

# Aufgabe 17

**a)**

Einige Regeln, z.B. warn-if-low, sollen nur ein einziges Mal feuern und nicht weitere Male aufgrund des selben Ereignisses, beispielsweise um mehrfache Ausgaben des selben Ereignisses zu unterbinden. Dies wird durch negative Prämissen erreicht.

**b)**

Dies ist die Regel sleep-if-bored, sie dient dazu idle zu inkrementieren und den Prozess 25ms warten zu lassen. Die Priorität ist so niedrig gewählt, damit diese Regel lediglich feuert, falls keine andere möglich ist. Vor allem die Regeln, die die Pumpenleistung ändern müssen vor dieser Regel feuern.

**c)**

Bei der Tiefensuche erreichen die Pumpen zwischenzeitig höhere Auslastungsstufen, bis zu 9, bei der Breitensuche werden die Pumpen gleichzeitig reguliert und erreichen daher nur maximal 6. Breitensuche ist daher sinnvoll, denn die Extreme möchte man meiden. Auf eine starke Auslastung folgt auch ein ebenso starker Abfall, der wiederum einen starken Aufstieg zu Folge hat.

---

Tiefensuche:

```
lionis:~{ki07} java jess.Main jess/examples/pumps/pumps.clp
```

```
Jess, the Java Expert System Shell
Copyright (C) 2001 E.J. Friedman Hill and the Sandia Corporation
Jess Version 6.1p2 5/21/2003
```

```
Warning: Cannot convert string "-monotype-arial-regular-r-normal--*-140-*-*p*-iso8859-1" to type
FontStruct
```

```
*** New Machine *** named MAIN of type class jess.examples.pumps.Tank
*** New Machine *** named AUX of type class jess.examples.pumps.Tank
*** New Machine *** named AUX of type class jess.examples.pumps.Pump
*** New Machine *** named MAIN of type class jess.examples.pumps.Pump
```

```
WARNING: TANK AUX IS LOW!
```

```
Raised pumping rate of pump AUX to 1
```

```
WARNING: TANK AUX IS LOW!
```

```
WARNING: TANK MAIN IS LOW!
```

```
Raised pumping rate of pump AUX to 2
```

```
WARNING: TANK AUX IS LOW!
```

```
Raised pumping rate of pump AUX to 3
```

```
WARNING: TANK AUX IS LOW!
```

```
Raised pumping rate of pump AUX to 4
```

```
WARNING: TANK AUX IS LOW!
```

```
Raised pumping rate of pump AUX to 5
```

```
WARNING: TANK AUX IS LOW!
```

```
Tank AUX is now OK.
```

Raised pumping rate of pump MAIN to 1  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 2  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 3  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 5  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 6  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 7  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 8  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 9  
WARNING: TANK MAIN IS LOW!  
Tank MAIN is now OK.  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 8  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 7  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 6  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 5  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 3

---

Breitensuche:

lionis:~{ki07} java jess.Main jess/examples/pumps/pumps.clp

Jess, the Java Expert System Shell

Copyright (C) 2001 E.J. Friedman Hill and the Sandia Corporation

Jess Version 6.1p2 5/21/2003

Warning: Cannot convert string "-monotype-arial-regular-r-normal--\*-140-\*-\*p-\*-\*iso8859-1" to type FontStruct

\*\*\* New Machine \*\*\* named MAIN of type class jess.examples.pumps.Pump  
\*\*\* New Machine \*\*\* named AUX of type class jess.examples.pumps.Pump  
\*\*\* New Machine \*\*\* named AUX of type class jess.examples.pumps.Tank  
\*\*\* New Machine \*\*\* named MAIN of type class jess.examples.pumps.Tank  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump MAIN to 1  
WARNING: TANK MAIN IS LOW!  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump AUX to 1  
WARNING: TANK AUX IS LOW!

Raised pumping rate of pump MAIN to 2  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 2  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 3  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 3  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 4  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 5  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 5  
WARNING: TANK AUX IS LOW!  
Tank MAIN is now OK.  
Raised pumping rate of pump AUX to 6  
WARNING: TANK AUX IS LOW!  
Tank AUX is now OK.  
WARNING: TANK AUX IS LOW!  
Tank AUX is now OK.  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 5  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 4  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 3  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 2  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 1  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 0  
WARNING: TANK AUX IS HIGH!  
Tank AUX is now OK.  
WARNING: TANK MAIN IS HIGH!  
Tank MAIN is now OK.  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 3

## d)

Die Reaktionszeit wird höher, was zu kritischeren Werten der Füllstände und bei der Tiefensuche sogar zu einem Feuer führt. Auch hier zeigt sich, dass wie in c) beschrieben die Breitensuche sinnvoller ist.

---

Tiefensuche:

lionis:~{ki07} java jess.Main jess/examples/pumps/pumps.clp

Jess, the Java Expert System Shell

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Jess Version 6.1p2 5/21/2003

Warning: Cannot convert string "-monotype-arial-regular-r-normal--\*-140-\*-\*p-\*-iso8859-1" to type FontStruct

```
*** New Machine *** named AUX of type class jess.examples.pumps.Tank
*** New Machine *** named MAIN of type class jess.examples.pumps.Tank
*** New Machine *** named AUX of type class jess.examples.pumps.Pump
*** New Machine *** named MAIN of type class jess.examples.pumps.Pump
```

WARNING: TANK MAIN IS LOW!

Raised pumping rate of pump MAIN to 1

WARNING: TANK MAIN IS LOW!

WARNING: TANK AUX IS LOW!

Raised pumping rate of pump MAIN to 2

WARNING: TANK MAIN IS LOW!

Raised pumping rate of pump MAIN to 3

WARNING: TANK MAIN IS LOW!

Raised pumping rate of pump MAIN to 4

WARNING: TANK MAIN IS LOW!

Raised pumping rate of pump MAIN to 5

WARNING: TANK MAIN IS LOW!

Tank MAIN is now OK.

\*\*\*\*\*

\* Tank AUX has run dry and caught fire.

\*\*\*\*\*

Tank ran dry and caught fire!

---

Breitensuche:

Jess, the Java Expert System Shell

Copyright (C) 2001 E.J. Friedman Hill and the Sandia Corporation

Jess Version 6.1p2 5/21/2003

Warning: Cannot convert string "-monotype-arial-regular-r-normal--\*-140-\*-\*p-\*-iso8859-1" to type FontStruct

```
*** New Machine *** named MAIN of type class jess.examples.pumps.Pump
*** New Machine *** named AUX of type class jess.examples.pumps.Pump
*** New Machine *** named MAIN of type class jess.examples.pumps.Tank
*** New Machine *** named AUX of type class jess.examples.pumps.Tank
```

WARNING: TANK MAIN IS LOW!

Raised pumping rate of pump MAIN to 1

WARNING: TANK MAIN IS LOW!

WARNING: TANK AUX IS LOW!

Raised pumping rate of pump AUX to 1

WARNING: TANK AUX IS LOW!

Raised pumping rate of pump MAIN to 2

WARNING: TANK MAIN IS LOW!

Raised pumping rate of pump AUX to 2

WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 3  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 3  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 4  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 5  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 5  
Tank MAIN is now OK.  
WARNING: TANK AUX IS LOW!  
WARNING: TANK MAIN IS LOW!  
Tank MAIN is now OK.  
Raised pumping rate of pump AUX to 6  
WARNING: TANK AUX IS LOW!  
Tank AUX is now OK.  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 5  
WARNING: TANK AUX IS HIGH!  
Tank AUX is now OK.  
WARNING: TANK AUX IS HIGH!  
Tank AUX is now OK.  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 4  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump AUX to 3  
WARNING: TANK AUX IS HIGH!  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump AUX to 2  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump MAIN to 3  
WARNING: TANK MAIN IS HIGH!  
Lowered pumping rate of pump AUX to 1  
WARNING: TANK AUX IS HIGH!  
Lowered pumping rate of pump MAIN to 2  
WARNING: TANK MAIN IS HIGH!  
Tank AUX is now OK.  
Lowered pumping rate of pump MAIN to 1

**e)**

---

## Programmcode

```
.....  
;;;;;;;;;;  
;; Free-standing Pumps and Tanks control example. The damped algorithm  
;; coded in this file works reasonably well and can protect both Tanks
```

```
;; indefinitely.
```

```
.....
;;;;;;;;;;;;;
;; Register Java classes for matching like deftemplates.
;; Bean-like properties become slots. Classes must support
;; addPropertyChangeListener. First argument is the 'deftemplate name'.
```

```
(import jess.examples.pumps.*)
(import javax.swing.*)
(import java.awt.*)
```

```
(set-strategy breadth)
```

```
;;(defclass machine jess.examples.pumps.Machine )
(deftemplate machine (slot name) (slot class) (slot OBJECT))
(defclass tank Tank extends machine)
(defclass pump Pump extends machine)
```

```
.....
;;;;;;;;;;;;;
;; This fact will be used to sleep when idle
```

```
(defacts idle-fact
  (idle 0)
  (adjust-time 0))
```

```
.....
;;;;;;;;;;;;;
;; If tank is low, raise appropriate pump's pumping rate
;; Don't raise it too high!
;; Notice how we can call methods of the objects we match, like Pump.setFlow()
```

```
(defrule warn-if-low
  (tank (name ?name) (low TRUE) (intact TRUE))
  (not (warning low ?name))
  =>
  (assert (warning low ?name))
  (printout t "WARNING: TANK " ?name " IS LOW!" crlf)
  )
```

```
(defrule raise-rate-if-low
  ?warning <- (warning low ?name)
  (pump (name ?name) (flow ?flow-rate) (OBJECT ?pump))
  (test (< ?flow-rate 25))
  (idle ?n)
  ?a <- (adjust-time ?t&:(< ?t (- ?n 20)))
  =>
  (retract ?warning)
  (assert (reset-normal ?name))
  (set ?pump flow (+ ?flow-rate 1))
  (assert (adjust-time ?n))
  (retract ?a)
  (printout t "Raised pumping rate of pump " ?name " to "
    (get ?pump flow) crlf))
```

```

.....
;; If tank is high, lower appropriate pump's pumping rate
;; Don't lower it too much.

```

```

(defrule warn-if-high
  (tank (name ?name) (high TRUE) (intact TRUE))
  (not (warning high ?name))
  =>
  (assert (warning high ?name))
  (printout t "WARNING: TANK " ?name " IS HIGH!" crlf)
)

(defrule lower-rate-if-high
  ?warning <- (warning high ?name)
  (pump (name ?name) (flow ?flow-rate) (OBJECT ?pump))
  (test (> ?flow-rate 0))
  (idle ?n)
  ?a <- (adjust-time ?t:(< ?t (- ?n 20)))
  =>
  (retract ?warning)
  (assert (reset-normal ?name))
  (retract ?a)
  (set ?pump flow (- ?flow-rate 1))
  (assert (adjust-time ?n))
  (printout t "Lowered pumping rate of pump " ?name " to "
    (get ?pump flow) crlf)

```

```

.....
;; If tank is ok, sleep for 25 milliseconds
;; Notice outcall to Java static method!

```

```

(defrule notify-if-ok
  ?warning <- (warning ? ?name)
  (tank (name ?name) (high FALSE) (low FALSE))
  (not (warning normal ?name))
  =>
  (assert (warning normal ?name))
  (retract ?warning)
  (printout t "Tank " ?name " is now OK." crlf)

```

Ein normale Meldung wird assertet um später darauf zu reagieren

```

(defrule sleep-if-bored
  (declare (salience -100))
  ?idle <- (idle ?n)
  =>
  (retract ?idle)
  (call Thread sleep 25)
  (assert (idle (+ ?n 1)))

```

```

.....
;; If in normal condition, set pump rate to 1

```

```

(defrule reset-normal
  (reset-normal ?name)
  ?warning <- (warning normal ?name)
  =>
  (retract ?warning)
)

```

Setzt die Warnung zurück, falls nötig

```

(defrule set-pump-to-normal
  (declare (salience 10))
  ?warning <- (warning normal ?name)
  (pump (name ?name) (flow ?flow-rate) (OBJECT ?pump))
  =>
  (set ?pump flow 1)
  (retract ?warning)
  (printout t "Set pumping rate of pump" ?name "to 1" crlf)
)

```

Setzt die Pumpe auf 1 falls die Warnung auf normal gesetzt ist. Die Wichtigkeit wurde heruntergesetzt um eventuelle, wichtigere Anpassungen zu bevorzugen

```

.....
;; If tank is damaged, report it

```

```

(defrule report-fire
  ?t <- (tank (name ?name) (low TRUE) (intact FALSE))
  =>
  (printout t "*****" crlf)
  (printout t "* Tank " ?name " has run dry and caught fire. " crlf)
  (printout t "*****" crlf)
  (retract ?t)
  (halt))

```

```

(defrule report-explosion
  ?t <- (tank (name ?name) (high TRUE) (intact FALSE))
  =>
  (printout t "*****" crlf)
  (printout t "* Tank " ?name " has overfilled and exploded " crlf)
  (printout t "*****" crlf)
  (retract ?t)
  (halt))

```

```

.....
;; Announce new machine. This is just to demonstrate
;; how inheritance works.

```

```

(defrule announce-new-machinery
  ?m <- (machine (name ?n) (class ?c))
  (not (saw-machine ?n ?c))
  =>
  (assert (saw-machine ?n ?c))
  (printout t "*** New Machine *** named " ?n " of type " (call ?c toString) crlf))

```

```

.....
;; Create hardware, register for matching
;; Create two pumps and two tanks
;; Notes:

```



```
;; 1) See how we use the 'deftemplate name' from the defclass calls.
;; 2) Objects in definstance must be assignable to the type named in defclass
;; 3) The semantics here are different that definstances in CLIPS - this allows
;;    us to use pre-existing objects.
```

```
(defrule startup
```

```
=>
```

```
(bind ?frame (new JFrame "Pumps Demo"))
(call (?frame getContentPane) setLayout (new GridLayout 2 3))
(definstance tank (bind ?tank (new Tank "MAIN")))
(call (?frame getContentPane) add (?tank getComponent))
(definstance pump (bind ?pump (new Pump "MAIN" ?tank)))
(call (?frame getContentPane) add (?pump getComponent))
(call (?frame getContentPane) add (new JLabel "MAIN"))
(definstance tank (bind ?tank (new Tank "AUX")))
(call (?frame getContentPane) add (?tank getComponent))
(definstance pump (bind ?pump (new Pump "AUX" ?tank)))
(call (?frame getContentPane) add (?pump getComponent))
(call (?frame getContentPane) add (new JLabel "AUX"))
(?frame pack)
(?frame setVisible TRUE))
```

```
(reset)
```

```
(run)
```

---

## Ausgabe

```
lionis:~{ki07} java jess.Main jess/examples/pumps/pumps.clp
```

```
Jess, the Java Expert System Shell
```

```
Copyright (C) 2001 E.J. Friedman Hill and the Sandia Corporation
```

```
Jess Version 6.1p2 5/21/2003
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Warning: Cannot convert string "-monotype-arial-regular-r-normal--*-140-*-*p-*-*iso8859-1" to type
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```
*** New Machine *** named MAIN of type class jess.examples.pumps.Pump
```

```
*** New Machine *** named AUX of type class jess.examples.pumps.Pump
```

```
*** New Machine *** named MAIN of type class jess.examples.pumps.Tank
```

```
*** New Machine *** named AUX of type class jess.examples.pumps.Tank
```

```
WARNING: TANK AUX IS LOW!
```

```
WARNING: TANK MAIN IS LOW!
```

```
Raised pumping rate of pump AUX to 1
```

```
WARNING: TANK AUX IS LOW!
```

```
Raised pumping rate of pump MAIN to 1
```

```
WARNING: TANK MAIN IS LOW!
```

```
Raised pumping rate of pump AUX to 2
```

```
WARNING: TANK AUX IS LOW!
```

```
Raised pumping rate of pump MAIN to 2
```

WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 3  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 3  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 4  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 5  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 5  
WARNING: TANK MAIN IS LOW!  
Tank AUX is now OK.  
Set pumping rate of pumpAUXto 1  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 6  
WARNING: TANK MAIN IS LOW!  
Tank MAIN is now OK.  
Set pumping rate of pumpMAINTto 1  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 2  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 2  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 3  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 3  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 4  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 4  
WARNING: TANK MAIN IS LOW!  
Raised pumping rate of pump AUX to 5  
WARNING: TANK AUX IS LOW!  
Raised pumping rate of pump MAIN to 5  
WARNING: TANK MAIN IS LOW!  
Tank AUX is now OK.  
Set pumping rate of pumpAUXto 1