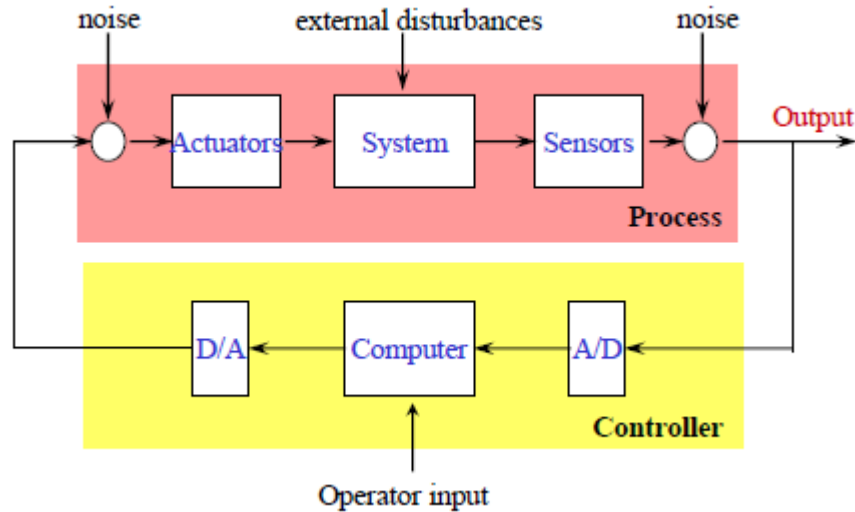




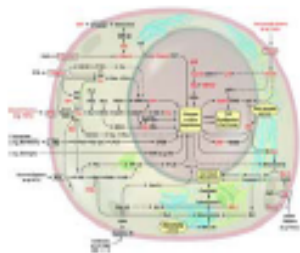
Fuzzy Logic Control

Sistem Kendali



Kendali = pengukuran, penggerak (aktuator) dan prosesor

[Video Pendulum Terbalik](#)



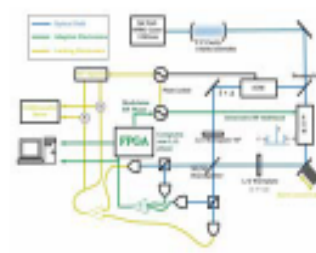
Molecular and chemical processes



Information Systems



Mechanical and Aero Systems

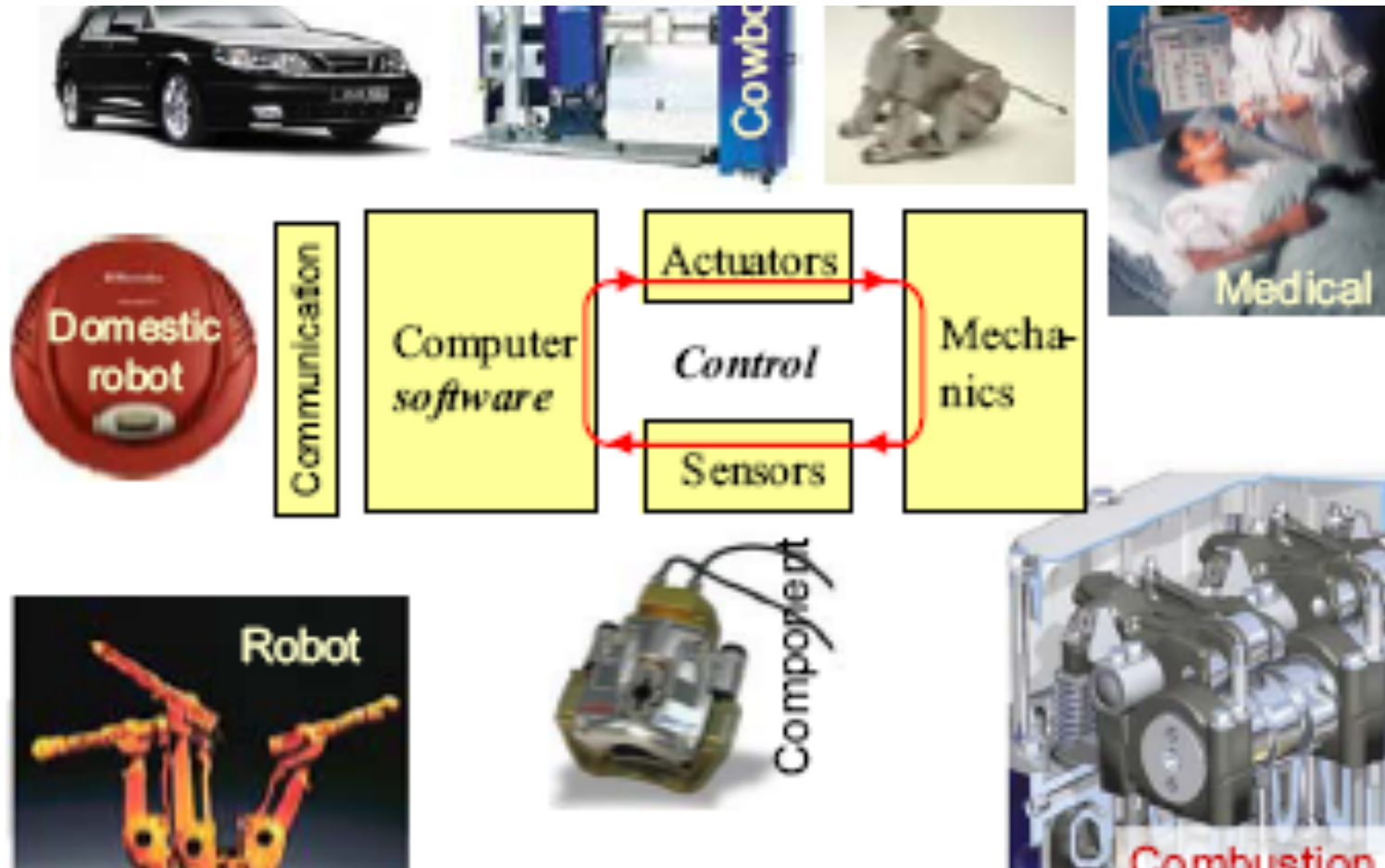


Electrical and Electronic Systems



Robotics and Autonomy

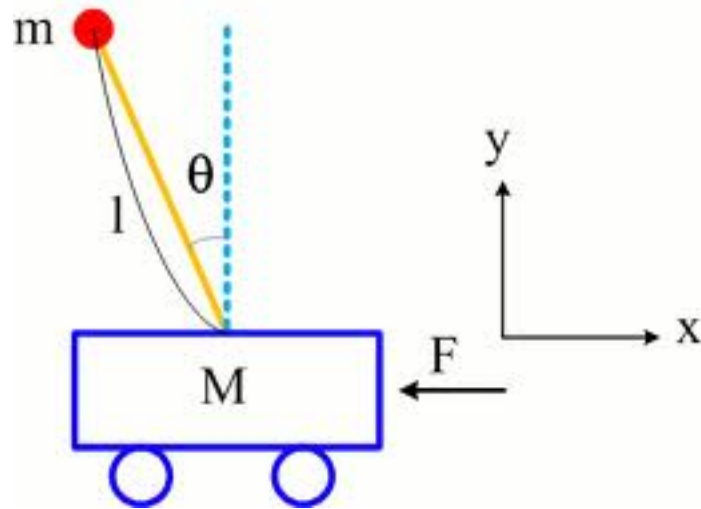
Produk yg mendasarkan pada *embedded control*

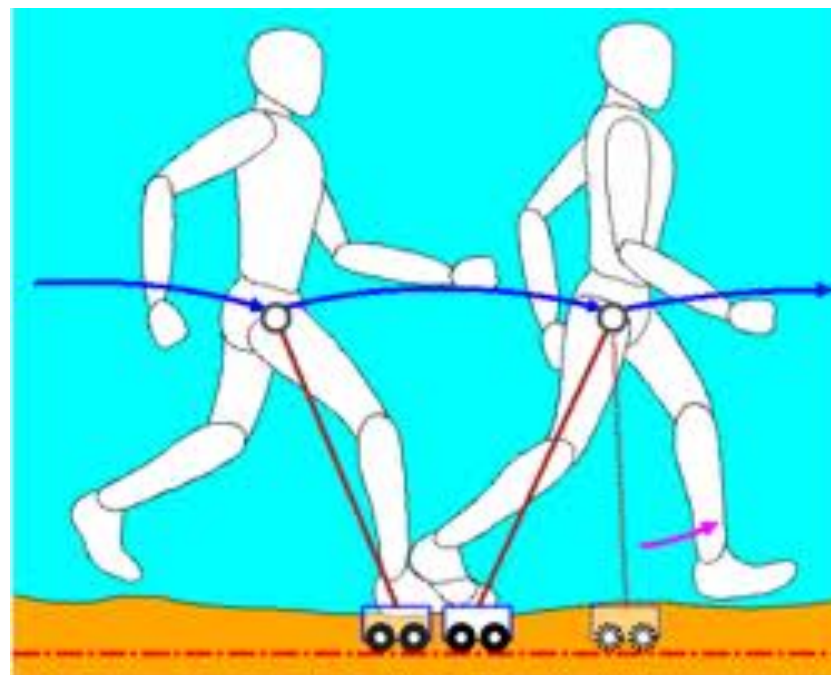


Embedded control di sekitar kita

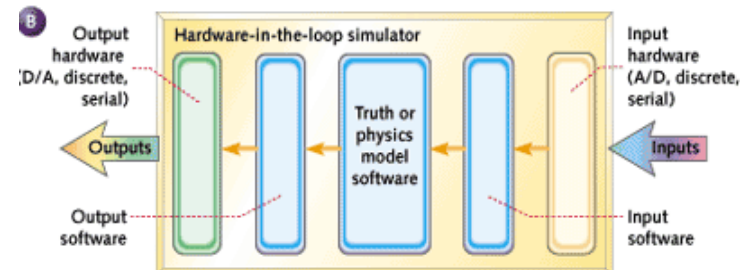
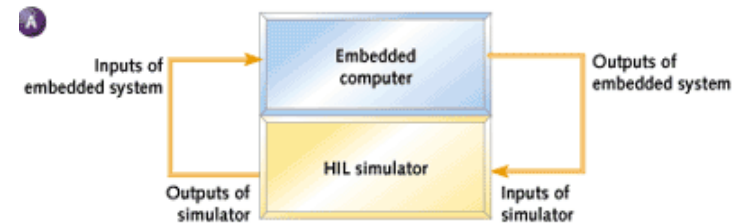
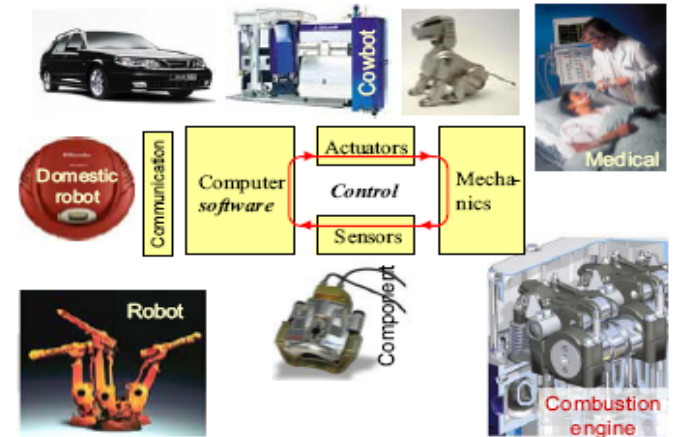
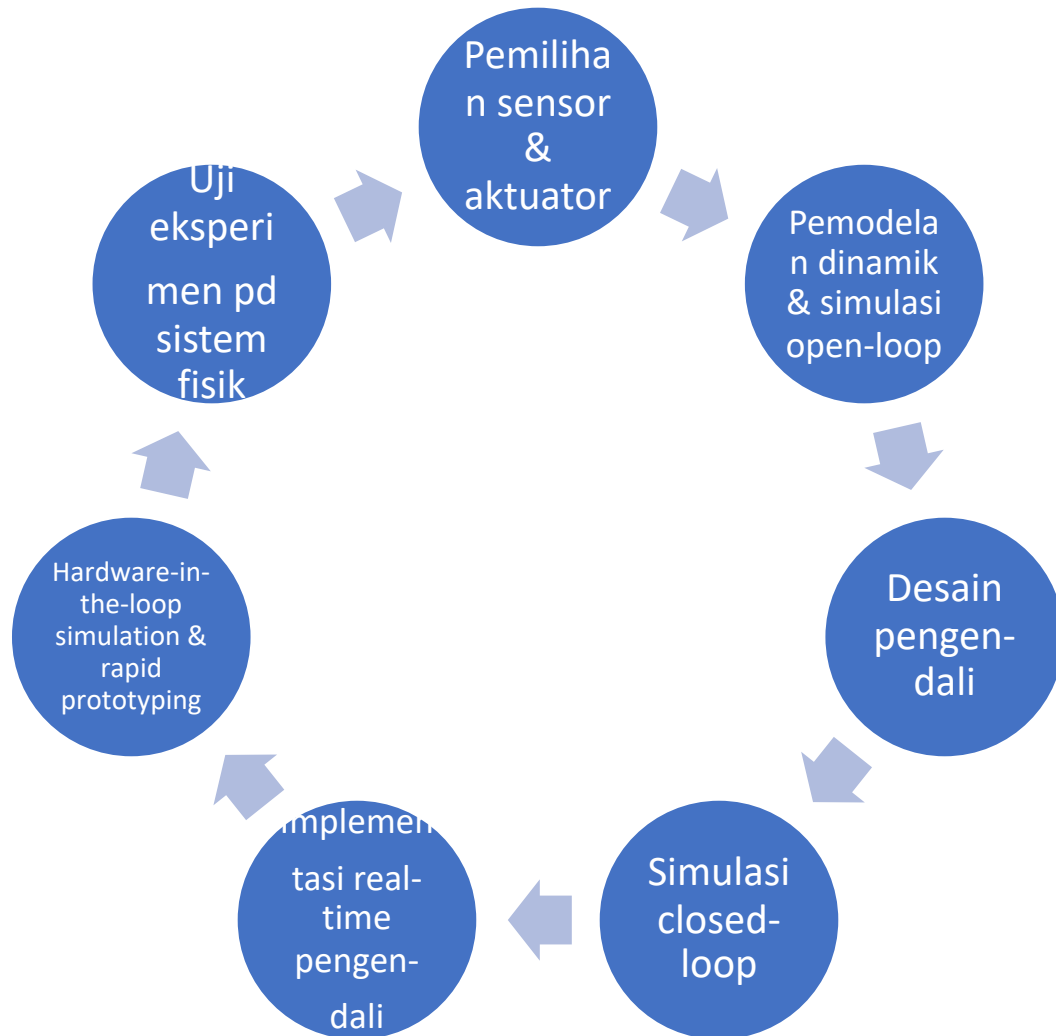


Inverted Pendulum



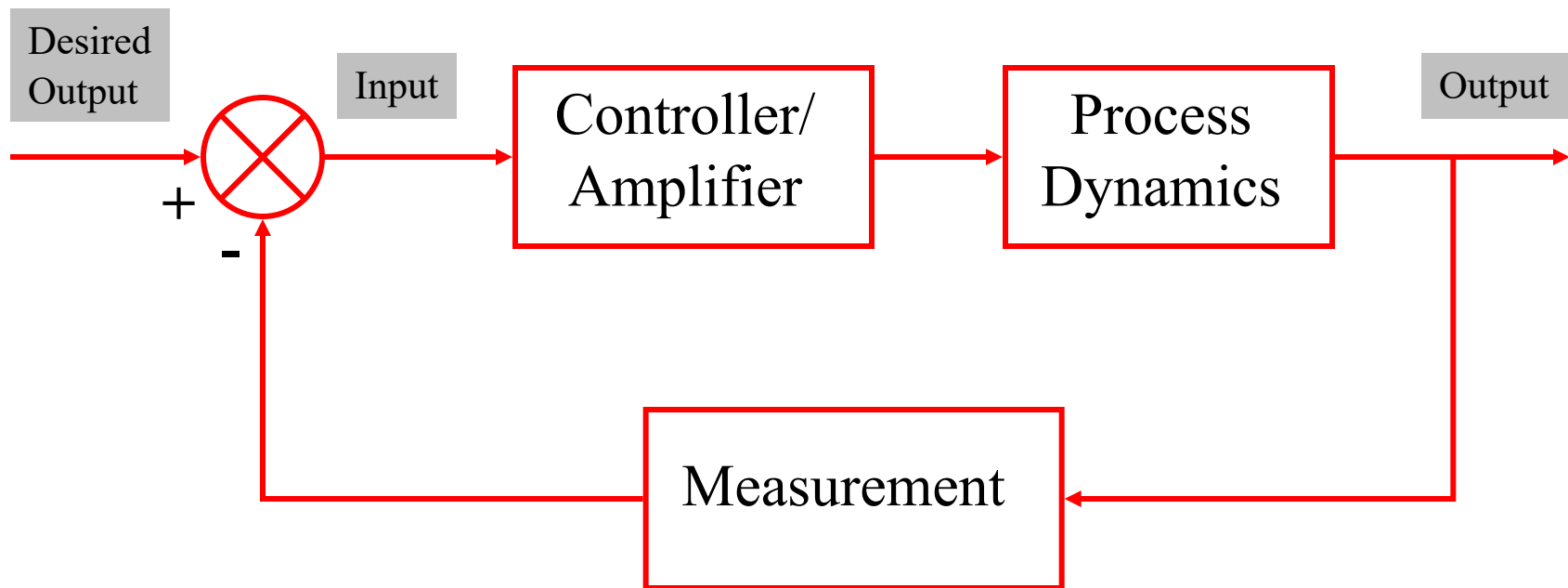


Siklus Desain Sistem Kendali

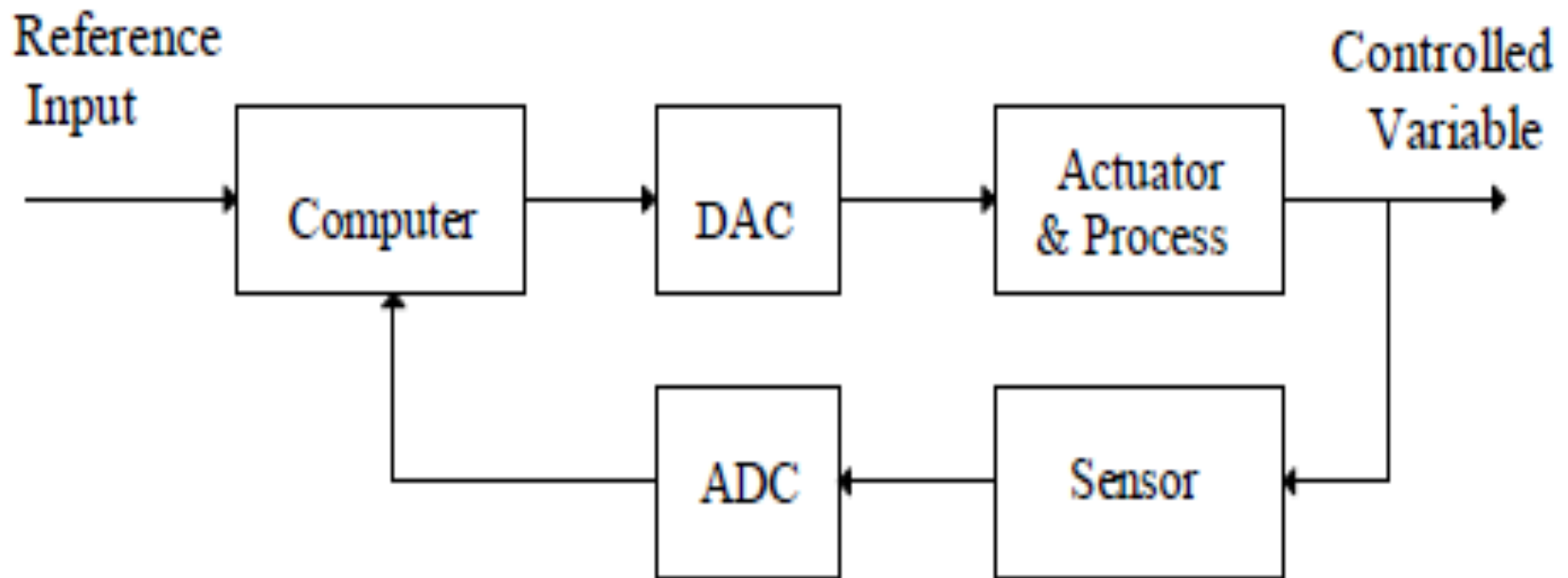


CONVENTIONAL CONTROL

- Open-loop control is 'blind' to actual output
- Closed-loop control takes account of actual output and compares this to desired output

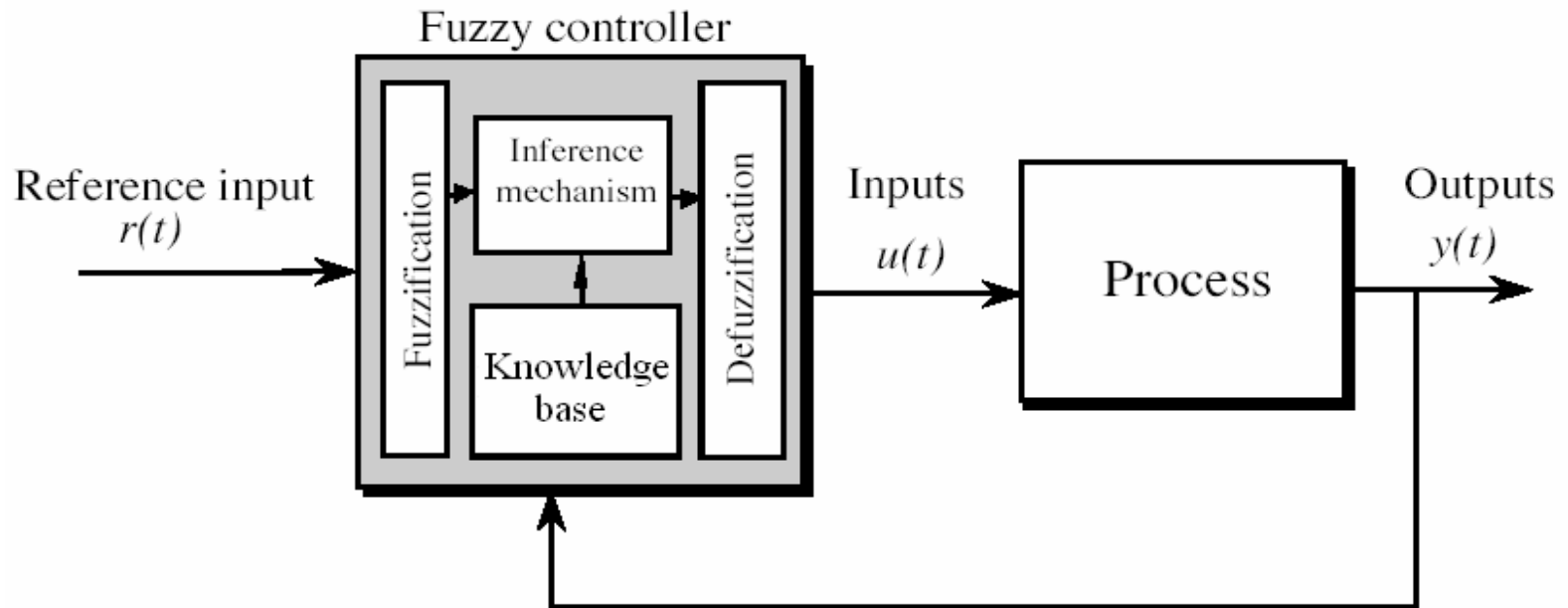


Digital Control System Configuration

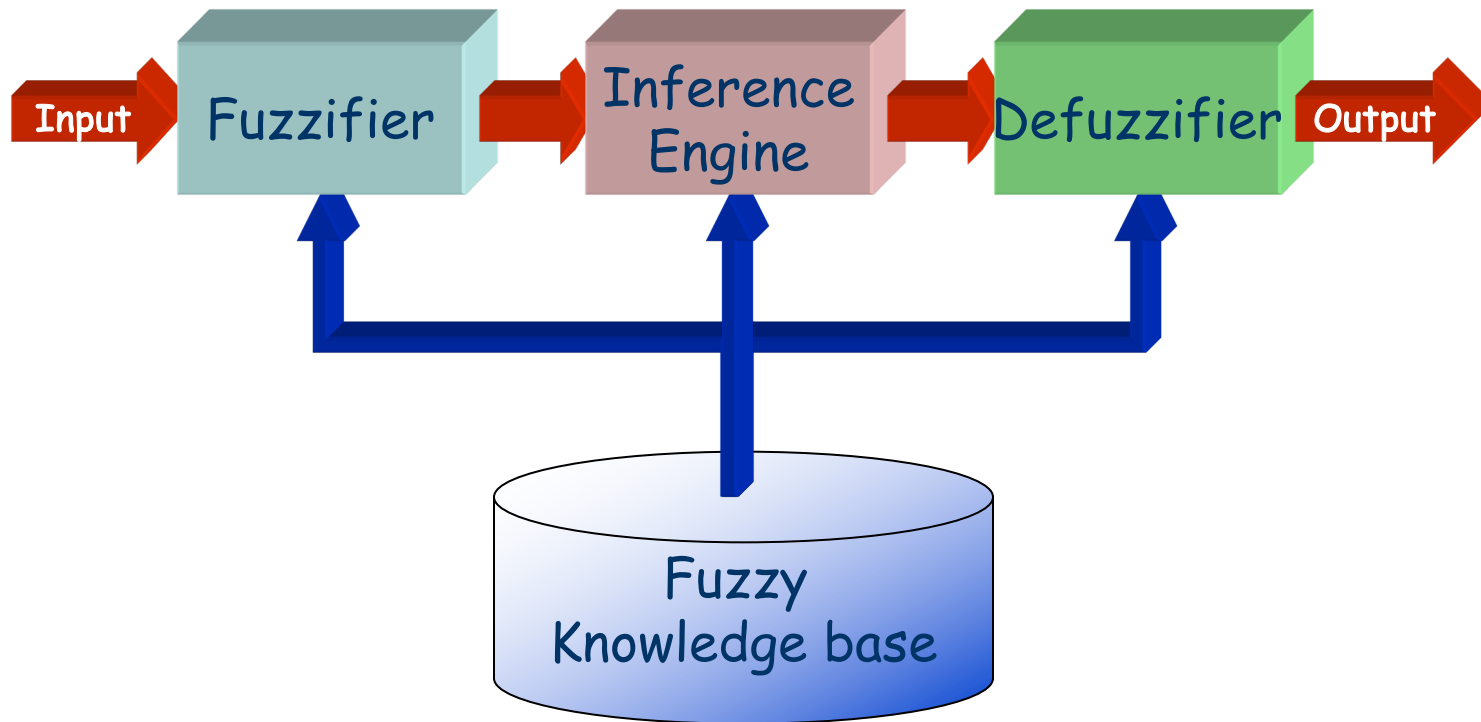


Fuzzy Control

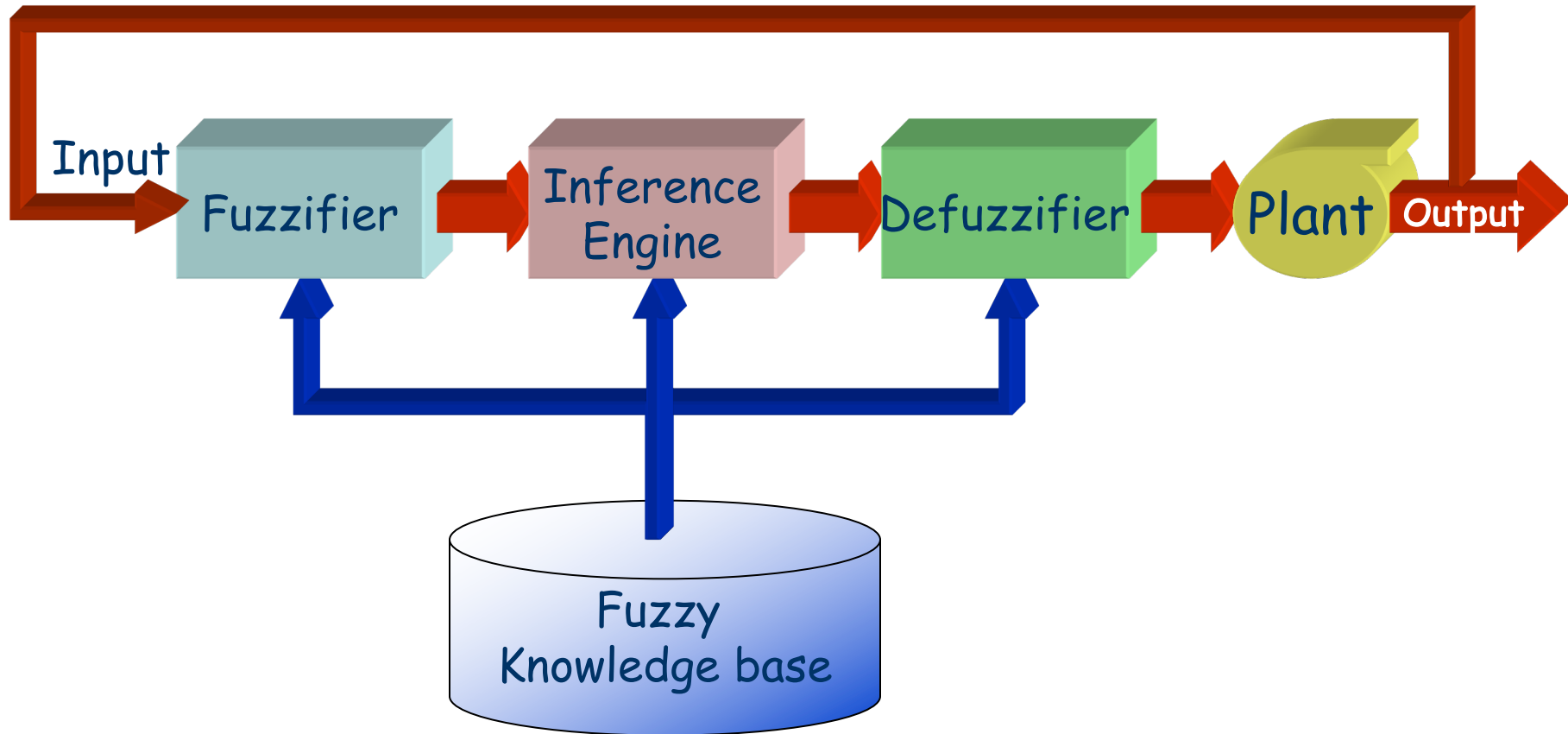
Fuzzy control provides a formal methodology for representing, manipulating, and implementing a human's heuristic knowledge about how to control a system.



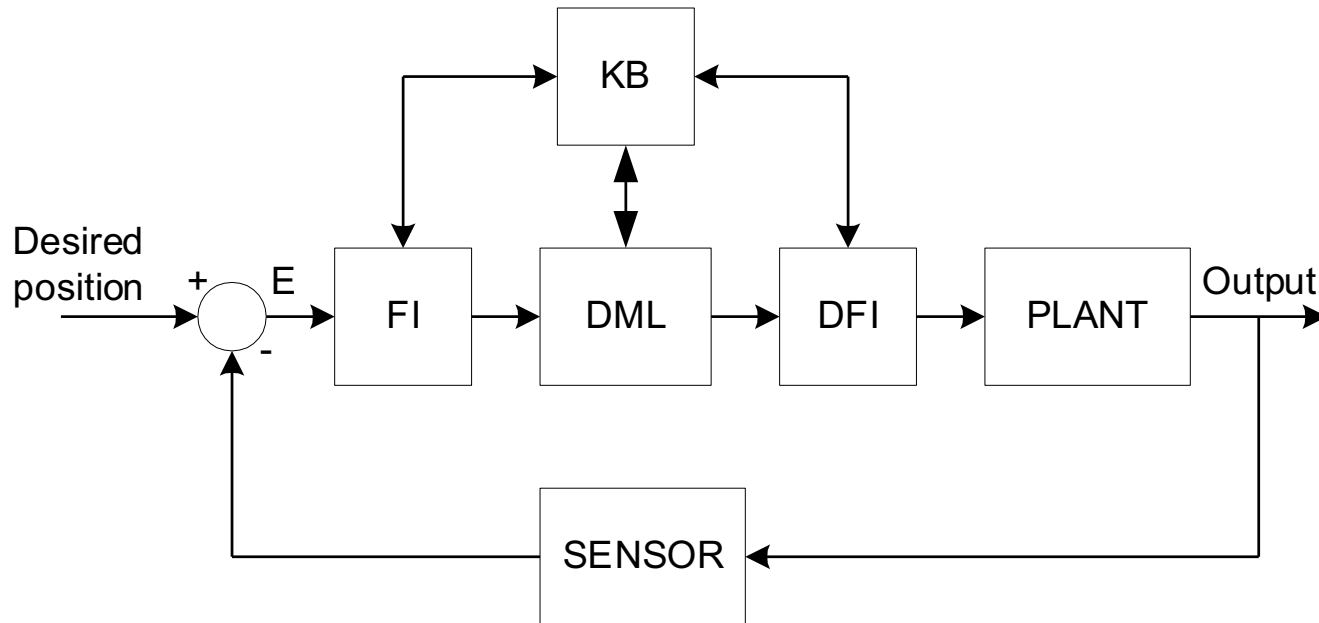
Fuzzy Systems



Fuzzy Control Systems

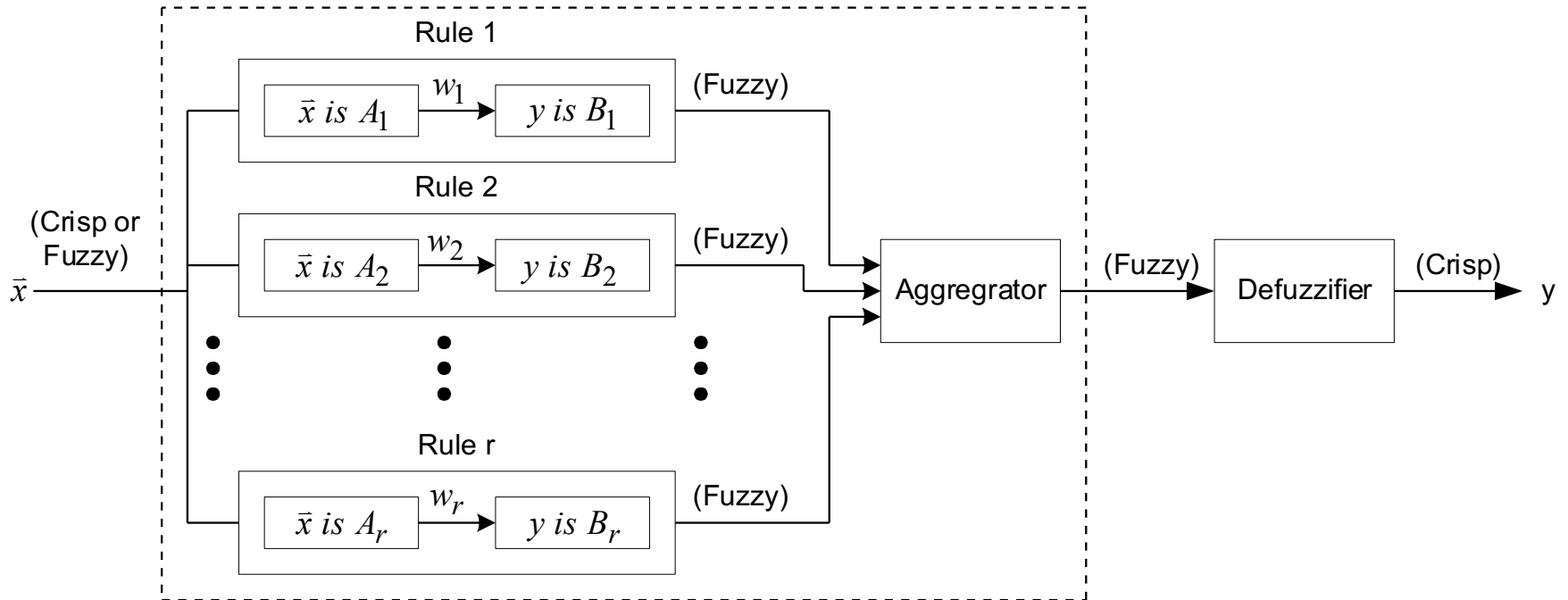


Basic configuration of fuzzy logic control system

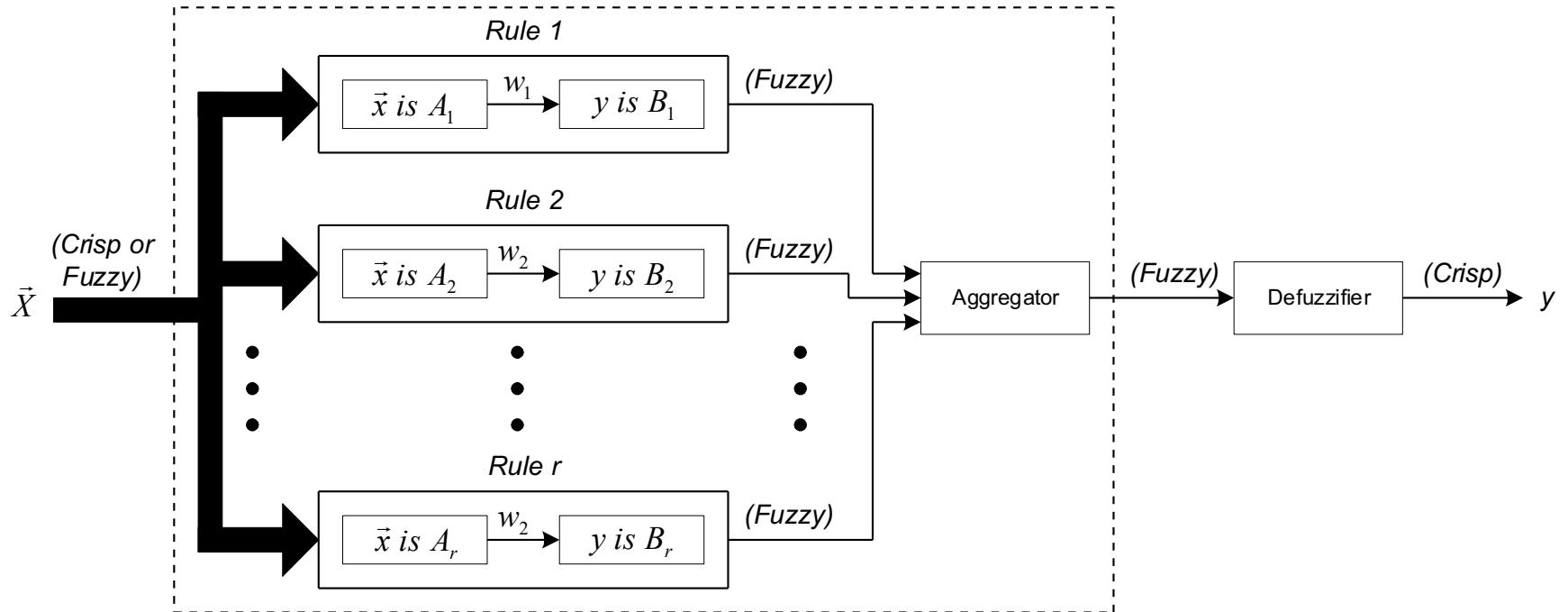


KB: Knowledge Base,
FI: Fuzzification interface,
DML: Decision Making Logic,
DFI: Defuzzification interface

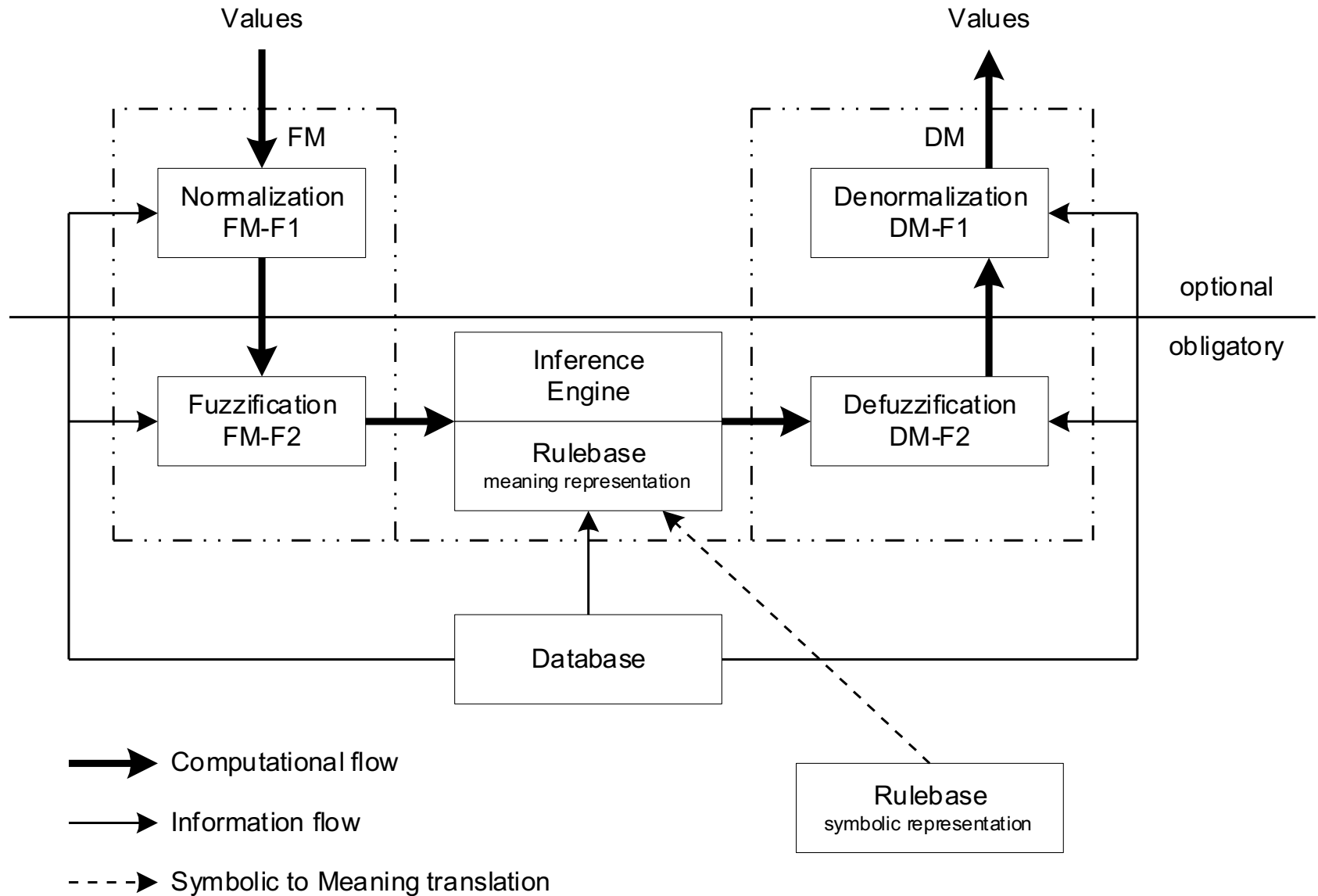
Block diagram for a fuzzy inference system



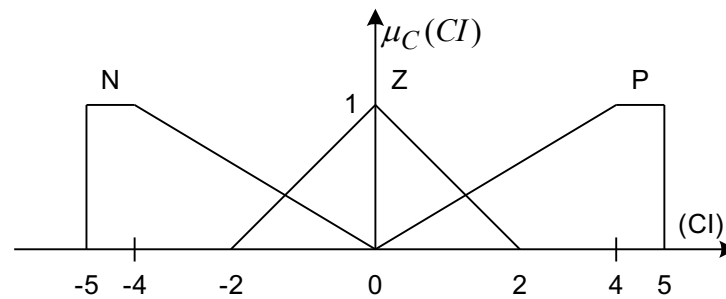
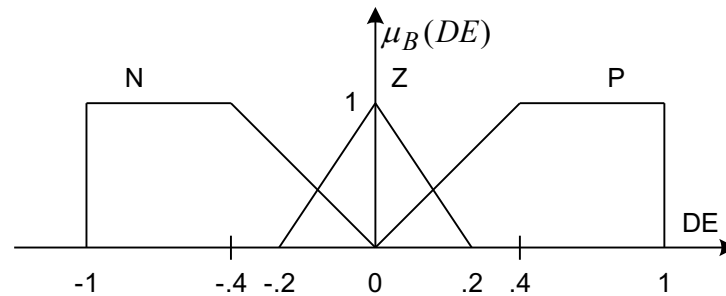
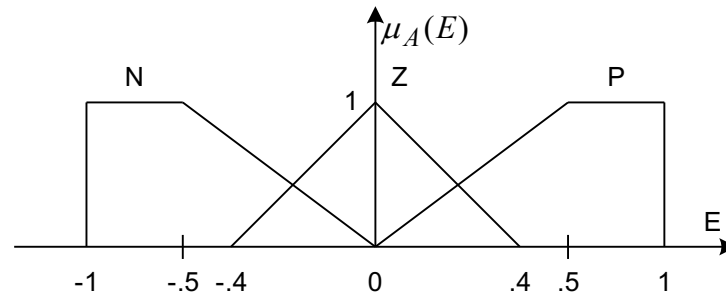
Block diagram for a fuzzy inference system



The structure of a FKBC



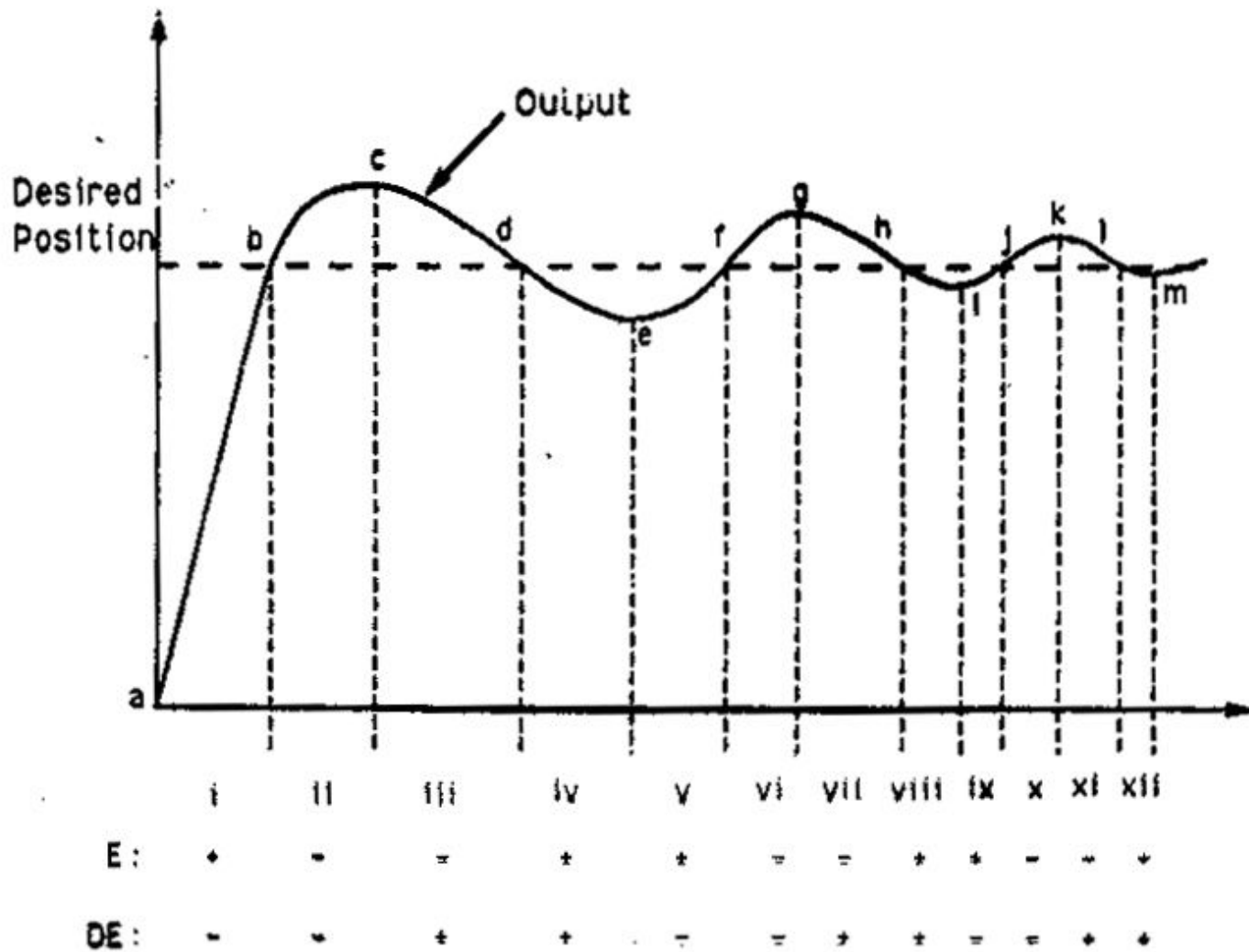
**Three fuzzy partition terms:
N(Negative), Z(Zero), and P(Positive)**



Rule Base Construction

- Intuitive Method
- Method based Operator (Expert) Experience
- Response Ideal Method

Fuzzy decision rule justification by using step response



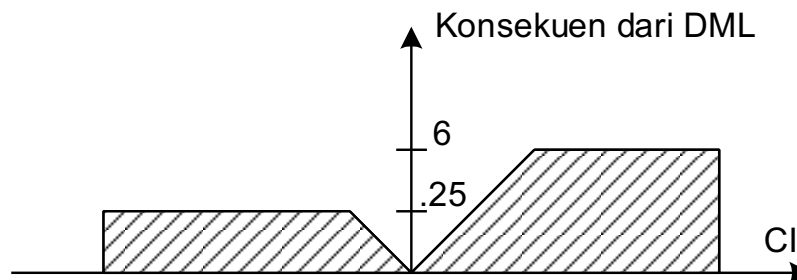
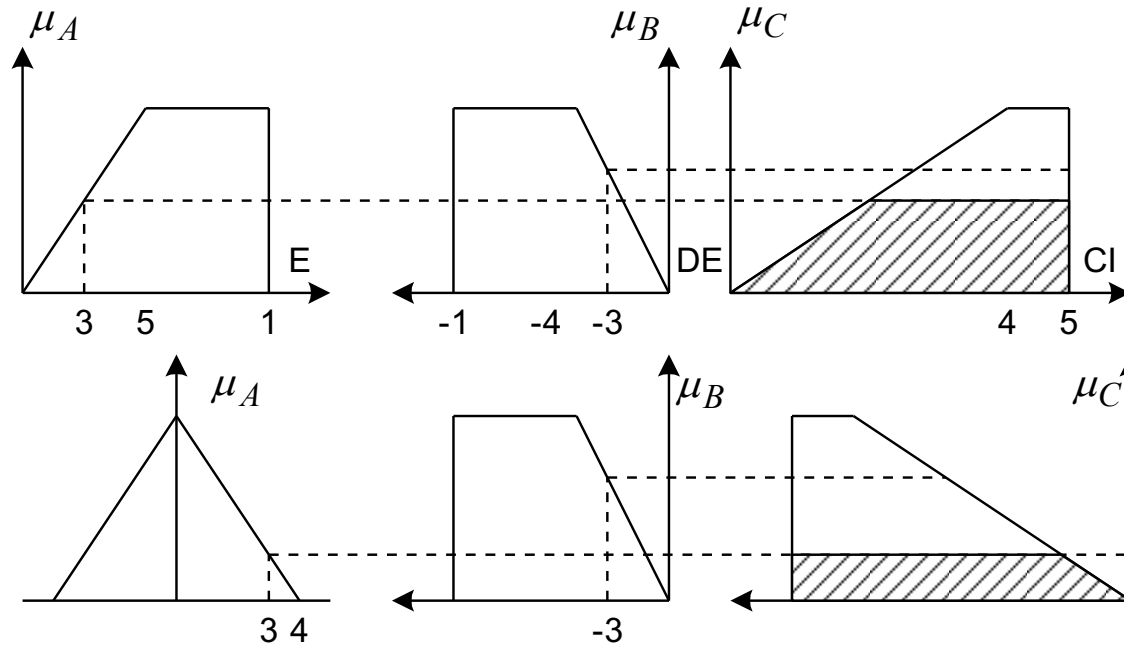
**DML Rule Prototype with Three Fuzzy Set Term
(negative, zero, positive)**

Rule Number	E	DE	CI	Reference Points
1	P	Z	P	a, e, i
2	Z	N	N	b, f, j
3	N	Z	N	c, g, k
4	Z	P	P	d, h, l
5	Z	Z	Z	desired position

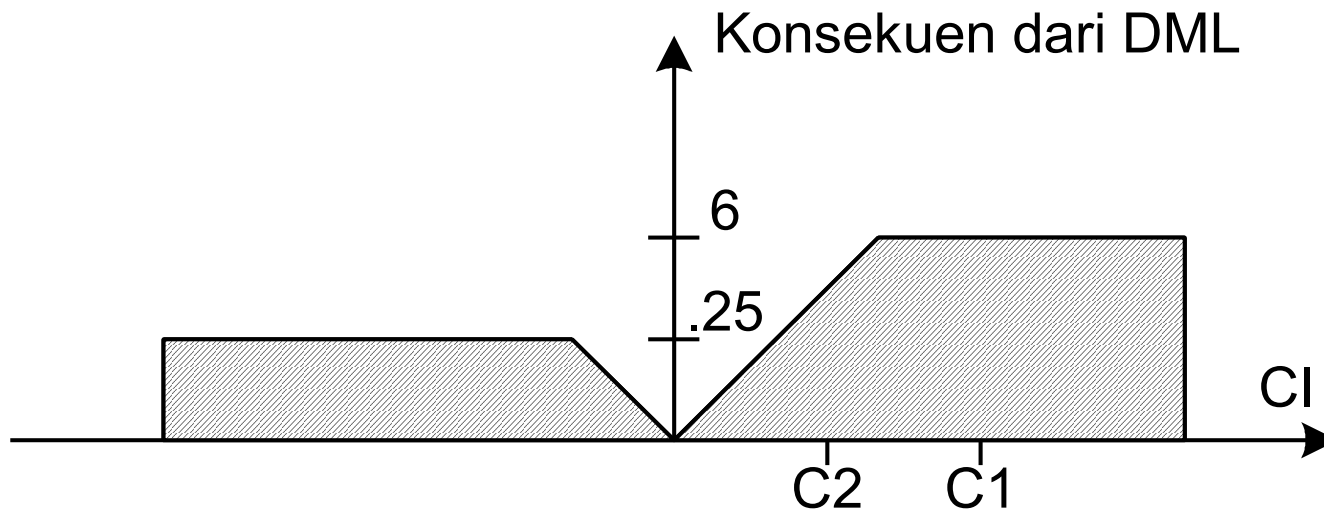
Rule Justification with Three Fuzzy Set Terms

Rule Number	E	DE	CI	Reference Region
6	P	N	P	i(rise time),v
7	N	N	N	ii(overshoot),vi
8	N	P	N	iii, vii
9	P	P	P	iv, viii
10	P	N	Z	ix
11	N	P	Z	xi

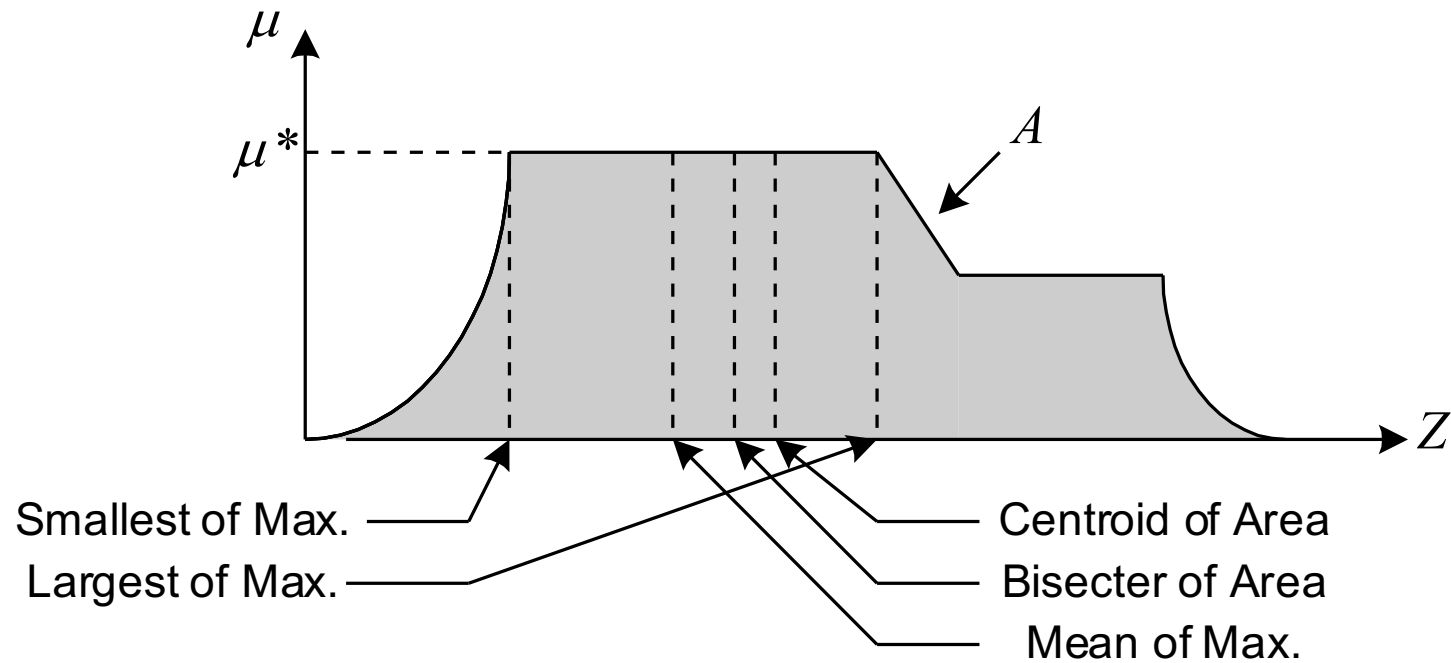
Configuration Procedure and DML Consequence



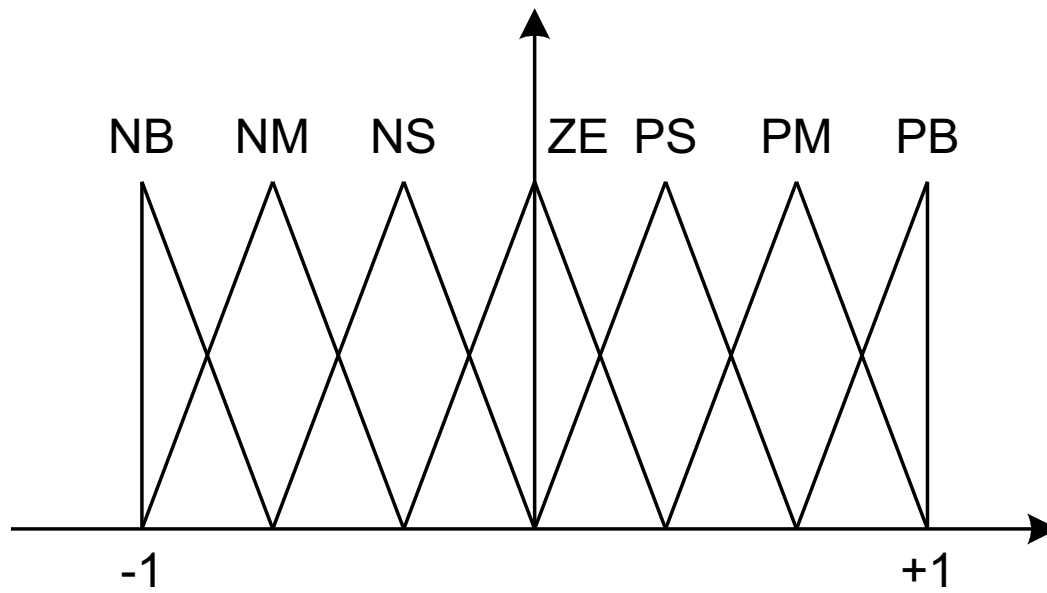
Masukan kendali setelah tahap defuzzifikasi
(Masukan kendali C1: Metoda maksimum rata-rata
Masukan kendali C2: Metoda pusat area)



Various defuzzification schemes for obtaining a crisp output.



Fuzzy Partition using Seven Terms



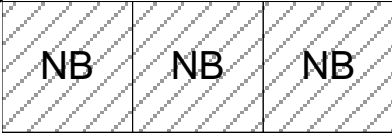

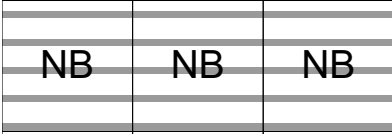
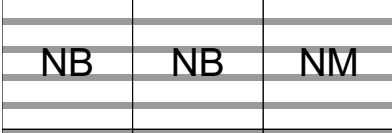

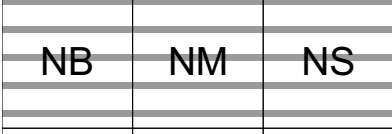
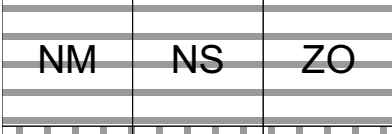




Fuzzy Rules with 7 Terms
{NB, NM, NS, ZE, PS, PM, PB}

Rule No.	E	DE	CI	Reference Region/Point
1	PB	ZE	PB	a
2	PM	ZE	PM	e
3	PS	ZE	PS	i
4	ZE	NB	NB	b
5	ZE	NM	NM	f
6	ZE	NS	NS	j
7	NB	ZE	NB	c
8	NM	ZE	NM	g
9	NS	ZE	NS	k
10	ZE	PB	PB	d
11	ZE	PM	PM	h
12	ZE	PS	PS	i
13	ZE	ZE	ZE	desired position

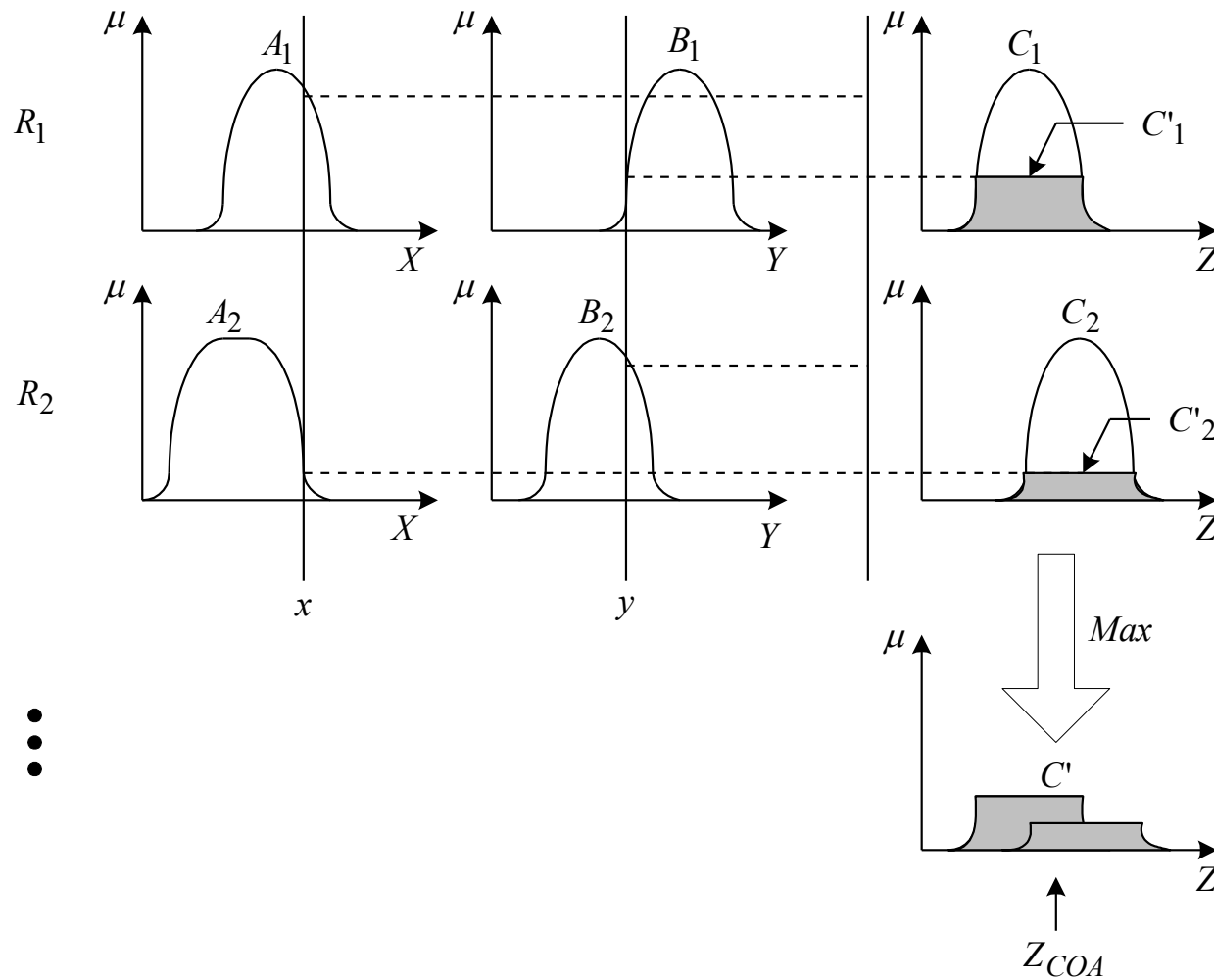
Tabel Justifikasi kaidah dengan tujuh subset fuzzy

Nomor Kaidah	E	DE	CI	Daerah Acuan
14	PB	NS	PM	i(rise-time)
15	PS	NB	NM	ii(overshoot)
16	NB	PS	NM	iii
17	NS	PB	PM	viii
18	PS	NS	ZE	ix
19	NS	PS	ZE	xi

The rule base of a PI-like FKBC in tabular form:
the five groups of rule

e \ Δe		NB	NM	NS	ZO	PS	PM	PB		
NB		NB	NB	NB	NB	NM	NS	ZO		Group 0
NM		NB	NB	NB	NM	NS	ZO	PS		
NS		NB	NB	NM	NS	ZO	PS	PM		Group 2
ZO		NB	NM	NS	ZO	PS	PM	PB		
PS		NM	NS	ZO	PS	PM	PB	PB		Group 3
PM		NS	ZO	PS	PM	PB	PB	PB		
PB		ZO	PS	PM	PB	PB	PB	PB		Group 4

The Mamdani fuzzy inference system using min and max for T-norm
And T-conorm operators, respectively.



IF X is A1 and Y is B1 THEN Z is C1 : R1

IF X is A2 and Y is B2 THEN Z is C2 : R2

⋮