SIRM 2019: Quiz

Problem 1: Peterson's lock

Consider the following simplified variant of Peterson's 2-process mutual exclusion algorithm:

```
Shared atomic variables:
  flag[0], flag[1]: boolean atomic registers
  turn: atomic register

Code for process p_i (i=0,1):
  flag[i] := true
  turn := 1-i
  if (flag[1-i]) and (turn=1-i) then
     return false // failure
  else
     return true // critical section
```

Draw the complex of states reachable by the two processes after they complete the algorithm.

Problem 2: test-and-set

Consider the model in which $n+1$ processes $p_0, \ldots, p_n$ communicate via a *test-and-set* (*T&S*) object. The object is initialized to 0 and exports one atomic operation *TAS*() which returns the value of the object and then sets the value to 1.

1. Draw the protocol complexes of the model for $n = 1$ (two processes) and $n = 2$ (three processes).

2. The task of *input-less consensus* is defined as a tuple $(\mathcal{I}, \mathcal{O}, \Delta)$, where the input complex $\mathcal{I}$ is the simplex $\{(0,0), \ldots, (n,n)\}$ plus all its faces, the output complex $\mathcal{O}$ is a set of simplices $\{(0,0), \ldots, (n,0)\}$, $\{(0,1), \ldots, (n,1)\}$, $\ldots$, $\{(0,n), \ldots, (n,n)\}$ plus all their faces, and Δ would maps each $\sigma = \{(i_1, i_1), \ldots, (i_k, i_k)\}$ in $\mathcal{I}$ to the set of simplices of $\mathcal{O}$ in which vertices have the form (i,j) such that $i, j \in \{i_1, \ldots, i_k\}$.

   Intuitively, every process has its identifier as an input, and the goal of the task is to agree on the identifier of one of the participating processes.

   Is the task of simplified consensus task solvable in the model above for $n = 1$? For $n = 2$? Explain why.

Problem 3: solving set agreement with test-and-set

Assuming that the input complex $\mathcal{I}$ is $\mathbf{s}^n$ (the standard n-dimensional simplex with all its faces), give an $(n+1)$-process protocol for solving $\lceil \frac{n+1}{2} \rceil$-set agreement using *test-and-set* objects.