# Model Checking

COS 741

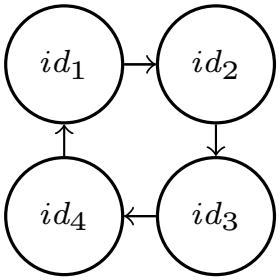
Practical Assignment 2

**Please note:**
You can solve this assignment in groups of up to three students. You have until the end of the day to solve this practical assignment. Upload your solution onto the ClickUP COS 741 website by midnight. Add the names and student numbers of all group members to your submitted file.

**EXERCISE 1** (9 Marks)**:**

A ring network consists of a number of nodes where each node is exactly connected to two other nodes. The ring is assumed to be unidirectional, which means that nodes can only receive messages from one direction and only send messages to the other direction. Each node has a unique id.

A unidirectional ring network can implement a leader election protocol as follows: Nodes send their ids to their right neighbour and wait to receive id messages from their left neighbour. If a node receives an id that is greater than its own id, then it forwards the received id to its right neighbour, else it ignores the received id. If a node receives an id that is equal to its own id, then the node declares itself as the elected leader and announces its election to its right neighbour. The other nodes forward the announcement to the right and turn themselves to non-elected.




a) [6 Marks]:
Model the leader election protocol with four nodes with randomly or non-deterministically selected but unique ids $id_1$ to $id_4$ in PROMELA. Make sure that each node keeps track of whether a leader has been found or not. Moreover, make sure that eventually each node knows who the leader is.

b) [3 Marks]:
Verify the following properties with SPIN:
**Termination:** The protocol will eventually finish once the leader is elected.
**Uniqueness:** Eventually there will be exactly one node that considers itself as the leader.
**Agreement:** All nodes will eventually know who the leader is.
Give the corresponding LTL formulas and explain the result.

You can add your answer to b) a comment to your Promela program.