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E/16/156

CO542 – Neural Networks and Fuzzy Systems

Lab1 – Fuzzy Logic

1. Define the rule-base for the scenario.

- If speed is too slow, speed up the voltage (increase the input voltage)
  Too slow(speed) ⇨ speed up (voltage)
- If speed is about right, don't change much the input voltage
  About right(speed) ⇨ not much change (voltage)
- If speed is too fast, slow down the voltage (reduce the input voltage)
  Too fast(speed) ⇨ slow down (voltage)

2. **Suppose, the speed increases from the set point of 2420 to 2437.4 rpm. This is depicted on the membership function as shown in Figure 2. Calculate required voltage to maintain an rpm at set speed (Use Mamdani model and maximum defuzzification method)**

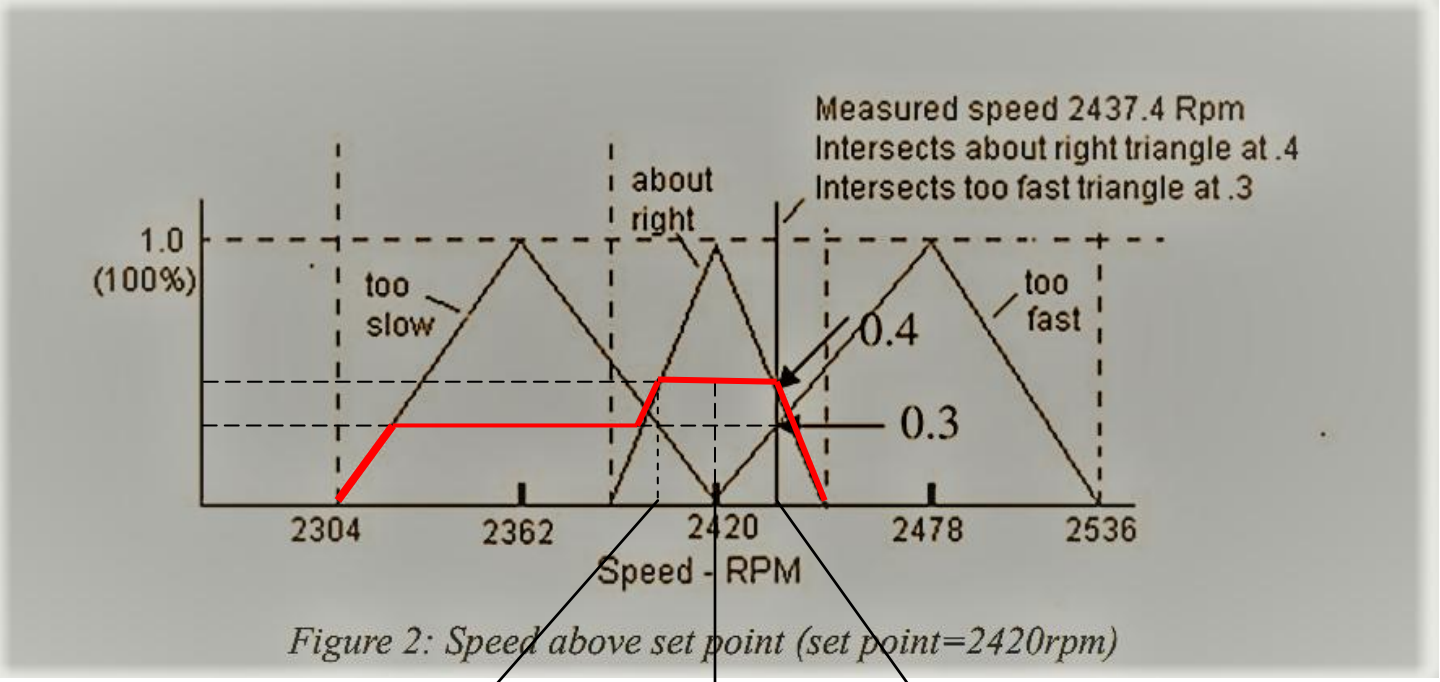


Figure 2: Speed above set point (set point=2420rpm)

SOM MOM LOM

Using maximum difuzzification method,

SOM (Small of maximum)

$$\frac{1 - 0}{2.40 - 2.38} = \frac{0.4 - 0}{x - 2.38}$$

$X = 2.388$

LOM (Large of maximum)

$$\frac{1 - 0}{2.40 - 2.42} = \frac{0.4 - 0}{Z - 2.42}$$

$Z = 2.412$

MOM (Mean of maximum)

$$Y = \frac{x + z}{2}$$

$$Y = \frac{2.388 + 2.412}{2}$$

$$Y = 2.400$$

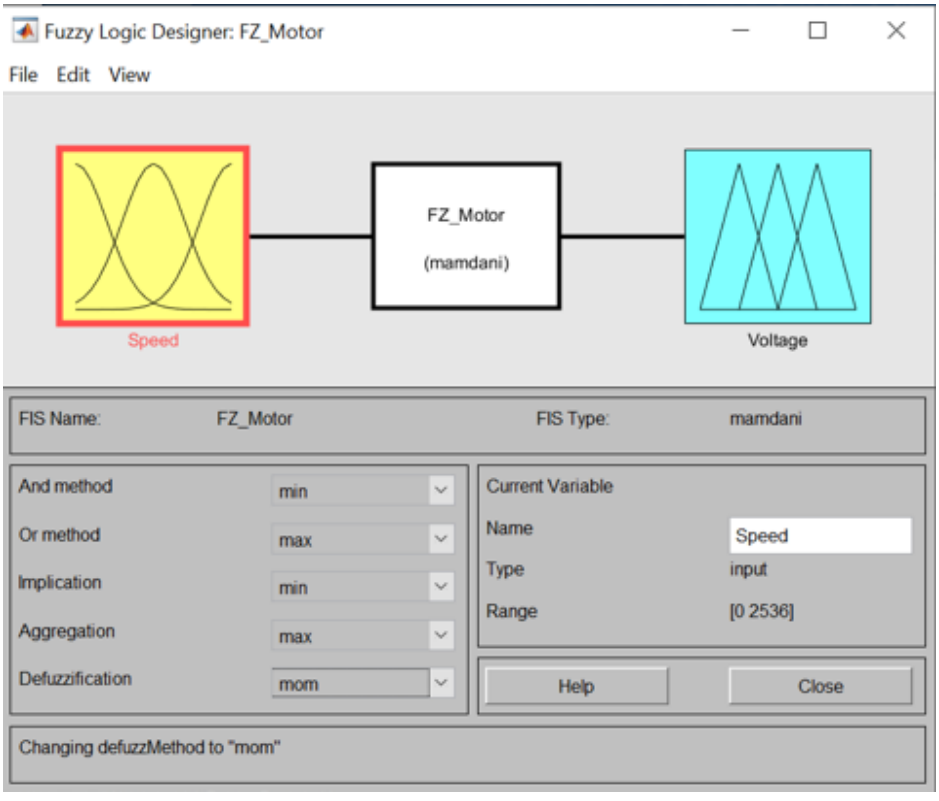
The required voltage to maintain rpm at set speed,

SOM = 2.388 Volts
MOM = 2.412 Volts
LOM = 2.400 Volts

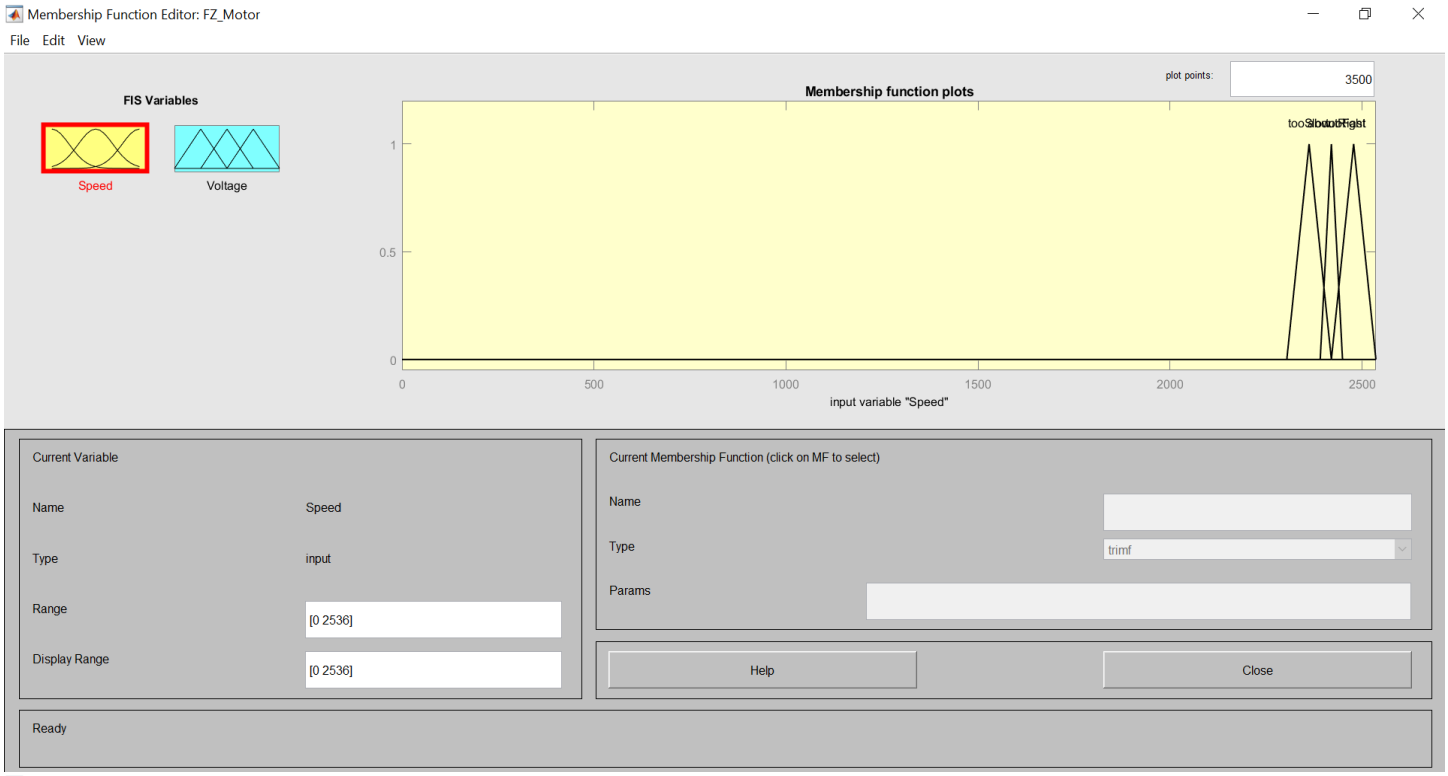
3. Solve the same using Fuzzy logic tool box in Matlab.

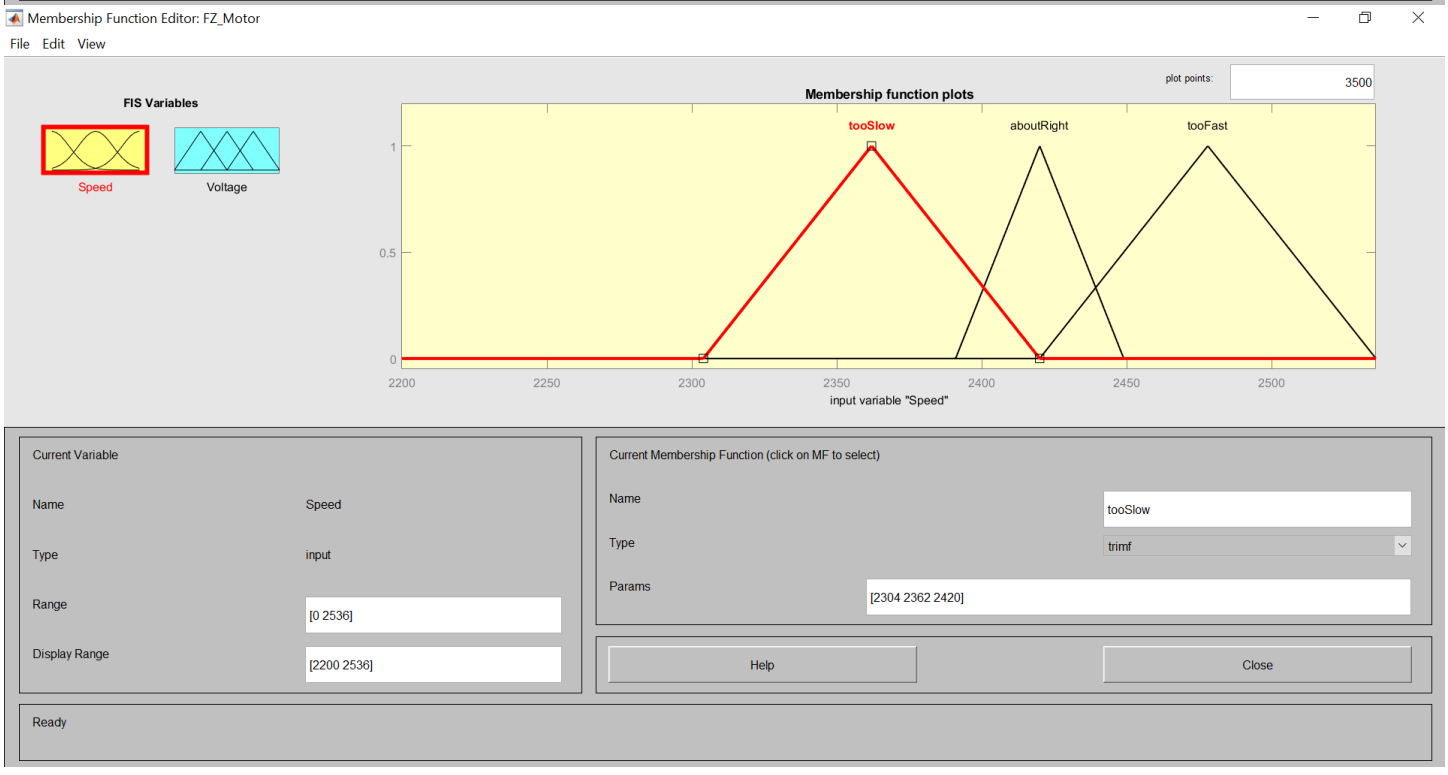
Use Fuzzy Logic tool

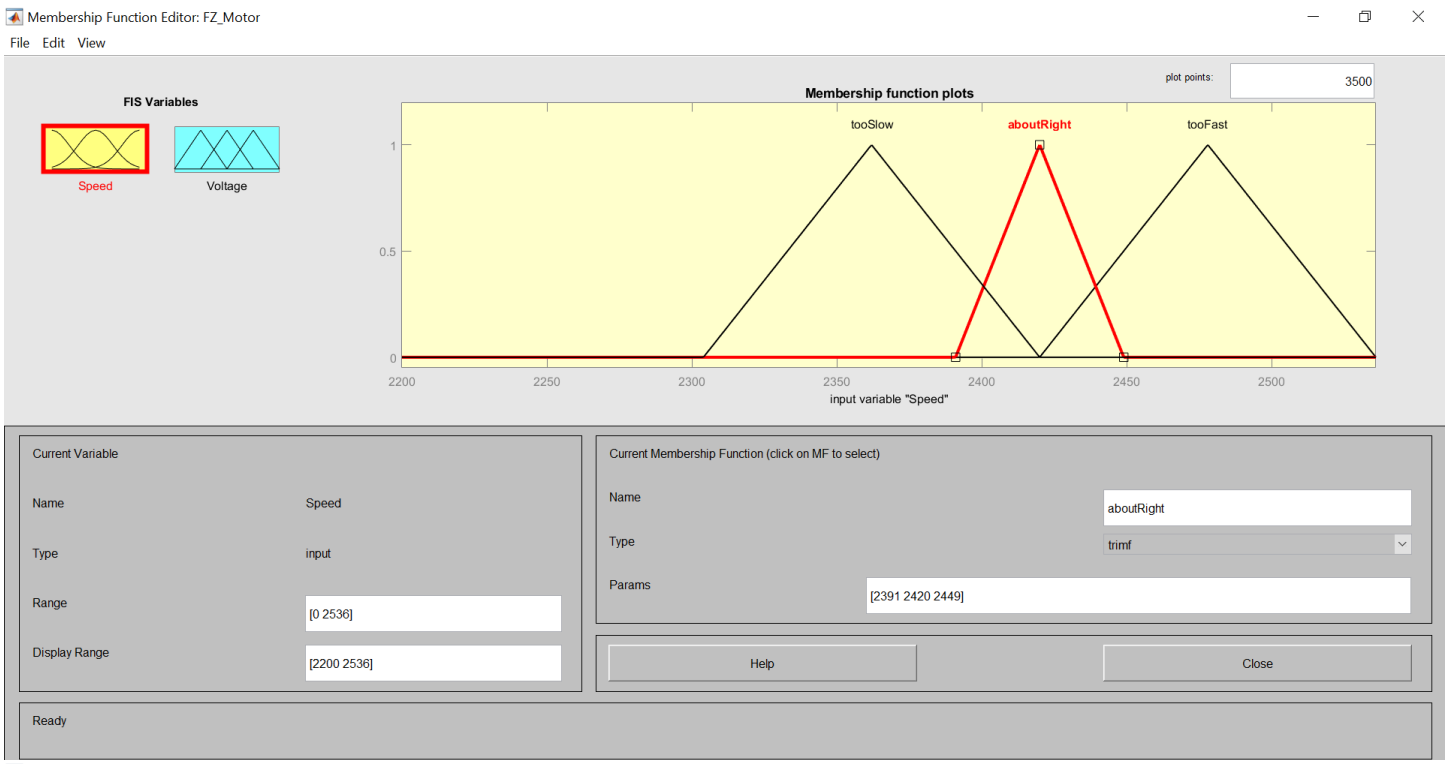
defuzzification method: 'mom'
Aggregation: 'max'

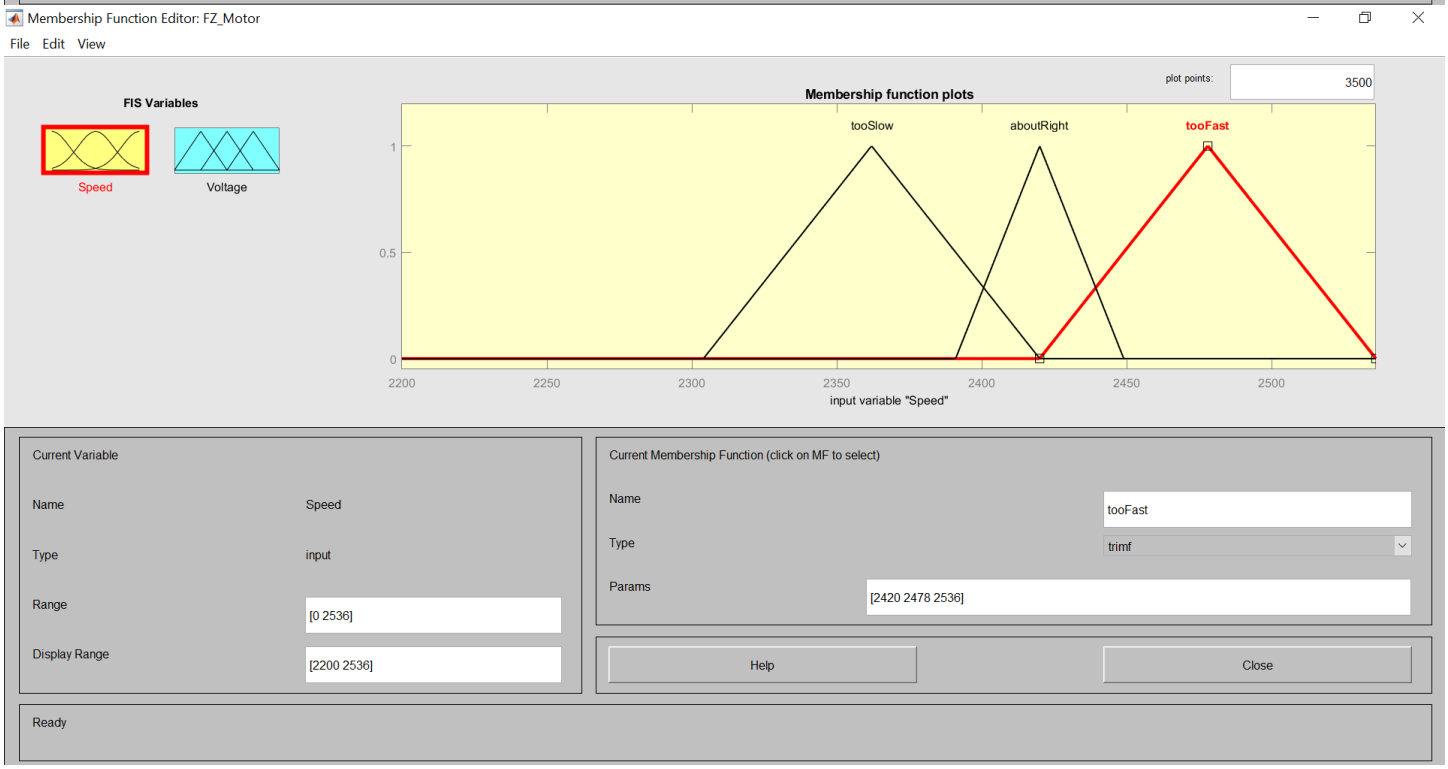


Input membership function

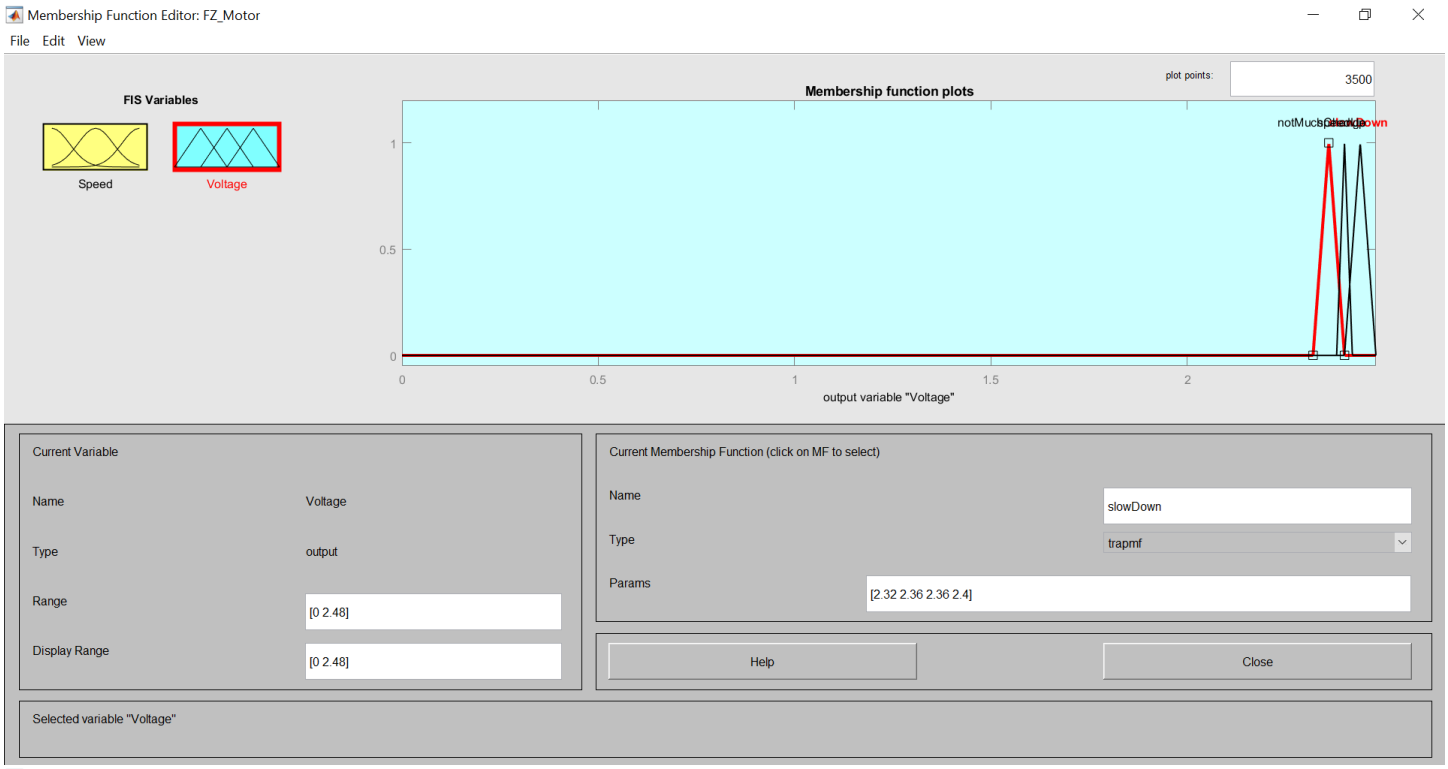


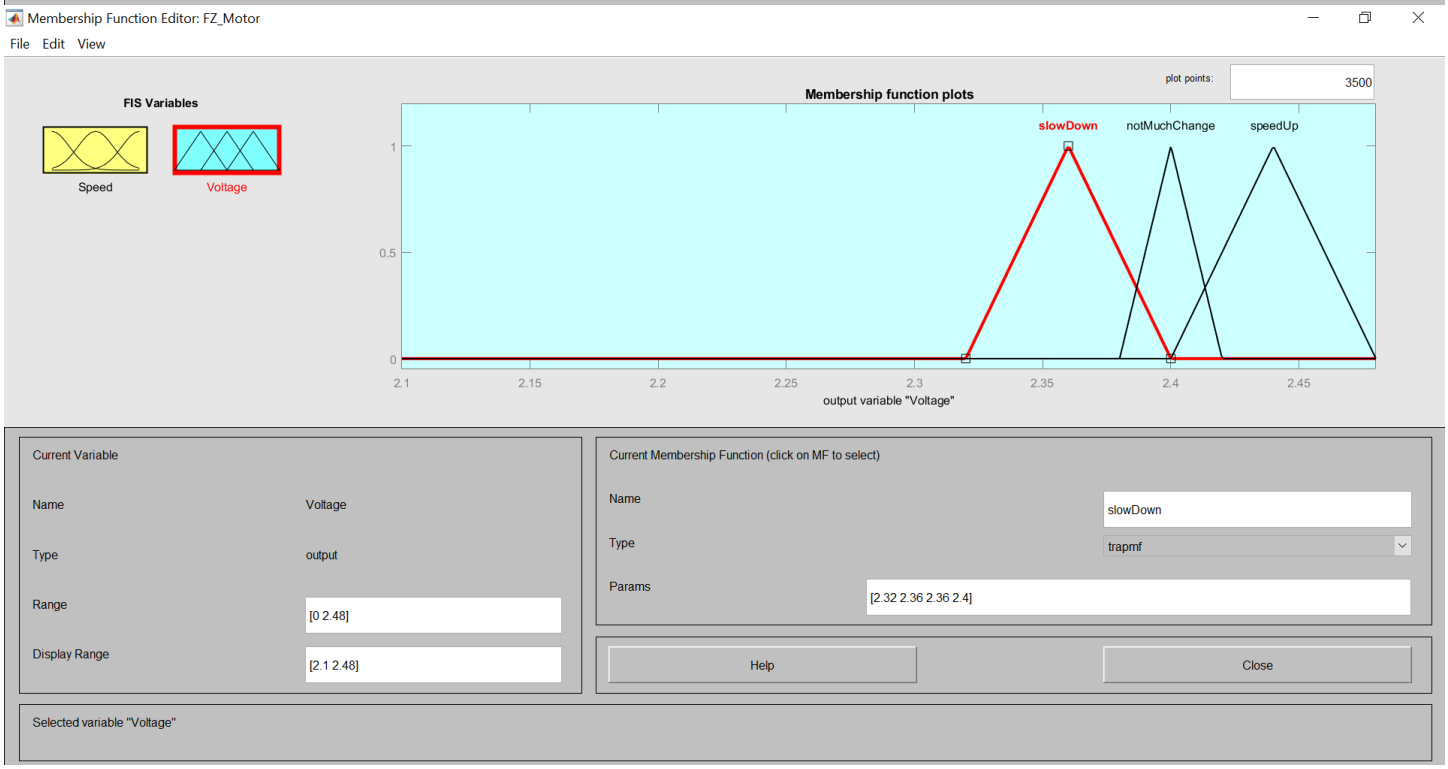



Membership Function Editor: FZ_Motor
File Edit View
FIS Variables
Speed
Voltage
plot points:
3500
Membership function plots
tooSlow
aboutRight
tooFast
1
0.5
0
2200
2250
2300
2350
2400
2450
2500
input variable "Speed"
Current Variable
Name
Speed
Type
input
Range
[0 2536]
Display Range
[2200 2536]
Current Membership Function (click on MF to select)
Name
aboutRight
Type
trimf
Params
[2391 2420 2449]
Help
Close
Ready

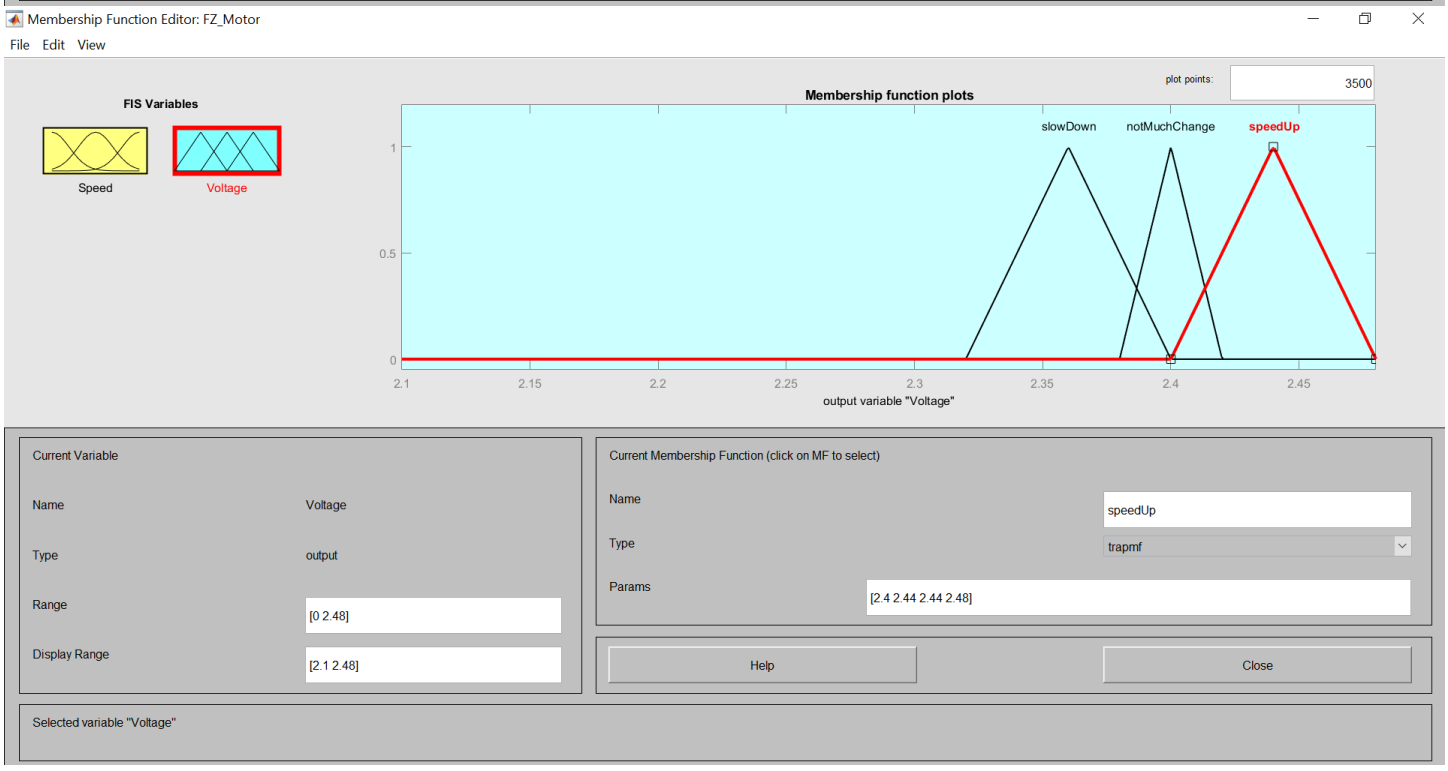

Membership Function Editor: FZ_Motor
File Edit View
FIS Variables
Speed
Voltage
plot points:
3500
Membership function plots
tooSlow
aboutRight
tooFast
1
0.5
0
2200
2250
2300
2350
2400
2450
2500
input variable "Speed"
Current Variable
Name
Speed
Type
input
Range
[0 2536]
Display Range
[2200 2536]
Current Membership Function (click on MF to select)
Name
tooFast
Type
trimf
Params
[2420 2478 2536]
Help
Close
Ready

Output membership function

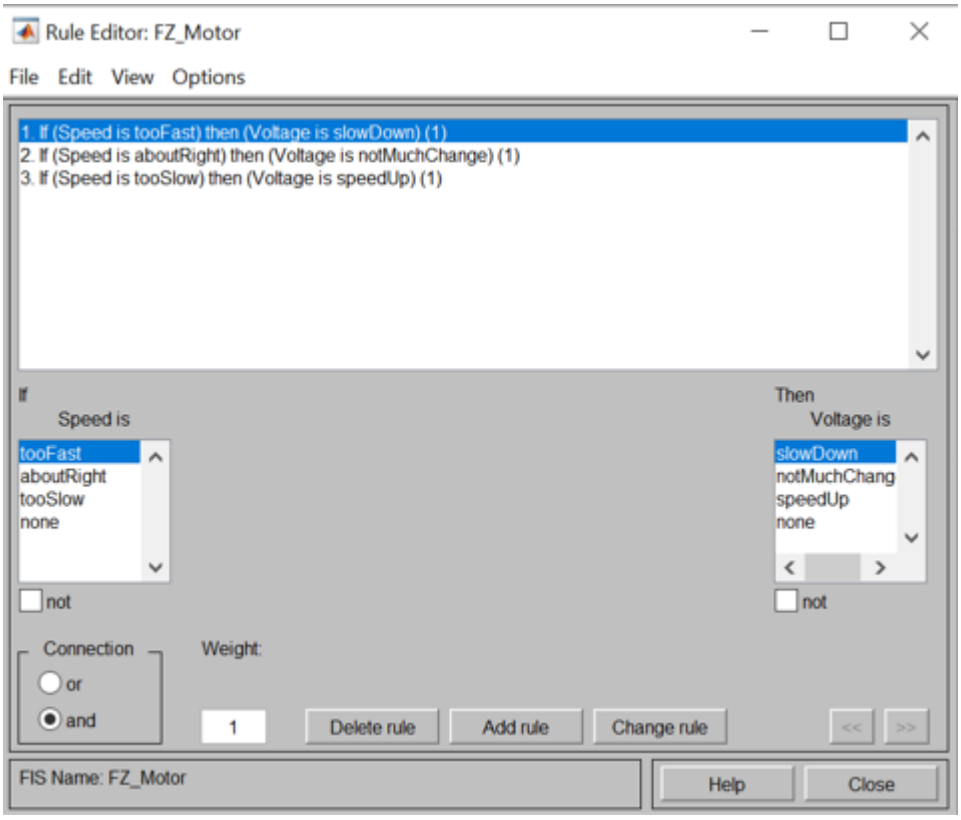





Membership Function Editor: FZ_Motor
File Edit View
FIS Variables
Speed
Voltage
plot points:
3500
Membership function plots
slowDown
notMuchChange
speedUp
1
0.5
0
2.1
2.15
2.2
2.25
2.3
2.35
2.4
2.45
output variable "Voltage"
Current Variable
Name
Voltage
Type
output
Range
[0 2.48]
Display Range
[2.1 2.48]
Current Membership Function (click on MF to select)
Name
notMuchChange
Type
trapmf
Params
[2.38 2.4 2.4 2.42]
Help
Close
Selected variable "Voltage"

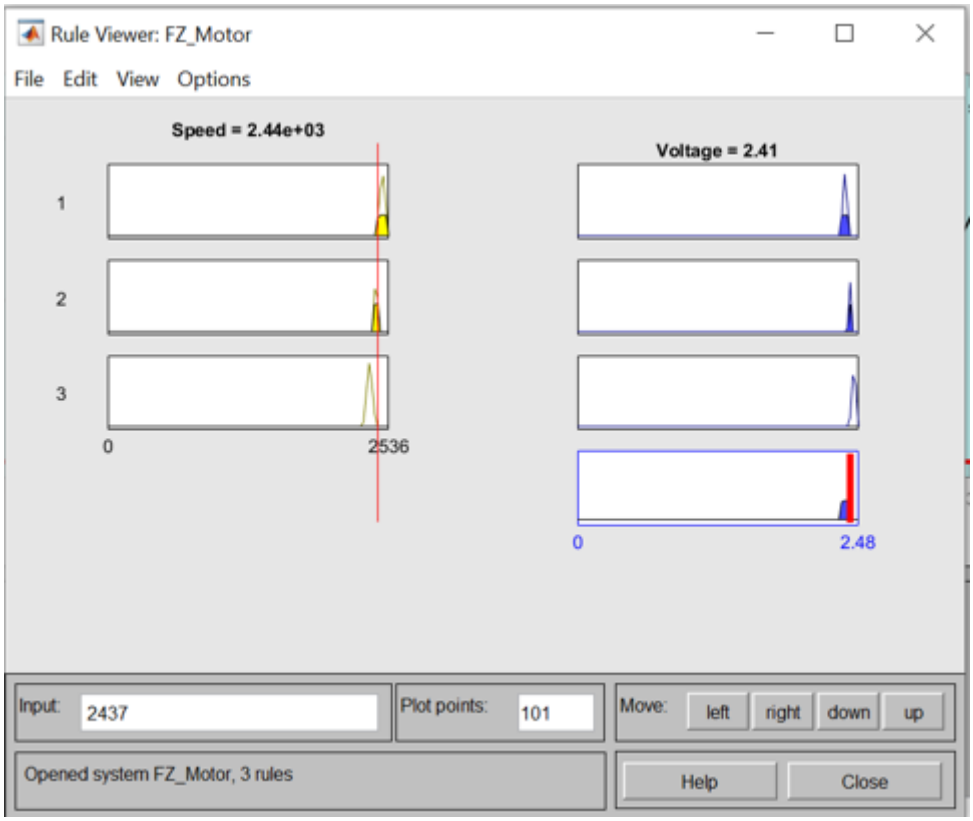

Membership Function Editor: FZ_Motor
File Edit View
FIS Variables
Speed
Voltage
plot points:
3500
Membership function plots
slowDown
notMuchChange
speedUp
1
0.5
0
2.1
2.15
2.2
2.25
2.3
2.35
2.4
2.45
output variable "Voltage"
Current Variable
Name
Voltage
Type
output
Range
[0 2.48]
Display Range
[2.1 2.48]
Current Membership Function (click on MF to select)
Name
speedUp
Type
trapmf
Params
[2.4 2.44 2.44 2.48]
Help
Close
Selected variable "Voltage"

Rule Editor



Calculations (voltage for the speed of 2437.4rpm)

```
Command Window
>> fuzzy
>> fis =readfis('FZ_Motor')

fis =

  struct with fields:

           name: 'FZ_Motor'
           type: 'mamdani'
      andMethod: 'min'
       orMethod: 'max'
   defuzzMethod: 'mom'
      impMethod: 'min'
      aggMethod: 'max'
          input: [1×1 struct]
         output: [1×1 struct]
           rule: [1×3 struct]

>> out= evalfis(2437.4,fis)

out =

    2.4056
```


Rule Viewer: FZ_Motor
File Edit View Options
Speed = 2.44e+03
Voltage = 2.41
1
2
3
0
2536
0
2.48
Input: 2437
Plot points: 101
Move: left right down up
Opened system FZ_Motor, 3 rules
Help
Close