5.8 The roller coaster problem

This problem is from Andrews's *Concurrent Programming* [1], but he attributes it to J. S. Herman's Master's thesis.

> Suppose there are n passenger threads and a car thread. The passengers repeatedly wait to take rides in the car, which can hold C passengers, where $C < n$. The car can go around the tracks only when it is full.

Here are some additional details:

- Passengers should invoke `board` and `unboard`.
- The car should invoke `load`, `run` and `unload`.
- Passengers cannot board until the car has invoked `load`
- The car cannot depart until C passengers have boarded.
- Passengers cannot unboard until the car has invoked `unload`.

Puzzle: Write code for the passengers and car that enforces these constraints.

5.8.1 Roller Coaster hint

Roller Coaster hint

```
mutex = Semaphore(1)
mutex2 = Semaphore(1)
boarders = 0
unboarders = 0
boardQueue = Semaphore(0)
unboardQueue = Semaphore(0)
allAboard = Semaphore(0)
allAshore = Semaphore(0)
```

`mutex` protects `passengers`, which counts the number of passengers that have invoked `boardCar`.

Passengers wait on `boardQueue` before boarding and `unboardQueue` before unboarding. `allAboard` indicates that the car is full.

5.8.2 Roller Coaster solution

Here is my code for the car thread:

Roller Coaster solution (car)

```
load()
boardQueue.signal(C)
allAboard.wait()

run()

unload()
unboardQueue.signal(C)
allAshore.wait()
```

When the car arrives, it signals C passengers, then waits for the last one to signal `allAboard`. After it departs, it allows C passengers to disembark, then waits for `allAshore`.

Roller Coaster solution (passenger)

```
boardQueue.wait()
board()

mutex.wait()
   boarders += 1
   if boarders == C:
       allAboard.signal()
       boarders = 0
mutex.signal()

unboardQueue.wait()
unboard()

mutex2.wait()
   unboarders += 1
   if unboarders == C:
       allAshore.signal()
       unboarders = 0
mutex2.signal()
```

Passengers wait for the car before boarding, naturally, and wait for the car to stop before leaving. The last passenger to board signals the car and resets the passenger counter.