

# T-106.420 Concurrent programming

## Example solution for homework assignment 2

1. (a) The average of the array  $x[0\dots N - 1]$ ,  $N \geq 1$ , is  $m$ :  
$$m = (\sum i : 0 \leq i < N : x[i]) / N$$

(b) The segment of the array  $x$  that is between indices  $p$  and  $q - 1$  inclusive contains only zeroes:  
$$(\forall i : p \leq i < q : x[i] = 0)$$

(c) The index of the minimum value of the array  $x[0\dots N]$ ,  $N \geq 0$ , is  $i$ :  
$$0 \leq i \leq N \wedge (\forall j : 0 \leq j \leq N : x[i] \leq x[j])$$

(d) The value of each element in array  $x[0\dots N]$ ,  $N \geq 1$ , is unique (within the array):  
$$(\forall i, j : 0 \leq i, j \leq N : x[i] = x[j] \Rightarrow i = j)$$
  
Or, equivalently:  
$$(\forall i, j : 0 \leq i, j \leq N : i \neq j \Rightarrow x[i] \neq x[j])$$
2. (a) The solution does not work. For example one process flips the lock to 1 and enters the critical section. The other process flips the lock to 0 and enters the inner loop. Lock is 0, so go back and flip again to 1, and enter critical section.
- (b) This solution works. One process flips the lock to 1 and enters the critical section. The other process flips the lock to 2 and spins in the inner loop until  $\text{lock} == 0$ , which happens when the first process exits the critical section. The solution works, but is not fair.