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Fuzzy Backpropagation Network

* Explain LR type Fuzzy numbers with operation.

=> LR-type Fuzzy numbers are a specific type of fuzzy number that incorporates asymmetric uncertainty.

They introduced functions called L(and R) which map $R^+ \to [0, 1]$

An LR-type fuzzy numbers which is represented as $[a, l, r]$

where a = Central Value
l = Left spread
r = Right spread

The central value 'a' is represent the core value which the uncertainty is centered.

The Left spread is represent the degree of Fuzziness on the left side of the center value.

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The Right Spread is indicates the range of values that are acceptable.

A Fuzzy number $\bar{M}$ is of LR type if there exist reference function L, R

$$\mu_{\bar{M}}(x) = \begin{cases} L\left(\frac{m-x}{\alpha}\right) & \text{For } x \leq m \\ R\left(\frac{x-m}{\beta}\right) & \text{For } x \geq m \end{cases}$$

Here, $m \rightarrow$ called the mean value of $\bar{M}$

$\alpha, \beta \rightarrow$ Real number called Left and Right Spread.

$\mu_m \rightarrow$ Membership Function

LR types Fuzzynmbers are used in decision-making processes.

They are applied in Risk Assessment, Fuzzy logic system and Fuzzy Control.

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=) Operation :

Let $\bar{M}$ and $\bar{N}$ be two LR type Fuzzy numbers given by

$\bar{M} = (m, \alpha, \beta)$ $\bar{N} = (n, \gamma, \delta)$

1 Addition :

$(m, \alpha, \beta)_{LR} \oplus (n, \gamma, \delta)_{LR} = (m+n, \alpha+\gamma, \beta+\delta)_{LR}$

2 Subtraction :

$(m, \alpha, \beta)_{LR} \ominus (n, \gamma, \delta)_{LR} = (m-n, \alpha-\gamma, \beta-\delta)_{LR}$

3 Multiplication :

-> For $m \geq 0$, $n \geq 0$

$(m, \alpha, \beta)_{LR} \otimes (n, \gamma, \delta)_{LR} = (mn, m\gamma + n\alpha, m\delta + n\beta)_{LR}$

-> For $n \geq 0$, $m < 0$

$(m, \alpha, \beta)_{RL} \otimes (n, \gamma, \delta)_{LR} = (mn, n\alpha - m\delta, n\beta - m\gamma)_{RL}$

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→ For $m<0, n<0$

$$(m,\alpha,\beta)_{LR} \otimes (n,\gamma,\delta)_{LR} = (mn, -n\beta - m\delta, -n\alpha - m\gamma)_{RL}$$

4 Scalar Multiplication

→ $\forall \lambda \geq 0, \lambda \in R$

$$\lambda \cdot (m,\alpha,\beta)_{LR} = (\lambda m, \lambda\alpha, \lambda\beta)_{LR}$$

→ $\forall \lambda < 0, \lambda \in R$

$$\lambda \cdot (m,\alpha,\beta)_{LR} = (\lambda m, -\lambda\alpha, -\lambda\beta)_{RL}$$

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