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Tutorials for “Formal methods for Java” Exercise sheet 9

Exercise 1: Implementing and verifying a circular array queue

- (a) On the website you will find an interface `Queue.java` with method contracts for a Queue data structure. Implement the interface with a circular array queue.

Your class should have a constructor with the contract

```
/*@ public normal_behaviour
   @ ensures size() == 0 && \fresh(footprint);
   @*/
```

Hints:

- You can find a description of a circular queue (or buffer) for example on Wikipedia (https://en.wikipedia.org/wiki/Circular_buffer).
- We propose that your data structure has (at least) the fields `Object[] array`, `int start`, and `int size`.
- Because KeY does not harmonize well with libraries, we advise you to do for instance copying of arrays “manually”.
- We propose that the push operation uses a method `enlarge`, which is triggered when the array is full.

- (b) Verify that your implementation fulfills the contracts in the interface using KeY. You will need to give loop invariants and a class invariant, and a contract for the `enlarge` method.

Hints:

- Avoid the modulo operator, use case distinctions instead.
- Avoid using the `get(i)` method in the contract of the `enlarge` method.
- The loop invariant of the `enlarge` method may need the statement `\disjoint(footprint, newArray[*])`.