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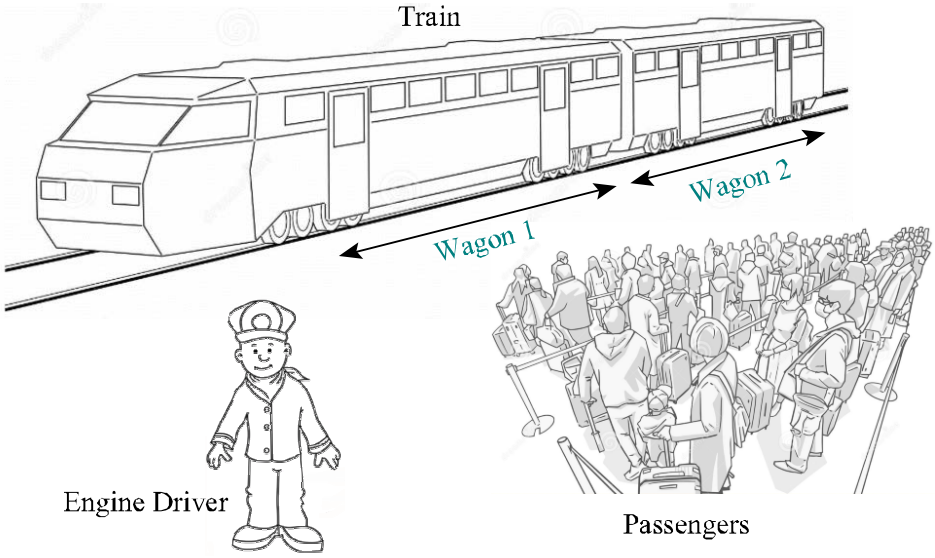
Dpto. de Lenguajes y Ciencias de la Computación

Systems Programming and Concurrency

2nd Official Exam. Course 2021-2022
September 12th, 2022.

Description of the system

A **Train** has two wagons with a capacity of **N Passengers** in each of them. In addition, the **Train** has an **Enginer Driver** that starts it only when the two wagons are full.



In the next sections is described the behaviour of both the **Engine Driver** and the **Passengers**:

- **Passenger**:
  - When a **Passenger** wants to board on the train, s/he *waits* in case a) the train is full, b) the train is running, or c) the passengers inside the train are getting out.
  - When the train is stopped and there is any empty seat, the passenger boards on and takes a seat. The **passenger** takes a seat in the wagon 1 but if its full (it already contains N passengers) s/he takes a seat in the second one, wagon 2. The last **passenger** to take a seat in the train informs to the **Engine Driver** that the train is full and the trip may start yet.
  - When a **Passenger** takes his/her seat, s/he *waits* the trip to finish before getting out the train.
  - When the trip has finished, a **passenger** can get out the train. *However, this operation has to be done orderly, i.e. the passengers of the first wagon get out firstly and, only then , the passengers of the second one.* **Note**: en each wagon, it is allowed that the passengers get off in a different order in which the board on. The only rule to be observed is that the all the passengers of the wagon 1 must get off before anybody of the wagon 2.
- **Engine Driver**:
  - The **Engine Driver** *waits* for the **Train** to be full before starting the trip.
  - Once the trip finishes, he informs to the **passengers** that they can get out the train.

To model this problem, the next classes are given to the student in the Virtual Campus:

- **Passenger**. It is a thread class that model the behaviour of a single **passenger**. Its **run()** method calls the method **trip()** of the class **Train** in an endless way. Each call corresponds to a single trip of the passenger in the train. This class is already implemented.
- **Enginer Driver.** It is a thread class that model the behaviour of the **engine driver**. Its **run()** method calls the methods **beginTrip()** and **endTrip()** of the class **Train** in an endless way. The calls to both methods corresponds to a single trip. This class is already implemented.
- **Train**. This class models the shared resource. It contains the next methods that must be implemented by the student:
    - `public void trip(int id)`: this method is called by the passenger **id** when s/he wants to make a trip. This method *cannot* finish until the passenger has really gone on a trip as previously described.
    - `public void beginTrip()`: this method is called by the engine driver to wait until the train is full and the trip may start.
    - `public void endTrip()`: this method is called by the engine driver to inform that the trip has finished and the passengers are allowed to get off the train.
- **Driver**. This class creates the **Train** and, progressivley, the **Passengers**.

Please, note that this exercise has several synchronization conditions:

1. **CS-EngineDriver**. The engine driver can not start the train until the the two wagons are full.
2. **CS_Passenger_1**. A passenger can not board on the train if its full or there are other passengers getting off.
3. **CS_Passenger_2**. A passenger of the wagon 1 can not get off the train until the trip has finished.
4. **CS_Passenger_3**. A passenger of the wagon 2 can not get off the train until the trip has finished and all the passengers of the wagon 1 have got off (the wagon 1 is empty).

You have to develop two implementations of the Supermarket class, one of type 1 and another of type 2:
Type 1: Binary semaphores (5 pts.).
Type 2: Synchronized methods or Locks (5 pts.).

(See the next page for an example of trace)

A possible trace of the program with 20 passengers and wagons of size N=5 may be as follows:

```
Passenger 19 has board on wagon 1
Passenger 5 has board on wagon 1
Passenger 4 has board on wagon 1
Passenger 1 has board on wagon 1
Passenger 0 has board on wagon 1
Passenger 13 has board on wagon 2
Passenger 12 has board on wagon 2
Passenger 9 has board on wagon 2
Passenger 16 has board on wagon 2
Passenger 8 has board on wagon 2
      Engine Driver: the trip Starts
      Engine Driver: the trip Ends
Passenger 19 has got off wagon 1
Passenger 5 has got off wagon 1
Passenger 4 has got off wagon 1
Passenger 1 has got off wagon 1
Passenger 0 has got off wagon 1
Passenger 8 has got off wagon 2
Passenger 16 has got off wagon 2
Passenger 9 has got off wagon 2
Passenger 12 has got off wagon 2
Passenger 13 has got off wagon 2
********************************
Passenger 10 has board on wagon 1
Passenger 18 has board on wagon 1
Passenger 17 has board on wagon 1
Passenger 14 has board on wagon 1
Passenger 11 has board on wagon 1
Passenger 7 has board on wagon 2
Passenger 15 has board on wagon 2
Passenger 6 has board on wagon 2
Passenger 2 has board on wagon 2
Passenger 3 has board on wagon 2
      Engine Driver: the trip Starts
      Engine Driver: the trip Ends
Passenger 10 has got off wagon 1
Passenger 18 has got off wagon 1
Passenger 17 has got off wagon 1
Passenger 14 has got off wagon 1
Passenger 11 has got off wagon 1
Passenger 3 has got off wagon 2
Passenger 2 has got off wagon 2
Passenger 6 has got off wagon 2
Passenger 15 has got off wagon 2
Passenger 7 has got off wagon 2
********************************
Passenger 1 has board on wagon 1
Passenger 5 has board on wagon 1
Passenger 19 has board on wagon 1
Passenger 4 has board on wagon 1
Passenger 0 has board on wagon 1
Passenger 8 has board on wagon 2
Passenger 16 has board on wagon 2
Passenger 9 has board on wagon 2
Passenger 13 has board on wagon 2
Passenger 12 has board on wagon 2
      Engine Driver: the trip Starts
      Engine Driver: the trip Ends
Passenger 1 has got off wagon 1
Passenger 5 has got off wagon 1
Passenger 19 has got off wagon 1
Passenger 4 has got off wagon 1
Passenger 0 has got off wagon 1
Passenger 12 has got off wagon 2
Passenger 13 has got off wagon 2
Passenger 9 has got off wagon 2
Passenger 16 has got off wagon 2
Passenger 8 has got off wagon 2
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Passenger 9 has board on wagon 2
Passenger 13 has board on wagon 2
Passenger 8 has board on wagon 2
Passenger 0 has board on wagon 2
Passenger 12 has board on wagon 2
      Engine Driver: the trip Starts
      Engine Driver: the trip Ends
Passenger 19 has got off wagon 1
Passenger 4 has got off wagon 1
Passenger 1 has got off wagon 1
Passenger 5 has got off wagon 1
Passenger 16 has got off wagon 1
Passenger 12 has got off wagon 2
Passenger 0 has got off wagon 2
Passenger 8 has got off wagon 2
Passenger 13 has got off wagon 2
Passenger 9 has got off wagon 2
```