

Producer-Consumer – Layer 3

This project implements the classic Producer-Consumer problem using POSIX threads and semaphores. The main goal is to simulate how multiple producers and consumers share a limited buffer while avoiding race conditions and incorrect access to shared data.

For this implementation, I used the standard three-semaphore solution. The buffer is treated as a bounded circular queue, and access to it is controlled using:

mutex – a binary semaphore that ensures only one thread (producer or consumer) can access the buffer at a time.

empty – a counting semaphore that tracks how many empty slots remain. Producers must wait here when the buffer is full.

full – a counting semaphore that tracks how many items are available. Consumers must wait here when the buffer is empty.

Compilation Process

I used Ubuntu inside VirtualBox to run and test the program.

To compile the program in the terminal, use:

```
gcc -pthread producer_consumer.c -o producer_consumer
```

or if using a Makefile:

```
make
```

Execution Instructions

To run the program:

```
./producer_consumer
```

While the program runs, you should see output showing:

- Producers adding items into the buffer
- Consumers removing items

- Updated buffer state after each action

Let it run for at least 1–2 minutes to verify:

- The buffer never exceeds its capacity
- Consumers never consume from an empty buffer
- No threads freeze or get stuck

To stop the program, press:

Ctrl + C

```

yrome@yrome: ~/Layer3-Producer-Consumer
yrome@yrome:~/Layer3-Producer-Consumer$ ./producer_consumer
Producer -411503968 produced 71 at 0
Buffer: [71, 0, 0, 0, 0]
Producer -411503648 produced 98 at 1
Buffer: [71, 98, 0, 0, 0]
Consumer -411503328 consumed 71 from 0
Buffer: [0, 98, 0, 0, 0]
Press Ctrl+C to stop
Consumer -411502688 consumed 98 from 1
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 11 at 2
Buffer: [0, 0, 11, 0, 0]
Consumer -411503008 consumed 11 from 2
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 77 at 3
Buffer: [0, 0, 0, 77, 0]
Consumer -411502688 consumed 77 from 3
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 68 at 4
Buffer: [0, 0, 0, 0, 68]
Consumer -411503328 consumed 68 from 4
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 47 at 0
Buffer: [47, 0, 0, 0, 0]
Consumer -411503008 consumed 47 from 0
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 50 at 1
Buffer: [0, 50, 0, 0, 0]
Consumer -411502688 consumed 50 from 1
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 5 at 2
Buffer: [0, 0, 5, 0, 0]
Consumer -411503328 consumed 5 from 2
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 43 at 3
Buffer: [0, 0, 0, 43, 0]
Consumer -411503328 consumed 43 from 3
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 30 at 0
Buffer: [30, 0, 0, 0, 0]
Consumer -411503008 consumed 30 from 0
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 58 at 1
Buffer: [0, 58, 0, 0, 0]
Consumer -411502688 consumed 58 from 1
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 69 at 2
Buffer: [0, 0, 69, 0, 0]
Consumer -411503328 consumed 69 from 2
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 56 at 3
Buffer: [0, 0, 0, 56, 0]
Consumer -411502688 consumed 56 from 3
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 69 at 4
Buffer: [0, 0, 0, 0, 69]
Consumer -411503008 consumed 69 from 4
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 11 at 0
Buffer: [11, 0, 0, 0, 0]
Consumer -411503328 consumed 11 from 0
Buffer: [0, 0, 0, 0, 0]
Producer -411503968 produced 99 at 1
Buffer: [0, 99, 0, 0, 0]
Consumer -411502688 consumed 99 from 1
Buffer: [0, 0, 0, 0, 0]
Producer -411503648 produced 93 at 2
Buffer: [0, 0, 93, 0, 0]
Consumer -411503008 consumed 93 from 2
Buffer: [0, 0, 0, 0, 0]
^C
yrome@yrome:~/Layer3-Producer-Consumer$

```