Exercise 1: Universe Type System
On the lecture’s webpage you find an implementation of a heap. The heap is realized by an array, and every element in the heap stores its position in the heap. A method to enqueue new elements into the heap, and a method to remove an element from the heap are provided. The Universe Type System is used to guard the invariant that every element in the heap knows its current position. Unfortunately, this does not work. Explain the problem(s) and discuss why they cannot be solved with this type system.

Exercise 2: Pack/Unpack
Use the pack/unpack mechanism to guard the invariant. Change the implementation and verify it with ESC/Java 2. Your solutions are allowed to contain warnings for possible exceptions due to compareTo calls.

Hint: To get rid of all warnings you have to tell ESC/Java 2 that the elems arrays are not shared between different heaps, i.e., you need an invariant of the form

```java
//@ invariant (\forall Heap h; ; h == this || h.elems != elems);
```

Note that this invariant is independent of pack/unpack.