Assignment-4 (15)

Posting date: 14th Nov 2019 Submission Date: 27th Nov by 3pm;

Implement FIS (Fuzzy Inference System) using MATLAB fuzzy logic toolbox and evaluate the performance of a student. The goal is to find the overall performance of the student. The evaluation criteria are based on the following three input parameters. The output of the system is the performance score of a given student in range [0, 10].

Inputs:

- Academics: Performance in academics are measured by CGPA (scale 0-10)
- Sports: Total number of games won or participated (scale 0-10)
- Co-curricular activities: the number of certificates (participation and winning certificate in the range of 0 to 10).

Outputs:

- Performance: score of a given student in range [0, 10] inferred based on a set of rules.

Define the following and make a document containing all details in text file. (3)

- Define linguistic variables - Academics, sports and co-curricular (3 input) and performance (1 output) and the corresponding fuzzy membership functions (4)

INPUT VARIABLES

1. Academics: Performance in academics are measured by CGPA (scale 0-10)
   Range[0, 10]
   Linguistic Variables:
   POOR – Membership function : Pi-shaped [0, 2.2, 3.5, 4.4]
   AVG - Membership function : Pi-shaped [4.3, 5, 6.3, 6.9]
   GOOD - Membership function : Pi-shaped [6.1, 6.7, 7.7, 8.9]
   EXCELLENT - Membership function : Pi-shaped [8.3, 9.5, 10, 10]
2. Sports: Total number of games won or participated
   Range[0, 10]
   Linguistic Variables:
   POOR - Membership function : Generalised Bell-shaped [2.1, 2.5, -1.38e-16]
   AVG - Membership function : Pi-shaped [1.25, 4.6, 5.4, 8.75]
   GOOD - Membership function : S-shaped [6.25, 9.583]
3. CCA (Co-curricular activities): number of certificates (participation and winning certificate)
   Range [0, 10]
   Linguistic Variables:
   POOR - Membership function : Gaussian [1.769, 1.2]

AVG - Membership function : Gaussian [1.769, 5]
GOOD - Membership function : Pi-shaped [6.25 9.6 10.45 10.75]

OUTPUT VARIABLES

1. Performance:

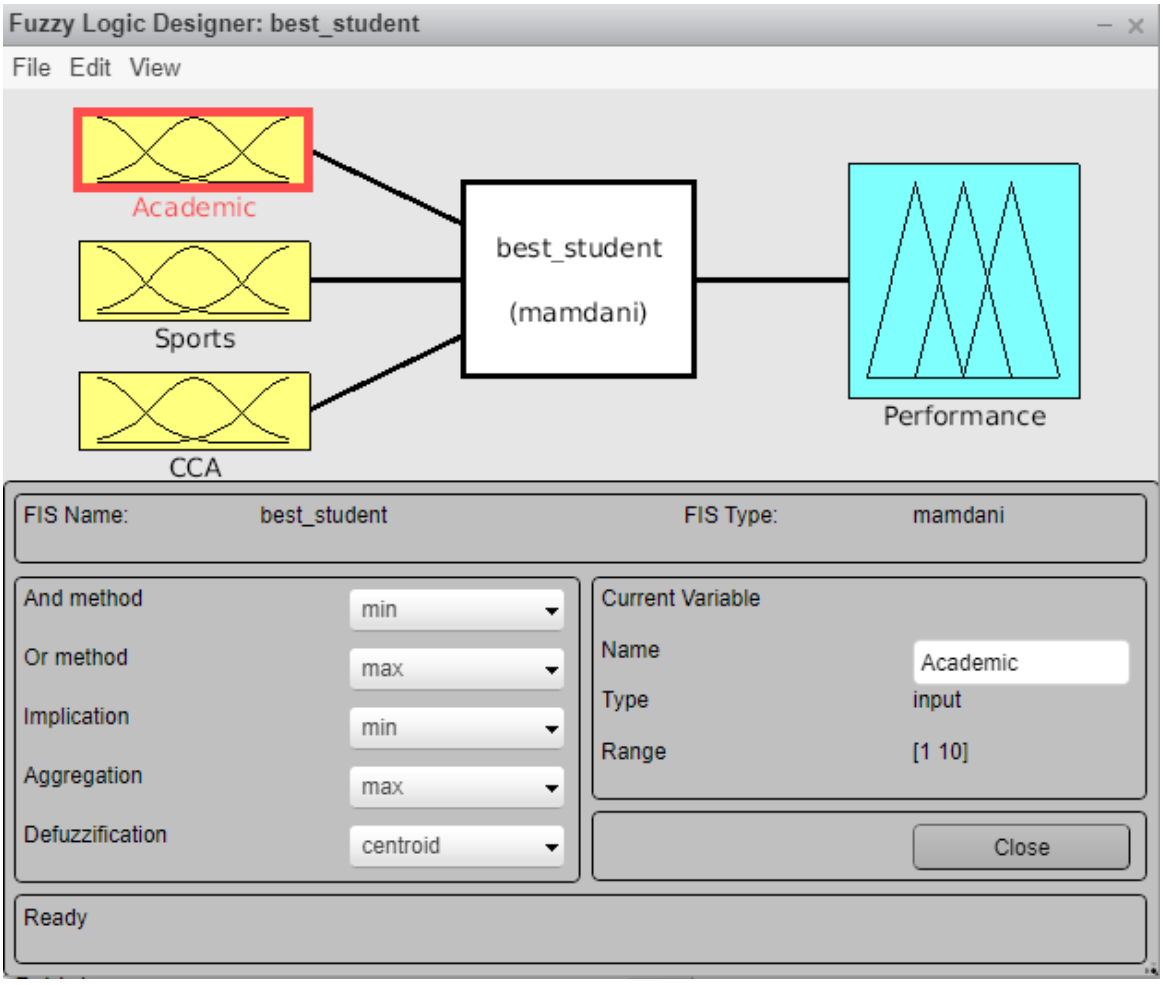
Range [0,10]

Linguistic Variables:

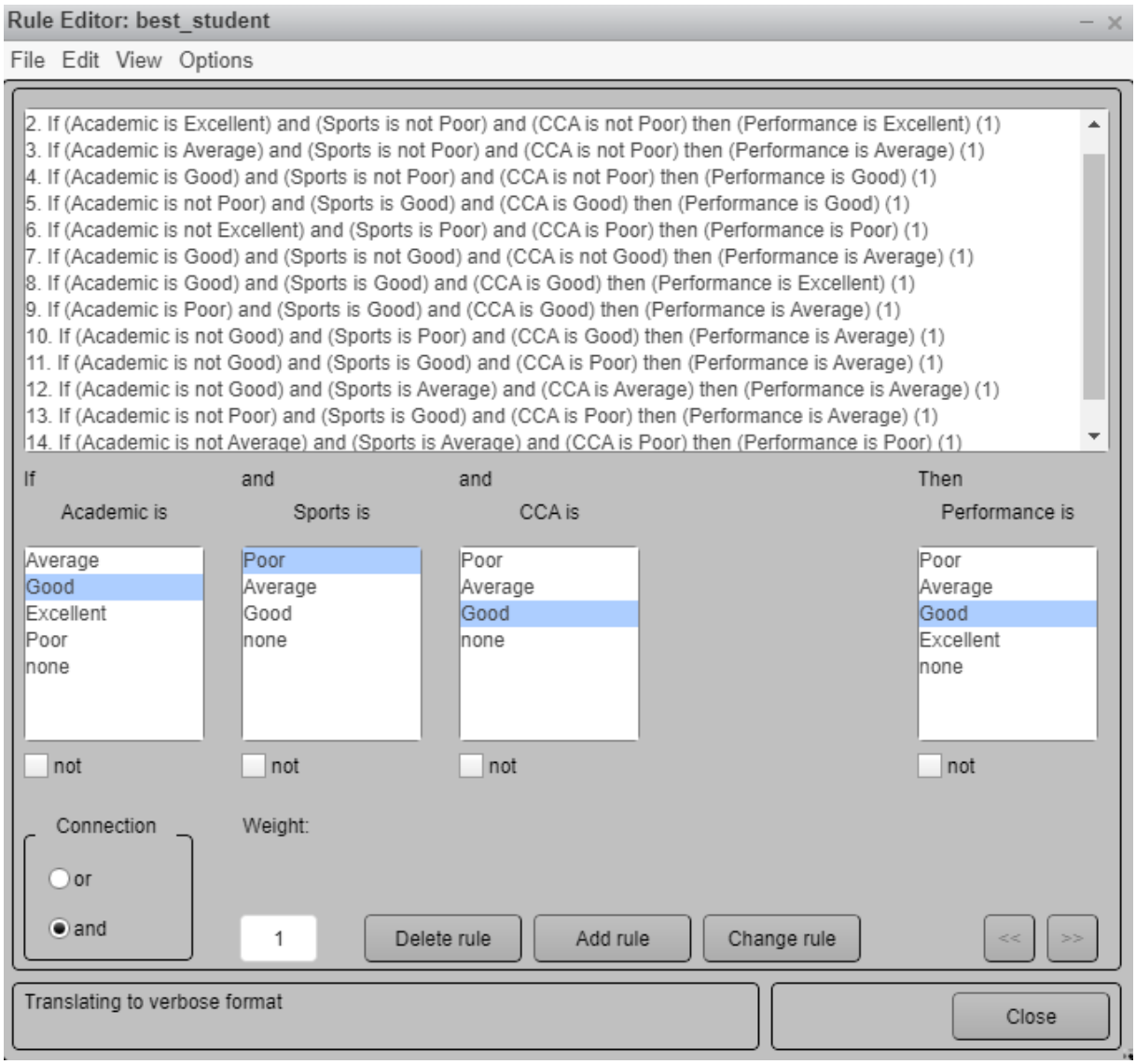
POOR - Membership function : Triangular shaped [0, 2.4, 4]
AVG - Membership function : Pi-shaped [3.8, 4, 6, 7]
GOOD - Membership function : Pi-shaped [6.6, 7.2, 7.5, 8.4]
EXCELLENT - Membership function : Pi-shaped [7.5, 8.2, 10, 10]

USE OF MEMBERSHIP FUNCTIONS

1. Pi- shaped membership function is used when the value is true in a broad range.
2. Triangular shaped membership function is used when the truth value is more concentrated at a point.
3. Gaussian and Bell shaped membership functions are used where the truth value is concentrated at a point but is also spread about that point in a very small range.



- Define Fuzzy rule base that seems to be suitable for the given system. (3)

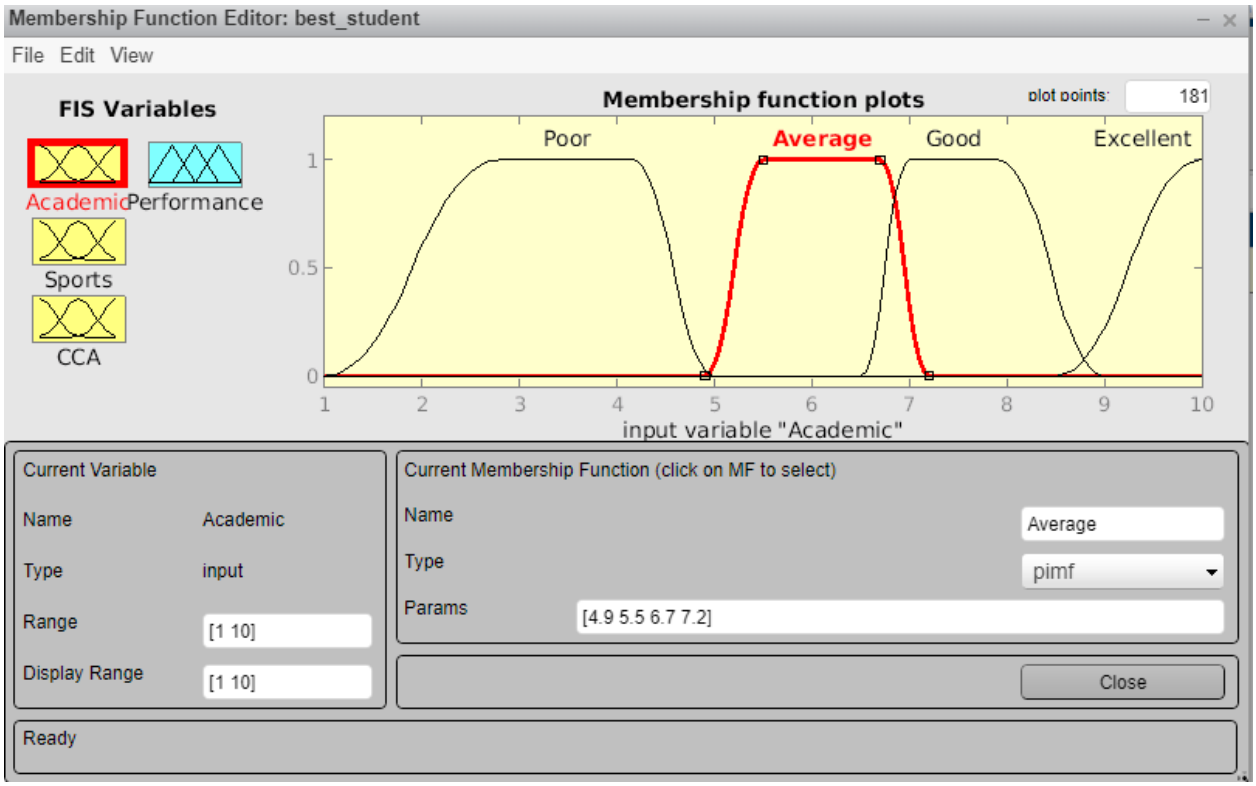


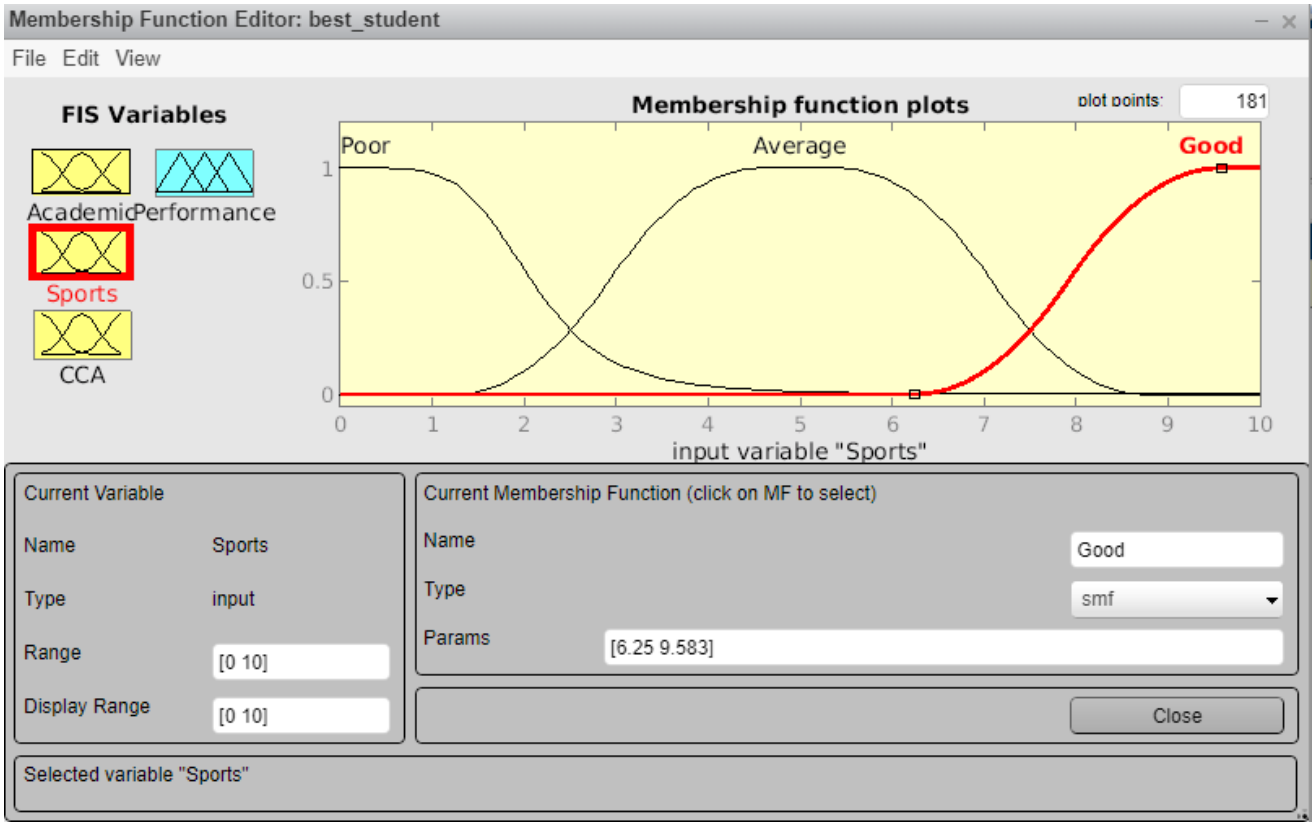
- Develop FIS to compute performance of the student (5)

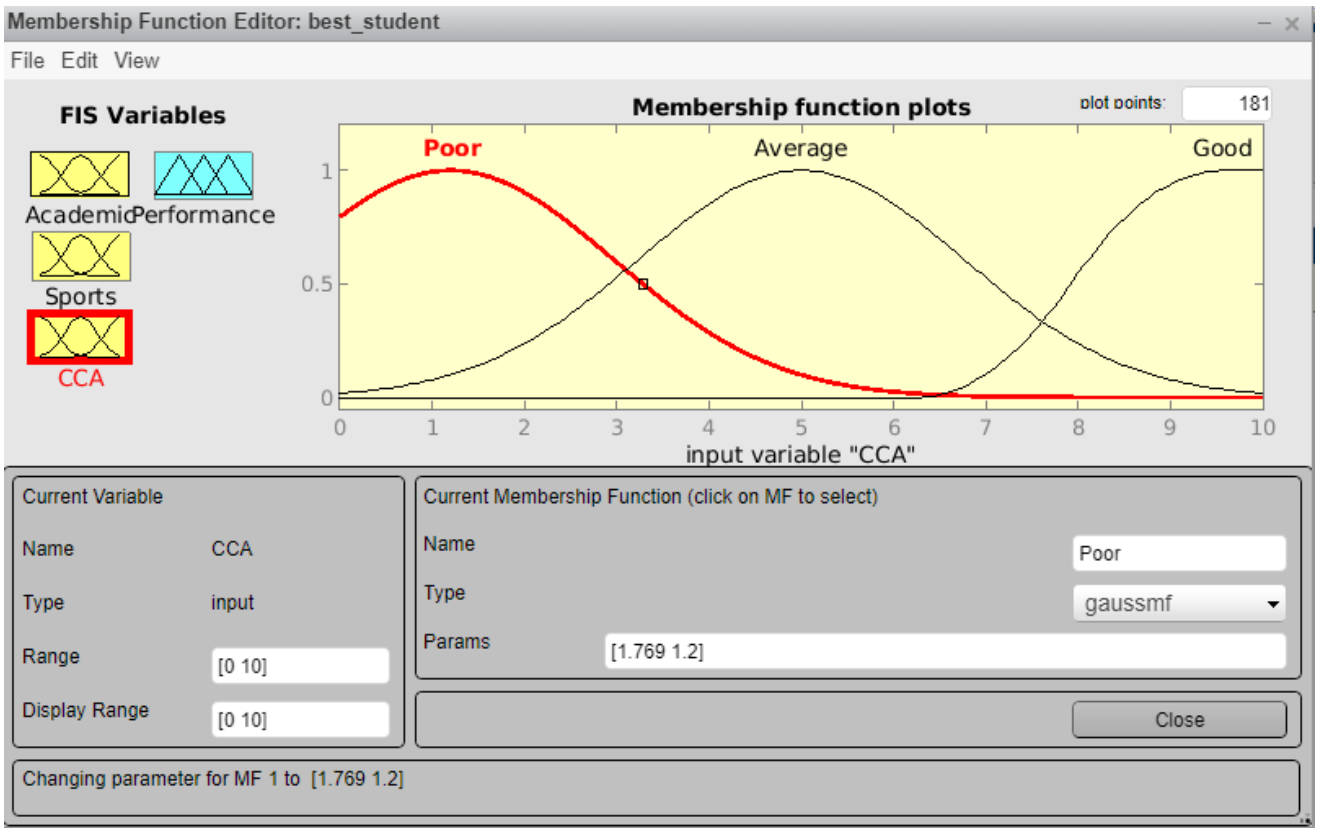
CODE:

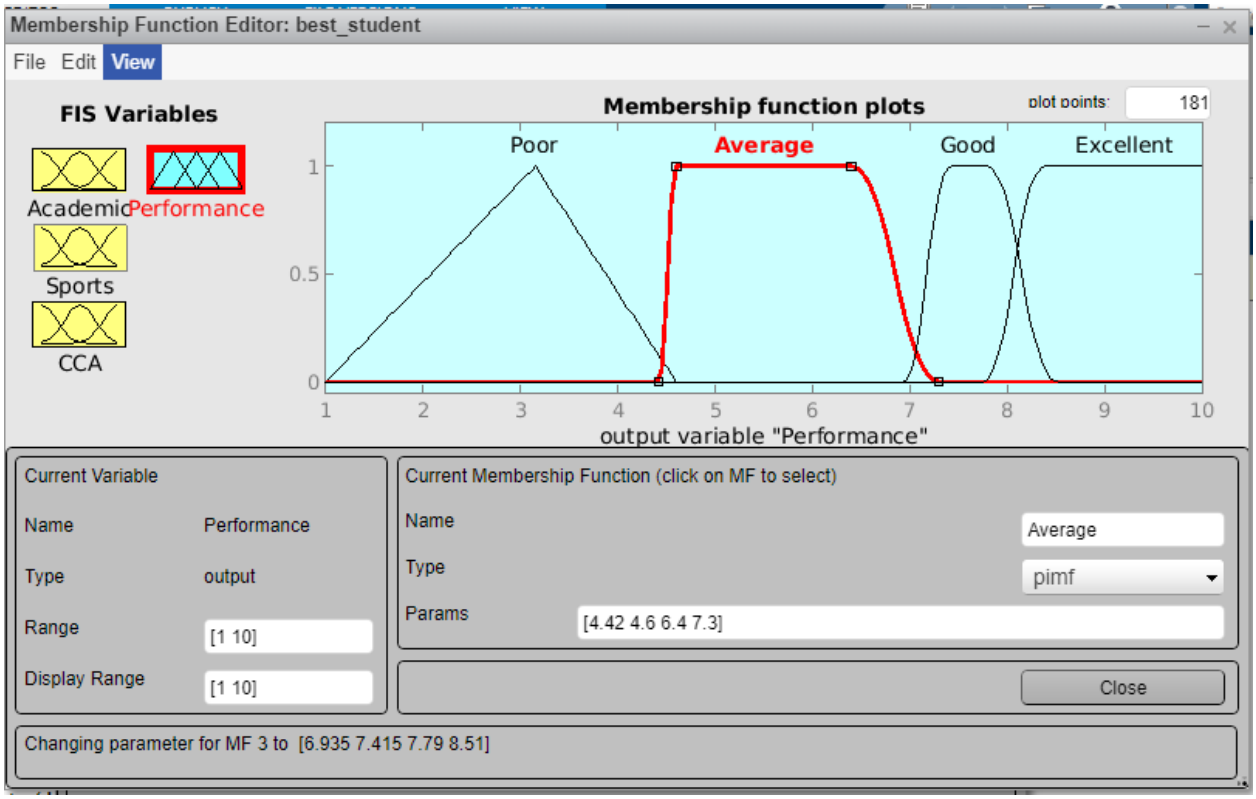
```
[System]
Name='best_student'
Type='mamdani'
Version=2.0
NumInputs=3
NumOutputs=1
NumRules=15
AndMethod='min'
OrMethod='max'
ImpMethod='min'
AggMethod='max'
DefuzzMethod='centroid'


[Input1]
Name='Academic'
Range=[0 10]
NumMFs=4
MF1='Average':'pimf',[4.333 5 6.333 6.889]
MF2='Good':'pimf',[6.111 6.667 7.667 8.889]
MF3='Excellent':'pimf',[8.333 10 10 10]
MF4='Poor':'pimf',[0 2 3.5 4.444]


[Input2]
Name='Sports'
Range=[0 10]
NumMFs=3
MF1='Poor':'gbellmf',[2.083 2.5 -1.388e-16]
MF2='Average':'pimf',[1.25 4.583 5.417 8.75]
MF3='Good':'smf',[6.25 9.583]


[Input3]
Name='CCA'
Range=[0 10]
NumMFs=3
MF1='Poor':'gaussmf',[1.769 1.2]
MF2='Average':'gaussmf',[1.769 5]
MF3='Good':'pimf',[6.25 9.583 10.42 13.75]


[Output1]
Name='Performance'
```

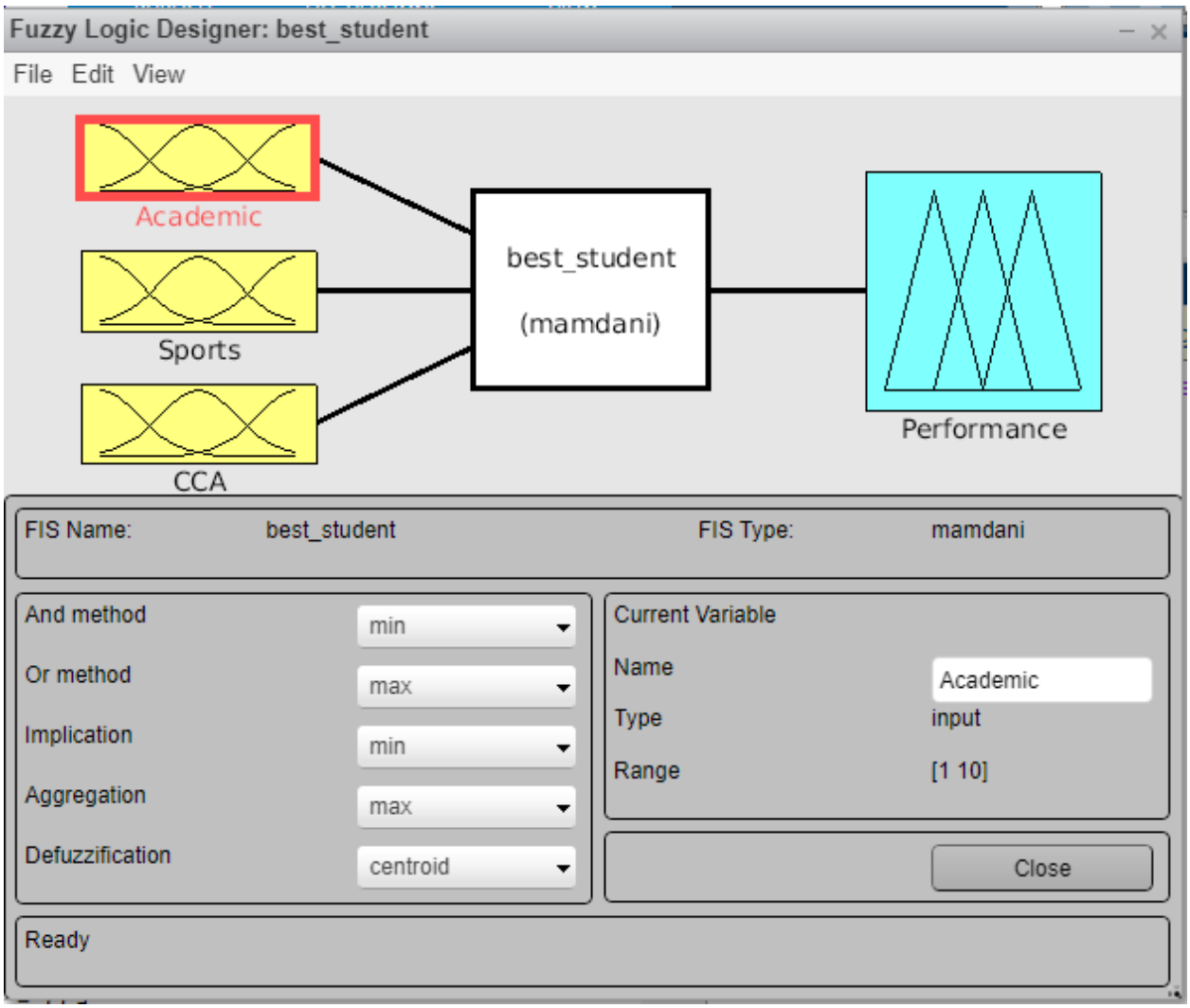
```
Range=[0 10]
NumMFs=4
MF1='Poor':'trimf',[0 2.389 4]
MF2='Average':'pimf',[3.8 4 6 7]
MF3='Good':'pimf',[6.594 7.128 7.544 8.344]
MF4='Excellent':'pimf',[7.5 8.2 10 10]


[Rules]
4 0 0, 1 (1) : 1
3 -1 -1, 4 (1) : 1
1 -1 -1, 2 (1) : 1
2 -1 -1, 3 (1) : 1
-4 3 3, 3 (1) : 1
-3 1 1, 1 (1) : 1
2 -3 -3, 2 (1) : 1
2 3 3, 4 (1) : 1
4 3 3, 2 (1) : 1
-2 1 3, 2 (1) : 1
-2 3 1, 2 (1) : 1
-2 2 2, 2 (1) : 1
-4 3 1, 2 (1) : 1
-1 2 1, 1 (1) : 1
2 1 3, 3 (1) : 1
```



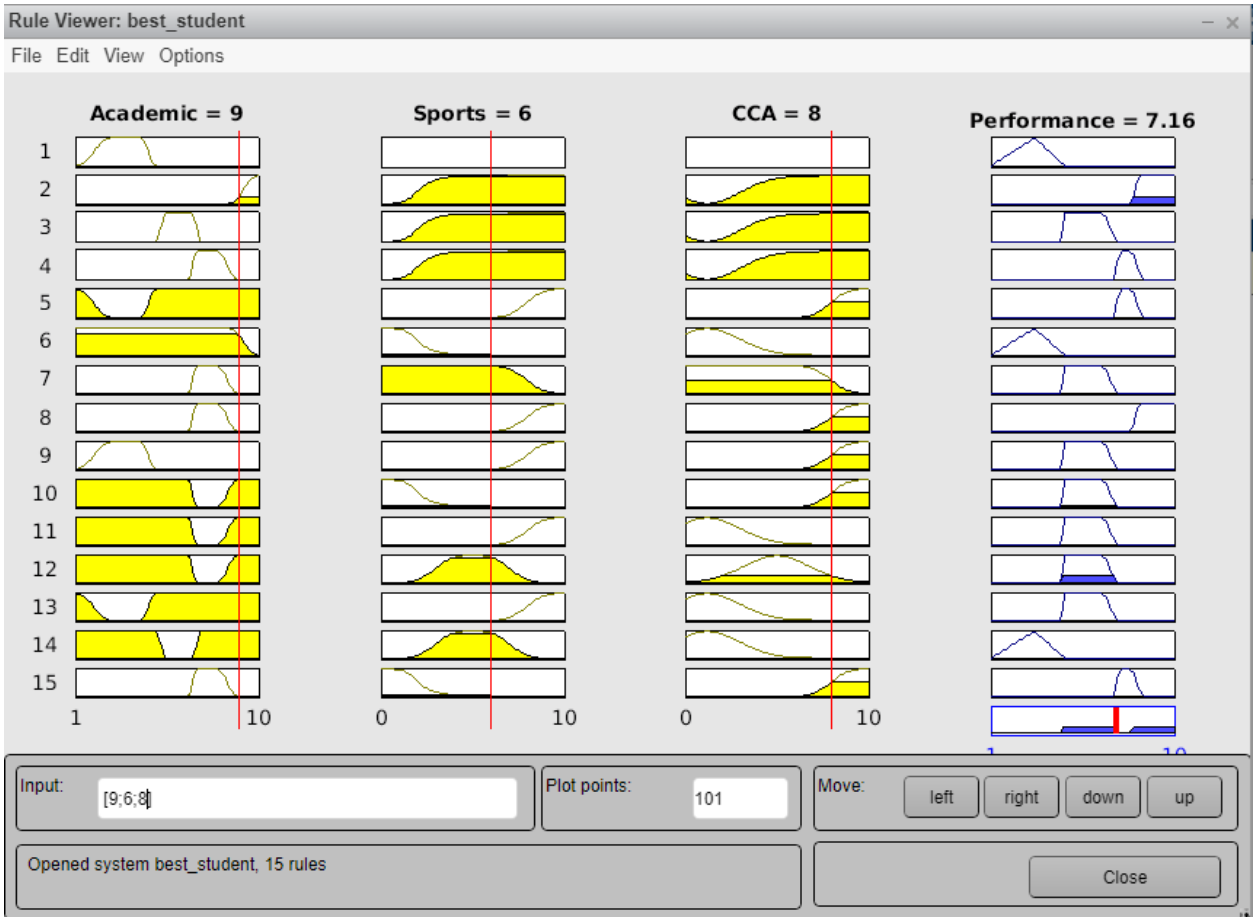

Membership Function Editor: best_student
File Edit View
FIS Variables
AcademicPerformance
Sports
CCA
Membership function plots
plot points: 181
Poor
Average
Good
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10
input variable "Sports"
Current Variable
Name Sports
Type input
Range [0 10]
Display Range [0 10]
Current Membership Function (click on MF to select)
Name Good
Type smf
Params [6.25 9.583]
Close
Selected variable "Sports"

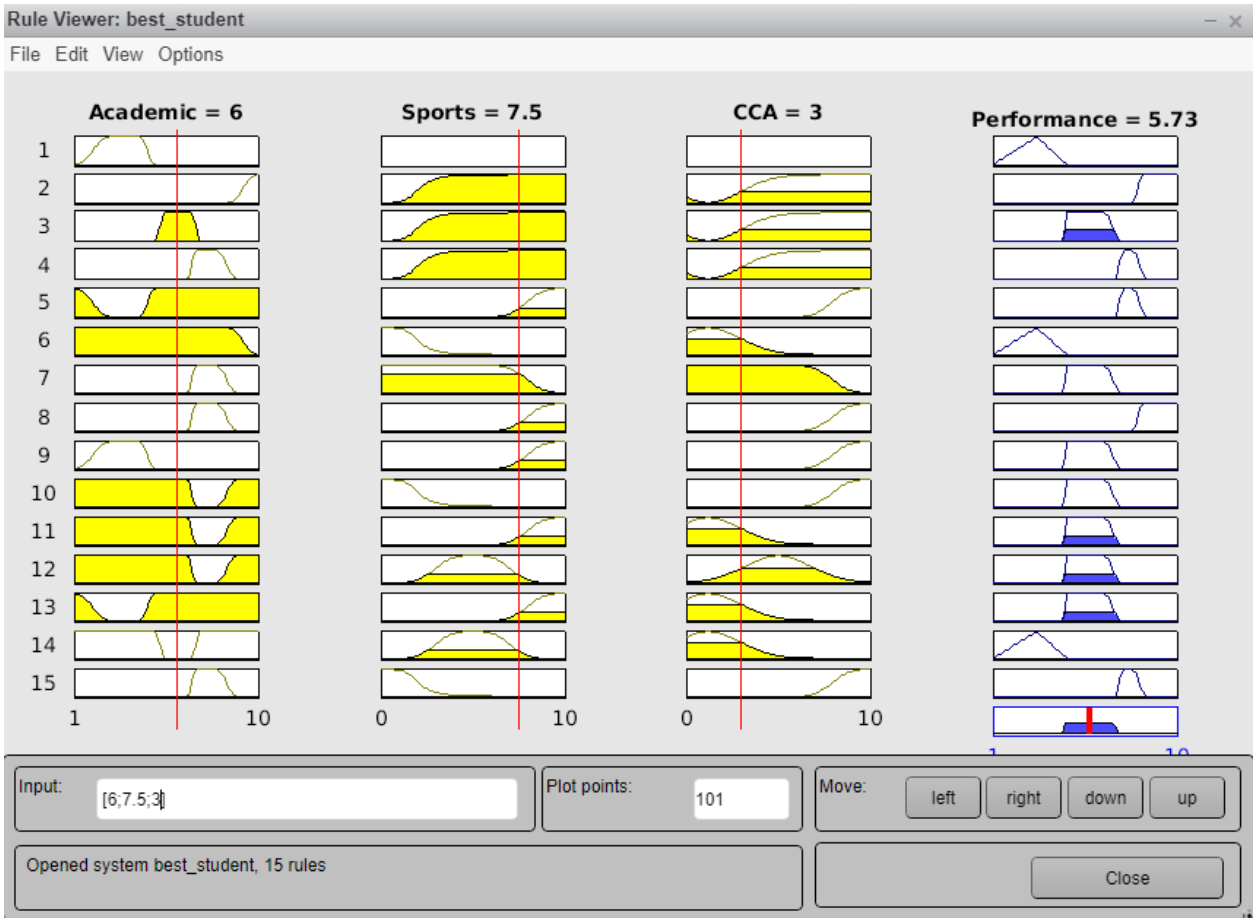

Membership Function Editor: best_student
File Edit View
FIS Variables
AcademicPerformance
Sports
CCA
Membership function plots
plot points: 181
Poor
Average
Good
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10
input variable "CCA"
Current Variable
Name CCA
Type input
Range [0 10]
Display Range [0 10]
Current Membership Function (click on MF to select)
Name Poor
Type gaussmf
Params [1.769 1.2]
Close
Changing parameter for MF 1 to [1.769 1.2]

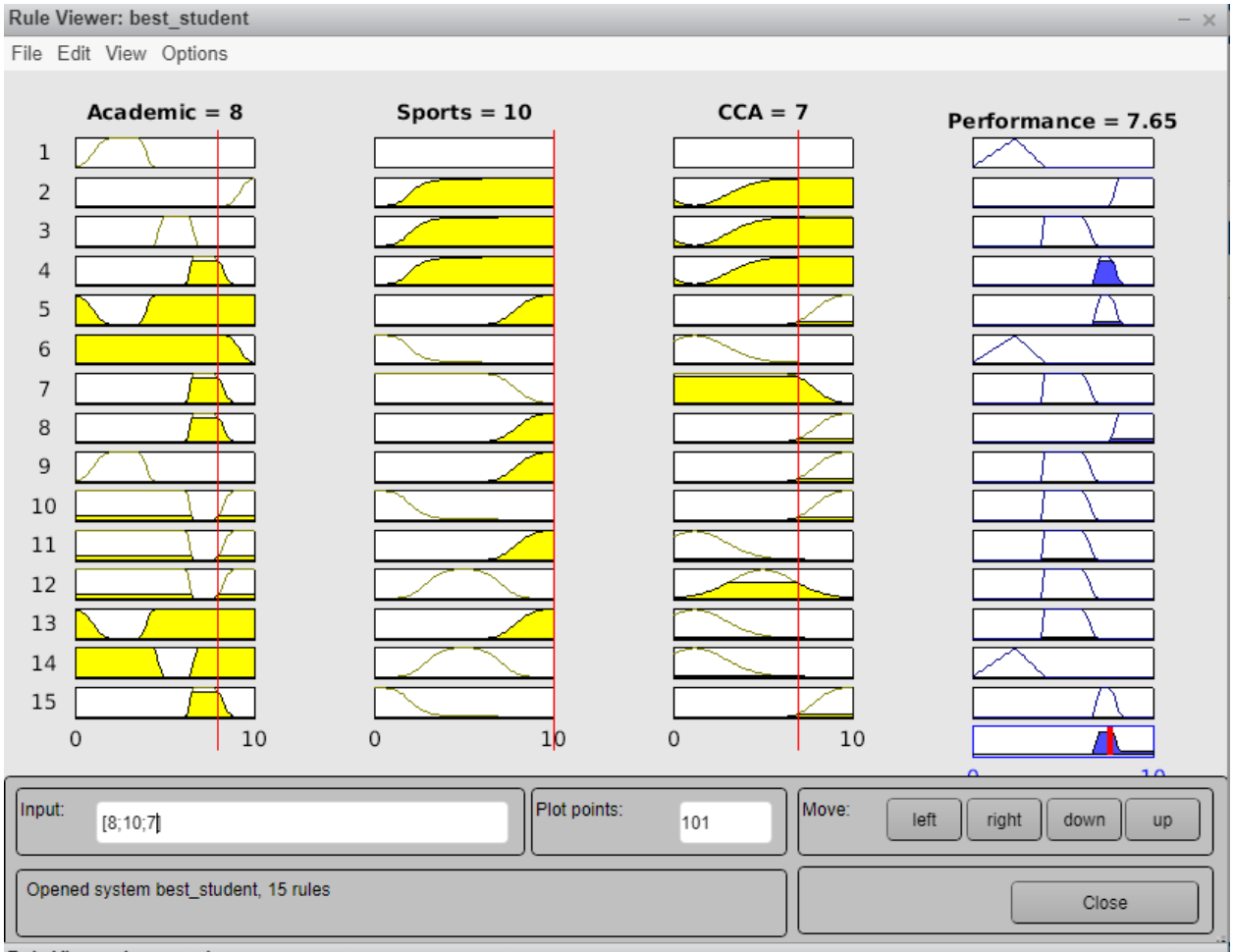

Membership Function Editor: best_student
File Edit View
FIS Variables
Academic
Performance
Sports
CCA
Membership function plots
plot points: 181
Poor
Average
Good
Excellent
1
0.5
0
1 2 3 4 5 6 7 8 9 10
output variable "Performance"
Current Variable
Name Performance
Type output
Range [1 10]
Display Range [1 10]
Current Membership Function (click on MF to select)
Name Average
Type pimf
Params [4.42 4.6 6.4 7.3]
Close
Changing parameter for MF 3 to [6.935 7.415 7.79 8.51]

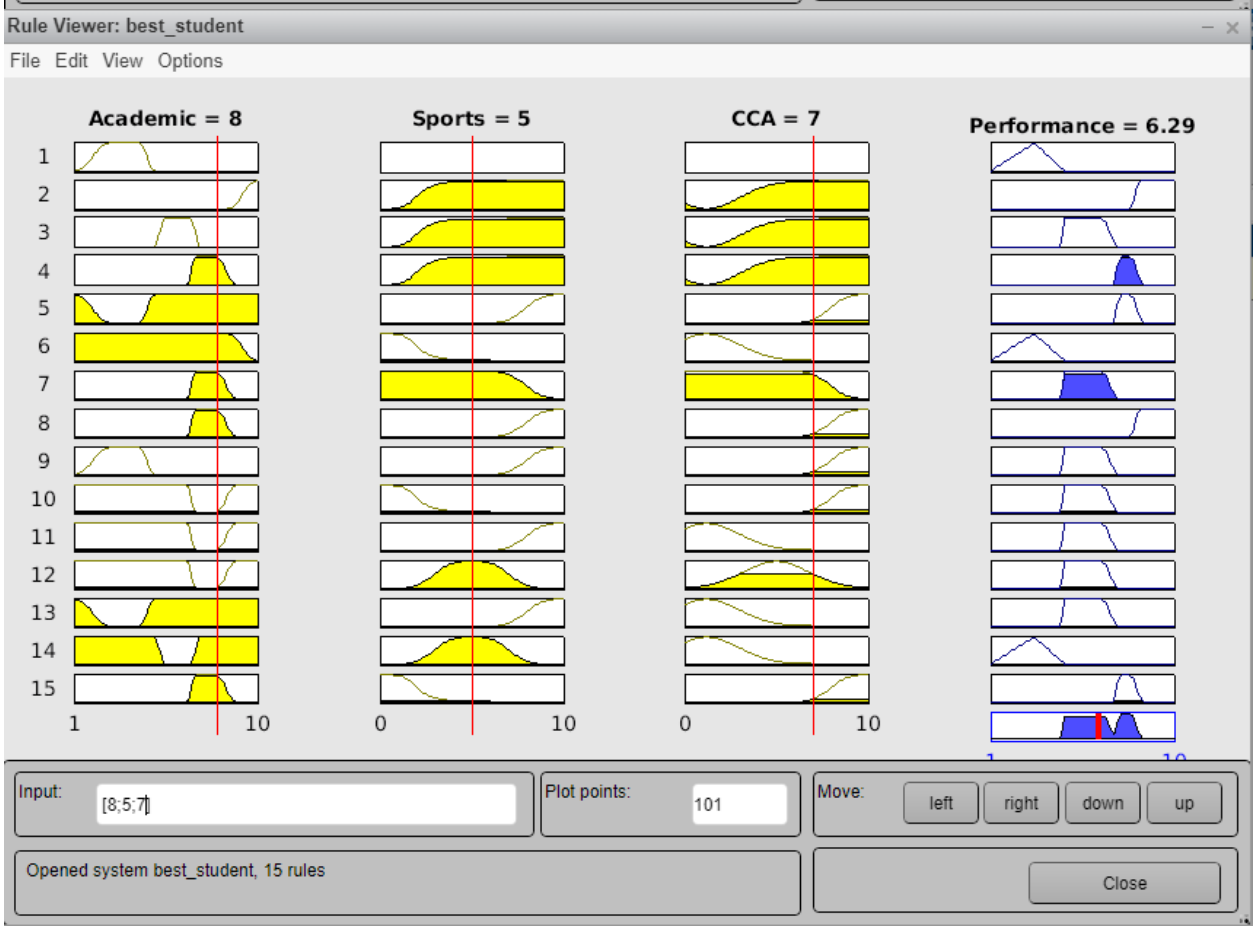

Fuzzy Logic Designer: best_student
File Edit View
Academic
Sports
CCA
best_student
(mamdani)
Performance
FIS Name: best_student
FIS Type: mamdani
And method min
Or method max
Implication min
Aggregation max
Defuzzification centroid
Current Variable
Name Academic
Type input
Range [1 10]
Close
Ready

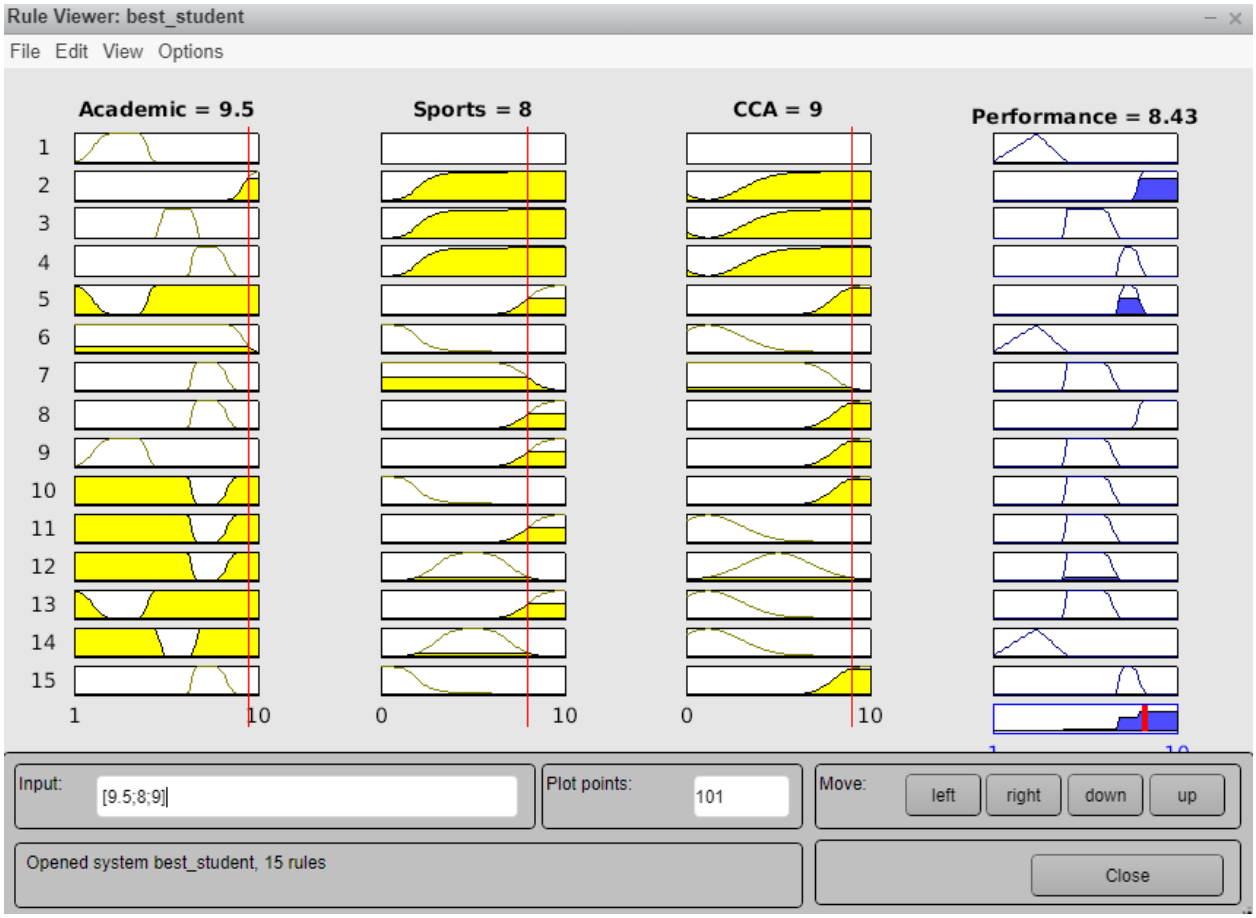
Performance:

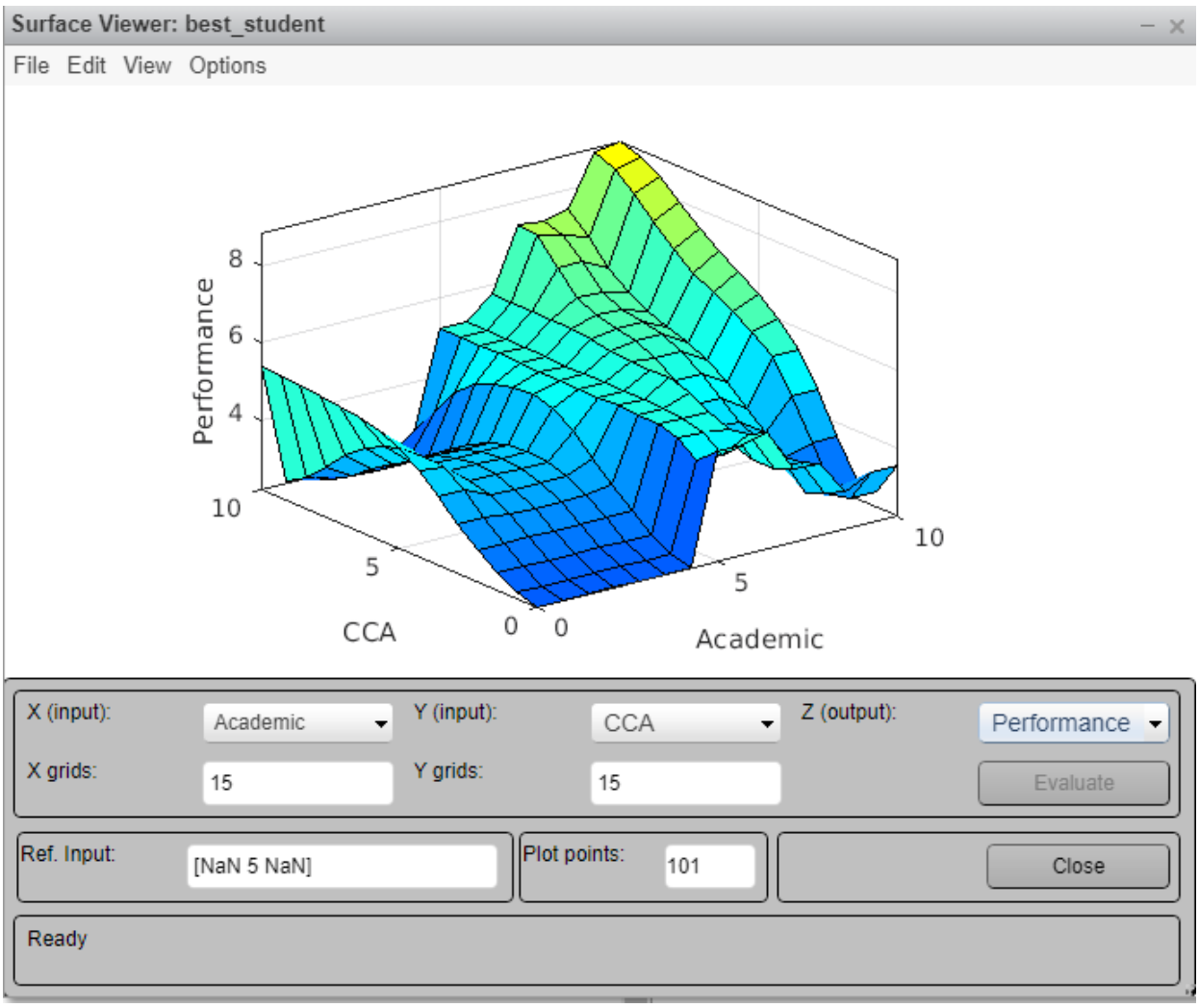





Rule Viewer: best_student
File Edit View Options
Academic = 8
Sports = 10
CCA = 7
Performance = 7.65
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
10
0
10
0
10
Input:
[8;10;7]
Plot points:
101
Move:
left
right
down
up
Opened system best_student, 15 rules
Close


Rule Viewer: best_student
File Edit View Options
Academic = 8
Sports = 5
CCA = 7
Performance = 6.29
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1
10
0
10
0
10
Input:
[8;5;7]
Plot points:
101
Move:
left
right
down
up
Opened system best_student, 15 rules
Close


Rule Viewer: best_student
File Edit View Options
Academic = 9.5
Sports = 8
CCA = 9
Performance = 8.43
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1
10
0
10
0
10
Input:
[9.5;8;9]
Plot points:
101
Move:
left
right
down
up
Opened system best_student, 15 rules
Close


Surface Viewer: best_student
File Edit View Options
Performance
8
6
4
10
5
0
CCA
0
5
10
Academic
X (input):
Academic
Y (input):
CCA
Z (output):
Performance
X grids:
15
Y grids:
15
Evaluate
Ref. Input:
[NaN 5 NaN]
Plot points:
101
Close
Ready