Intelligent Control Systems: Qualitative modelling – Tutorial

Katalin Hangos

Department of Electrical Engineering and Information Systems
University of Pannonia
e-mail: hangos.katalin@virt.uni-pannon.hu

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Normalized intervals

Qualitative range space: for variables with "normal" N value

$$\mathcal{Q} = \{H, N, L, 0\}, \quad \mathcal{B} = \{0, 1\}, \quad \mathcal{Q}_E = \{H, N, L, 0, e+, e-\}$$

Operation table for addition

$[a] + [b]$	0	L	N	H
0	0	L	N	H
L	L	N	H	$e+$
N	N	H	$e+$	$e+$
H	H	$e+$	$e+$	$e+$

TASK: Construct (a possible) operation table for multiplication

(A possible) Solution

$[a] * [b]$	0	L	N	H
0	0	0	0	0
L	0	L	L	N
N	0	L	N	H
H	0	N	H	H

TASK: Construct another possible operation table for the multiplication.

Confluences

Given a tank with in- and outflow, and a possible hole at the bottom of the tank.
The dynamic model originates from the mass balance

$$\frac{dm}{dt} = v_{in} - v_{out} - \kappa m$$

where $\kappa \in \{0, 1\}$ is the fault (hole) indicator variable.

TASK: Derive the confluence from the model, and give its solution. Derive the set of rules from the confluence.

Qualitative difference equation models

Given a (static) model of a sensor that suffers from a multiplicative bias over the normalized qualitative range set $\mathcal{Q}$:

$$[x^m](k) = [x](k) * \chi_{Mx}$$

where $[x] \in \mathcal{Q}$ is the real value, $[x^m] \in \mathcal{Q}_E$ is the value indicated by the (possibly faulty) sensor), and $\chi_{Mx} \in \{L, N\}$ is the fault (bias) indicator variable.

Use the qualitative multiplication constructed at the beginning of the tutorial.

TASK: Give the solution table of the qualitative model.

Construct rules from the rows of the solution table.