 occurrences of X
40 occurrences of Y
32 occurrences of Z
547 occurrences of [
3741 occurrences of \
545 occurrences of ^
59 occurrences of _
1107 occurrences of `
2 occurrences of {
2577 occurrences of a
1032 occurrences of b
1937 occurrences of c
2458 occurrences of d
2393 occurrences of e
818 occurrences of f
914 occurrences of g
680 occurrences of h
1728 occurrences of i
81 occurrences of j
204 occurrences of k
1398 occurrences of l
584 occurrences of m
1796 occurrences of n
1554 occurrences of o
939 occurrences of p
102 occurrences of q
1564 occurrences of r
2043 occurrences of s
2010 occurrences of t
946 occurrences of u
581 occurrences of v
405 occurrences of w
2630 occurrences of x
844 occurrences of y
85 occurrences of z
353 occurrences of <
204 occurrences of !
355 occurrences of >
0 occurrences of ~
0 occurrences of 0x7f
```

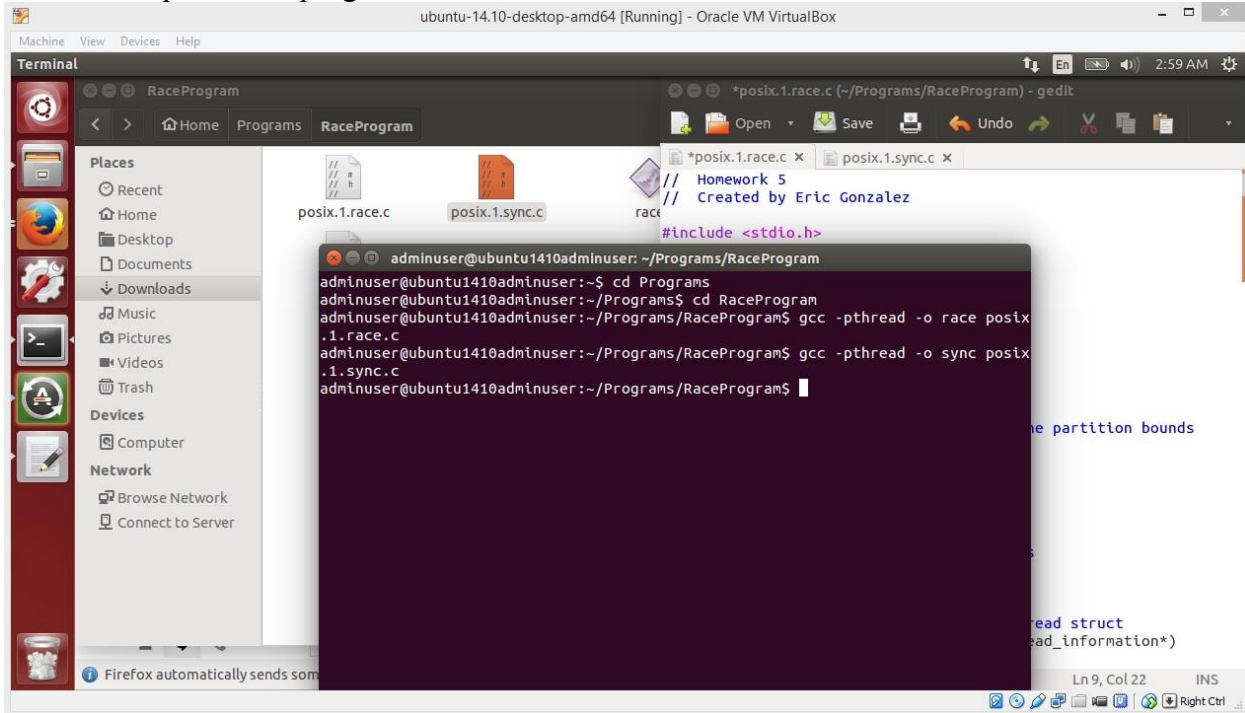
(win32.1.sync.c)

```
Visual Studio Command Prompt - win32.1.sync.exe test.txt
72 occurrences of H
117 occurrences of I
55 occurrences of J
86 occurrences of K
75 occurrences of L
103 occurrences of M
74 occurrences of N
135 occurrences of O
62 occurrences of P
61 occurrences of Q
73 occurrences of R
124 occurrences of S
96 occurrences of T
57 occurrences of U
39 occurrences of V
57 occurrences of W
29 occurrences of X
40 occurrences of Y
32 occurrences of Z
555 occurrences of [
3892 occurrences of \
550 occurrences of ^
59 occurrences of _
1141 occurrences of `
2 occurrences of {
2835 occurrences of a
1077 occurrences of b
2087 occurrences of c
2645 occurrences of d
2631 occurrences of e
846 occurrences of f
1077 occurrences of g
713 occurrences of h
1895 occurrences of i
81 occurrences of j
208 occurrences of k
1472 occurrences of l
626 occurrences of m
1929 occurrences of n
1672 occurrences of o
986 occurrences of p
102 occurrences of q
1682 occurrences of r
2159 occurrences of s
2258 occurrences of t
930 occurrences of u
594 occurrences of v
414 occurrences of w
2801 occurrences of x
853 occurrences of y
86 occurrences of z
356 occurrences of <
206 occurrences of !
355 occurrences of >
0 occurrences of ~
0 occurrences of 0x7f
```

-When comparing the counts you can see that *win32.1.sync.c* has larger numbers than *win32.1.race.c*, its clearly seen in the sample results I boxed. This is the case because in *win32.1.sync.c* we use a mutex, meaning we ensure that no two concurrent processes are in their critical condition at the same time therefore preventing race conditions, something we see in *win32.1.race.c* because the output is dependent on the sequence or timing of other uncontrollable events, in our case essentially counting the wrong number of occurrences of a certain ASCII character.

Posix

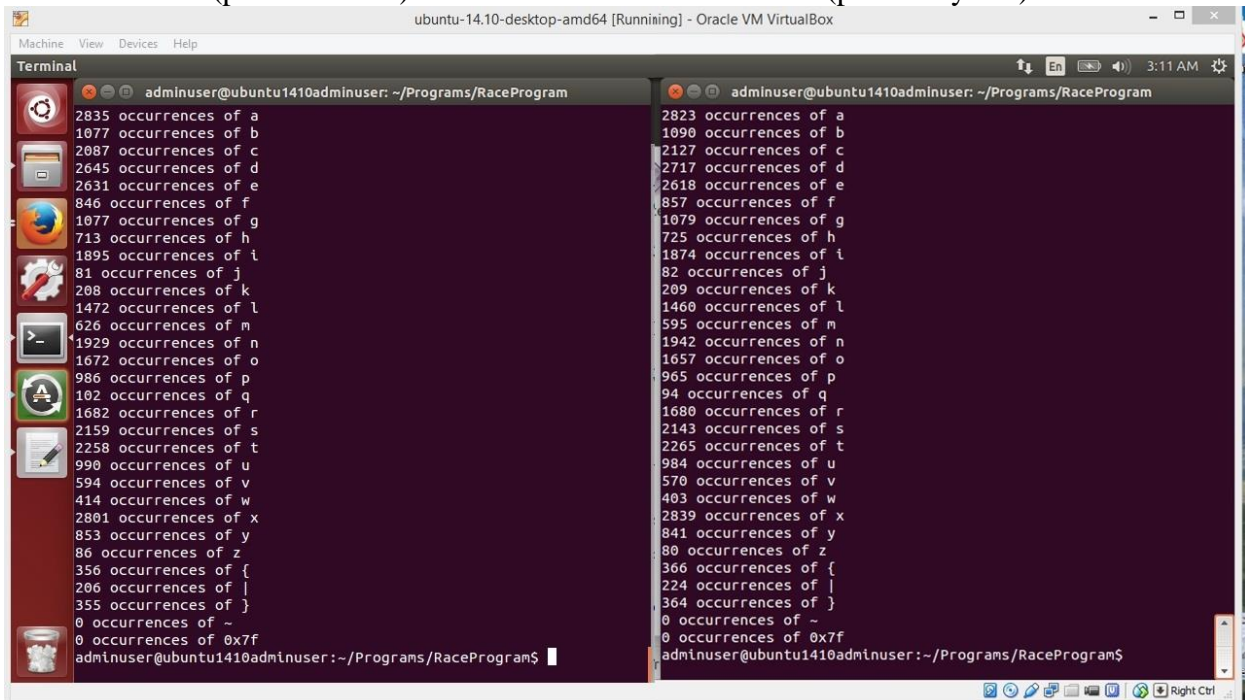
- First I compiled both programs...



-Next I executed them using the same test.txt file I used for win32...

(posix.1.race.c)

(posix.1.sync.c)

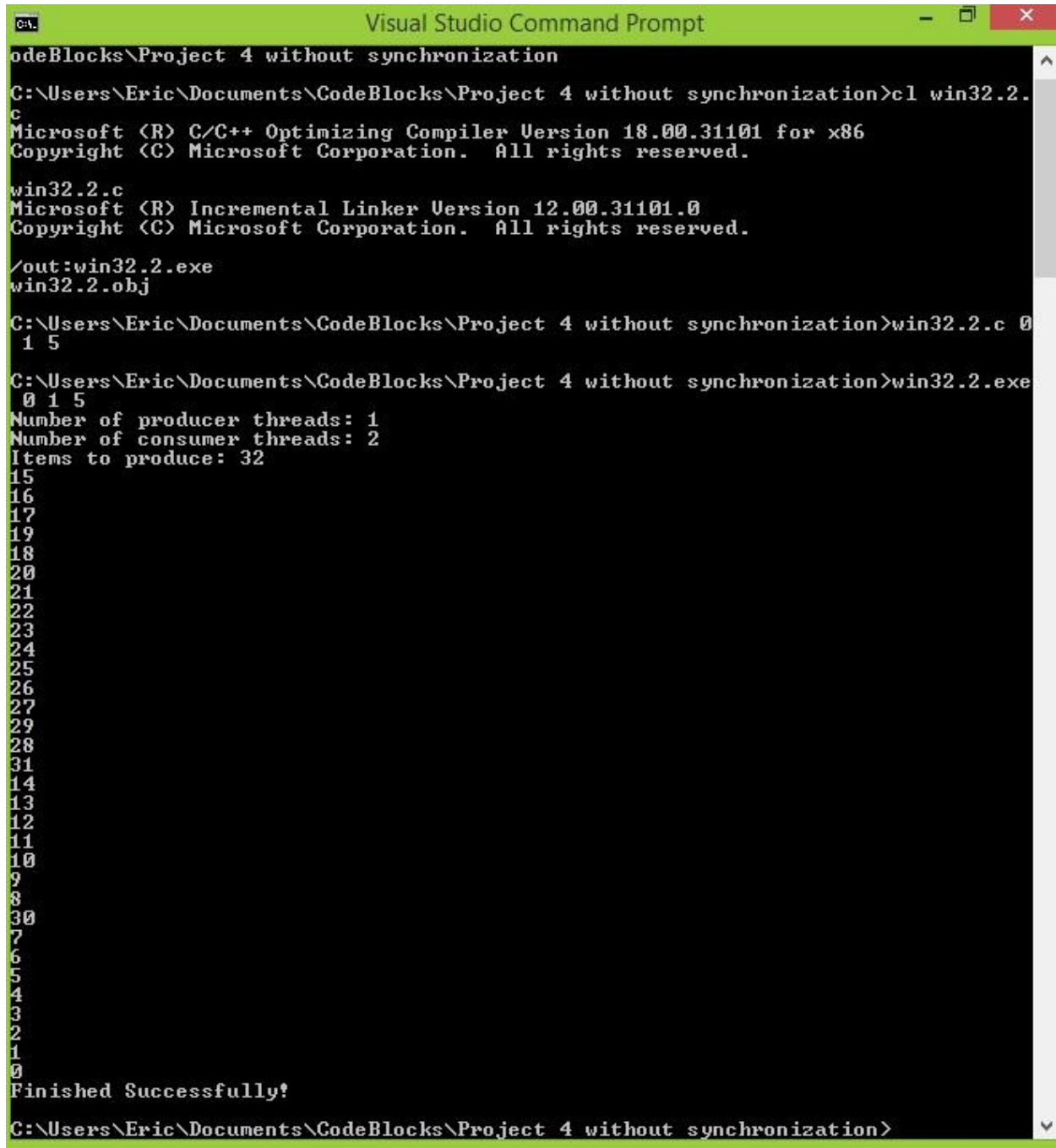


-When comparing the counts you can see that *posix.1.sync.c* has larger numbers than *posix.1.race.c*. Should be the same explanation I gave above for the win32 case.

Part 2:

Win32

-First I compiled the program then executed with 1 producer, 2 consumer, and 32 items to produce...



```
odeBlocks\Project 4 without synchronization
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>cl win32.2.c
Microsoft (R) C/C++ Optimizing Compiler Version 18.00.31101 for x86
Copyright (C) Microsoft Corporation. All rights reserved.

win32.2.c
Microsoft (R) Incremental Linker Version 12.00.31101.0
Copyright (C) Microsoft Corporation. All rights reserved.

/out:win32.2.exe
win32.2.obj
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>win32.2.c 0
1 5
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>win32.2.exe
0 1 5
Number of producer threads: 1
Number of consumer threads: 2
Items to produce: 32
15
16
17
19
18
20
21
22
23
24
25
26
27
29
28
31
14
13
12
11
10
9
8
30
7
6
5
4
3
2
1
0
Finished Successfully!
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>
```

-then executed the program with 2 producers, 1 consumer and 32 items to produce...

```
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>win32.2.exe
1 0 5
Number of producer threads: 2
Number of consumer threads: 1
Items to produce: 32
17
1
31
2
3
4
5
6
7
8
9
10
11
12
13
14
15
30
29
28
27
26
25
24
23
22
21
20
19
18
16
0
Finished Successfully!
```

-then again executed the program with 2 producers, 4 consumers and 32 items to produce...

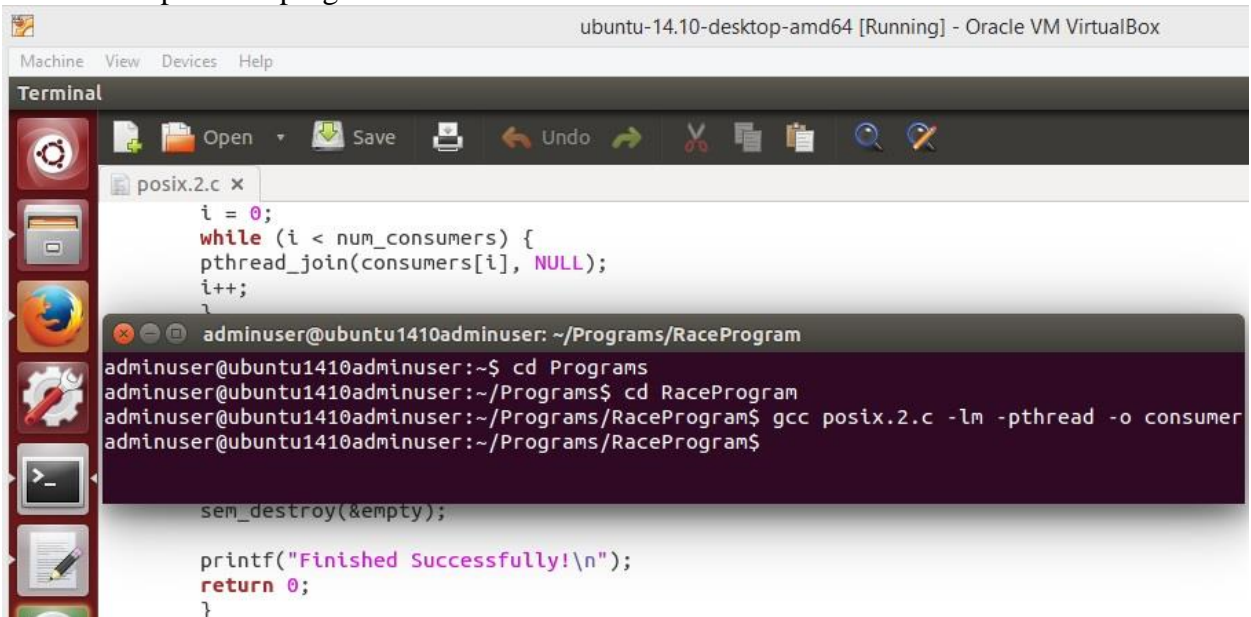
```
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>win32.2.exe
1 2 5
Number of producer threads: 2
Number of consumer threads: 4
Items to produce: 32
19
31
1
5
3
7
2
9
10
11
12
13
14
15
4
30
29
28
27
26
25
8
24
23
22
21
20
6
18
17
16
0
Finished Successfully!
```


-then finally executed the program with 4 consumers, 2 producers and 32 items to produce...

```
C:\Users\Eric\Documents\CodeBlocks\Project 4 without synchronization>win32.2.exe
2 1 5
Number of producer threads: 4
Number of consumer threads: 2
Items to produce: 32
15
16
24
25
18
26
19
27
17
20
21
29
22
30
23
28
14
13
12
11
10
9
31
7
8
6
5
4
3
2
1
0
Finished Successfully!
```

Posix

- First I compiled the program



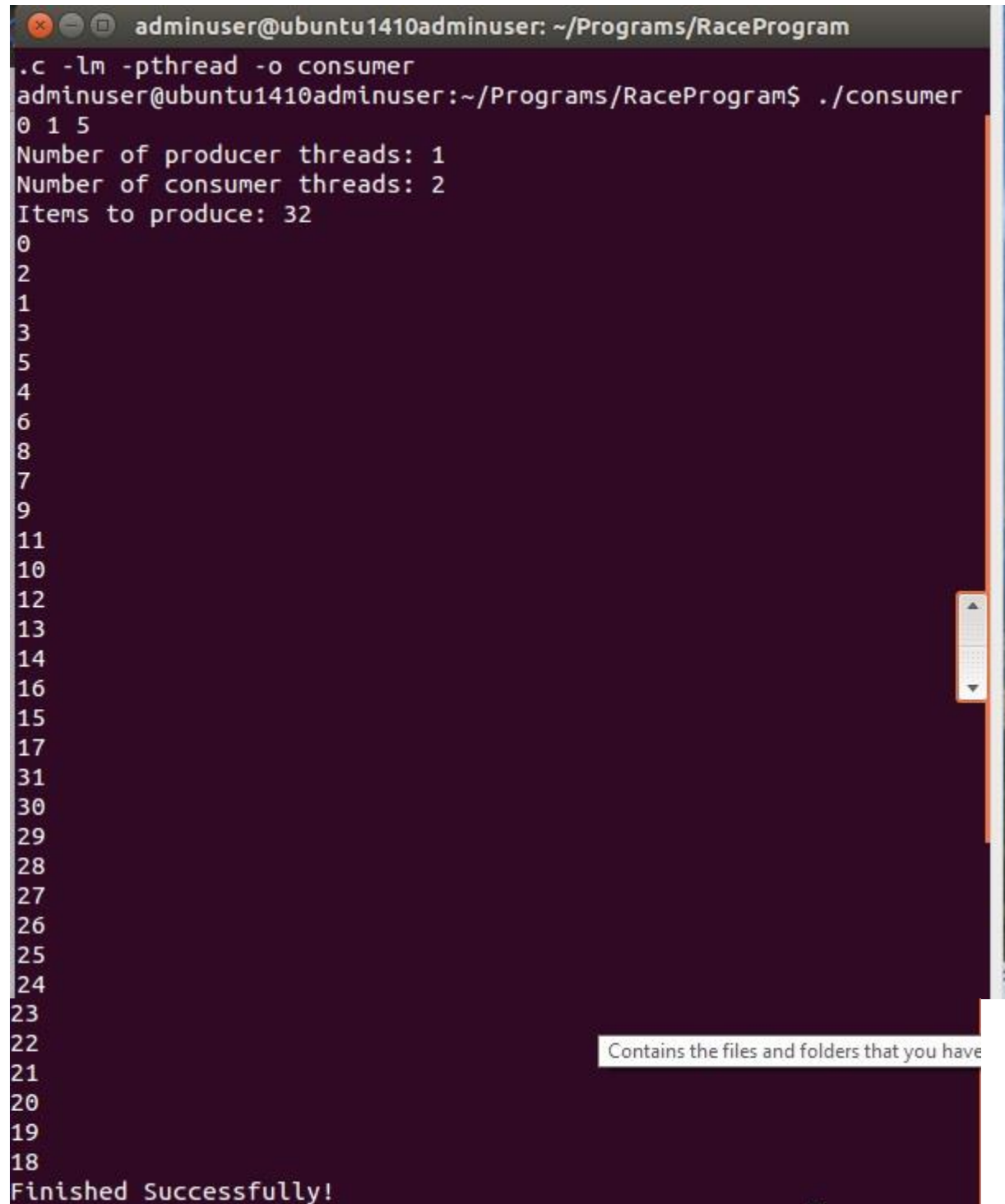
The screenshot shows a terminal window titled "ubuntu-14.10-desktop-amd64 [Running] - Oracle VM VirtualBox". The terminal displays the following commands and output:

```
adminuser@ubuntu1410adminuser: ~/Programs/RaceProgram
adminuser@ubuntu1410adminuser:~$ cd Programs
adminuser@ubuntu1410adminuser:~/Programs$ cd RaceProgram
adminuser@ubuntu1410adminuser:~/Programs/RaceProgram$ gcc posix.2.c -ln -pthread -o consumer
adminuser@ubuntu1410adminuser:~/Programs/RaceProgram$
```

The output of the program is shown in the background, matching the output from the first image:

```
2 1 5
Number of producer threads: 4
Number of consumer threads: 2
Items to produce: 32
15
16
24
25
18
26
19
27
17
20
21
29
22
30
23
28
14
13
12
11
10
9
31
7
8
6
5
4
3
2
1
0
Finished Successfully!
```

-then I executed the program with 1 producer, 2 consumer, and 32 items to produce...

A terminal window titled 'adminuser@ubuntu1410adminuser: ~/Programs/RaceProgram'. The window shows the compilation of a C program with pthread support and its execution. The program outputs the number of producer and consumer threads, the number of items to produce, and a sequence of numbers from 0 to 31. The terminal has a dark purple background and a scrollbar on the right side.

```
adminuser@ubuntu1410adminuser: ~/Programs/RaceProgram
.c -lm -pthread -o consumer
adminuser@ubuntu1410adminuser:~/Programs/RaceProgram$ ./consumer
0 1 5
Number of producer threads: 1
Number of consumer threads: 2
Items to produce: 32
0
2
1
3
5
4
6
8
7
9
11
10
12
13
14
16
15
17
31
30
29
28
27
26
25
24
23
22
21
20
19
18
Finished Successfully!
```

-then executed the program with 2 producers, 1 consumer and 32 items to produce...

```
adminuser@ubuntu1410adminuser:~/Programs/RaceProgram$ ./consumer
1 0 5
Number of producer threads: 2
Number of consumer threads: 1
Items to produce: 32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Finished Successfully!
```

Contains the files and folders that you have

-then again executed the program with 2 producers, 4 consumers and 32 items to produce...

```
adminuser@ubuntu1410adminuser:~/Programs/RaceProgram$ ./consumer
1 2 5
Number of producer threads: 2
Number of consumer threads: 4
Items to produce: 32
16
20
19
18
17
31
29
28
27
26
25
24
23
30
21
22
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Finished Successfully!
```

Contains the files and folders that you have

-then finally executed the program with 4 consumers, 2 producers and 32 items to produce...

```
adminuser@ubuntu1410adminuser:~/Programs/RaceProgram$ ./consumer
```

```
2 1 5
```

```
Number of producer threads: 4
```

```
Number of consumer threads: 2
```

```
Items to produce: 32
```

```
31
```

```
30
```

```
29
```

```
28
```

```
27
```

```
25
```

```
24
```

```
26
```

```
23
```

```
22
```

```
21
```

```
20
```

```
19
```

```
17
```

```
16
```

```
18
```

```
15
```

```
13
```

```
14
```

```
12
```

```
11
```

```
10
```

```
9
```

```
8
```

```
0
```

```
1
```

```
2
```

```
3
```

```
4
```

```
5
```

```
6
```

```
7
```

```
Finished Successfully!
```