CSCI 340 Operating Systems Project

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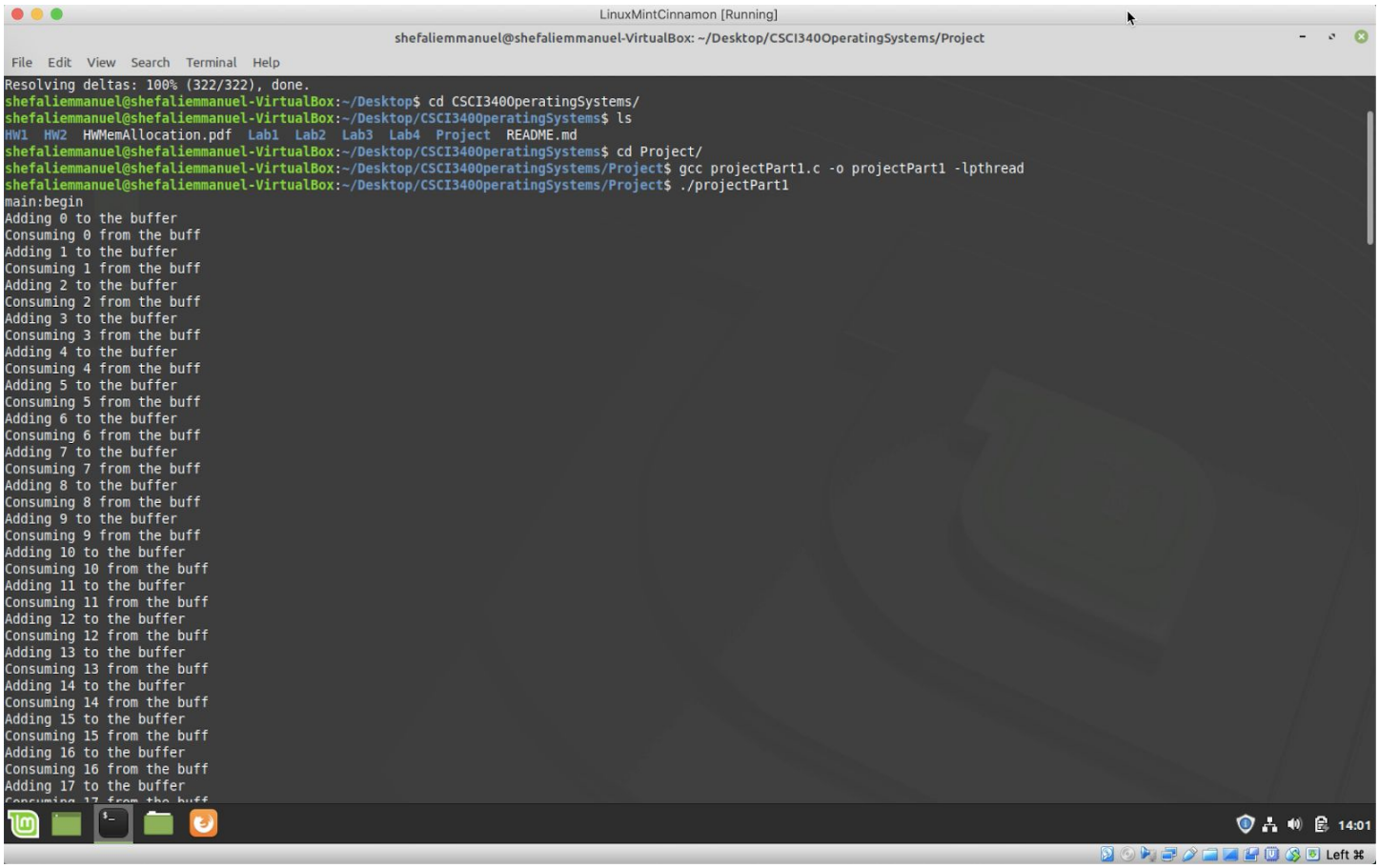
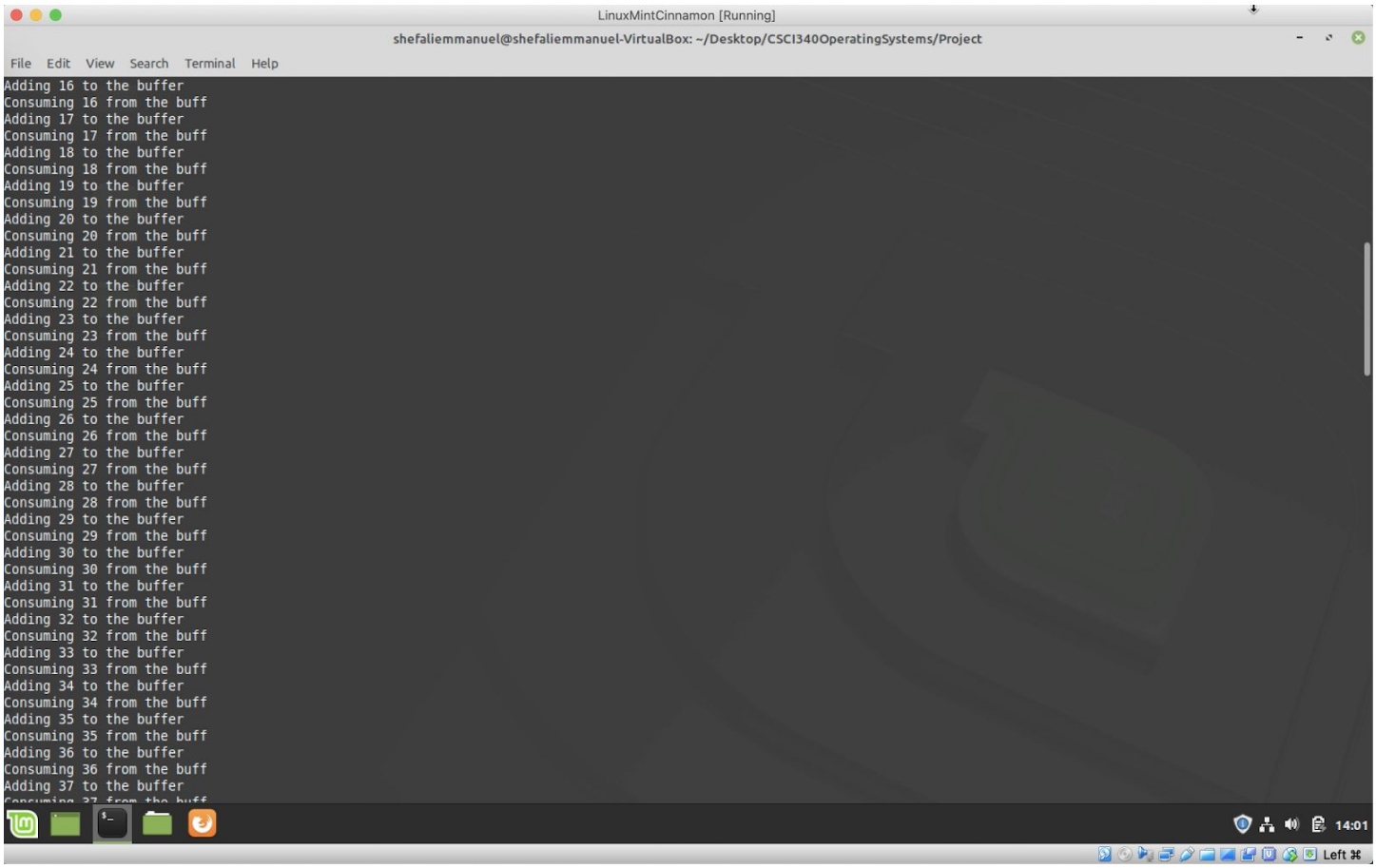
I compiled the program by stating '*gcc filename.c -o filename -lpthread*' followed by '*./filename*' . I found many resources on how to link the pthread library with the program, but I preferred this solution as it was the shortest. I have written the commands for each part below their headers.

Here is a link to my main reference:
https://www.includehelp.com/c-programming-questions/compiling-program-with-pthread-library-linux.aspx
I also referenced various parts of the book and github.

Part 1:

gcc projectPart1.c -o projectPart1 -lpthread
./projectPart1




LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/Desktop/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
Adding 16 to the buffer
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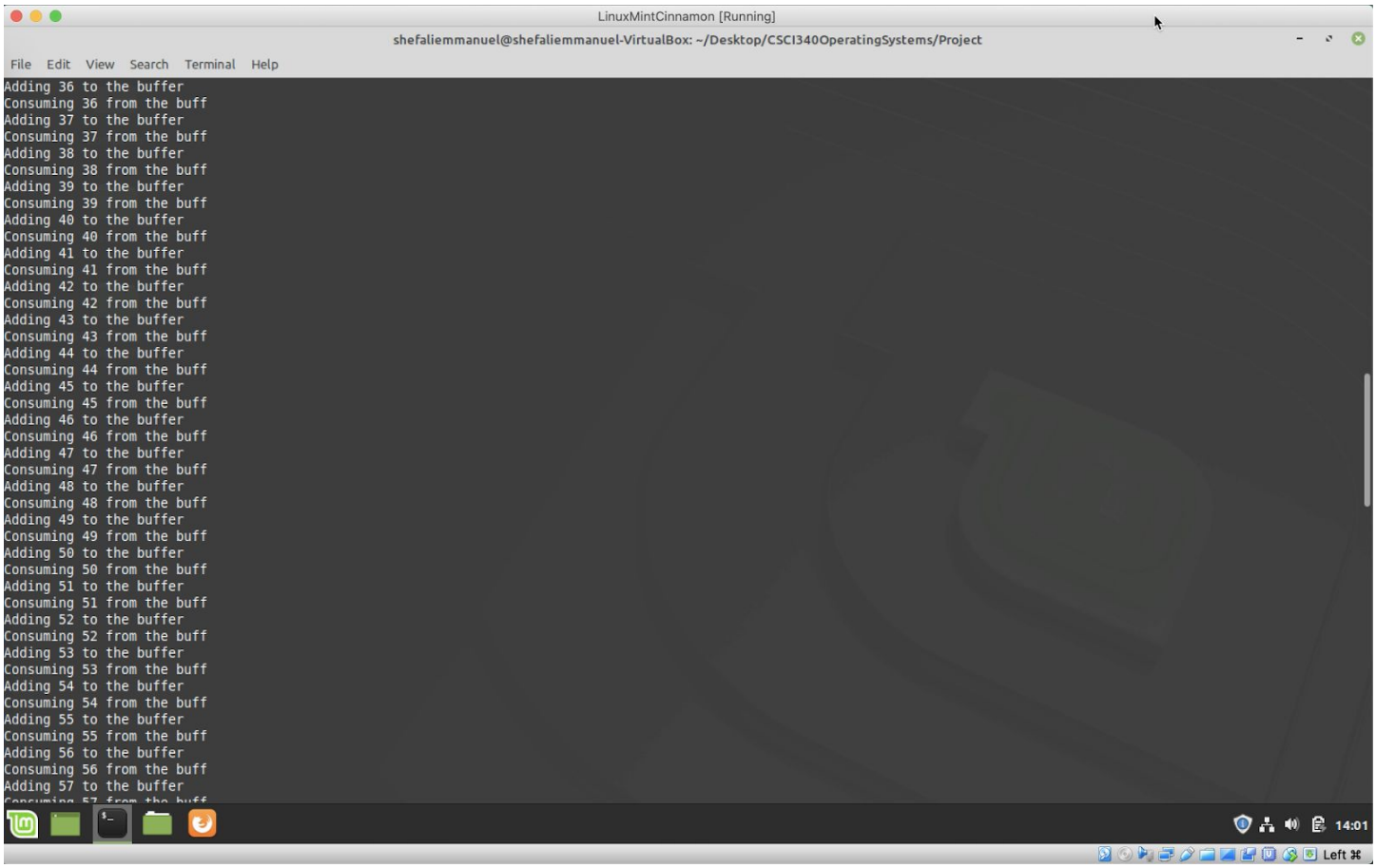
LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/Desktop/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
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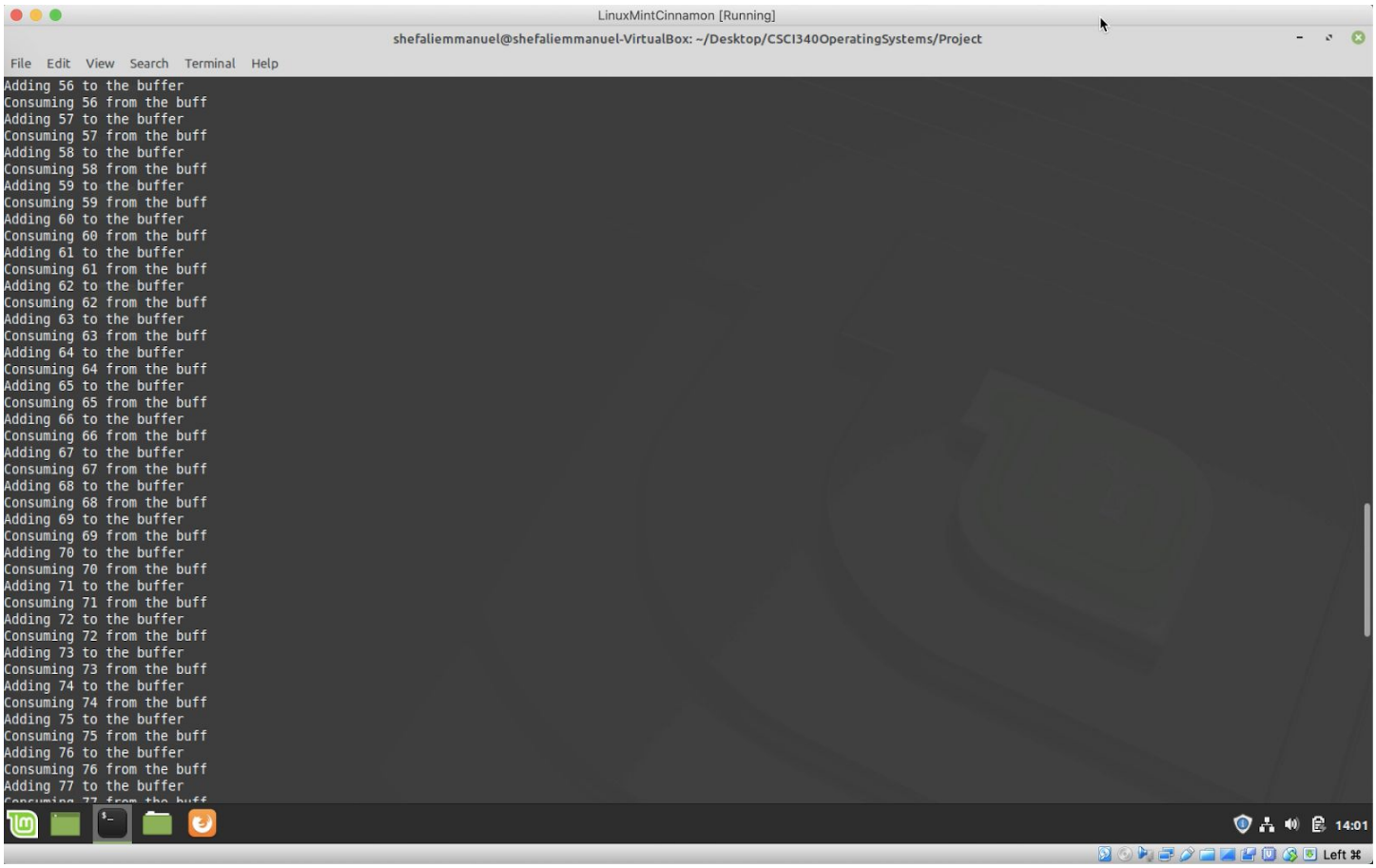
LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/Desktop/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
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Consuming 76 from the buff
Adding 77 to the buffer
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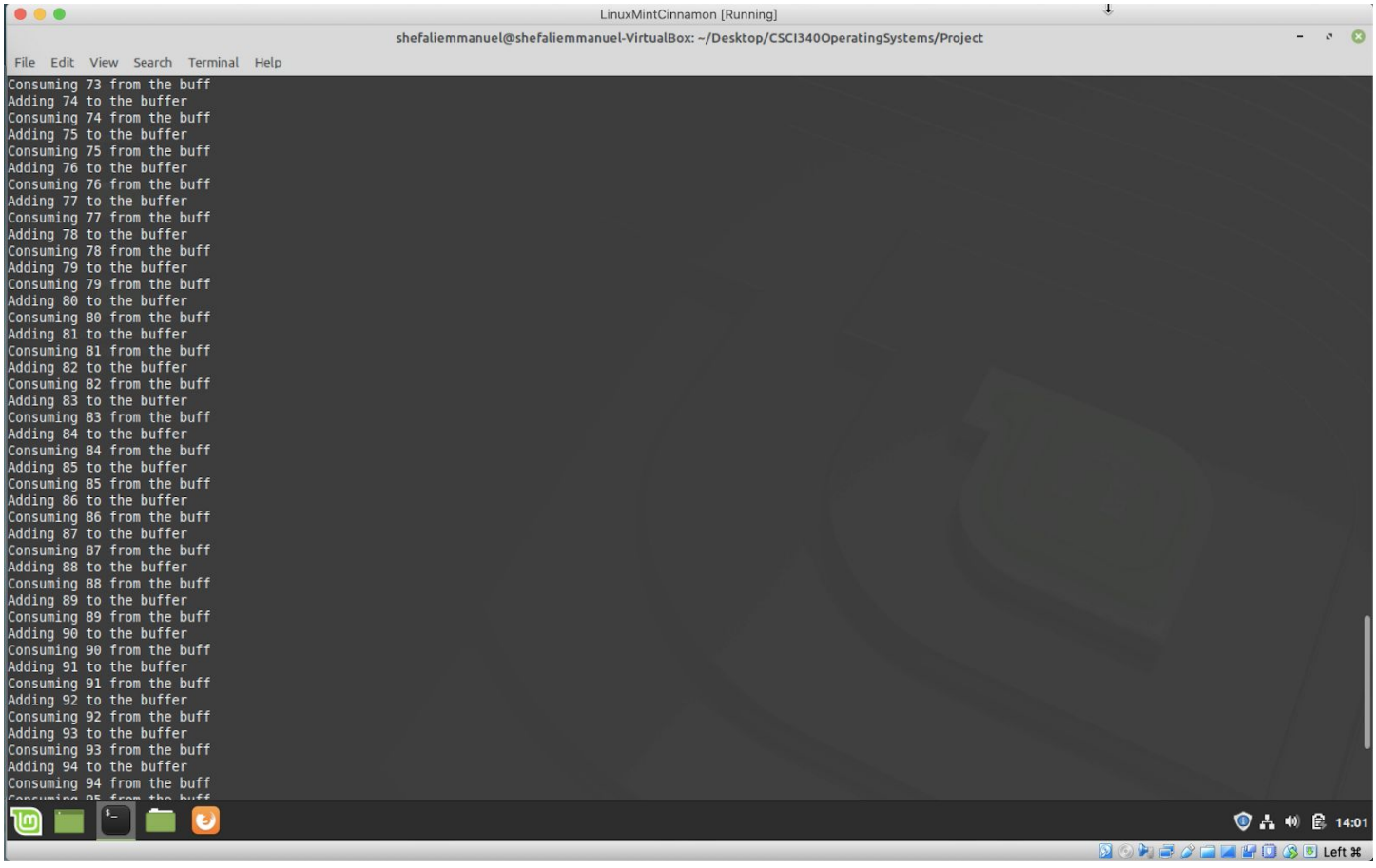
Left ⌘


LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/Desktop/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
Consuming 73 from the buff
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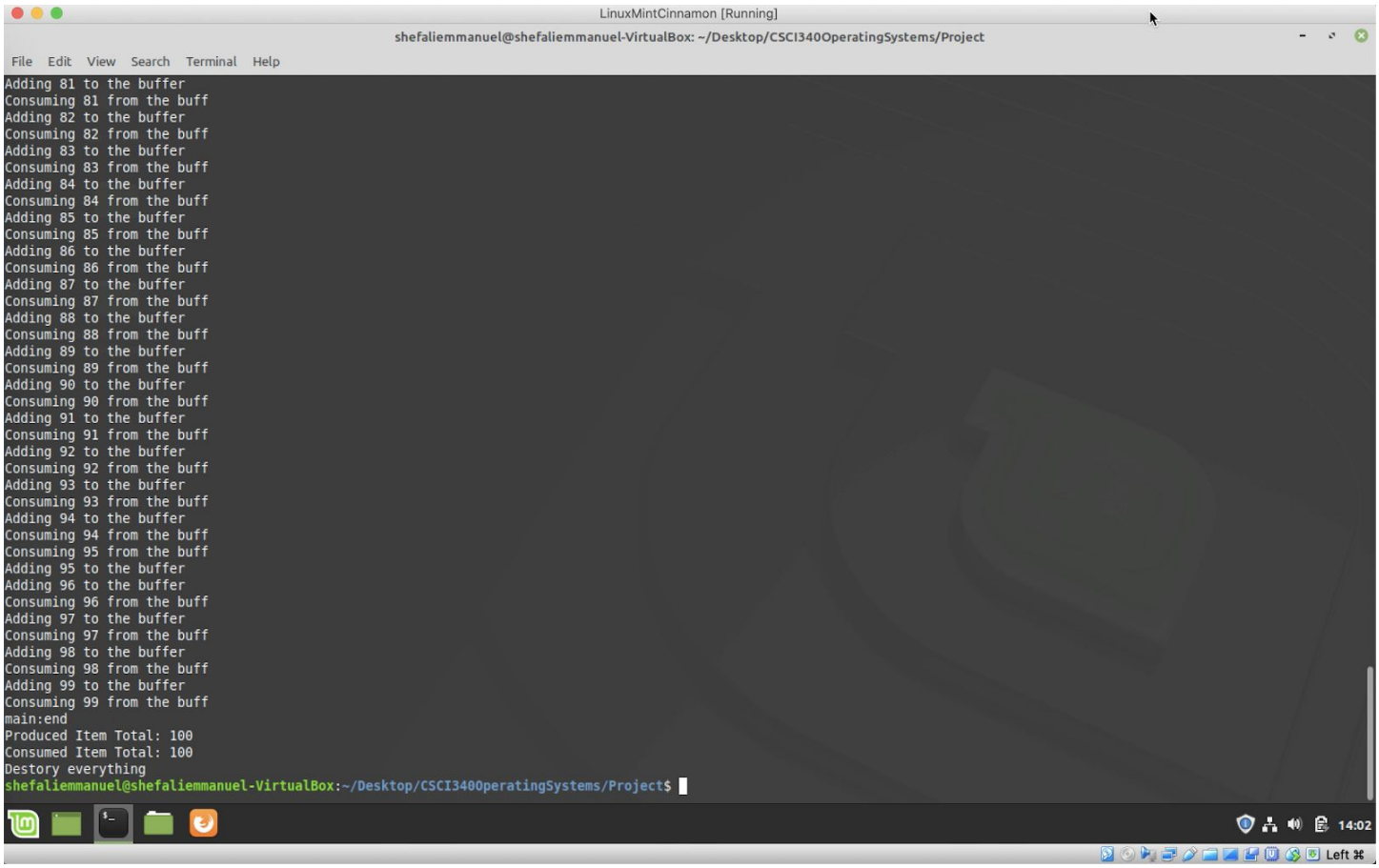
Consuming 93 from the buff
Adding 94 to the buffer
Consuming 94 from the buff
14:01
Left ⌘


LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/Desktop/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
Adding 81 to the buffer
Consuming 81 from the buff
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Consuming 96 from the buff
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Consuming 98 from the buff
Adding 99 to the buffer
Consuming 99 from the buff
main:end
Produced Item Total: 100
Consumed Item Total: 100
Destory everything
shefaliemmanuel@shefaliemmanuel-VirtualBox:~/Desktop/CSCI340OperatingSystems/Project$
14:02
Left ⌘

Part 2:

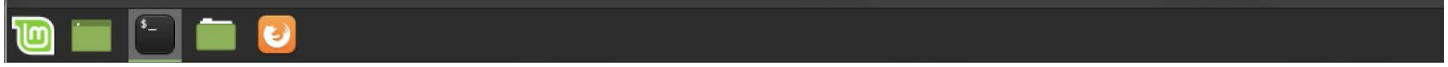
gcc projectPart2.c -o projectPart2 -lpthread
./projectPart2

Code that was changed from part 1:

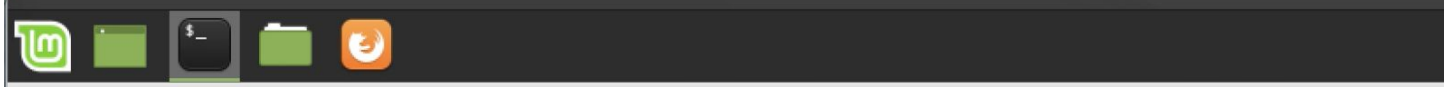
```
void *consumer(void *arg)
{
    sem_wait(&mutex);
    sem_wait(&full);
    int tmp = get();
    sem_post(&empty);
    sem_post(&mutex);
    printf("Consuming %d from the buff\n", tmp);
}

void *producer(void *arg)
{
    sem_wait(&mutex);
    sem_wait(&empty);
    put(counter);
    sem_post(&full);
    sem_post(&mutex);
    printf("Adding %d to the buffer\n", counter);
    counter++;
}
```

Screenshots:

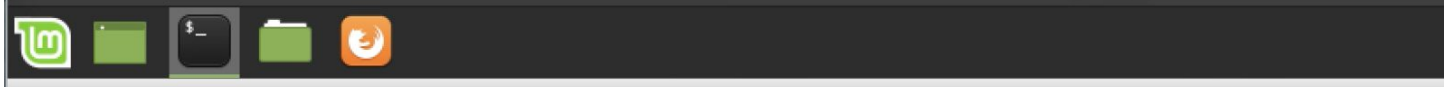
```
shefaliemmanuel@shefaliemmanuel-VirtualBox:~/Desktop/CSCI340OperatingSystems/Project$ gcc projectPart2.c -o projectPart2 -lpthread
shefaliemmanuel@shefaliemmanuel-VirtualBox:~/Desktop/CSCI340OperatingSystems/Project$ ./projectPart2
main:begin
Adding 0 to the buffer
Consuming 0 from the buff
Adding 1 to the buffer
Consuming 1 from the buff
Adding 2 to the buffer
Consuming 2 from the buff
Adding 3 to the buffer
Consuming 3 from the buff
Adding 4 to the buffer
Consuming 4 from the buff
Adding 5 to the buffer
Consuming 5 from the buff
```

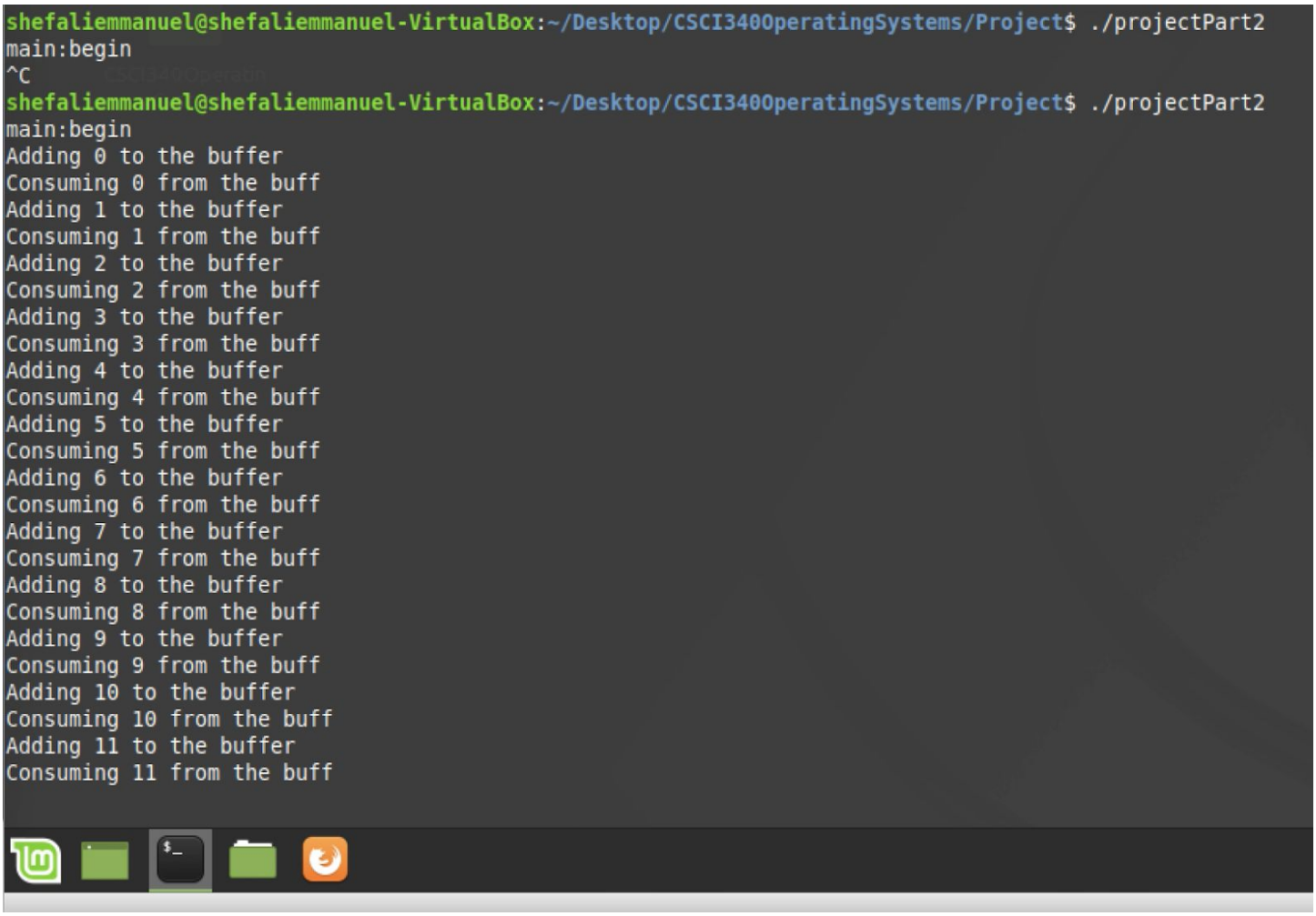


```
shefaliemmanuel@shefaliemmanuel-VirtualBox:~/Desktop/CSCI340OperatingSystems/Project$ ./projectPart2
main:begin
Consuming 0 from the buff
Adding 0 to the buffer
Adding 1 to the buffer
Consuming 1 from the buff
^C
shefaliemmanuel@shefaliemmanuel-VirtualBox:~/Desktop/CSCI340OperatingSystems/Project$ ./projectPart2
main:begin
Adding 0 to the buffer
Consuming 0 from the buff
```



```
shefaliemmanuel@shefaliemmanuel-VirtualBox:~/Desktop/CSCI340OperatingSystems/Project$ ./projectPart2
main:begin
Adding 0 to the buffer
Consuming 0 from the buff
Adding 1 to the buffer
Consuming 1 from the buff
Adding 2 to the buffer
Consuming 2 from the buff
Adding 3 to the buffer
Consuming 3 from the buff
```





After running the program multiple times, it was clear to me that the output was not the same. This version 2 of the project is indeterministic. This version will produce a deadlock. A producer can accept a mutex, but then get blocked when all buffer slots are being utilized. Since it is holding the mutex, the consumer can not rid itself of the buffer. I did not expect the program to reach a different breaking point upon each execution. Sometimes it would not even start the first thread creation… other times it would create multiple!

Part 3:

gcc projectPart3.c -o projectPart3 -lpthread
./projectPart3

Code that was changed from part 1:

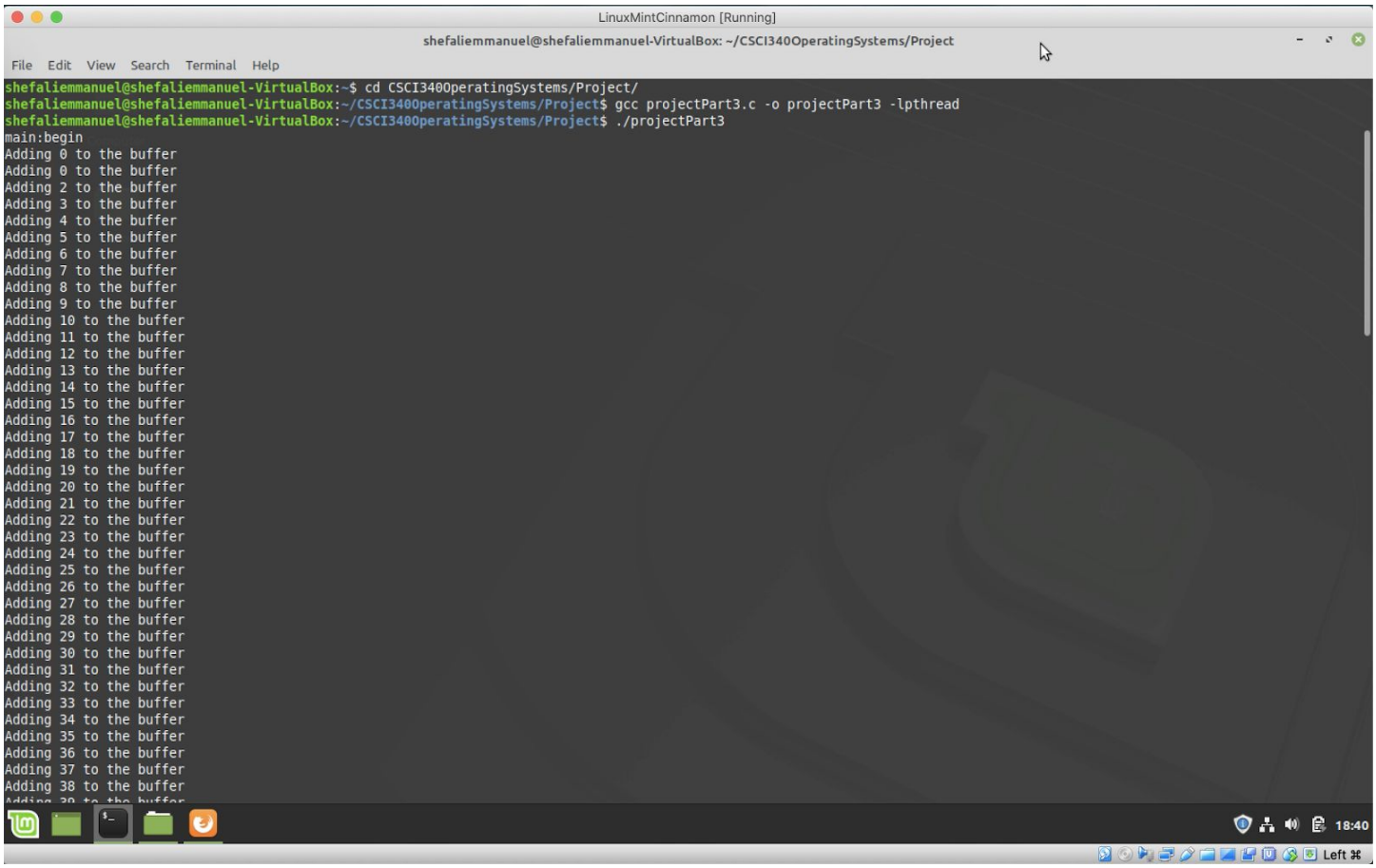
```
void *consumer(void *arg)
{
    for (int s = 0; s < MAX_BUFFER_SIZE; s++)
    {
        sem_wait(&full);
        //sem_wait(&mutex);
        int tmp = get();
        //sem_post(&mutex);
        sem_post(&empty);
        printf("Consuming %d from the buff\n", tmp);
    }
}

void *producer(void *arg)
{
    for (int s = 0; s < MAX_BUFFER_SIZE; s++)
    {
        sem_wait(&empty);
        //sem_wait(&mutex);
        put(counter);
        //sem_post(&mutex);
        sem_post(&full);
        printf("Adding %d to the buffer\n", counter);
        counter++;
    }
}
```

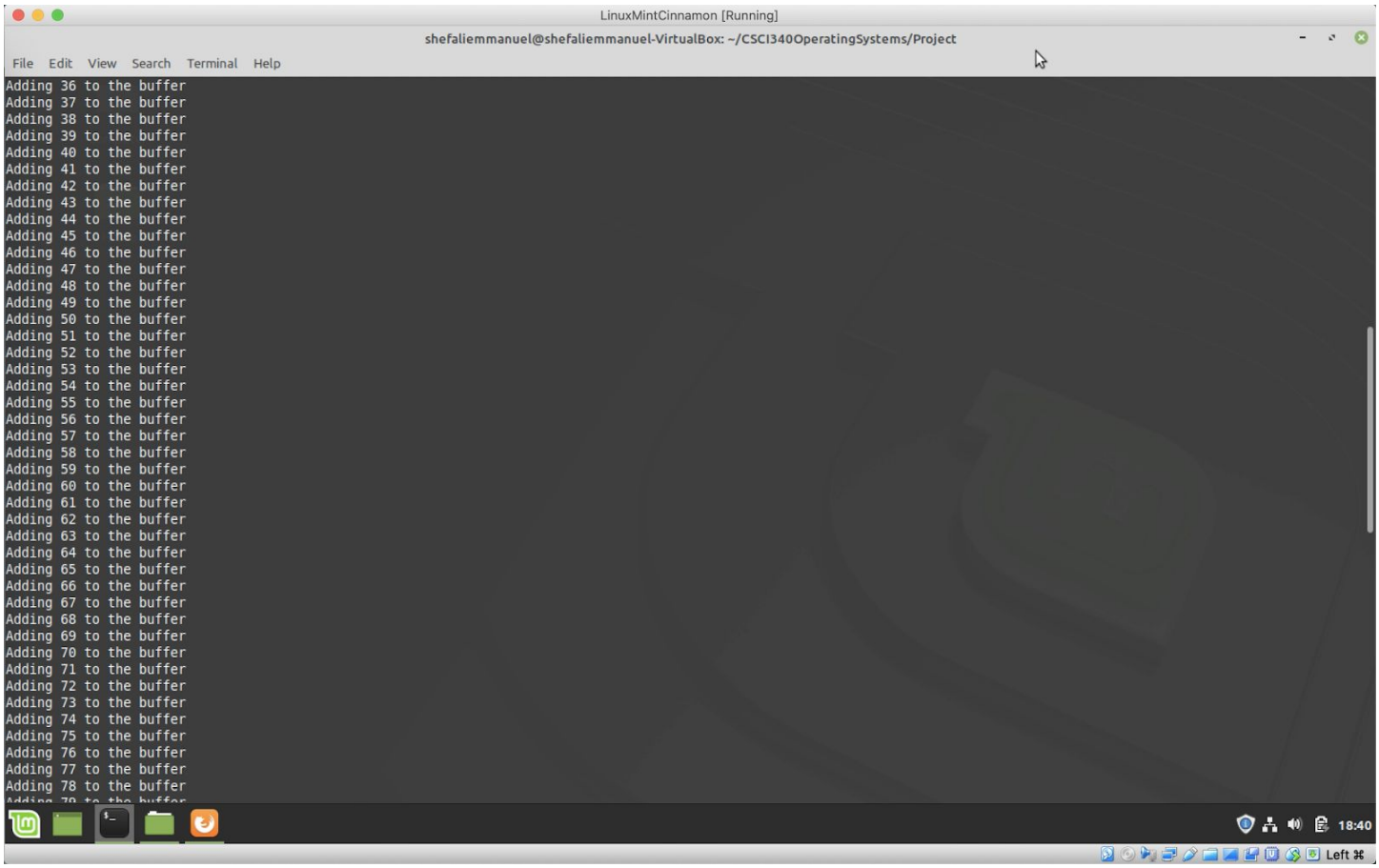
```
int main(int argc, char *argv[])
{
    pthread_t p1, p2, p3;
    int rc;

    //initialize semaphore that will garuntee mutal exclusive access to the shared counter
    sem_init(&mutex, 0, 1); //at most 1 may access guarded resources
    sem_init(&full, 0, 0);
    sem_init(&empty, 0, MAX_BUFFER_SIZE);

    printf("main:begin\n");
    pthread_create(&p1, NULL, producer, "A");
    pthread_create(&p2, NULL, producer, "B");
    pthread_create(&p3, NULL, consumer, "C");
    pthread_join(p1, NULL);
    pthread_join(p2, NULL);
    pthread_join(p3, NULL);

    printf("main:end\n");
    printf("Produced Item Total: %d\n", fillIndex);
    printf("Consumed Item Total: %d\n", useIndex);

    printf("Destory everything\n");
    sem_destroy(&mutex);
    sem_destroy(&full);
    sem_destroy(&empty);

    return 0;
}
```

initialize the new producer added

Create & Join new producer

Screenshots:




LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
Adding 36 to the buffer
Adding 37 to the buffer
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Adding 75 to the buffer
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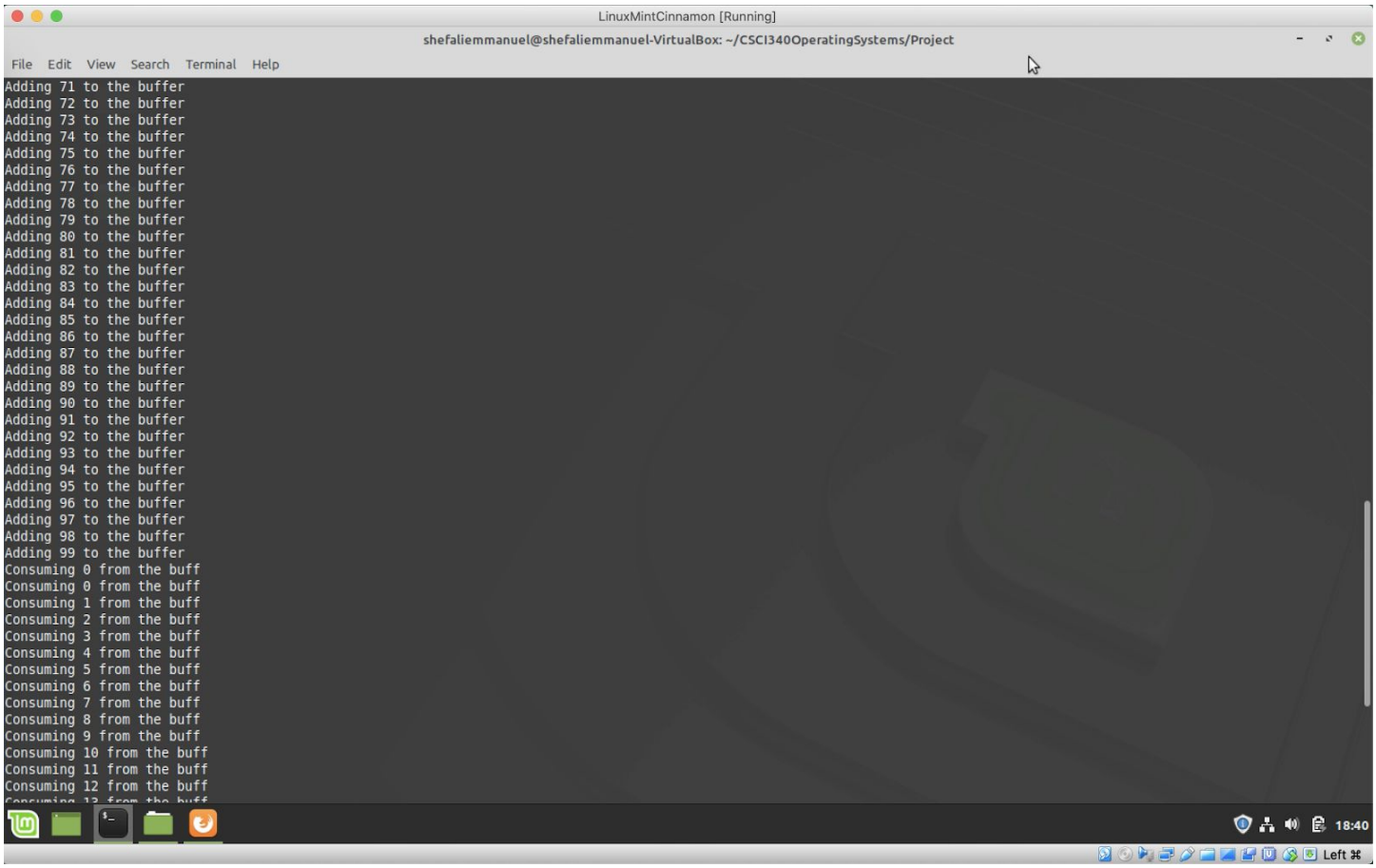
Adding 77 to the buffer
Adding 78 to the buffer
18:40
Left ⌘


LinuxMintCinnamon [Running]
shefaliemmanuel@shefaliemmanuel-VirtualBox: ~/CSCI340OperatingSystems/Project
File Edit View Search Terminal Help
Adding 71 to the buffer
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Consuming 0 from the buff
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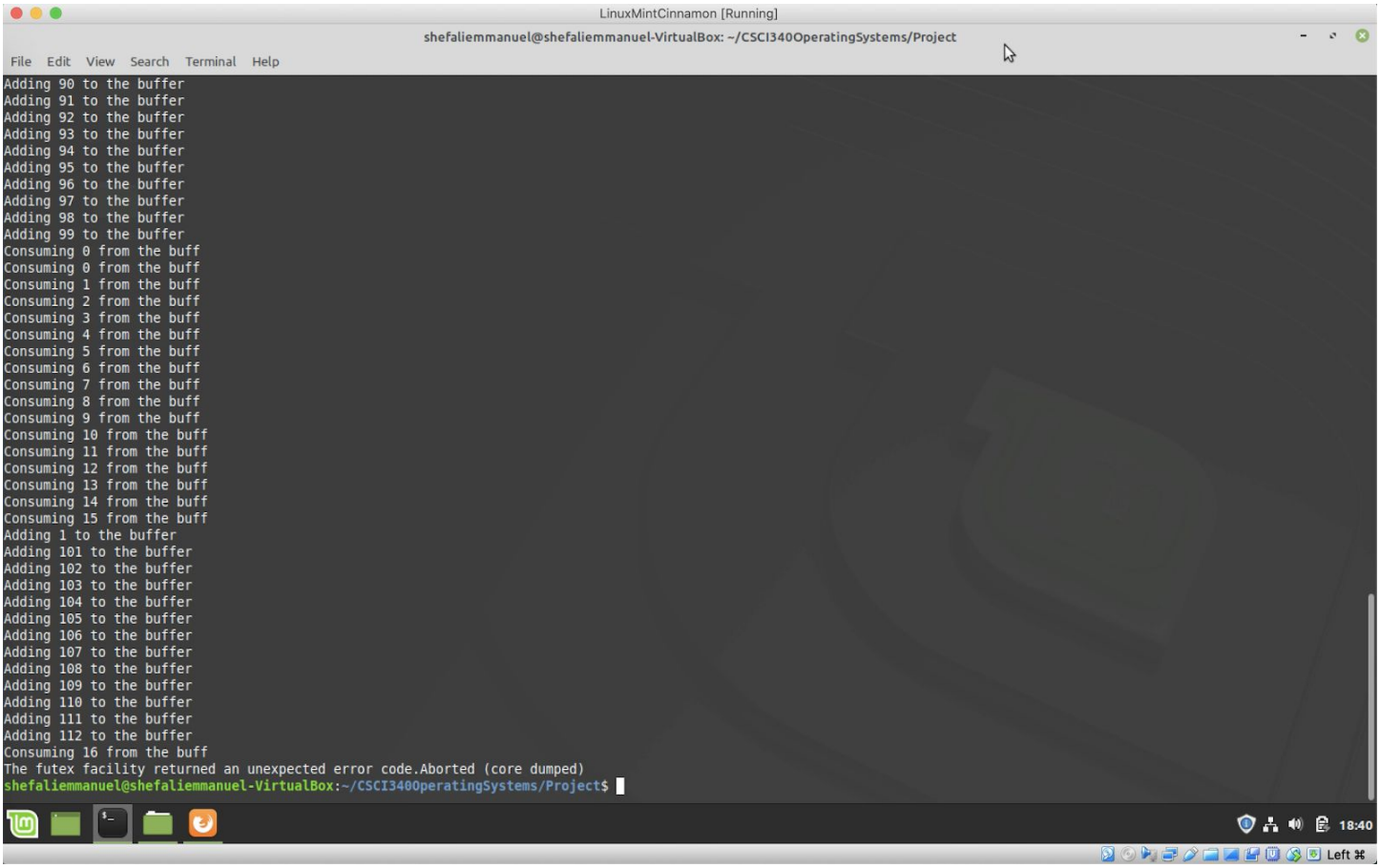
18:40
Left ⌘



These results are indeterministic due to a race condition that is going on. I created 2 procedures followed by a consumer. In the race condition mentioned above, the first procedure runs to its fullest extent. Next the consumer gets allocated some memory which is quickly taken away by the start of the second producer who starts promptly after the consumer has run for a little bit. Each time I ran this executable, the consumer ends at a different number.