XỬ LÝ THÔNG TIN MỜ TDK

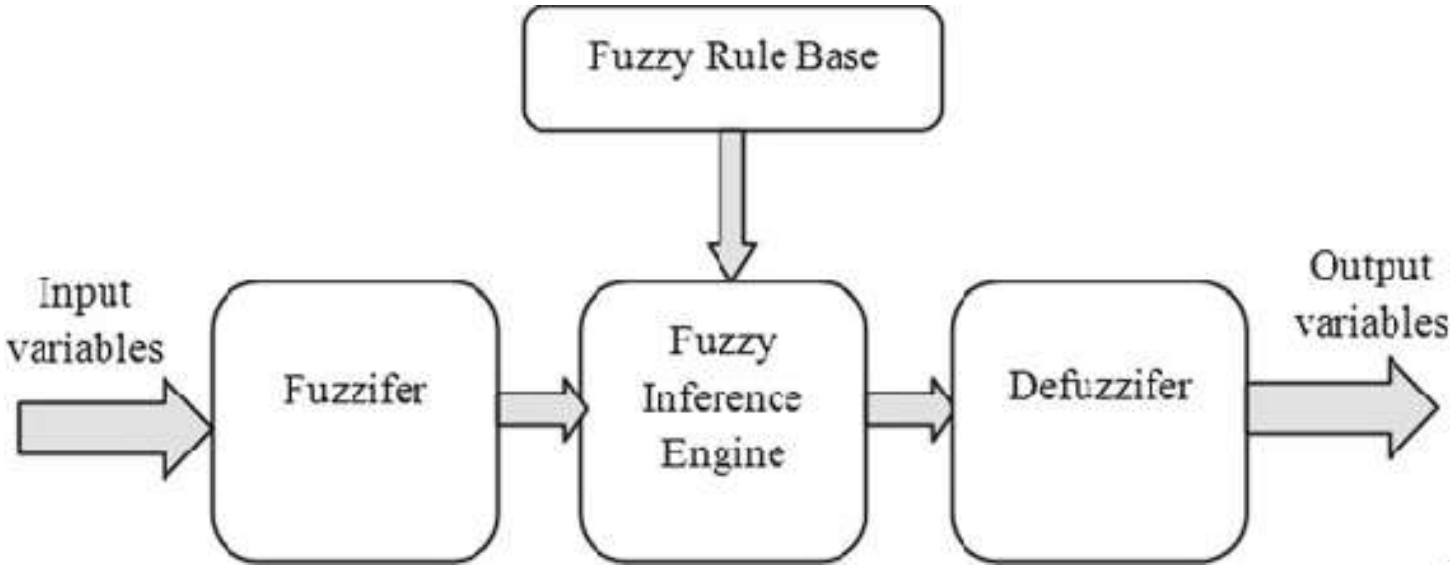
CHƯƠNG 6 – HỆ MỜ

- Hệ mờ
- Xây dựng hệ mờ

6.1. HỆ MỜ

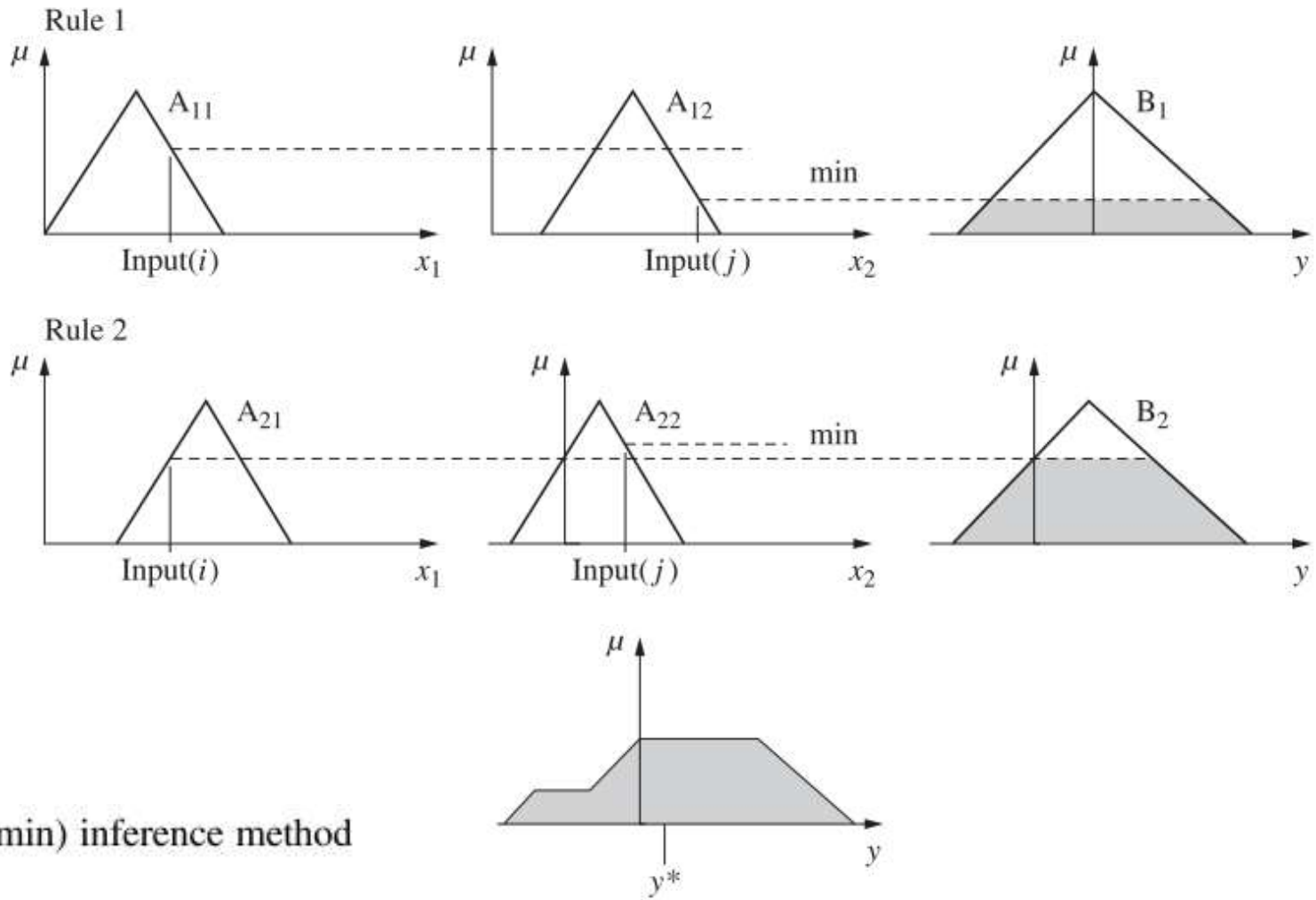
- Ứng dụng lý thuyết tập mờ và logic mờ, khi thông tin không đầy đủ, không chắc chắn, nhiễu; tri thức chuyên gia biểu diễn dạng ngôn ngữ tự nhiên; ranh giới các lớp đối tượng không rõ ràng; hệ thống phức tạp ...

CẤU TRÚC HỆ MỜ



RULES IN MAMDANI'S FORM

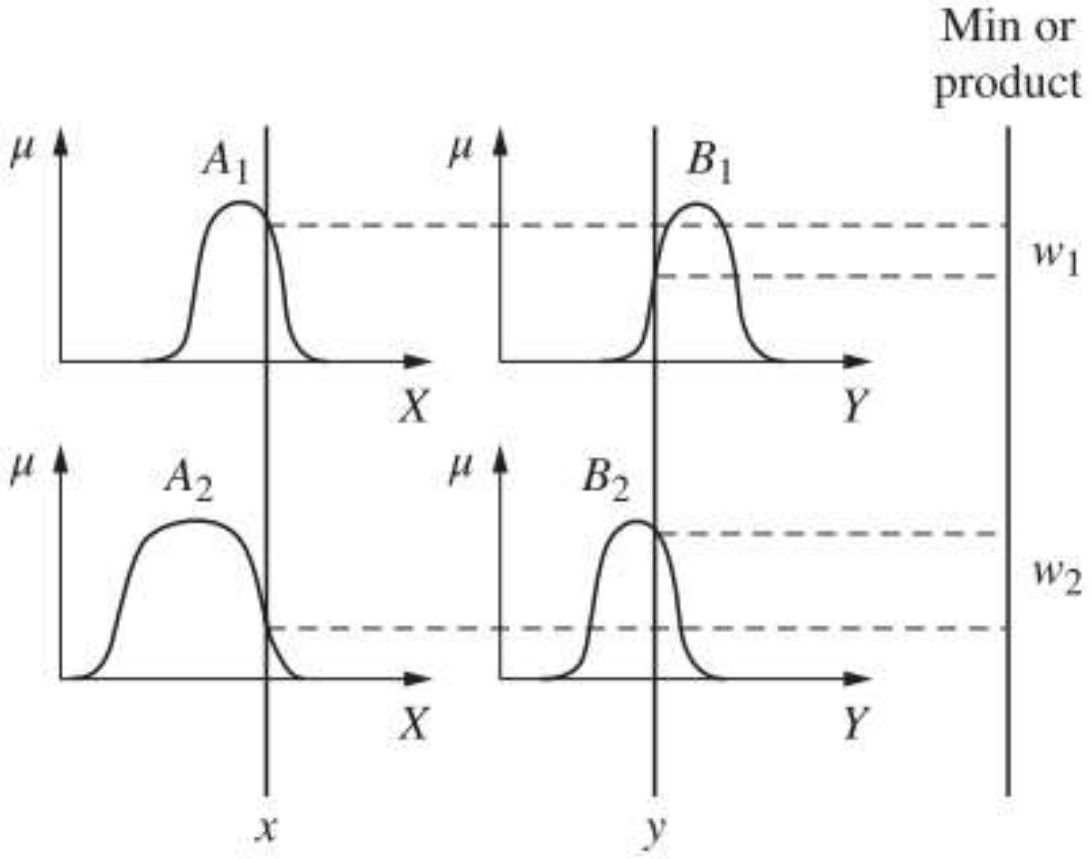
IF x_1 is $\underset{\sim}{A}_1^k$ and x_2 is $\underset{\sim}{A}_2^k$ THEN y^k is $\underset{\sim}{B}^k$, for $k = 1, 2, \ldots, r$,



(max–min) inference method

RULES IN TSK'S FORM

IF x is $\underset{\sim}{A}$ *and* y is $\underset{\sim}{B}$, THEN z is $z = f(x, y)$.



$$z_1 = p_1 x + q_1 y + r_1$$

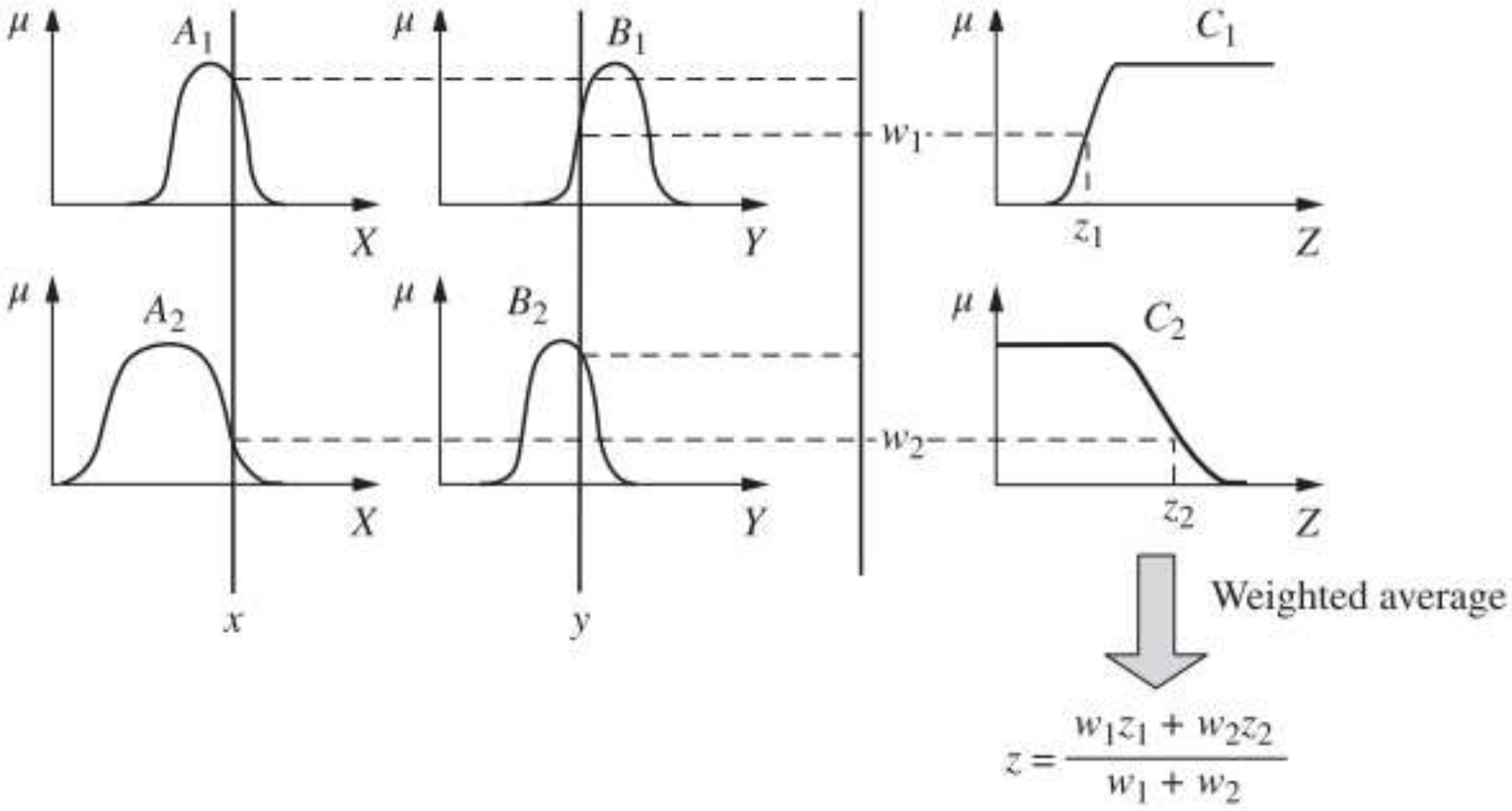
$$z_2 = p_2 x + q_2 y + r_2$$

Weighted average

$$z = \frac{w_1 z_1 + w_2 z_2}{w_1 + w_2}$$

TSUKAMOTO FUZZY MODEL

Membership functions of output are monotone



6.2. XÂY DỰNG HỆ MỜ

Các bước:

- Lựa chọn cấu trúc mô hình: Biến vào, biến ra, các giá trị ngôn ngữ cho mỗi biến, các hàm thuộc, phép toán t, s, khử mờ, hợp thành, …
- Huấn luyện: Tính toán hàm thuộc cho các giá trị ngôn ngữ, các luật mờ
- Kiểm tra, điều chỉnh các tham số (luật, hàm thuộc) để đầu ra của hệ mờ phù hợp với đầu ra thực tế

HUẤN LUYỆN TẬP LUẬT MỜ

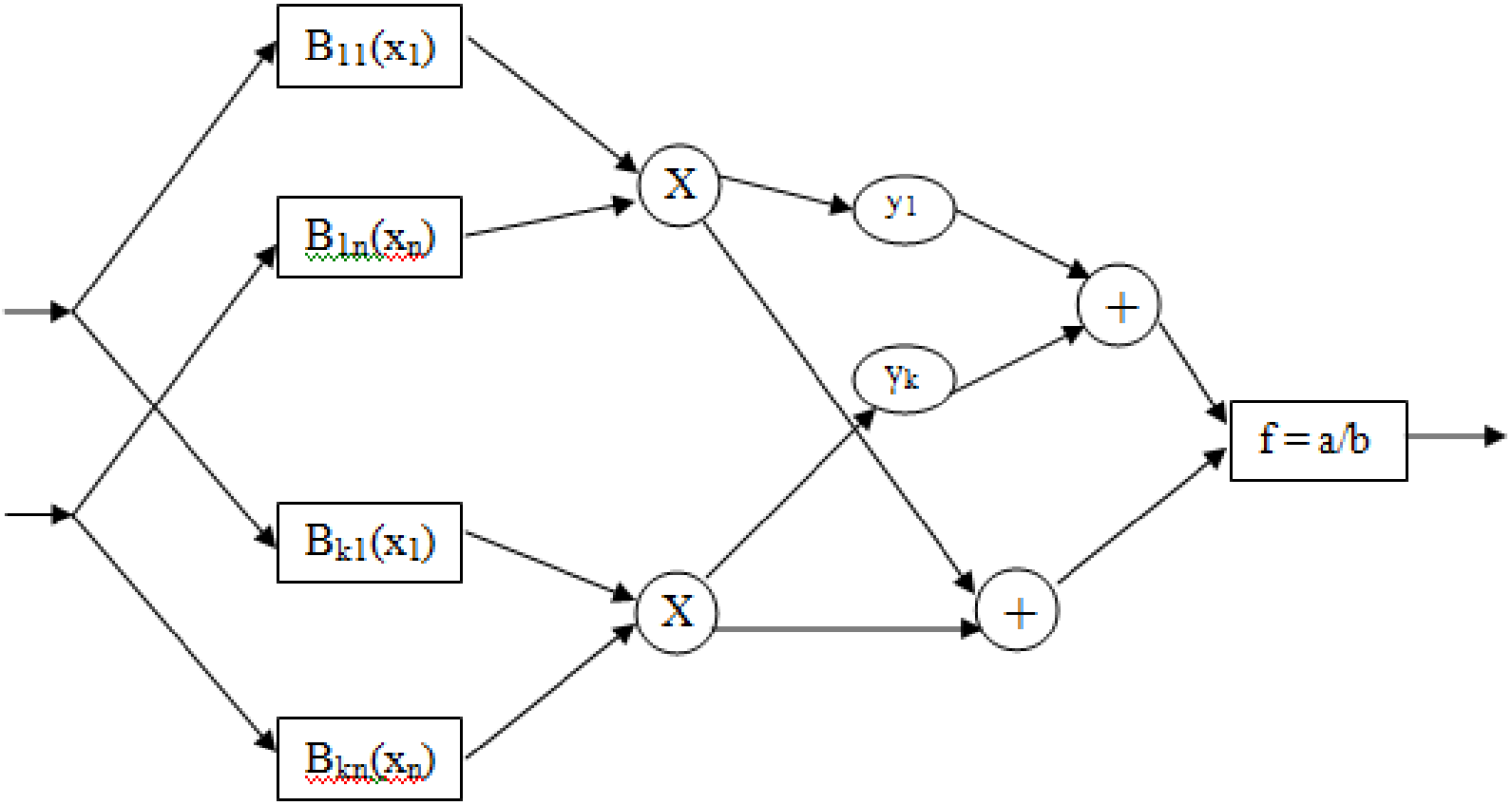
Input: Tập mẫu dữ liệu (x_1^p, …, x_n^p; y^p), với p=1..N

Output: Tập luật mờ

- Bước 1: xác định các tập mờ A. cho mỗi biến ngôn ngữ X, sao cho $[\min_X, \max_X] \subset \cup \text{supp}(A.)$
- Bước 2: Với mỗi mẫu dữ liệu: $x_i^p \in \text{supp}(A_{ij})$ với độ thuộc μ_{ij}^p, thì sinh các luật mờ:

  If X_1 is A_{1j} and … and X_n is A_{nj} then Y is B_j,
  với độ thuộc $\Pi\mu_{ij}^p$
- Bước 3: Loại bỏ các luật dư thừa, loại bỏ các luật mâu thuẫn

PHƯƠNG PHÁP GRADIENT NGƯỢC



Hệ mờ: n Input, 1 Output, k luật mờ, tập mờ tam giác cân (tâm c., bán kính b.), hợp thành max-product, …

- $B_{li}(x_i) = (1 - |x_i - c_{li}|) / b_{li}$, nếu $c_{li} - b_{li} \le x_i \le c_{li} + b_{li}$

  0, ngược lại

  c_{li}, b_{li} là tham số của tập mờ tam giác cân

- $z_l = \prod B_{li}(x_i)$ với l = 1,2,…,k

$$a = \sum y_l z_l \qquad b = \sum z_l$$

- Output $f = a/b$
- Cần điều chỉnh các tham số y_l, c_{li}, b_{li}

$$y_l(j+1) = y_l(j) - \alpha . \partial e / \partial y_l |_j \quad \partial e / \partial y_l = (f-d).(\partial f / \partial a).(\partial a / \partial y_l) = (f-d).z_l / b$$

$$c_{li}(j+1) = c_{li}(j) - \alpha . \partial e / \partial c_{li} |_j \quad \partial e / \partial c_{li} = \pm (f-d).(y_l - f).z_l / (b.b_{li}.B_{li}(x_i))$$

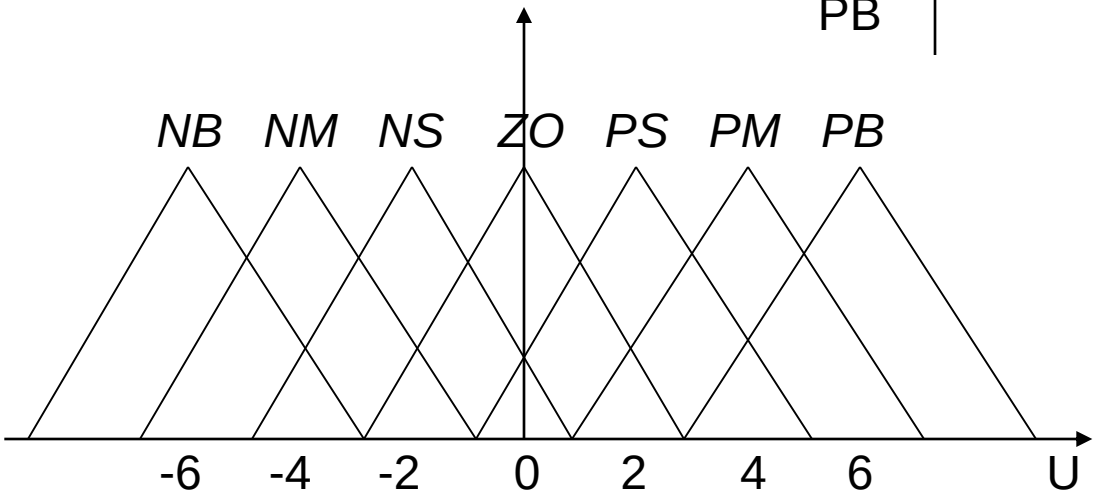
$$b_{li}(j+1) = b_{li}(j) - \alpha . \partial e / \partial b_{li} |_j \quad \partial e / \partial b_{li} = (f-d).(y_l - f).|x_i - c_{li}|.z_l / (b.b_{li}^2.B_{li}(x_i))$$

VÍ DỤ (CON LẮC NGƯỢC)

Fuzzy Rules :

$e, \Delta e \rightarrow \Delta q$

e \ Δe	NB	NM	NS	ZO	PS	PM	PB
NB				PB			
NM				PM			
NS				PS			
ZO	PB	PM	PS	ZO	NS	NM	NB
PS				NS			
PM				NM			
PB				NB			

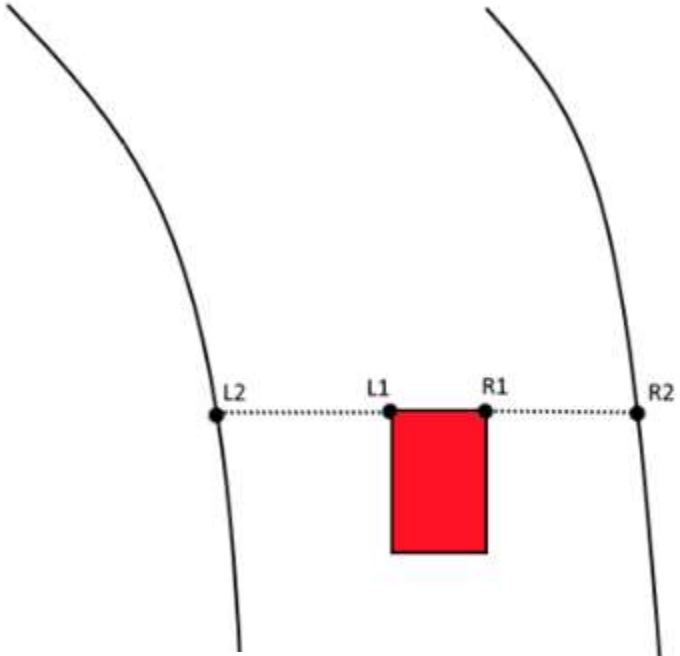


CASE STUDY

ĐIỀU KHIỂN HƯỚNG

Input Variable: Deviation

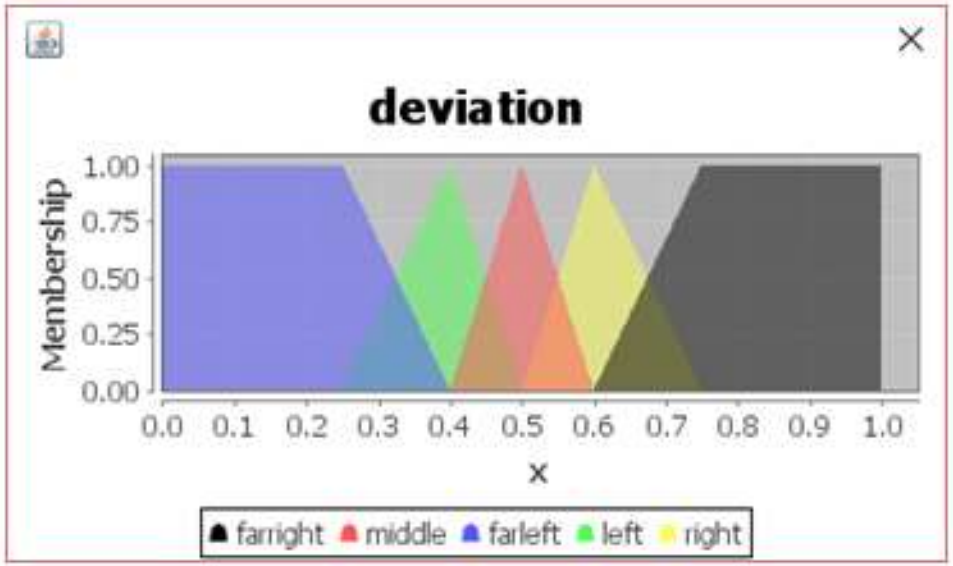
Output Variable: Steering

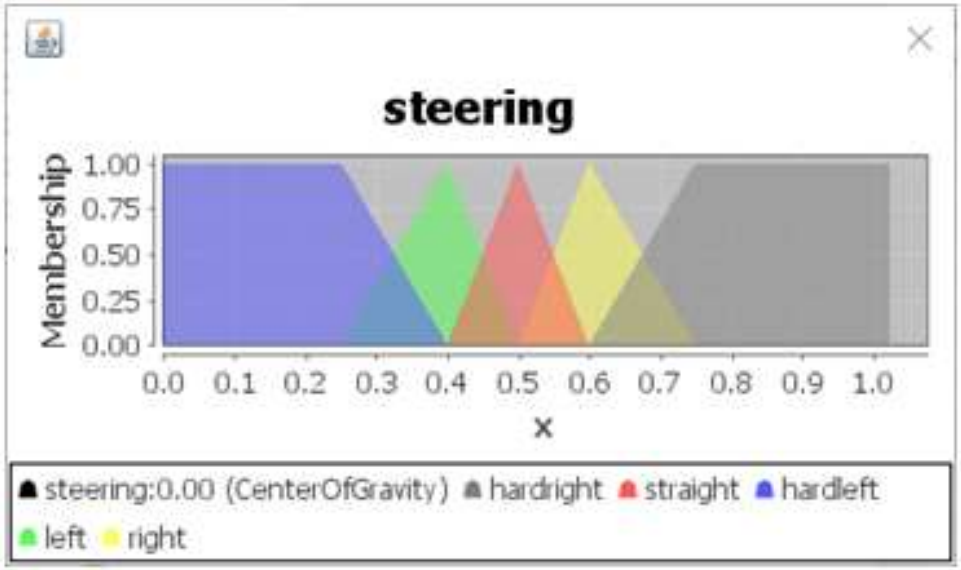


$$d_L = \sqrt{(x_{L1} - x_{L2})^2 + (y_{L1} - y_{L2})^2}$$

$$d_R = \sqrt{(x_{R1} - x_{R2})^2 + (y_{R1} - y_{R2})^2}$$

$$x = \frac{dL}{dL + dR}$$





ĐIỀU KHIỂN HƯỚNG

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RULE1: IF deviation IS farleft THEN steering IS hardright;

RULE2: IF deviation IS left THEN steering IS right;

RULE3: IF deviation IS middle THEN steering IS straight;

RULE4: IF deviation IS right THEN steering IS left;

RULE5: IF deviation IS farright THEN steering IS hardleft;
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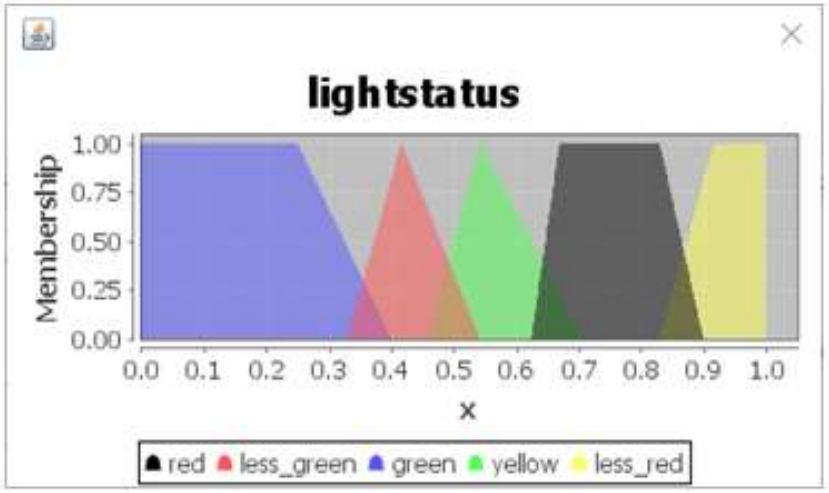
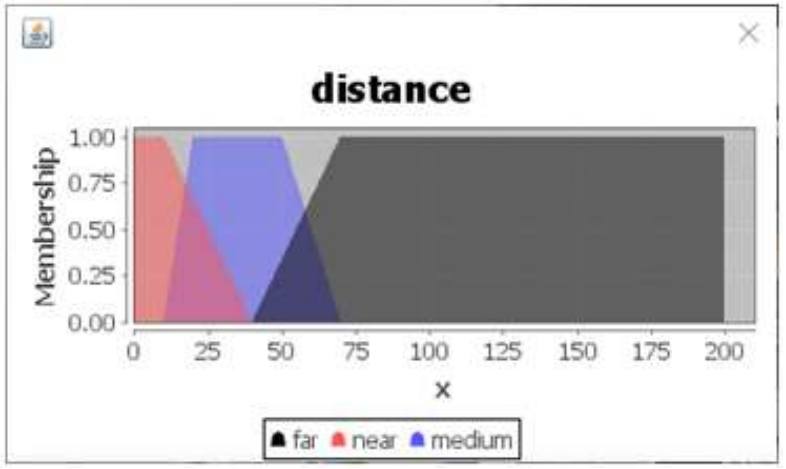
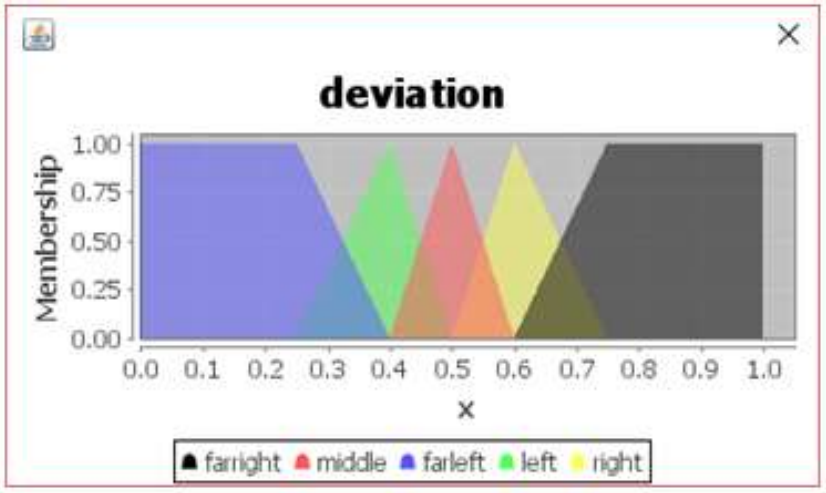
ĐIỀU KHIỂN VẬN TỐC

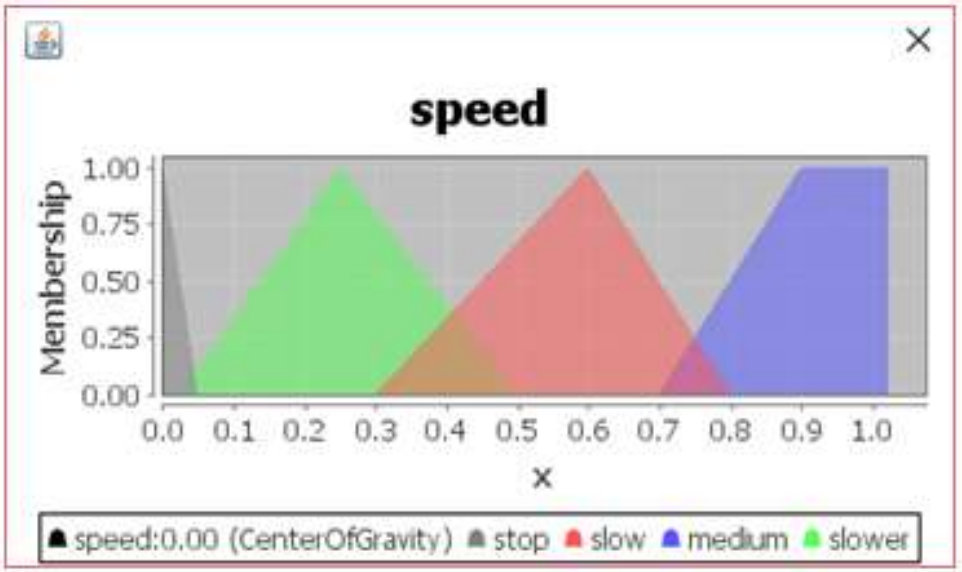
Input Variable: Distance, Lightstatus, Deviation

Output Variable: Speed









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RULE1: IF lightstatus IS green AND deviation IS middle THEN speed IS medium;

RULE2: IF lightstatus IS green AND deviation IS left THEN speed IS slow;

RULE3: IF lightstatus IS green AND deviation IS right THEN speed IS slow;

RULE4: IF lightstatus IS green AND deviation IS farleft THEN speed IS slower;

RULE5: IF lightstatus IS green AND deviation IS farright THEN speed IS slower;

RULE6: IF distance IS far AND deviation IS middle THEN speed IS medium;

RULE7: IF distance IS far AND deviation IS left THEN speed IS slow;

RULE8: IF distance IS far AND deviation IS right THEN speed IS slow;

RULE9: IF distance IS far AND deviation IS farleft THEN speed IS slower;

RULE10: IF distance IS far AND deviation IS farright THEN speed IS slower;

RULE11: IF lightstatus IS yellow AND distance IS medium AND deviation IS middle THEN
speed IS slow;

RULE12: IF lightstatus IS yellow AND distance IS medium AND deviation IS left THEN
speed IS slower;
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RULE13: IF lightstatus IS yellow AND distance IS medium AND deviation IS right THEN
speed IS slower;

RULE14: IF lightstatus IS yellow AND distance IS medium AND deviation IS farleft THEN
speed IS slower;

RULE15: IF lightstatus IS yellow AND distance IS medium AND deviation IS farright
THEN speed IS slower;

RULE16: IF lightstatus IS yellow AND distance IS near THEN speed IS stop;

RULE17: IF lightstatus IS red AND distance IS medium AND deviation IS middle THEN
speed IS slow;

RULE18: IF lightstatus IS red AND distance IS medium AND deviation IS left THEN speed
IS slower;

RULE19: IF lightstatus IS red AND distance IS medium AND deviation IS right THEN
speed IS slower;

RULE20: IF lightstatus IS red AND distance IS medium AND deviation IS farleft THEN
speed IS slower;
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RULE21: IF lightstatus IS red AND distance IS medium AND deviation IS farright THEN
speed IS slower;

RULE22: IF lightstatus IS red AND distance IS near THEN speed IS stop;

RULE23: IF lightstatus IS less_green AND distance IS medium AND deviation IS middle
THEN speed IS medium;

RULE24: IF lightstatus IS less_green AND distance IS medium AND deviation IS left
THEN speed IS slow;

RULE25: IF lightstatus IS less_green AND distance IS medium AND deviation IS right
THEN speed IS slow;

RULE26: IF lightstatus IS less_green AND distance IS medium AND deviation IS farleft
THEN speed IS slower;

RULE27: IF lightstatus IS less_green AND distance IS medium AND deviation IS farright
THEN speed IS slower;

RULE28: IF lightstatus IS less_green AND distance IS near AND deviation IS middle
THEN speed IS slower;
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RULE29: IF lightstatus IS less_green AND distance IS near AND deviation IS left THEN
speed IS slower;

RULE30: IF lightstatus IS less_green AND distance IS near AND deviation IS right THEN
speed IS slower;
RULE31: IF lightstatus IS less_green AND distance IS near AND deviation IS farleft
THEN speed IS stop;

RULE32: IF lightstatus IS less_green AND distance IS near AND deviation IS farright
THEN speed IS stop;

RULE33: IF lightstatus IS less_red AND distance IS medium AND deviation IS middle
THEN speed IS slow;

RULE34: IF lightstatus IS less_red AND distance IS medium AND deviation IS left THEN
speed IS slower;

RULE35: IF lightstatus IS less_red AND distance IS medium AND deviation IS right THEN
speed IS slower;

RULE36: IF lightstatus IS less_red AND distance IS medium AND deviation IS farleft
THEN speed IS slower;

RULE37: IF lightstatus IS less_red AND distance IS medium AND deviation IS farright
THEN speed IS slower;

RULE38: IF lightstatus IS less_red AND distance IS near THEN speed IS stop;
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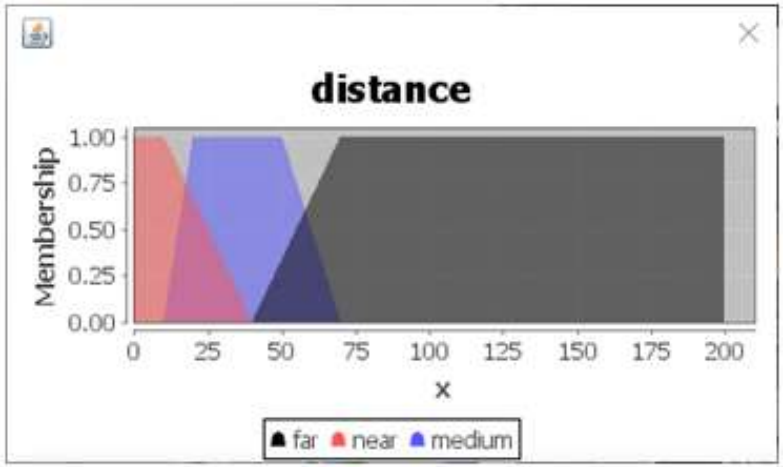
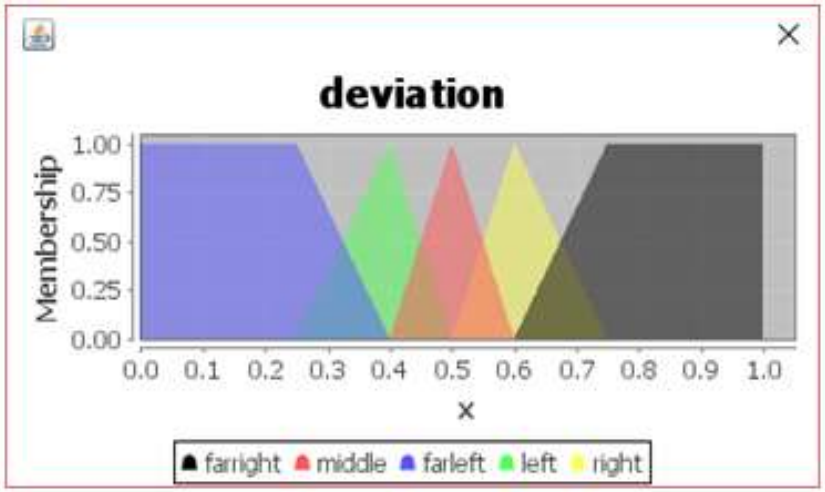
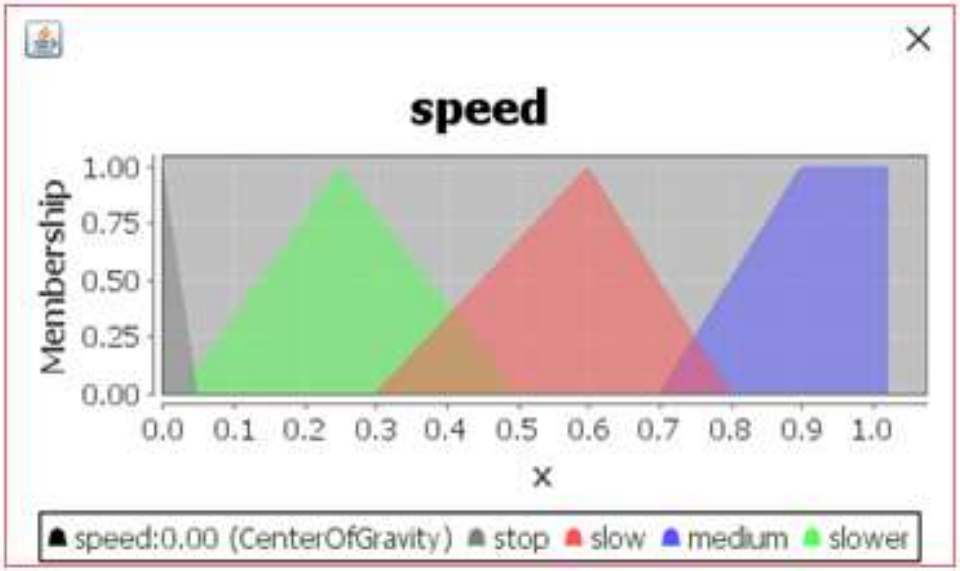
KHI GẶP VẬT CẢN

Input Variable: Distance,
Deviation

Output Variable: Speed







KHI GẶP VẬT CẢN

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RULE1: IF distance IS near THEN speed IS stop;

RULE2: IF distance IS medium AND deviation IS farleft THEN speed IS slower;

RULE3: IF distance IS medium AND deviation IS farright THEN speed IS slower;

RULE4: IF distance IS medium AND deviation IS left THEN speed IS slow;

RULE5: IF distance IS medium AND deviation IS right THEN speed IS slow;

RULE6: IF distance IS medium AND deviation IS middle THEN speed ISmedium;
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