CS 344
Artificial Intelligence
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Fuzzy Inferencing

Core

The Lukasiewitz rule

\[ t(P \rightarrow Q) = \min[1, 1 + t(P) - t(Q)] \]

An example

Controlling an inverted pendulum

\[ \dot{\theta} = \frac{d\theta}{dt} = \text{angular velocity} \]
The goal: To keep the pendulum in vertical position ($\theta=0$) in dynamic equilibrium. Whenever the pendulum departs from vertical, a torque is produced by sending a current ‘i’

Controlling factors for appropriate current

Angle $\theta$, Angular velocity $\theta^\prime$

Some intuitive rules

If $\theta$ is +ve small and $\theta^\prime$ is –ve small
then current is zero

If $\theta$ is +ve small and $\theta^\prime$ is +ve small
then current is –ve medium
## Control Matrix

<table>
<thead>
<tr>
<th></th>
<th>-ve med</th>
<th>-ve small</th>
<th>Zero</th>
<th>+ve small</th>
<th>+ve med</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ve med</td>
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Region of interest
Each cell is a rule of the form
If $\theta$ is $<>$ and $\theta'$ is $<>$
then $i$ is $<>$

4 “Centre rules”

1. if $\theta = = \text{Zero}$ and $\theta' = = \text{Zero}$ then $i = \text{Zero}$

2. if $\theta$ is $+\text{ve}$ small and $\theta' = = \text{Zero}$ then $i$ is $-\text{ve}$ small

3. if $\theta$ is $-\text{ve}$ small and $\theta' = = \text{Zero}$ then $i$ is $+\text{ve}$ small

4. if $\theta = = \text{Zero}$ and $\theta'$ is $+\text{ve}$ small then $i$ is $-\text{ve}$ small

5. if $\theta = = \text{Zero}$ and $\theta'$ is $-\text{ve}$ small then $i$ is $+\text{ve}$ small
Linguistic variables

1. Zero
2. +ve small
3. -ve small

Profiles
Inference procedure

1. Read actual numerical values of $\theta$ and $\theta'$.

2. Get the corresponding $\mu$ values $\mu_{\text{Zero}}$, $\mu_{(+\text{ve small)}}$, $\mu_{(-\text{ve small)}}$. This is called FUZZIFICATION.

3. For different rules, get the fuzzy I-values from the R.H.S of the rules.

4. “Collate” by some method and get ONE current value. This is called DEFUZZIFICATION.

5. Result is one numerical value of ‘i’.