16.3 Implementing a Monitor System

Here we will show how to implement a `Monitor` system using preemptive coroutines and Semaphore.

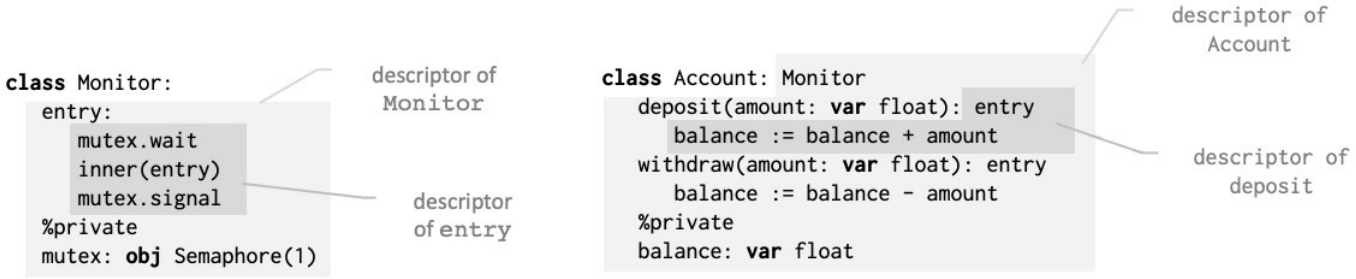
Below we show our first version of class `Monitor`:

```
class Monitor:
   entry:
      mutex.wait
      inner(entry)
      mutex.signal
   %private
   mutex: obj Semaphore(1)
```

A `Monitor`-object has a `Semaphore` attribute and a local method pattern, `entry`, which is to be used as a supermethod for methods in subclasses of `Monitor`. As can be seen, `entry` has an `inner(entry)`; `mutex.wait` is executed before `inner(entry)` and `mutex.signal` is executed after `inner(entry)`.

The `Account` class may be described as a subclass of `Monitor` in the following way:

```
class Account: Monitor
   deposit(amount: var float): entry
      balance := balance + amount
   withdraw(amount: var float): entry
      balance := balance - amount
   %private
   balance: var float
```



If `anAccount` refers to an `Account`-object, then execution of `anAccount.deposit(200)` has the effect that the supermethod `entry` of `deposit` works like a wrapper around the statement `balance := balance + amount`. This ensures that `mutex.signal` is executed before the statement and `mutex.signal` is executed afterwards. The same is the case for execution of a `anAccount.withDraw(300)`. All in all, using `entry` as a supermethod ensures that at most one `deposit` or `withdraw` may be executed at the same time, which guarantees exclusive acces to data-items within the `Monitor` object.

In section , `Monitor` is used as part of class that also defines a `MonitorProcess` class. We will show how to define such a system. It will contain the elements shown below:

```
class MonitorSystem
```

```
   class Monitor: ...
   class MonitorProcess: ...
   %private
   scheduler: obj ...
   SQS: obj ProcessQueue
```

Class `Monitor` is defined as shown above. Class `MonitorProcess` is supposed to be a superclass of all parallel objects in the `MonitorSystem`. The scheduler object handles scheduling of `MonitorProcess`-objects and `SQS` is a queue of `MonitorProcess`-objects that are ready for being executed.

Class `MonitorProcess` may be defined as follows:

```
class MonitorProcess:
   start:
      status := ACTIVE
      SQS.insert(this(MonitorProcess))
   status: var integer
   inner(MonitorProcess)
   status := TERMINATED
```

A `MonitorProcess` has four attributes:

- A `start` method that sets the status of the `MonitorProcess` object to `ACTIVE`.
- An integer variable `status` holding the status of the `MonitorProcess`.
- An `inner`-statement that implies execution of items in a subclass of `MonitorProcess`.
- Finally a statement setting `status` to `TERMINATED` whereafter execution of the `MonitorProcess` object ends.

Next we describe the `Scheduler` object:

```
scheduler: obj
  active: ref MonitorProcess
  cycle
     active := SQS.next
     if (active <> none) :then
        active.attach(100)
        if (active.status = ACTIVE) then
           SQS.insert(active)
```

The `scheduler` has a data-item active that is a reference to the `MonitorProcess` object currently being executed.

Then it has a `cycle`-statement that forever executes:

- A reference to the next `MonitorProcess` in the queue `SQS` of active `MonitorProcess`-objects is assigned to `active`.
- If there are no references in `SQS`, `active` will get the datum `none`.
- If `active` is not `none`, the method `active.attach(100)` is invoked implying that execution of `active` is resumed. If `active` has not bee executed before, execution starts from the

beginning of `active`; if `active` has been executed before ans execution has been suspended, execution is resumed after the point of suspension.

- `Active` will be preemptively suspended after 100 time units, but it may also terminate before the 100 time units have appeared.
- If active is preemptively suspended, `active.status = ACTIVE` and `active` is re-inserted into SQS.
- Otherwise `active` has terminated (`status = TERMINATED`) execution and thus not re-inserted into `SQS`.