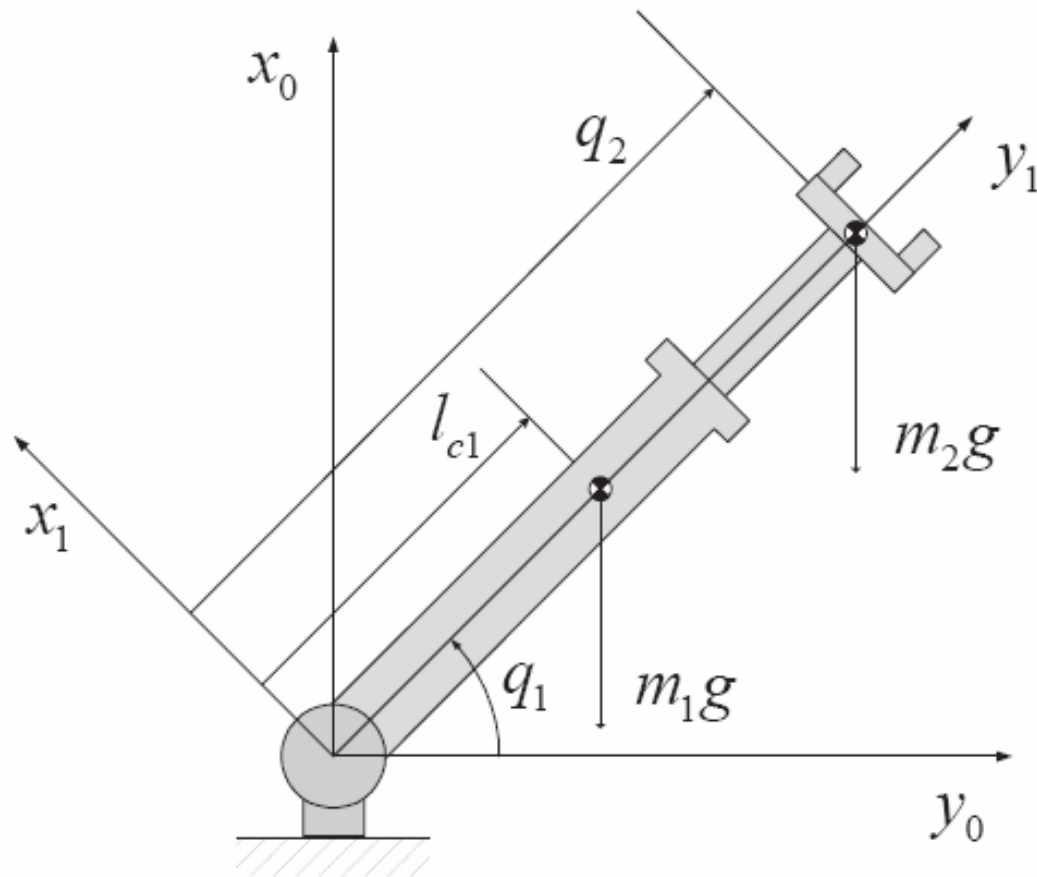# Vježba 1: Neizrazito upravljanje RT-robotom
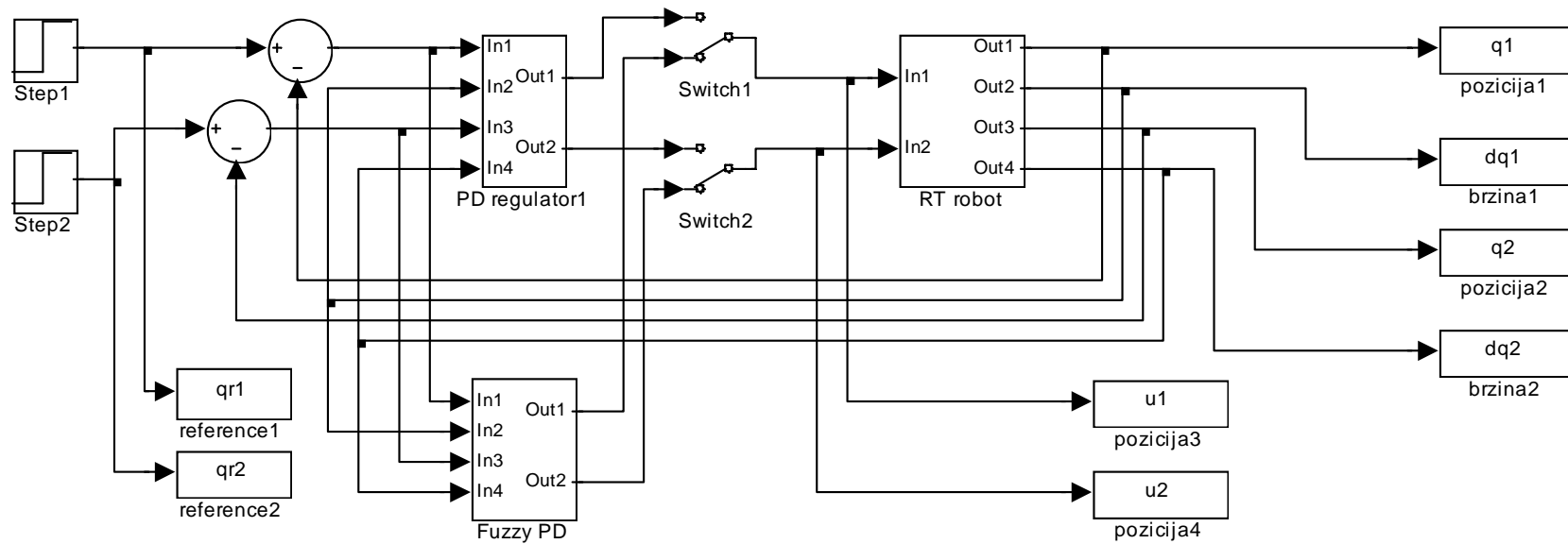
Neizrazita logika

RT robot

$$M(q)\ddot{q} + C(q,\dot{q})\dot{q} + g(q) = u,$$

$$M(q) = \begin{bmatrix} m_1 l_{c1}^2 + m_2 q_2^2 + I_1 + I_2 & 0 \\ 0 & m_2 \end{bmatrix},$$

$$C(\dot{q},q) = \begin{bmatrix} m_2 \dot{q}_2 q_2 & m_2 \dot{q}_1 q_2 \\ -m_2 \dot{q}_1 q_2 & 0 \end{bmatrix},$$

$$g(q) = \begin{bmatrix} m_1 l_{c1} g \cos q_1 + m_2 g q_2 \cos q_1 \\ m_2 g \sin q_1 \end{bmatrix},$$

Simulink model

MatIab code

```
clear
clc

m2=10;
m1=10;
lc1=0.8;
I12=0.1;
m0=m1*lc1*lc1 + I12;
g=9.81;

q10=0; q20=0;
dq10=0; dq20=0;

Kp=900; Kd=200;

fosc2 = readfis('fosc2.fis');

fuzzy fosc2

sim('rtpd')

figure(1)
subplot(2,2,1), plot(tout,q1,'b',tout,qr1,'r'),
xlabel('vrijeme'), ylabel('pozicija 1'), legend('odziv','ref. signal')
subplot(2,2,2), plot(tout,q2,'b',tout,qr2,'r'),
xlabel('vrijeme'), ylabel('pozicija 2'), legend('odziv','ref. signal')
subplot(2,2,3), plot(tout,dq1,'b'), xlabel('vrijeme'), ylabel('brzina 1')
subplot(2,2,4), plot(tout,dq2,'b'), xlabel('vrijeme'), ylabel('brzina 2')

figure(2)
subplot(2,2,1), plot(tout,u1,'b'), xlabel('vrijeme'), ylabel('moment 1')
subplot(2,2,2), plot(tout,u2,'b'), xlabel('vrijeme'), ylabel('sila 2')
```
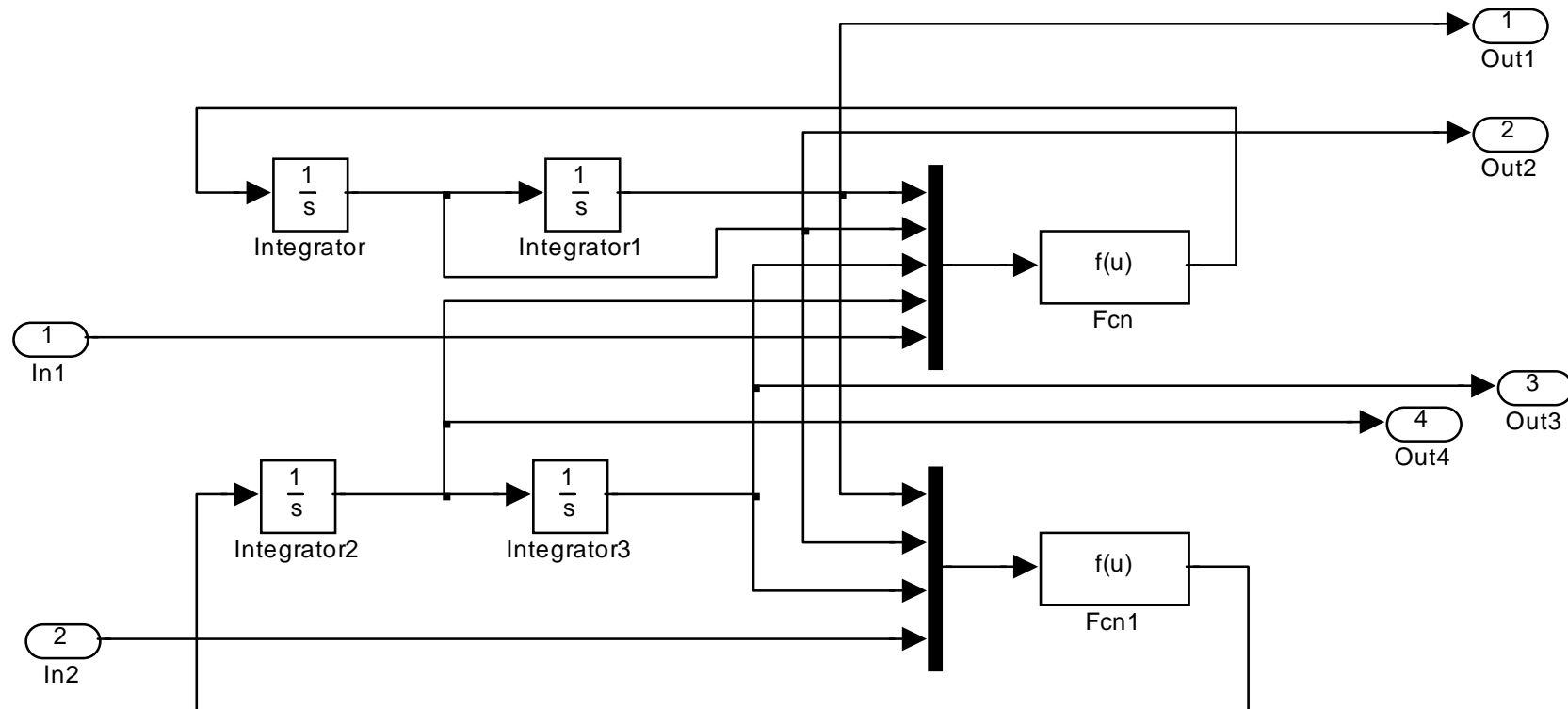
RT robot blok
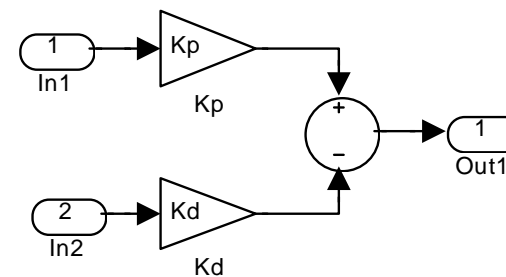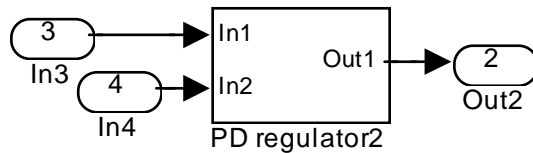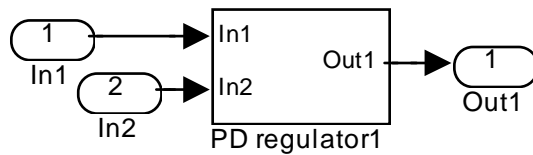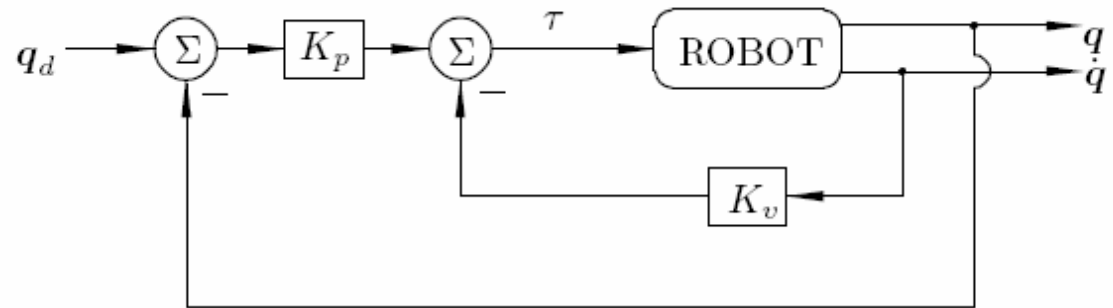

(-2*m2*u(3)*u(2)*u(4)-m1*lc1*g*cos(u(1))-m2*g*u(3)*cos(u(1))+u(5))/(m0+m2*u(3)*u(3))

u(3)*u(2)*u(2)-g*sin(u(1))+u(4)/m2

PD regulator blok

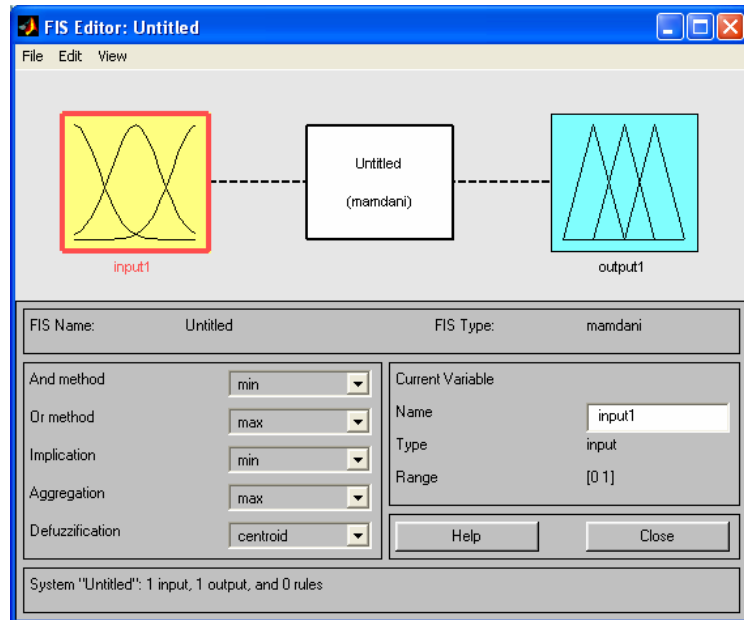$$\tilde{\boldsymbol{q}}(t) := \boldsymbol{q}_d - \boldsymbol{q}(t).$$

$$\boldsymbol{\tau} = K_p \tilde{\boldsymbol{q}} - K_v \dot{\boldsymbol{q}},$$

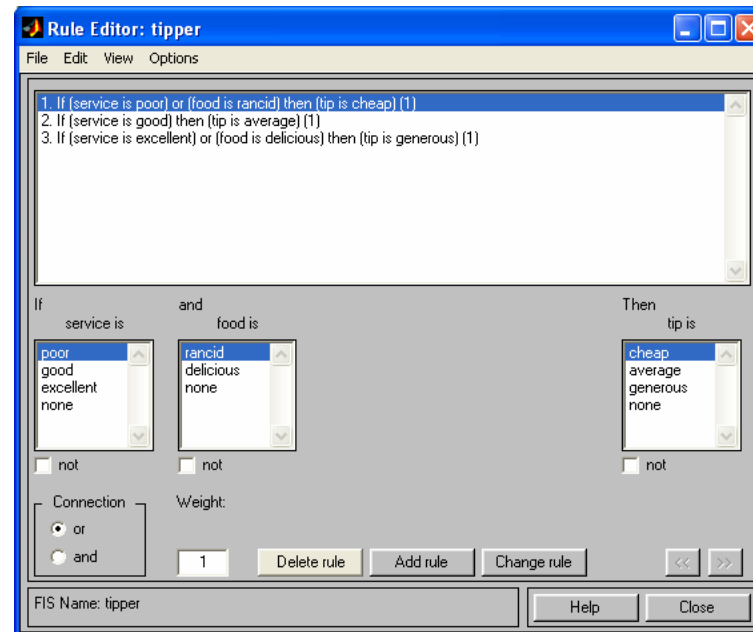# FIS (fuzzy inference system) Editor

`>> fuzzy`

`>> fuzzy tipper`

Membership Function Editor: tipper

File Edit View

FIS Variables

Membership function plots   plot points: 181

poor   good   excellent

service   tip

food

input variable "service"

Current Variable

Name   service
Type   input
Range   [0 10]
Display Range [0 10]

Current Membership Function (click on MF to select)

Name   poor
Type   gaussmf
Params   [1.5 0]

Help   Close

Ready

Membership Function Editor: tipper

File Edit View

FIS Variables

Membership function plots   plot points: 181

rancid   delicious

service   tip

food

input variable "food"

Current Variable

Name   food
Type   input
Range   [0 10]
Display Range [0 10]

Current Membership Function (click on MF to select)

Name   rancid
Type   trapmf
Params   [0 0 1 3]

Help   Close

Selected variable "food"

Membership Function Editor: tipper

File Edit View

FIS Variables

Membership function plots   plot points: 181

cheap   average   generous

service   tip

food

output variable "tip"

Current Variable

Name   tip
Type   output
Range   [0 30]
Display Range [0 30]

Current Membership Function (click on MF to select)

Name   cheap
Type   trimf
Params   [0 5 10]

Help   Close

Selected variable "tip"

Rule Editor: tipper

File Edit View Options

1. If (service is poor) or (food is rancid) then (tip is cheap) (1)
2. If (service is good) then (tip is average) (1)
3. If (service is excellent) or (food is delicious) then (tip is generous) (1)

If   and   Then
service is   food is   tip is

poor   rancid   cheap
good   delicious   average
excellent   none   generous
none   none

not   not   not

Connection   Weight:
or
and   1

Delete rule   Add rule   Change rule   << >>

FIS Name: tipper   Help   Close

Working from the Command Line

```
a = readfis('tipper.fis')

a.Type
a.defuzzMethod
a.input(1).mf(1)
```

`fuzzy(a)`	displays the FIS Editor.
`mfedit(a)`	displays the Membership Function Editor.
`ruleedit(a)`	displays the Rule Editor.
`ruleview(a)`	displays the Rule Viewer.
`surfview(a)`	displays the Surface Viewer.

FIS Evaluation:
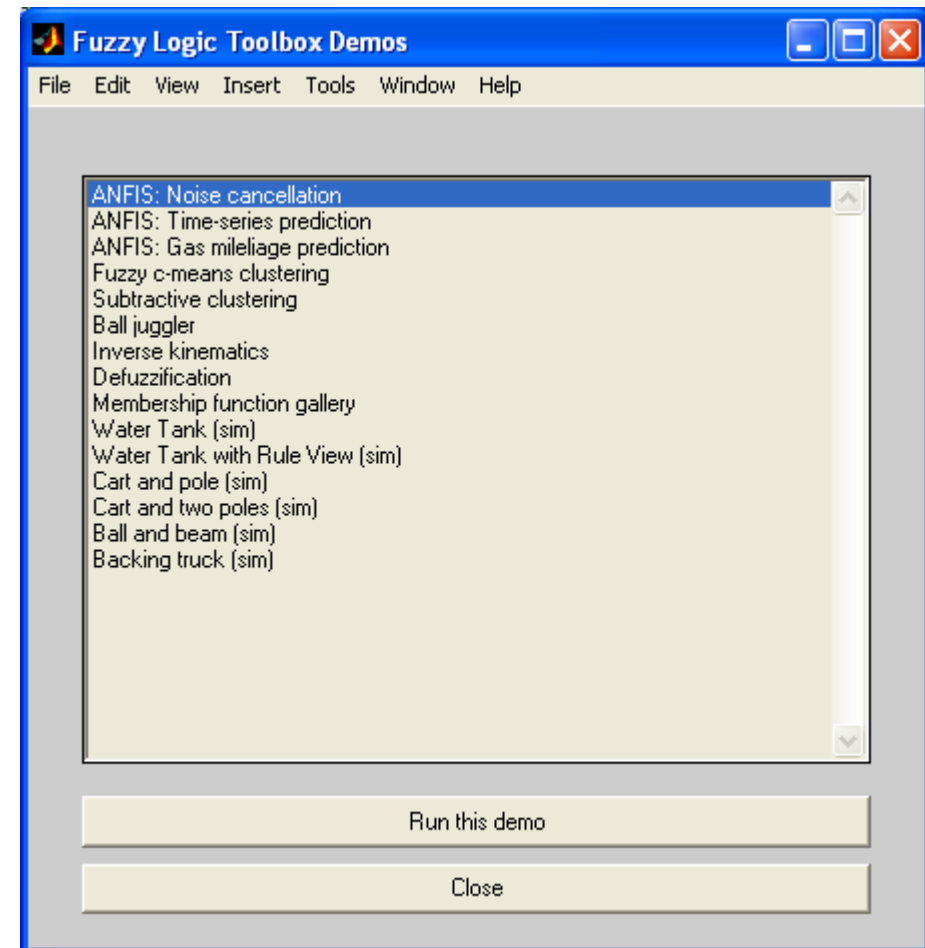
```
a = readfis('tipper');
evalfis([1 2], a)
```

```
evalfis([3 5; 2 7], a)
ans =
    12.2184
     7.7885
```

Simulink:

`>> fuzblock`

`>> fuzdemos`

Blok neizrazitog regulatora
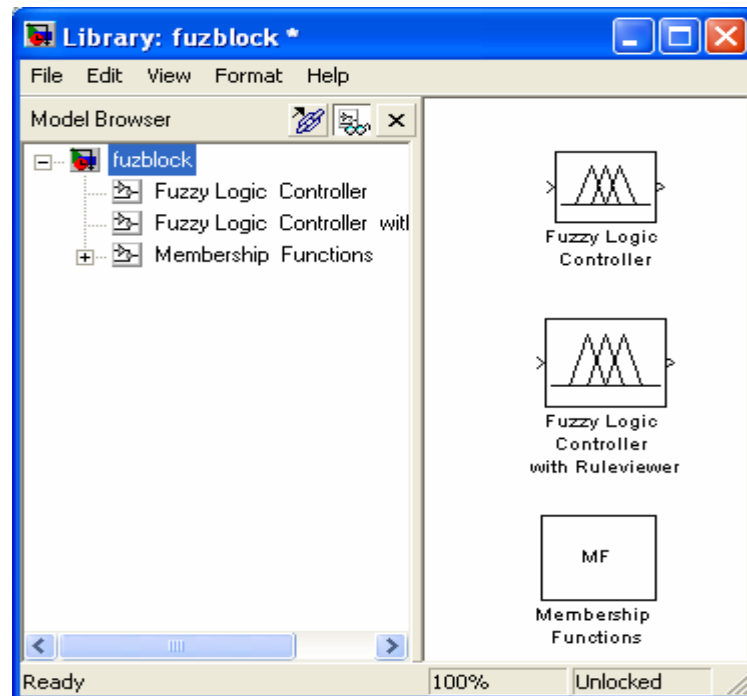
Upis datoteke
iz koje se učitavaju
parametri regulatora

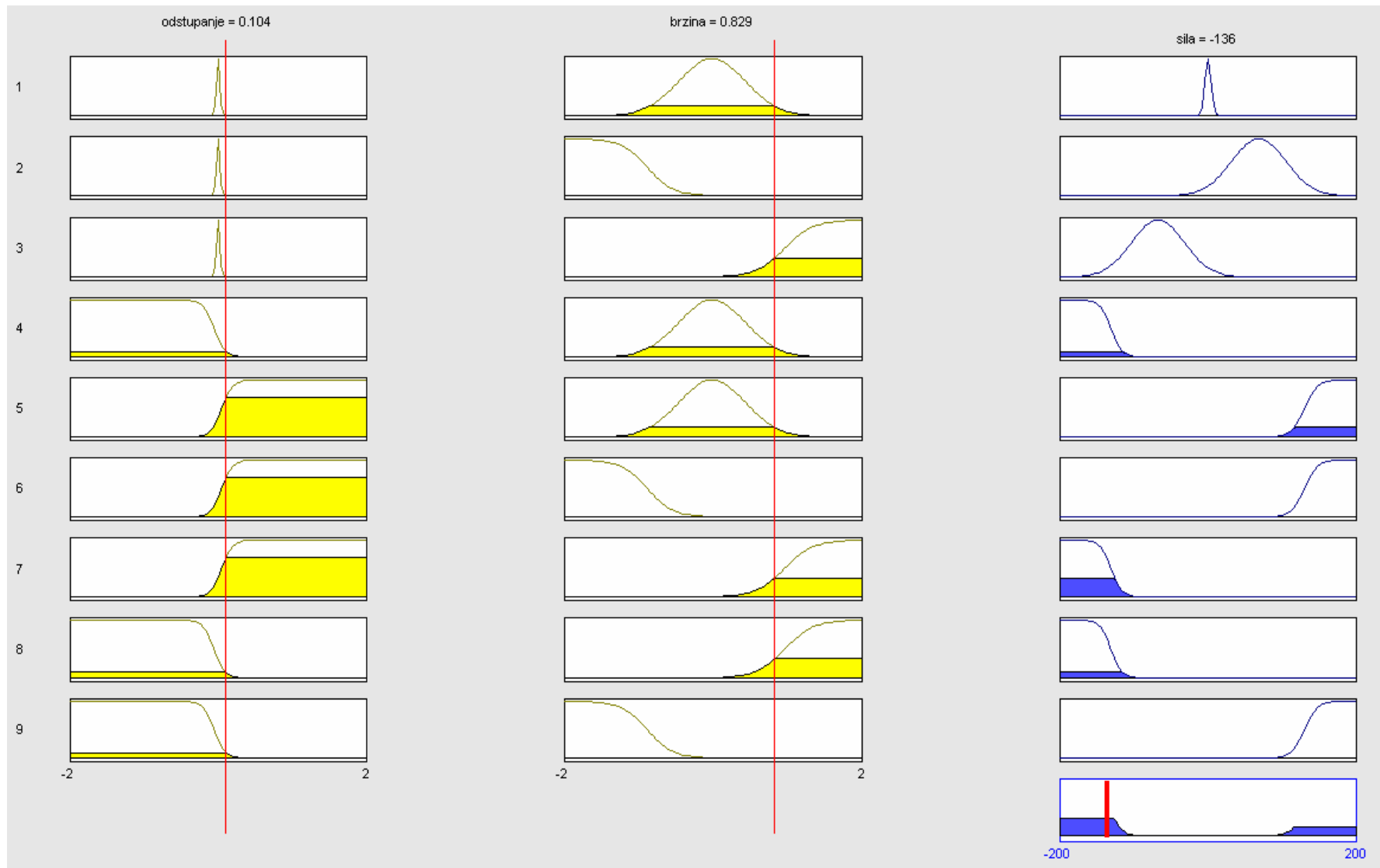# Fuzzy PD regulator blok
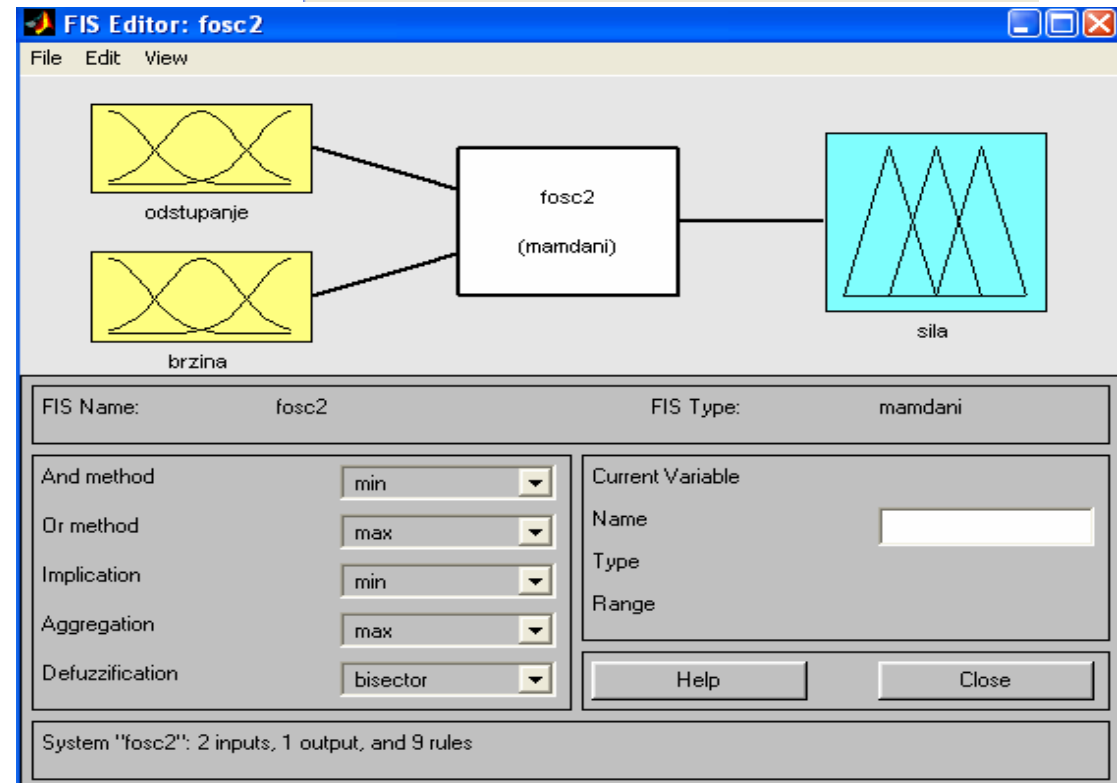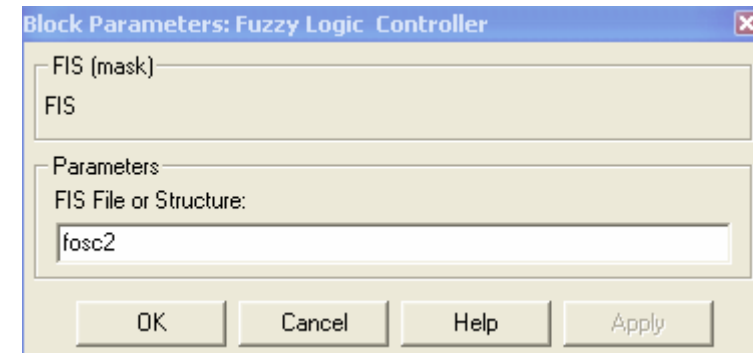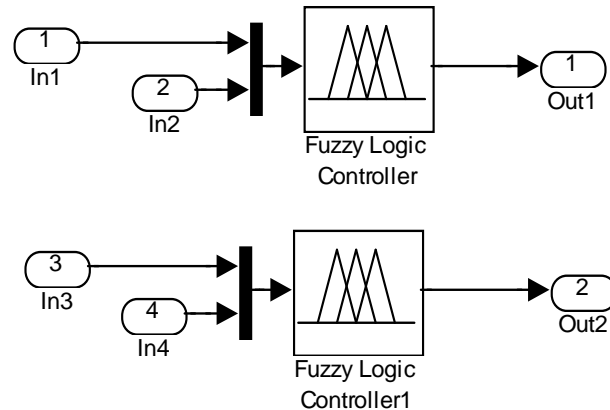
Funkcije pripadnosti
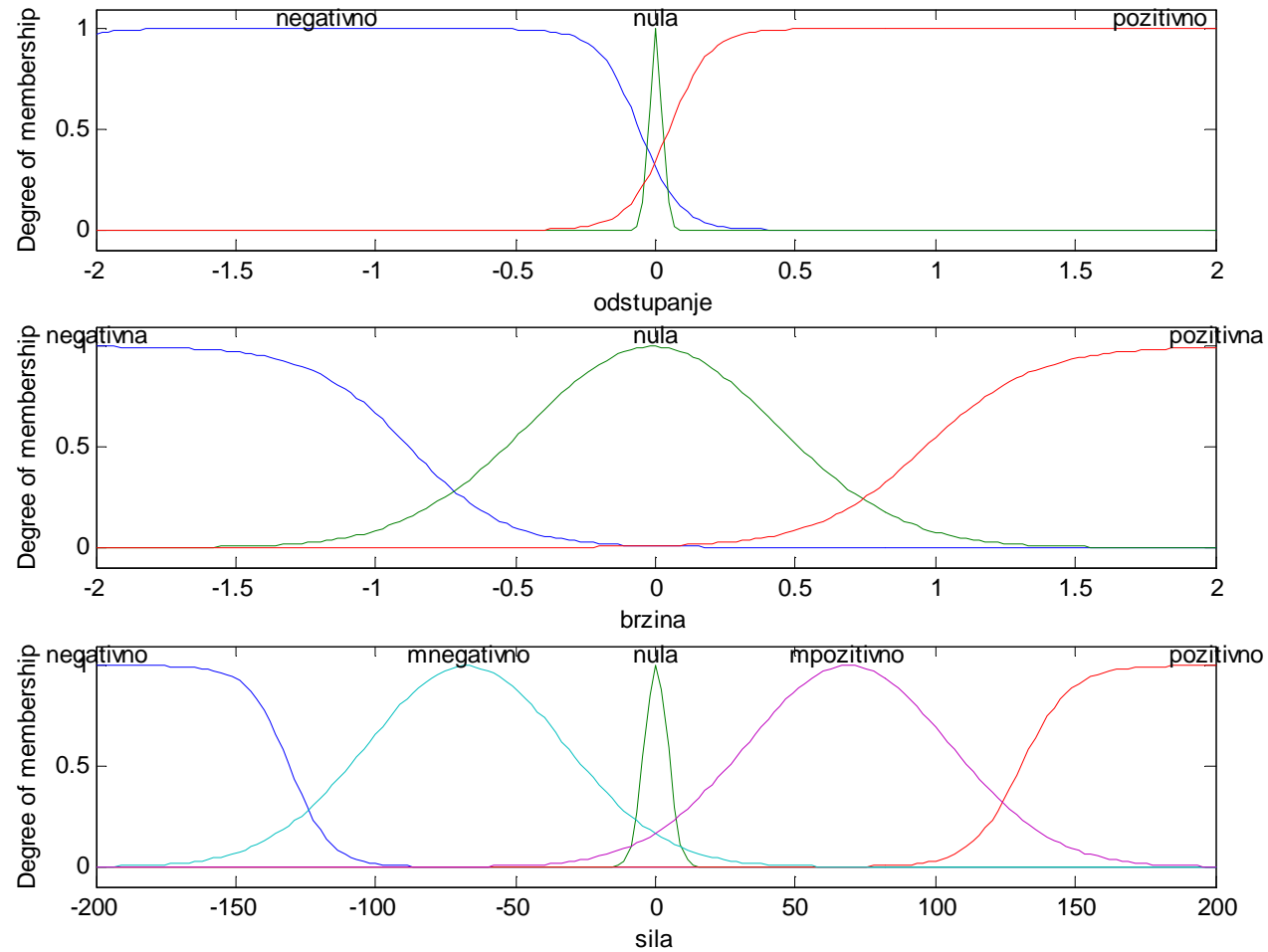
Baza pravila ponašanja

1. If (odstupanje is nula) and (brzina is nula) then (sila is nula) (1)
2. If (odstupanje is nula) and (brzina is negativna) then (sila is mpozitivno) (1)
3. If (odstupanje is nula) and (brzina is pozitivna) then (sila is mnegativno) (1)
4. If (odstupanje is negativno) and (brzina is nula) then (sila is negativno) (1)
5. If (odstupanje is pozitivno) and (brzina is nula) then (sila is pozitivno) (1)
6. If (odstupanje is pozitivno) and (brzina is negativna) then (sila is pozitivno) (1)
7. If (odstupanje is pozitivno) and (brzina is pozitivna) then (sila is negativno) (1)
8. If (odstupanje is negativno) and (brzina is pozitivna) then (sila is negativno) (1)
9. If (odstupanje is negativno) and (brzina is negativna) then (sila is pozitivno) (1)

de \ e	N	Z	P
N	P	MP	P
Z	N	Z	P
P	N	MN	N
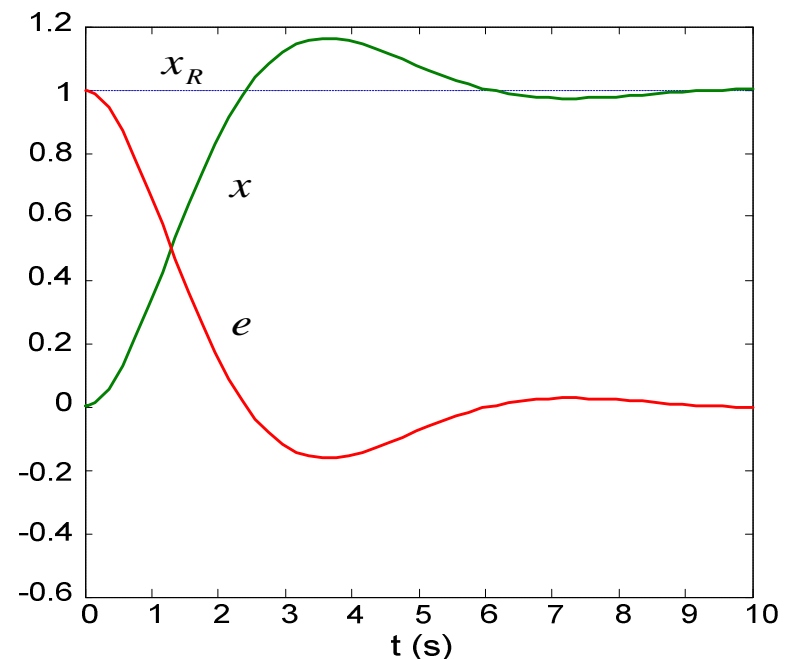
Rule viewer

Odzivi pozicija, brzina i sila