ELE075 - Sistemas Nebulosos
Atividade Prática 2 - Parte 1

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I.

$$Q = \begin{vmatrix} 0 & 0.8 & 0.6 & 0.25 \\ 0.7 & 0.98 & 0.15 & 0.5 \end{vmatrix}$$

$$R = \begin{vmatrix} 1 & 0.4 & 0.2 \\ 0.1 & 0.4 & 0.7 \\ 0.4 & 0.15 & 0.05 \\ 0.85 & 0.3 & 0.1 \end{vmatrix}$$

$$L = \begin{vmatrix} 1 & 0.2 & 0.6 & 0.8 \\ 0.85 & 0.3 & 0.8 & 0.88 \end{vmatrix}$$

$$M = Q \wedge \neg L = \begin{vmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \end{vmatrix}$$

em que $m_{ij} = min(Q_{ij}, 1 - L_{ij})$

$m_{11} = min(0, 0) = 0$
$m_{12} = min(0.8, 0.8) = 0.8$
$m_{13} = min(0.6, 0.4) = 0.4$
$m_{14} = min(0.25, 0.2) = 0.2$

$m_{21} = min(0.7, 0.15) = 0.15$
$m_{22} = min(0.98, 0.7) = 0.7$
$m_{23} = min(0.15, 0.2) = 0.15$
$m_{24} = min(0.5, 0.12) = 0.12$

$$M = Q \wedge \neg L = \begin{vmatrix} 0 & 0.8 & 0.4 & 0.2 \\ 0.15 & 0.7 & 0.15 & 0.12 \end{vmatrix}$$

$$P = Q \circ R = \begin{vmatrix} p_{11} & p_{12} & p_{13} \\ p_{21} & p_{22} & p_{23} \end{vmatrix}$$

em que $p_{ij} = max(Q_{i,*} * R_{*,j})$ com a operação $*$ representando multiplicação par a par.

$p_{11} = max((1, 0.1, 0.4, 0.85) * (0, 0.8, 0.6, 0.25))$
$p_{11} = max(0, 0.081, 0.24, 0.2125)$
$p_{11} = 0.24$

$p_{12} = max((0.4, 0.4, 0.15, 0.3) * (0, 0.8, 0.6, 0.25))$
$p_{12} = max(0, 0.32, 0.09, 0.075)$
$p_{12} = 0.32$

$p_{13} = max((0.2, 0.7, 0.05, 0.1) * (0, 0.8, 0.6, 0.25))$
$p_{13} = max(0, 0.56, 0.03, 0.025)$
$p_{13} = 0.56$

$p_{21} = max((0.1, 0.1, 0.4, 0.85) * (0.7, 0.98, 0.15, 0.5)$
$p_{21} = max(0.7, 0.098, 0.06, 0.425)$
$p_{21} = 0.7$

$p_{22} = max((0.4, 0.4, 0.150.3) * (0.7, 0.98, 0.15, 0.5)$
$p_{22} = max(0.28, 0.392, 0.0225, 0.15)$
$p_{22} = 0.392$

$p_{23} = max((0.2, 0.7, 0.05, 0.1) * (0.7, 0.98, 0.15, 0.5)$
$p_{23} = max(0.14, 0.686, 0.0075, 0.05)$
$p_{23} = 0.686$

$$P = Q \circ R = \begin{vmatrix} 0.24 & 0.32 & 0.56 \\ 0.7 & 0.392 & 0.686 \end{vmatrix}$$

II.

$$A = \begin{vmatrix} 1 & 0.5 & 0.4 & 0.2 \end{vmatrix}$$

$$R = \begin{vmatrix} 1 & 0.8 & 0 & 0 \\ 0.8 & 1 & 0.8 & 0 \\ 0 & 0.8 & 1 & 0.8 \\ 0 & 0 & 0.8 & 1 \end{vmatrix}$$

$$B = A \circ R = \begin{vmatrix} b1 & b2 & b3 & b4 \end{vmatrix}$$

em que $b_i = max(min(A_i, R_{*,i}))$

$b_1 = max(min((1, 0.5, 0.4, 0.2), (1, 0.8, 0, 0))$
$b_1 = max(1, 0.5, 0, 0) = 1$

$b_2 = max(min((1, 0.5, 0.4, 0.2), (0.8, 1, 0.8, 0))$
$b_2 = max(0.8, 0.5, 0.4, 0) = 0.8$

$b_3 = max(min((1, 0.5, 0.4, 0.2), (0, 0.8, 1, 0.8))$

$b_3 = max(0, 0.5, 0.4, 0.2) = 0.5$

$b_4 = max(min((1, 0.5, 0.4, 0.2), (0, 0, 0.8, 1))$
$b_4 = max(0, 0, 0.4, 0.2) = 0.4$

$$B = A \circ R = \begin{vmatrix} 1 & 0.8 & 0.5 & 0.4 \end{vmatrix}$$

III.

As curvas de pertinências são como na Figura 1.

$$\mu_{young}(x) = gaussian(x, 0, 20)$$
$$\mu_{old}(x) = gaussian(x, 100, 30)$$

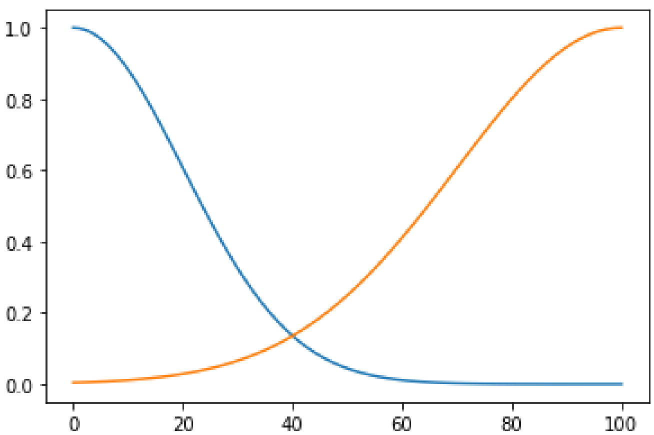

Figura 1. Curvas de pertinência, em azul μ_{young} e em laranja μ_{old}

IV.

As curvas de pertinências são como na Figura 2.

$$\mu_a(x) = \neg\mu_{young}^2 \wedge \neg\mu_{old}^2$$
$$\mu_b(x) = \mu_{young}^2 \wedge \mu_{old}^2$$

V.

$$A_1 = \begin{vmatrix} 0.2 & 0.4 & 0.5 \end{vmatrix}$$

$$A_2 = \begin{vmatrix} 1 & 1 & 0.3 \end{vmatrix}$$

$$B_1 = \begin{vmatrix} 0.1 & 0.3 \end{vmatrix}$$

$$B_1 = \begin{vmatrix} 0.6 & 0.2 \end{vmatrix}$$

$$A_1 \rightarrow B_1$$

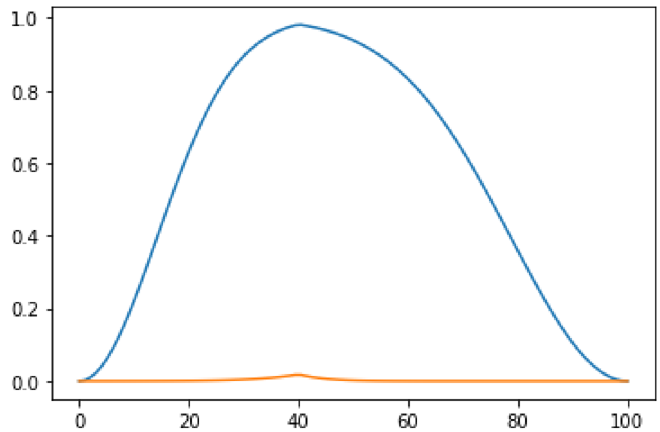

Figura 2. Curvas de pertinência, em azul μ_a e em laranja μ_b

$$A_2 \rightarrow B_2$$

$$A' = \begin{vmatrix} 0 & 1 & 0 \end{vmatrix}$$

$$\mu_{B'} = \bigvee_i [\vee(\mu_{A'} \wedge \mu_{A_i}) \wedge \mu_{B_i}]$$

$$i = 1$$

$$\mu_{B'_1} = \vee(\mu_{A'} \wedge \mu_{A_1}) \wedge \mu_{B_1} = \omega_1 \wedge \mu_{B_1}$$

$$\mu_{B'_1} = \vee(\begin{vmatrix} 0 & 0.4 & 0 \end{vmatrix}) \wedge \mu_{B_1} = 0.4 \wedge \mu_{B_1}$$

$$\mu_{B'_1} = \begin{vmatrix} 0.1 & 0.3 \end{vmatrix}$$

$$i = 2$$

$$\mu_{B'_2} = \vee(\mu_{A'} \wedge \mu_{A_2}) \wedge \mu_{B_2} = \omega_2 \wedge \mu_{B_2}$$

$$\mu_{B'_2} = \vee(\begin{vmatrix} 0 & 1 & 0 \end{vmatrix}) \wedge \mu_{B_1} = 1 \wedge \mu_{B_2}$$

$$\mu_{B'_1} = \begin{vmatrix} 0.6 & 0.2 \end{vmatrix}$$

$$\mu_{B'} = \mu_{B'_1} \vee \mu_{B'_2} = \begin{vmatrix} 0.6 & 0.3 \end{vmatrix} = 0.6/y_1 + 0.3/y_2$$

VI.

A curva de pertinência é como na Figura 3.

$$\mu_{A_1} = trapmf(x, \begin{bmatrix} 3 & 4 & 5 & 6 \end{bmatrix})$$

$$\mu_{A_2} = trapmf(x, \begin{bmatrix} 6 & 6.5 & 7 & 7.5 \end{bmatrix})$$

$$\mu_{C_1} = trimf(x, \begin{bmatrix} 3 & 4 & 5 \end{bmatrix})$$

$$\mu_{C_2} = trimf(x, \begin{bmatrix} 4 & 5 & 6 \end{bmatrix})$$

$$A_1 \rightarrow C_1$$
$$A_2 \rightarrow C_2$$

$$\mu_{A'} = trimf(x, \begin{bmatrix} 5 & 6 & 7 \end{bmatrix})$$

$$\mu_{C'} = \bigvee_i [\vee(\mu_{A'} \wedge \mu_{A_i}) \wedge \mu_{C_i}]$$

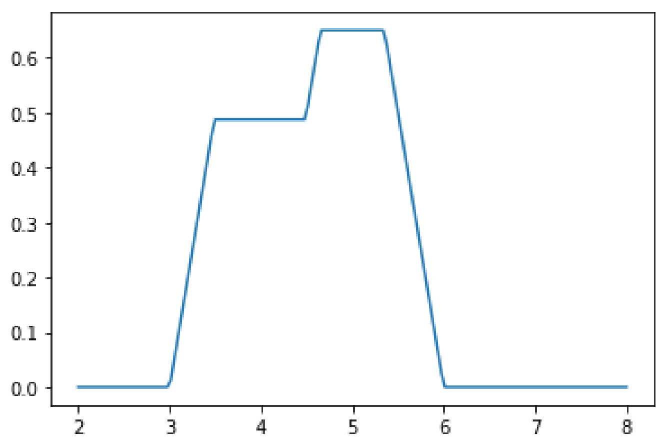

Figura 3. Curvas de pertinência de C'.