Intelligent Control Systems

Tutorial: VERIFICATION OF RULE BASES

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Consider the simple rule set below in section 1 that is related to the coffee machine in Fig. 1.

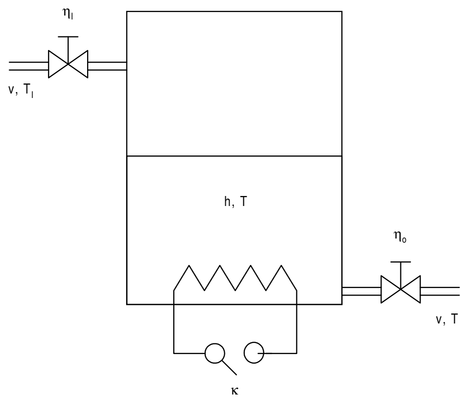

Figure 1: The flowsheet of the coffee machine

The variables are as follows.

t	time $[s]$
h	level in the tank $[m]$
h_L	low level $[m]$
h_H	high level $[m]$
T	temperature in the tank $[K]$
T_L	low temperature $[K]$
T_H	high temperature $[K]$
η_I	binary input valve [1/0]
η_O	binary output valve [1/0]
κ	binary switch to heater [1/0]

1 The simple rule set

Two sets of rules are considered.

1. *rules describing the dynamics of the coffee machine*

   if (the input valve is open **and** the output valve is closed)
   then the level is increasing;
   if (the input valve is open **and** the output valve is open)
   then the level does not change;
   if (the input valve is closed **and** the output valve is open)
   then the level is decreasing;

   if (the level is increasing **and** 5 min is elapsed **and** the tank is empty)
   then the level is low;
   if (the level is increasing **and** 5 min is elapsed **and** the level is low)
   then the level is high;
   if (the level is increasing **and** 5 min is elapsed **and** the level is high)
   then OVERFLOW;

   if (the level is decreasing **and** 5 min is elapsed **and** the level is low)
   then the tank is empty;
   if (the level is decreasing **and** 5 min is elapsed **and** the level is high)
   then the level is low;

2. *control rules*

   if (the level high **and** the level is increasing)
   then close the input valve;
   if (the level low **and** the level is decreasing)
   then open the input valve;
   if (the tank is empty **then** (open the input valve **and** close the output valve);

2 Tasks

The following tasks are to be carried out on the above rule set.

1. Identify the set of predicates and their relationships.
2. Transform the rule set into datalog form.
3. Draw the dependence graph of the rule set. Does it contain any circles?
4. Identify the root predicates.
5. Is the rule set complete? Is it contradiction free?
6. How could you improve the rule set to avoid its problems?