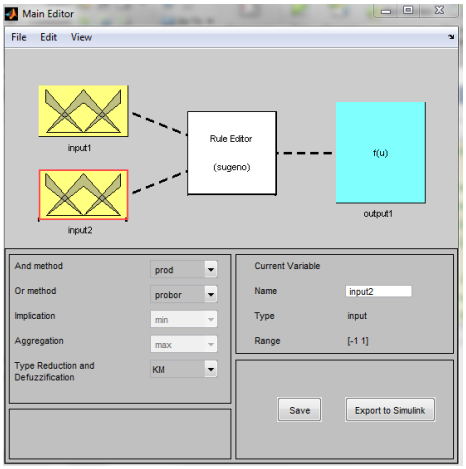
1. How to install the IT2-FLS Matlab/Simulink Toolbox

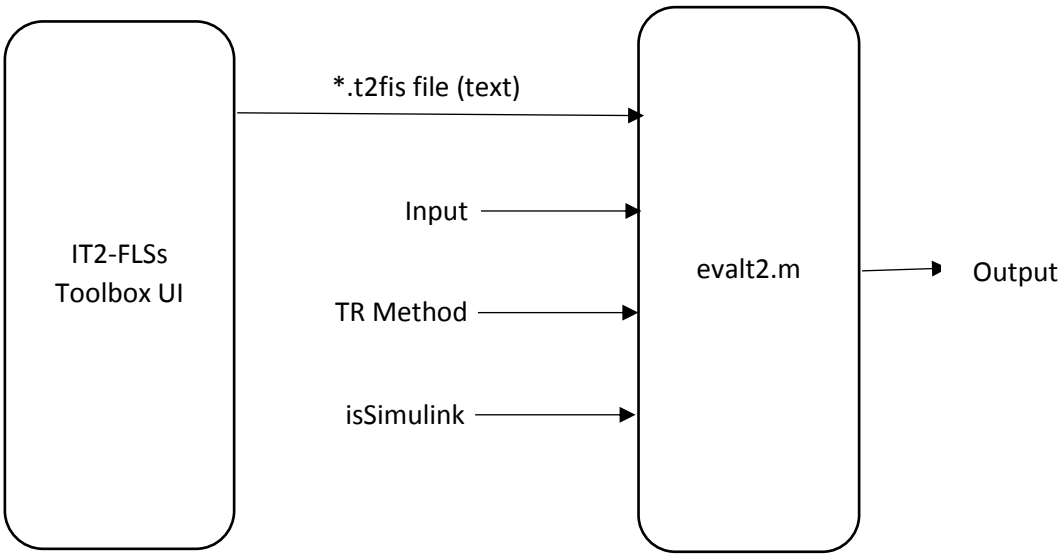
Download and Extract the RAR file into a convenient directory that is **not** part of the MATLAB distribution. Then use the MATLAB pathtool command. Navigate to the directory you just extracted into, down below the IT2FLSv1.0 directory to the IT2-FLS_Toolbox-v1.0 directory and add that to your MATLAB path. Then at the MATLAB command prompt, command

```
fuzzyt2
```



2. Main Workflow of the IT2-FLSs Toolbox

The general workflow of the IT2-FLSs toolbox is given below. The IT2-FLSs toolbox UI starts with fuzzyt2.m function and is basically used to create a text file with 'it2fis' extension. The created *.it2fis text file includes all information of the IT2FLSs designed by using the toolbox UI.



It is also possible to create or modify this *.it2fis text file manually. But, the text file has to be created or modified according to standard form. The standard structure of *.it2fis text file is given below.

```
[System]
Name='Example'  %% Name of the file
Type='sugeno'
Version=2.0
NumInputs=3  %% Number of inputs
NumOutputs=1 %% This version only supports one output
NumRules=4  %% Number of Type-2 Fuzzy rules
AndMethod='prod'
OrMethod='probor'
ImpMethod='prod'
AggMethod='sum'
DefuzzMethod='wtaver'
TypeRedMethod='KM' %% Define the TR method, KM, EKM,IASC, EIASC, EODS, WM, NT and BMM. Note that, for BMM, two more parameters most be defined (n,m). Thus, define 'BMM(n,m)'
outputType='icrisp'

[Input1] %% All inputs should have the following structure
Name='x1' %% Name of the first input
Range=[-1 1] %% the universe of discourse
NumMFs=3 %% Number of Type-2 Fuzzy sets for x1
MF1U='x1-N':'trimf',[-1.8 -1 -0.2 1] %Upper MF parameters for'x1-N'
MF1L='x1-N':'trimf',[-1.6 -1 -0.4 0.7] %Lower MF parameters for'x1-N'
MF2U='x1-Z':'trimf',[-0.8 0 0.8 1] %Upper MF parameters for'x1-Z'
MF2L='x1-Z':'trimf',[-0.6 0 0.6 0.7] %Lower MF parameters for'x1-Z'
MF3U='x1-P':'trimf',[0.2 1 1.8 1] %Upper MF parameters for'x1-P'
MF3L='x1-P':'trimf',[0.4 1 1.6 0.7] %Lower MF parameters for'x1-P'

[Input2]
Name='x2'%% Name of the second input
Range=[-1 1] %% the universe of discourse
NumMFs=3 %% Number of antecedent MFs for x2
MF1U='x2-N':'gaussmf',[0.4247 -1 1]
MF1L='mf1L':'gaussmf',[0.21235 -1 0.5]
MF2U='x2-Z':'gaussmf',[0.4247 0 1]
MF2L='mf2L':'gaussmf',[0.21235 0 0.5]
MF3U='x2-P':'gaussmf',[0.4247 1 1]
MF3L='mf3L':'gaussmf',[0.21235 1 0.5]

[Input3]
Name='x3'%% Name of the second input
Range=[-1 1] %% the universe of discourse
NumMFs=3 %% Number of antecedent MFs for x3
MF1U='x3-N':'trapmf',[-1.9 -1.1 -0.9 -0.1 1]
MF1L='mf1L':'gaussmf',[0.21235 -1 0.5]
MF2U='x3-Z':'trapmf',[-0.9 -0.1 0.1 0.9 1]
MF2L='mf2L':'gaussmf',[0.21235 0 0.5]
MF3U='x3-P':'trapmf',[0.1 0.9 1.1 1.9 1]
MF3L='mf3L':'gaussmf',[0.21235 1 0.5]

[Output1]%% the output must have the following structure
Name='y'
Range=[-1 1]
```

```
NumMFs=3 %% Number of consequent MFs.
MF1='N':'constant',[-5 -5] %Lower and Upper MF parameters, i.e. [low up]
MF2='Z':'constant',[0 0] %Lower and Upper MF parameters, i.e. [low up]
MF3='P':'constant',[5 5] %Lower and Upper MF parameters, i.e. [low up]

[Rules] %Rule Structure
1 1 1, 1 (1) : 1 %% If x1 is'x1-N' and x2 is'x2-N' and x3 is'x3-N', then y is y is 'N'
1 2 1, 3 (1) : 1
1 1 2, 3 (1) : 1
1 2 2, 2 (1) : 1 %% If x1 is'x1-N' and x2 is'x2-Z' and x3 is'x3-Z', then y is y is 'Z'
```

3. Evaluating the output of an IT2-FLS from Matlab

Firstly, the generated t2fis file is exported to workspace as follows:

Matlab Syntax:

```
T2FIS=readt2fis(fileName);
```

Inputs

fileName - *.t2fis file created by UI or manually.

Then, the evalt2.m function can be used to calculate the output for a given t2fis file and current input.

Matlab Syntax:

```
y=evalt2(T2FIS,input, TRType,issimulink)
```

Inputs

T2FIS - *.t2fis file created by UI or manually.

input – Current input values of the IT2FLSs to calculate output.

TRmethod – Type Reduction/ Defuzzification method:

TRmethod=1-> KM

TRmethod=2-> EKM

TRmethod=3-> IASC

TRmethod=4-> EIASC

TRmethod=5-> EODS

TRmethod=6-> WM

TRmethod=7-> NT

issimulink– A variable for the Simulink library, must be set as “false” while operating in Matlab

Outputs:

y – Double – the defuzzified output value.

Examples:

```
T2=readt2fis('Test.t2fis');
% using the TypeRedMethod in the t2fis file'KM'
yKM=evalt2(T2,[-1 -.4])
% changing the TypeRedMethod as 'NT'
yNT=evalt2(T2,[-1 -.4],7,false)
```