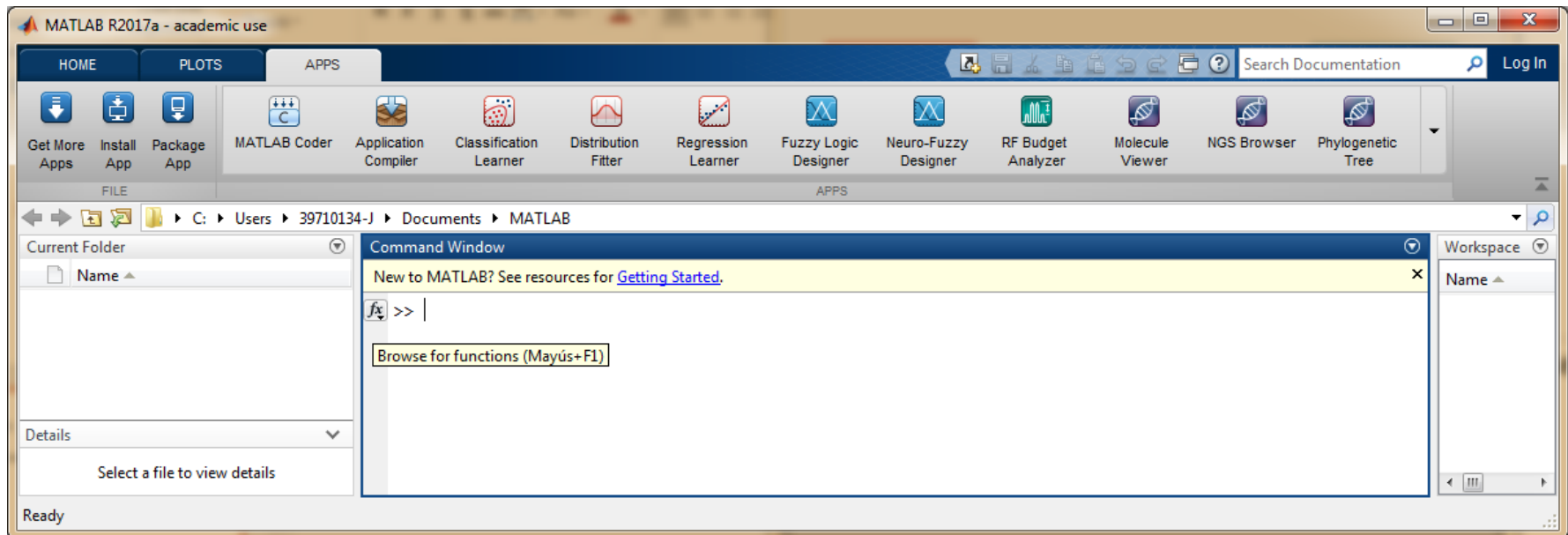


LAB: Linguistic Variables with Fuzzy Sets

Matlab Fuzzy Toolkit

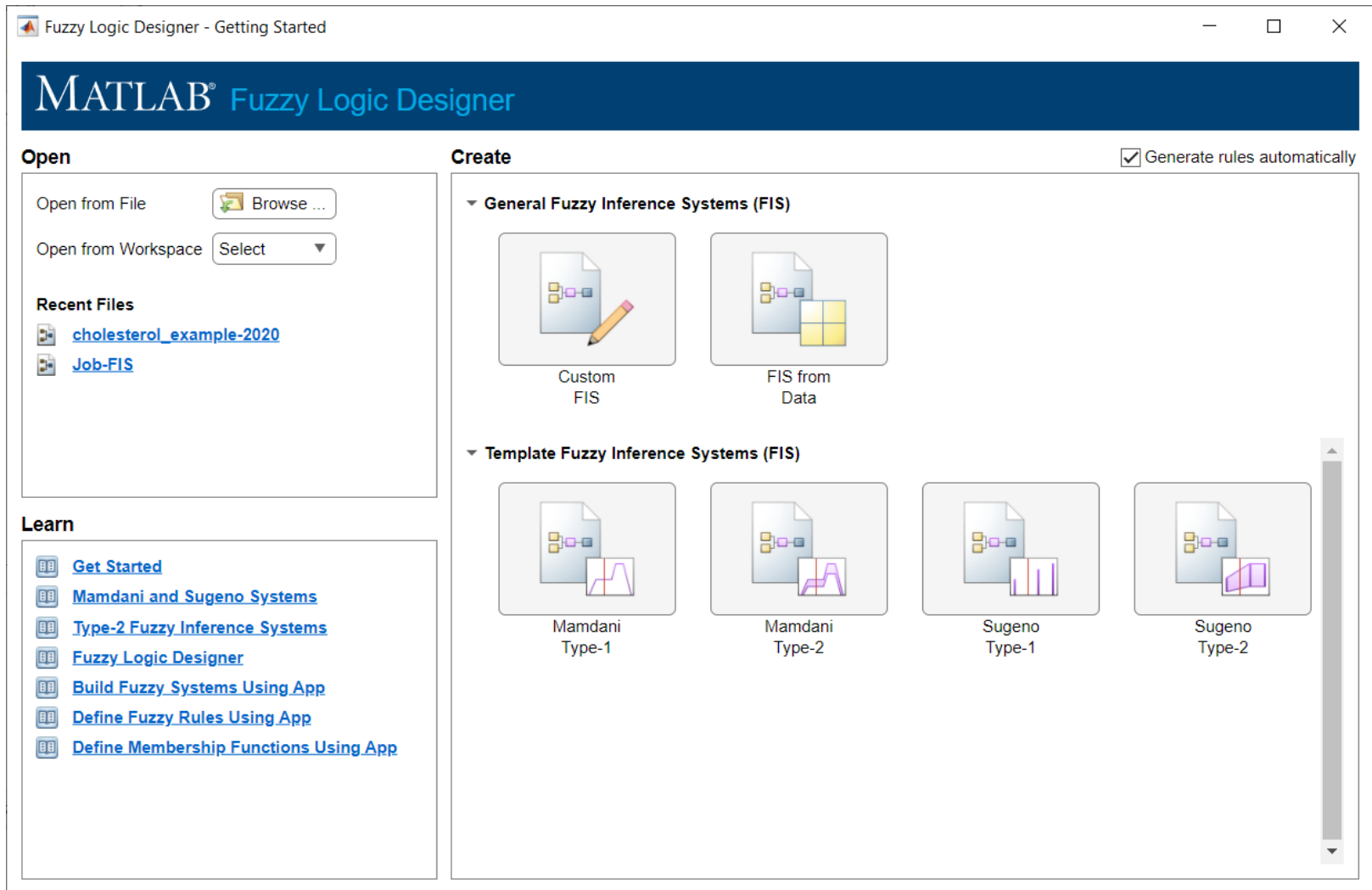
Software Matlab

- We will use Matlab. You can find it in VirtLabs section in the URV intranet. Install a version before R2022b.
- Then open Matlab and go to Apps => Fuzzy Logic Designer



Software: Matlab version R2022b

- Create a FIS (fuzzy inference system) from CUSTOM FIS.
- Or from Mamdani Type1.



Main window: empty project

The screenshot displays the Fuzzy Logic Designer (FIS) main window for a project named 'mamdanitype1'. The interface is divided into several sections:

- DESIGN BROWSER:** Located on the left, it shows the project structure. Under 'System: mamdanitype1', there are 'Inputs' (2), 'Outputs' (1), and 'Rules' (9).
- PROPERTY EDITOR: FIS:** On the right, it provides configuration options for the Mamdani Type-1 system. The 'Name' is 'mamdanitype1'. The 'And method' is set to 'min', 'Or method' to 'max', 'Implication method' to 'min', 'Aggregation method' to 'max', and 'Defuzzification method' to 'centroid'. The 'Inputs' are 2, 'Outputs' are 1, and 'Rules' are 9.
- Central Plot Area:** Displays a diagram of the Mamdani Type 1 inference process. It shows two input plots (input1 and input2, each with 3 MFs) feeding into a central 'Mamdani Type 1' block, which then feeds into an output plot (output1 with 3 MFs).
- Toolbars:** The top toolbar includes options for 'New', 'Save', 'Import', 'Input', 'Output', 'Rule', 'Add All Rules', 'Mamdani to Sugeno', 'Type-1 to Type-2', 'Number of Samples' (set to 101), 'Rule Inference', 'Control Surface', 'Store Current Design', and 'Export'.

In the main window of FIS, you can configure the operators (explained in other slides). We concentrate now on the input/output variables.

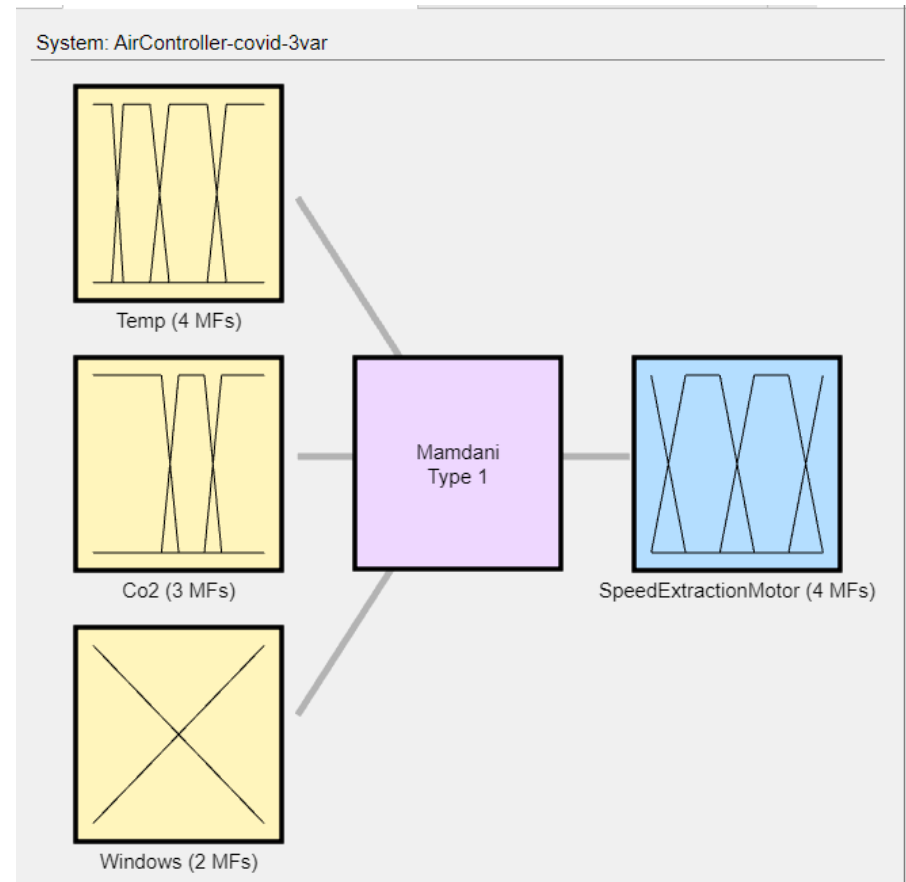
Example: CO2 air controller

We have a fuzzy expert system to control the CO2 in a classroom.

We have 3 input linguistic variables:

- Temperature at classroom ($^{\circ}\text{C}$)
- Co2 measured in
- Windows state (open / closed)

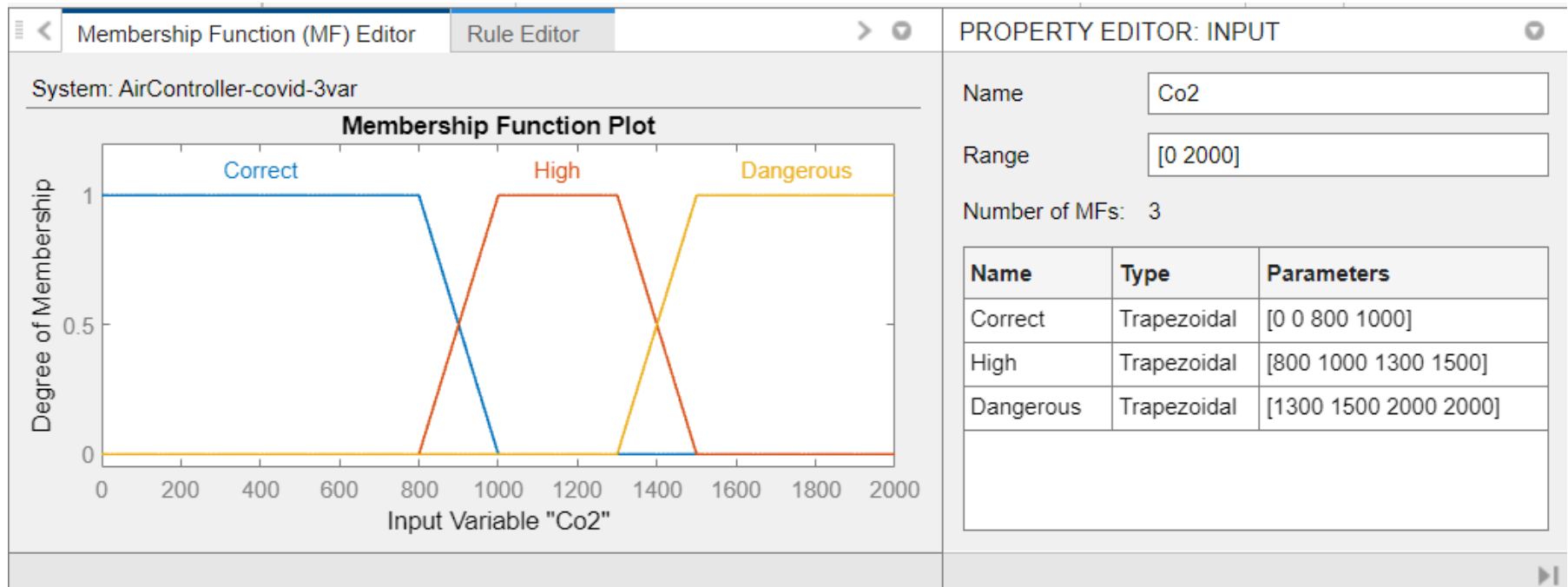
With these 3 inputs, the system calculates the speed of the extraction motor available in the classroom.



Example: CO2 air controller

Definitions of the variables are as follows. Example:

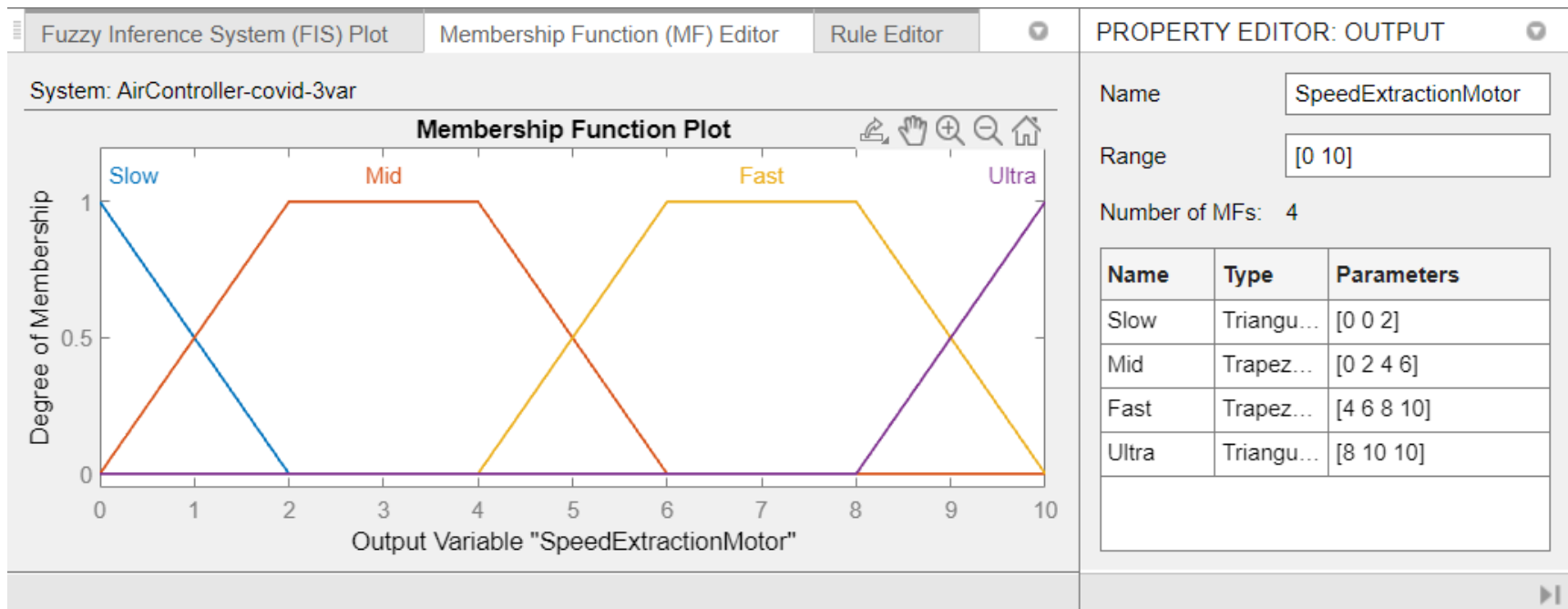
- Variable Co2 ranges from 0 to 2000, and it has 3 labels (MFs) with different covering of this range. Trapezoidal fuzzy sets are used.



Example: CO2 air controller

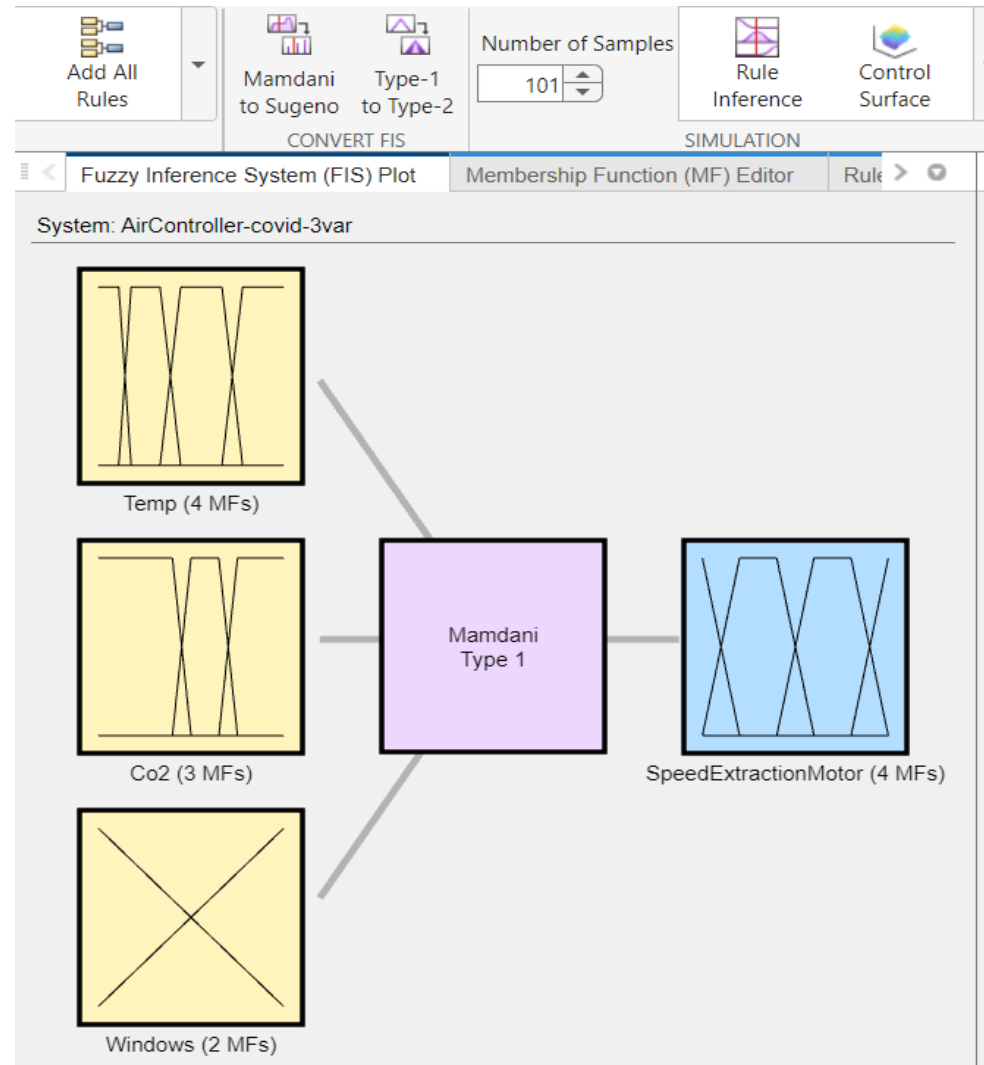
The output variable is also a linguistic variable, with a range of velocity between 0 (stop) and 10 (maximum speed).

Four linguistic terms are used. Two triangular and two trapezoidal.



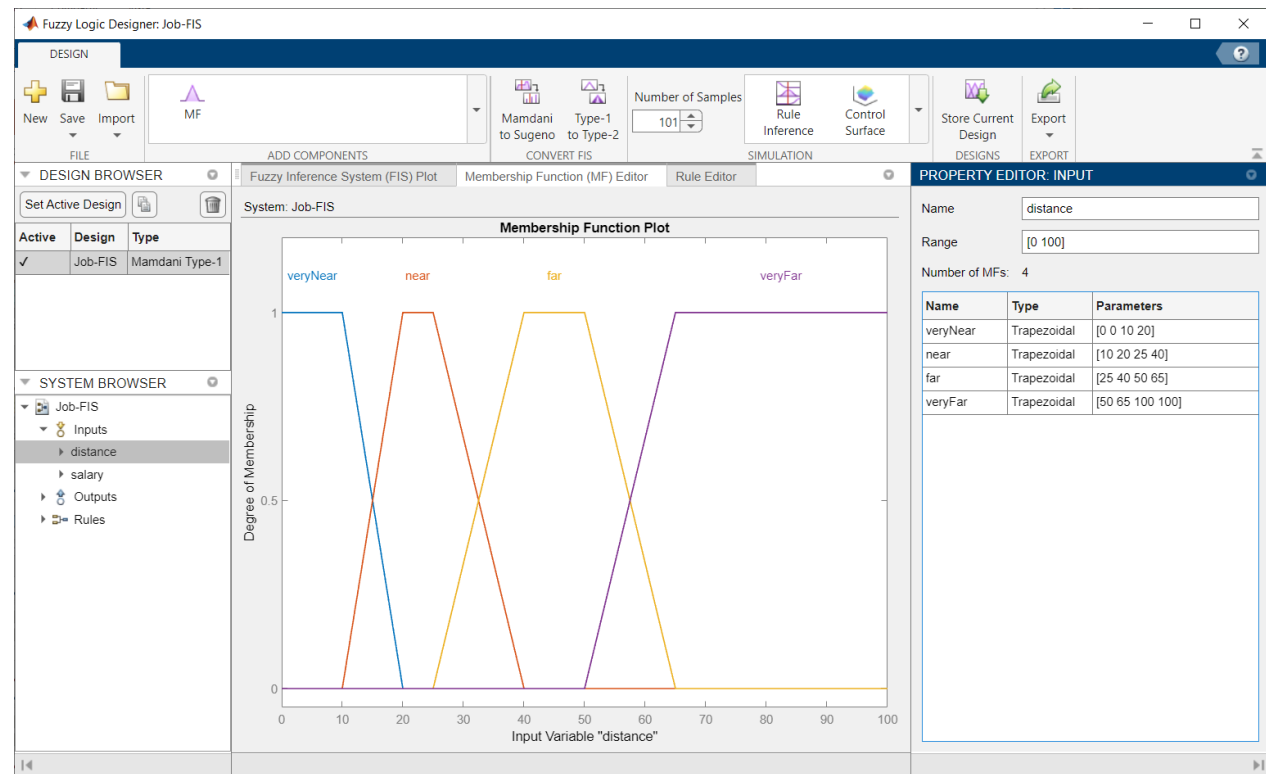
FIS variables definition

- The central panel shows:
 - Inputs: in yellow
 - Outputs: in blue
- Select tab “Membership Function MF Editor”
- Add more variables in the left window



FIS variables definition

version R2022b



- For each variable you can configure the name & range.
- You can configure the names and fuzzy sets of each label. Params indicate the x points that define the fuzzy set.
- In the top left menu bar, we can add more labels (mfs)

General issues

- You can create new projects from menu options. Choose Mamdani (type I)
- You can also import projects you already have.
- Export your project to a file before leaving the software, in File menu option.

Exercise1: Job recommender variables

We want to construct an expert system for evaluating jobs offers.

- Generate two input variables called “distance” and “salary” with the following linguistic values:
 - **Distance** (0 to 100 km): “very near”(about 10km), “near” (about 20km), “far”(about 50km), “very far”(about 80km)
 - **Salary** (700 to 4000 €): “minimum”(smaller than 1000€), “normal” (about 1800€), “good”(about 2500€), “awesome” (about 3500€)
 - Construct an output variable to measure our “interest” in a job. The output will be given in a scale from 0 to 10.
 - Decide the number of labels, names and fuzzy sets.
1. Use different types of membership functions: triangular, trapezoidal, Gaussian or sigmoidal
 2. Use symmetric and asymmetric/unbalanced fuzzy sets