

The Dining Philosophers Problem

A Monitor-Based Solution (*coded in the KPL language*)

1

The Philosophers' Threads

```
function PhilosphizeAndEat (p: int)
  var i: int
  for i = 1 to 7
    -- Now he is thinking
    mon.PickupForks (p)
    -- Now he is eating
    mon.PutDownForks (p)
  endFor
endFunction
```

2

Startup Code

```
var
  mon: ForkMonitor
  philosopher: array [5] of Thread =
    new array of Thread { 5 of new Thread }
...

-- Initialize the monitor...
mon = new ForkMonitor
mon.Init ()
mon.PrintAllStatus ()

-- Start up a thread for each philosopher...
philosopher[0].Init ("Plato")
philosopher[0].Fork (PhilosophizeAndEat, 0)
  ...etc...
philosopher[4].Init ("Aristotle")
philosopher[4].Fork (PhilosophizeAndEat, 4)
```

3

The Monitor

```
class ForkMonitor
  superclass Object
  fields
    monitorLock: Mutex
    status: array [5] of int
      -- HUNGRY, EATING, or THINKING
    startEating: array [5] of Condition
      -- Signaled when eating can begin
  methods
    Init ()
    PickupForks (p: int)      -- Entry Method
    PutDownForks (p: int)    -- Entry Method
    CheckAboutEating (p: int) -- Local Method
    PrintAllStatus ()        -- Local Method
endClass
```

4

Init

```
method Init ()
  -- Initialize so that all philosophers are
  -- THINKING. Also create the monitor lock
  -- and the 5 condition variables.
  var i: int
  status = new array of int { 5 of THINKING }
  startEating = new array of Condition
                                { 5 of new Condition }

  for i = 0 to 4
    startEating[i].Init ()
  endFor
  monitorLock = new Mutex
  monitorLock.Init ()
endMethod
```

5

PickupForks

```
method PickupForks (p: int)
  -- This method is called when philosopher 'p'
  -- wants to eat. Change his status to HUNGRY
  -- and then see if he can begin eating. If he
  -- was not able to begin immediately, then
  -- this thread must wait.
  monitorLock.Lock ()
  status [p] = HUNGRY
  self.PrintAllStatus ()
  self.CheckAboutEating (p)
  if status [p] != EATING
    startEating [p].Wait (& monitorLock)
  endIf
  monitorLock.Unlock ()
endMethod
```

6

PutDownForks

```
method PutDownForks (p: int)
  -- This method is called when the philosopher 'p'
  -- is done eating. Change his status. Also,
  -- this might make it possible for his left and
  -- right neighbors to begin eating, so check
  -- on them.
  monitorLock.Lock ()
  status [p] = THINKING
  self.PrintAllStatus ()
  self.CheckAboutEating ((p+1) % 5)
  self.CheckAboutEating ((p-1) % 5)
  monitorLock.Unlock ()
endMethod
```

7

CheckAboutEating

```
method CheckAboutEating (p: int)
  -- See if the p-th philosopher should begin
  -- eating. He should begin if he is HUNGRY and
  -- if his left and right neighbors are not
  -- eating. If so, change his status to EATING.
  -- Also, it could be that philosopher p's
  -- thread is waiting. Signal that thread's
  -- condition so it can resume, if it is waiting.
  if status [p] == HUNGRY &&
    status [(p+1) % 5] != EATING &&
    status [(p-1) % 5] != EATING
    status [p] = EATING
    self.PrintAllStatus ()
    startEating [p].Signal (& monitorLock)
  endif
endMethod
```

8

PrintAllStatus

```
method PrintAllStatus ()
  -- This is a "local" method.
  var p: int
  for p = 0 to 4
    switch status [p]
      case HUNGRY:
        print ("  ")
        break
      case EATING:
        print ("E  ")
        break
      case THINKING:
        print (".  ")
        break
    endSwitch
  endFor
  nl ()
endMethod
```