

Tutorial Session N°4: Monitors

Objective: Understand and apply process synchronization using monitors through exercises on managing shared resources, coordinating threads, and solving classic concurrency problems.

Propose a monitor-based synchronization algorithm for each of the following exercises:

Exercise 1: (Positive Shared Counter)

Consider a shared integer counter that is initially zero. Two types of processes can access the counter: incrementers, which increase its value, and decrementers, which decrease its value. A decrementer may only execute if the counter is greater than zero; otherwise, it must wait until the counter becomes positive.

Exercise 2: (Barber Shop)

Consider a barber shop with **N chairs** for waiting customers, and a **chair C** for the customer being served, and a **barber B**.

- ✓ If there are no customers, the barber **B** sleeps in chair **C**.
- ✓ When a customer arrives while the barber **B** is sleeping, the customer wakes him up, sits in **C**, and gets a haircut.
- ✓ If a customer arrives while the barber is busy: if one of the **N** chairs is free, the customer sits and waits; otherwise, the customer leaves.
- ✓ When the barber finishes a haircut and there are waiting customers, he serves the next customer.

Exercise 3: (Swimming Pool)

An Olympic swimming pool can receive swimmers from three synchronized swimming teams: **T1**, **T2**, and **T3**. To organize training sessions, the rule is: at any given time, the pool can accommodate any number of swimmers but from at most 2 teams. For example, swimmers from teams **T1** and **T3** can train simultaneously, but if a swimmer from team **T2** wants to enter, they must wait until all swimmers from one team have left the pool.

Exercise 4: (Bridge Load)

A bridge can support a maximum load of **20 tons**. The bridge is crossed by **trucks weighing 20 tons** and **cars weighing 5 tons**. You are asked to manage access to the bridge so that:

- ✓ The maximum bridge load is respected.
- ✓ Priority is given to cars: when a car and a truck request access simultaneously, the car must be allowed first, provided the bridge's maximum capacity is not exceeded.

Exercise 5: (ATM Alternation)

An **ATM** can be used by only one person at a time. When there are women and men waiting, a strict alternation must be ensured: after a woman uses the **ATM**, it must be a man's turn (if a man is waiting), otherwise women continue. The same applies for men. Initially, the turn is given to women.

Exercise 6: (single railway track)

Two cities **A** and **B** are connected by a **single railway track**. We consider two classes of processes: trains traveling **from A to B (T-AB)** and trains traveling **from B to A (T-BA)**. There may be an unspecified number of processes (i.e., trains). The traffic rules are as follows:

- The track must **never** be used simultaneously by two trains traveling in opposite directions.
- The track **may be used simultaneously** by one or more trains, as long as they are **all traveling in the same direction**.
- Trains traveling **from B to A** have **priority**.

GOOD LUCK