School of Computer Science and Engineering
VIT-AP University
Artificial Intelligence: CSE 3002
Laboratory Assignment

Topic: Mamadani Fuzzy Interface system

1. Consider a fuzzy logic controller is used to control the speed of a motor by changing its input voltage (V) according to two input variables; speed (SP), and speed change rate SC. Let the fuzzy set of SP be {Slow (S), Normal (N), Fast (F)}, and the fuzzy set for SC be {Low (L), Medium (M), High (H)}, and for the control action be {Slow Down (DN), No Change (NC), Speed Up (Up)}, where, (SP□ [500, 1000]), (SC □ [0, 10]), and (V □ [2, 3]) with step = 0.1. The membership functions for the input/output variables are described in Table 1. Construct the membership graph for SP, SC and V.Find and print the control action if SP=910 And SC= 6.5 based on the fuzzy rules shown in Table 2. Also, print the final rule and output graph based on input values, namely, SP=910 And SC= 6.5.

TABLE 1

SP		SC		∕	
Fuzzy terms	**Membership function**	**Fuzzy terms**	**Membership function**	**Fuzzy terms**	**Membership function**
S	L(600,750)	L	L(2 ,4)	DN	L(2.2 ,2.5)
N	□(600,750,900)	M	Π(2,4 ,6, 8)	NC	□(2.4, 2.5,2.6)
F	□(750,900)	H	□(6 ,8)	Up	□(2.5, 2.8)

TABLE : 2

SP / SC	S	N	F
L	Up	NC	NC
M	Up	NC	NC
H	NC	DN	DN

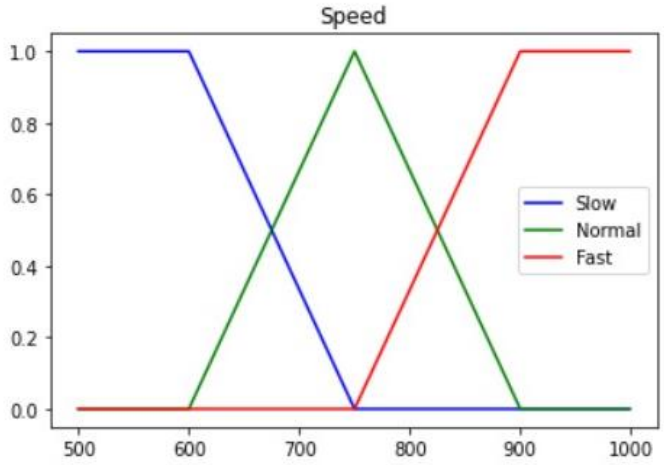
Code:

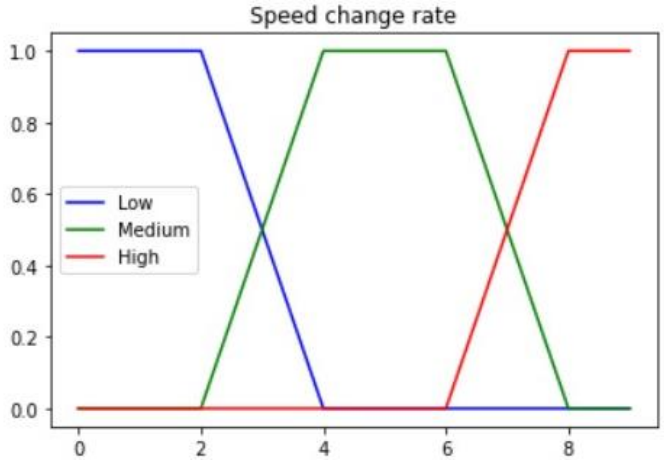
```
from os import sched_get_priority_min
sp = np.arange(500, 1000, 1)
sc = np.arange(0, 10, 1)
v = np.arange(2, 3, 0.1)

def findthevalueofy(x,a,b,c,d):
    if x<a:
        return 0
    elif a<x<=b:
        return ((x-a)/(b-a))
    elif b<x<c:
        return 1
    elif c<=x<d:
       return ((d-x)/(d-c))
    else:
        return (0)
def trap(p,q,r,s):

  y = []
  for i in sp:
    y.append(findthevalueofy(i,p,q,r,s))
  return y




sp_s = trap(450, 450, 600, 750)
sp_n = trap(600, 750, 750, 900 )
sp_f = trap(750, 900, 1000, 1000)


sc_l = fuzz.trapmf(sc,[0, 0, 2, 4])
sc_m = fuzz.trapmf(sc,[2, 4, 6, 8])
sc_h = fuzz.trapmf(sc,[6, 8, 10, 10])

v_dn = fuzz.trapmf(v,[2, 2, 2.2, 2.5])
v_nc = fuzz.trapmf(v,[2.4 ,2.5, 2.5, 2.6])
v_up = fuzz.trapmf(v,[2.5, 2.8, 3, 3])


plt.figure()
plt.plot(sp, sp_s , 'b', linewidth=1.5, label='Slow')
plt.plot(sp, sp_n, 'g', linewidth=1.5, label='Normal')
plt.plot(sp, sp_f, 'r', linewidth=1.5, label='Fast')
plt.title('Speed')
plt.legend()
plt.show()
```

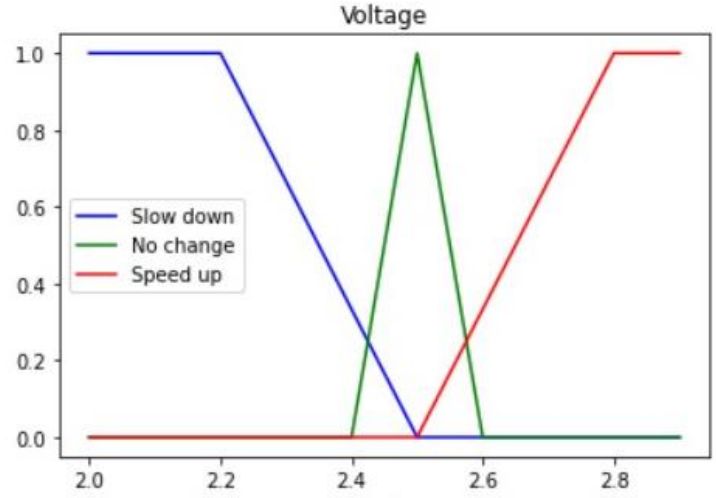
```
plt.figure()
plt.plot(sc, sc_l, 'b', linewidth=1.5, label='Low')
plt.plot(sc, sc_m, 'g', linewidth=1.5, label='Medium')
plt.plot(sc, sc_h, 'r', linewidth=1.5, label='High')
plt.title('Speed change rate')
plt.legend()
plt.show()

plt.figure()
plt.plot(v, v_dn, 'b', linewidth=1.5, label='Slow down')
plt.plot(v, v_nc, 'g', linewidth=1.5, label='No change')
plt.plot(v, v_up, 'r', linewidth=1.5, label='Speed up')
plt.title('Voltage')
plt.legend()
plt.show()

def givespeedmembership(x,a,b):
  if x<a:
    return 0
  elif x<b:
    return 1
  else:
    return 2

def givespeedchangemembership(x,a,b):
  if x<a:
    return 0
  elif x<b:
    return 1
  else:
    return 2
```

```
matrix = [[3,2,2],[3,2,2],[2,1,1]]

def result(x,y):
  y = matrix[givespeedmembership(x,675,825)][givespeedchangemembership(y,3,7)]
  if y ==1:
    print("Slow down")
  if y ==2:
    print("No change")
  if y == 3:
    print("Speed up")


print("The speed of the motor is 910 and the speed change rate is 6.5")
print("So, the vehicle should")
result(910,6.5)
```

Input:








```
The speed of the motor is 910 and the speed change rate is 6.5
So, the vehicle should
Slow down
```

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