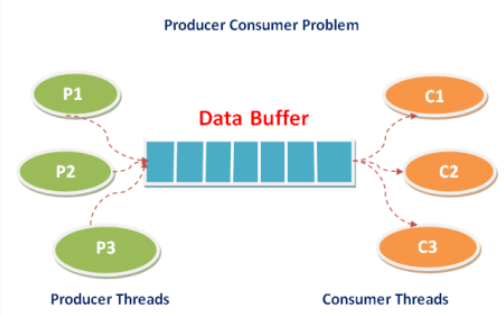
Producer Consumer Problem

The Producer-Consumer issue is a Classic Synchronization Problem. It is also known as Bounded Buffer Problem. This problem focuses primarily on two different tasks: Producer and Consumer. Both of them share a fixed size and a common buffer.

- The producer creates data and puts it into the buffer and restarts it.
- The consumer consumes the data. In other words, the consumer removes the data from the buffer that the producer has created.



Using the provided ProducerConsumer.c file, write a parallel code to implement the above problem using PThreads library:

- Case 1: we have only one producer and only one consumer. In this case, the producer fills **one or more** elements then the consumer reads **one or more** elements.
- Case 2: we have only one producer and only one consumer. In this case, the producer fills **all** elements then the consumer reads all elements before reproducing the data.
- Case 3: we have only one producer and only one consumer. In this case, the producer **fills in one or more chunk(s)** of the buffer, then the consumer **reads one or more chunks of the buffer**.
- Case 4: **we have many consumers and many producers**. Let us assume that each producer **fills in one or more chunk** of the buffer and each consumer **reads one or more chunk of the buffer**. The buffer should be **fully produced** before consuming and should be **fully consumed** before producing it again.
- Case 5: **we have many consumers and many producers**. Let us assume that each producer **fills in only a chunk** of the buffer and each consumer **reads only a chunk of the buffer**. The buffer should be **fully produced** before consuming and should be **fully consumed** before producing it again.

Implementing Multithreaded Operations

Objective:

In this exercise and using the provided FactorialMinMax.c file, you will enhance your understanding of POSIX Threads (PThreads) by implementing functions that calculate the factorial of a number, and find the minimum and maximum values in an array using multithreading. The results will be returned to the main function through thread exits.

Requirements:

1. **Shared Data:**
    - An integer variable **X** and an integer array **arr** of size **N** (defined by **#define N <size>**), both populated by user input.
2. **Functions to Implement:**
    - **factorial()**: Calculates the factorial of **X** and exits with the result using **pthread_exit**.
    - **min()**: Finds the minimum value in **arr** and **exits** with the result.
    - **max()**: Finds the maximum value in **arr** and **exits** with the result.
    - **minMax()**: Manages threads for **min** and **max** functions, stores their results in an array, and **exits** with this array.
3. **Main Function:**
    - Retrieves the factorial of **X**, and both the minimum and maximum values from the array by joining threads initiated for these computations.

Instructions:

- You will need to implement the thread creation and management within these functions using **PThread library functions**.
- Ensure proper synchronization (if necessary) to avoid race conditions and data inconsistency.