



# Principles of Distributed Computing

## Exercise 3

### 1 Leader Election in an “Almost Anonymous” Ring

- a) Is deterministic leader election possible in a synchronous ring in which all but one processors have the same identifier? Either give an algorithm or prove an impossibility result.
- b) Consider a synchronous ring in which exactly two nodes have identifier  $A$  and all the other nodes have identifier  $B$ . Is deterministic leader election possible in this setting? Either give an algorithm or prove an impossibility result.

### 2 Distributed Computation of the AND

Consider an anonymous ring where each processor has a single bit as input. You can assume that nodes can distinguish between their neighbors, i.e., when a node  $v$  receives a message,  $v$  knows which neighbor has sent the message (note that nodes may not know a consistent clockwise or counterclockwise orientation of the ring!).

- a) Prove that there is no uniform synchronous algorithm for computing the AND of all input bits.
- b) Present an asynchronous (non-uniform) algorithm for computing the AND; the algorithm should send  $O(n^2)$  messages in the worst case.
- c) Present a synchronous (non-uniform) algorithm for computing the AND; the algorithm should send  $O(n)$  messages in the worst case. What is the time complexity of your algorithm?