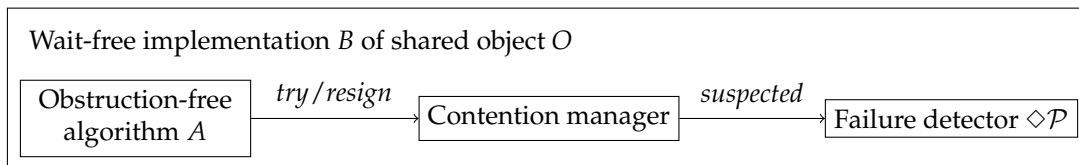


## Exercise 5

**Problem 1.**

Let  $A$  be an *obstruction-free* algorithm implementing some shared object  $O$  with operations  $op_1, \dots, op_k$ . The goal of the exercise is to transform algorithm  $A$  into a *wait-free* algorithm  $B$  that also implements shared object  $O$  (i.e., the operations  $op_1, \dots, op_k$ ). We will do it by implementing an abstraction called a *contention manager*, using an *eventually perfect* failure detector  $\diamond\mathcal{P}$  and atomic registers.



A contention manager implements two operations:  $try_i$  and  $resign_i$  (invoked by process  $p_i$ ). These operations do not take any arguments and always return *ok*. A contention manager resolves contention, and thus guarantees wait-freedom, by delaying some processes that have invoked  $try_i$ . In other words, when a process  $p_i$  invokes  $try_i$ , a contention manager can decide when to return from the operation—it can delay the response of  $try_i$  for an arbitrarily long time.

We assume that algorithm  $A$  uses the interface of the contention manager, i.e., that it invokes  $try_i$  and  $resign_i$ . More precisely, every time an operation  $op_m$ , implemented by  $A$ , is executed by a process  $p_i$ , the following conditions are satisfied:

1.  $try_i$  is called always before the first step of the implementation of  $op_m$  is executed (i.e., just after  $op_m$  is invoked), and possibly many times while  $op_m$  is being executed,
2.  $resign_i$  is called *only* immediately after the last step of the implementation of  $op_m$  is executed (i.e., just before the result of  $op_m$  is returned),
3. If process  $p_i$  is correct but never returns from operation  $op_m$  (i.e., the implementation of the operation is executed infinitely long), then  $p_i$  calls  $try_i$  infinitely many times.

Moreover, every time process  $p_i$  invokes  $try_i$  or  $resign_i$ ,  $p_i$  waits until  $try_i/resign_i$  returns before executing any further steps of algorithm  $A$ .

An eventually perfect failure detector  $\diamond\mathcal{P}$  maintains, at every process  $p_i$ , a set  $suspected_i$  of suspected processes.  $\diamond\mathcal{P}$  guarantees that eventually, after some unknown time, the following conditions are satisfied:

1. Every correct process permanently suspects every crashed process,
2. No correct process is ever suspected by any correct process.

This means that  $suspected_i$  can be arbitrary and different at every process for any *finite* period of time. However, eventually, at every correct process  $p_i$ , set  $suspected_i$  will be permanently equal to the set of processes that have crashed.

**Your task** is to implement a contention manager  $C$  (i.e., the operations  $try_i$  and  $resign_i$ , for every process  $p_i$ ) that converts obstruction-free algorithm  $A$  into wait-free algorithm  $B$ , and that uses only atomic registers and failure detector  $\diamond\mathcal{P}$ .