For use with Matlab

In case of publication of any application of this method, please, cite the work:

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How to Run:

Main.m – Just run the Main file.

Main Functions:

Main.m – This is the main function.

EvolveFLC.m - This function is the core function to self-evolve the fuzzy controller.

Initialization.m - This function initializes the struct x, i.e. the initial parameters (Algorithm 2 Step 2).

UpdateAntecedent.m - This function updates the antecedent parameters (Algorithm 2 Step 3.a).

UpdateConsequent.m - This function updates the consequent parameters (Algorithm 2 Step 3.b).

FuzzyController_EstimationError.m – This function obtains the estimated control error (equation (19), see Section III-C).

LocateMF_Gravity.m - This function obtains the position/center of the new (candidate) membership function for variable *j* (Equation (22)).

AddMF_ErrorAVG.m - In this function, if the Criterion 2 is met, a new membership function is added on input variable *j*.

AddNewConsequent.m - This function obtains the consequent parameters of the new fuzzy rule (Equation (23)).

FuzzyController.m - This function obtains the fuzzy control signal - equation 8.

Psi.m – This function obtains the variable Ψ (equation (11)).

trifp.m – This function obtains the fuzzy degree of a triangular MF for a given data.

update_window.m - This function updates the temporal sliding window.

Plot_Evolve_Parameterts.m – This function does plots of some important parameters on the evolving stage.

PlotMFs.m - This function presents the plots of the membership functions of all input variables.

Main Configuration Files:

ParametersConfig.m – This file contains the main variables of the algorithm to defined:

- universe_x - Minimum and maximum values of the inputs variables.
- eta_aux - parameters to define the minimal distance between MFs
- Rules_ini - Initial number of fuzzy rules (the same of initial MFs).
- control_min_max - Universe of discourse of the control variable [min max].
- window_size - temporal sliding windows size.
- beta - Learning gain β (antecedents).
- C - Learning gain C (consequents).
- delta - threshold δ.

reference.m – Definition of the reference and plant variables.

Definition of the Struct x:

x is a struct, in which, contains all parameters of the fuzzy controller.

x

1x2 struct with 4 fields

Fields	Limit	Rules_ini	eta	Rules
1	[0.0600,0.1200]	2	0.0040	*4x4 double*
2	[0.0600,0.1200]	2	0.0040	*3x4 double*

Figure 1: Example of struct x. Final values of the current example, CSTR plant.

Elements of struct x:

- **Rows**: contain all parameters of the fuzzy control rules for each input variable, e.g.:
  - row 1 contains the parameters of the fuzzy control rules for the input variable x_1
  - row *j* contains the parameters of the fuzzy control rules for the input variable x_j
  - Figure 1 contains the parameters of the 2 input variables of the CSTR plant example.
- **Columns:**
  - **First column:** contains the limits of the universe of discourse of the respective input variable.
  - **Second column:** contain the initial number of fuzzy control rules of the respective input variable.
  - **Third column:** contain the matrix rules of the respective input variable:

x(1).Rules

	1	2	3	4
1	0.0600	0.0600	0.0939	95.4206
2	0.0600	0.0939	0.0986	99.4442
3	0.0939	0.0986	0.1200	107.1727
4	0.0986	0.1200	0.1200	109.7336

Figure 2: Example of the matrix rules.

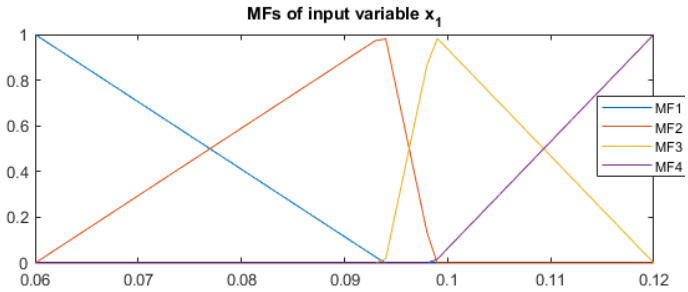

Figure 3: Plot of MFs represented on Figure 2.

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- **Rows:** each row represents a fuzzy control rule;

- **1º column:** represents parameter $a_{j,l}$ (lower limit of the respective membership function);
- **2º column:** represents parameter $b_{j,l}$ (center value of the respective membership function);
- **3º column:** represents parameter $c_{j,l}$ (upper limit of the respective membership function);
- **4º column:** represents the consequent parameter of the respective rule.