
Interval Type 2 Fuzzy Logic System: Construction and Applications

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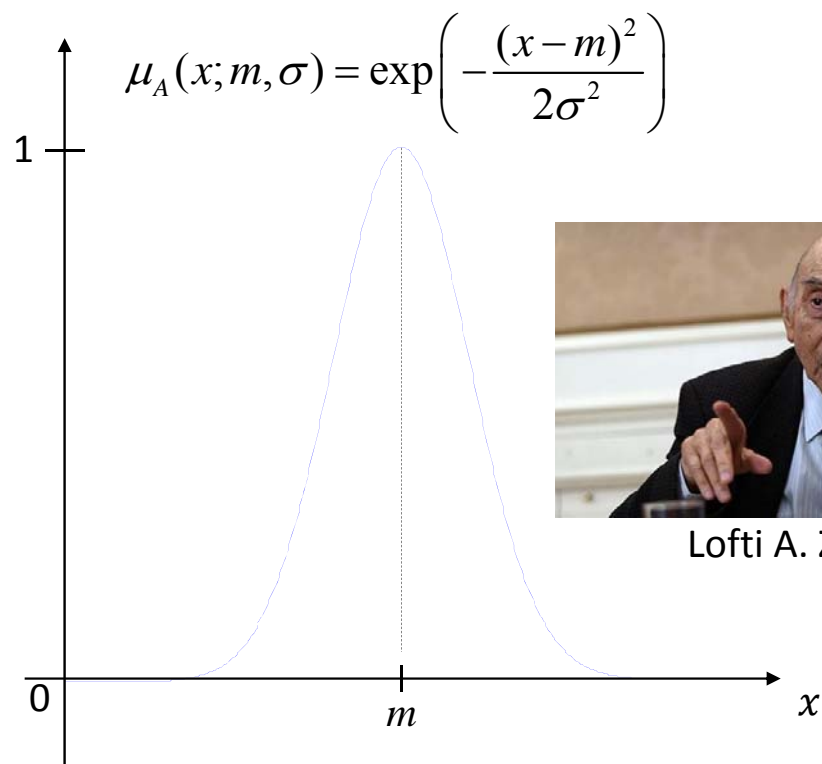
- Lofti A Zadeh introduced fuzzy logic in 1965.



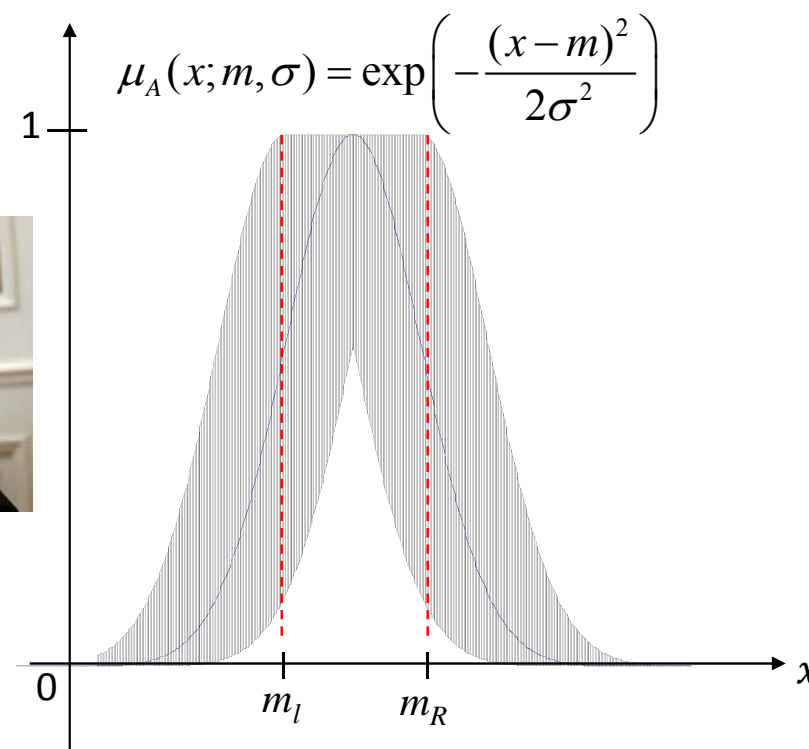
Background and related work

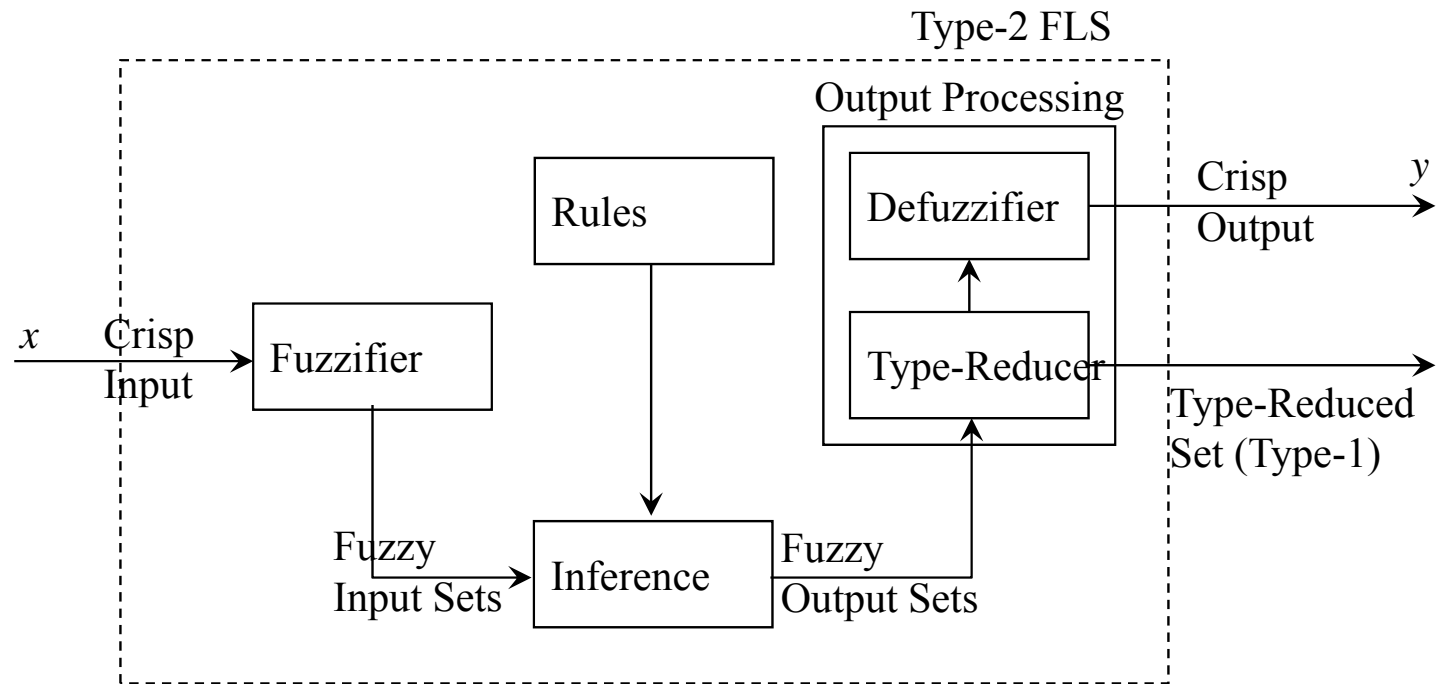
- Computational intelligence has been widely used in Pattern classification, Regression, & Control systems.
- One of the prominent intelligent systems is fuzzy system.
- Type-1 Fuzzy set does not model well on uncertainty.
- General Type-2 fuzzy set was introduced in 1975.
- General type-2 fuzzy systems are too complicated for small hardware.
- Interval type-2 fuzzy systems are easier for implementation.
- Many works has been proposed to construct type-1 fuzzy systems.
- Type-2 fuzzy systems still need to study more.

Type 1 and General Type 2 Fuzzy Systems



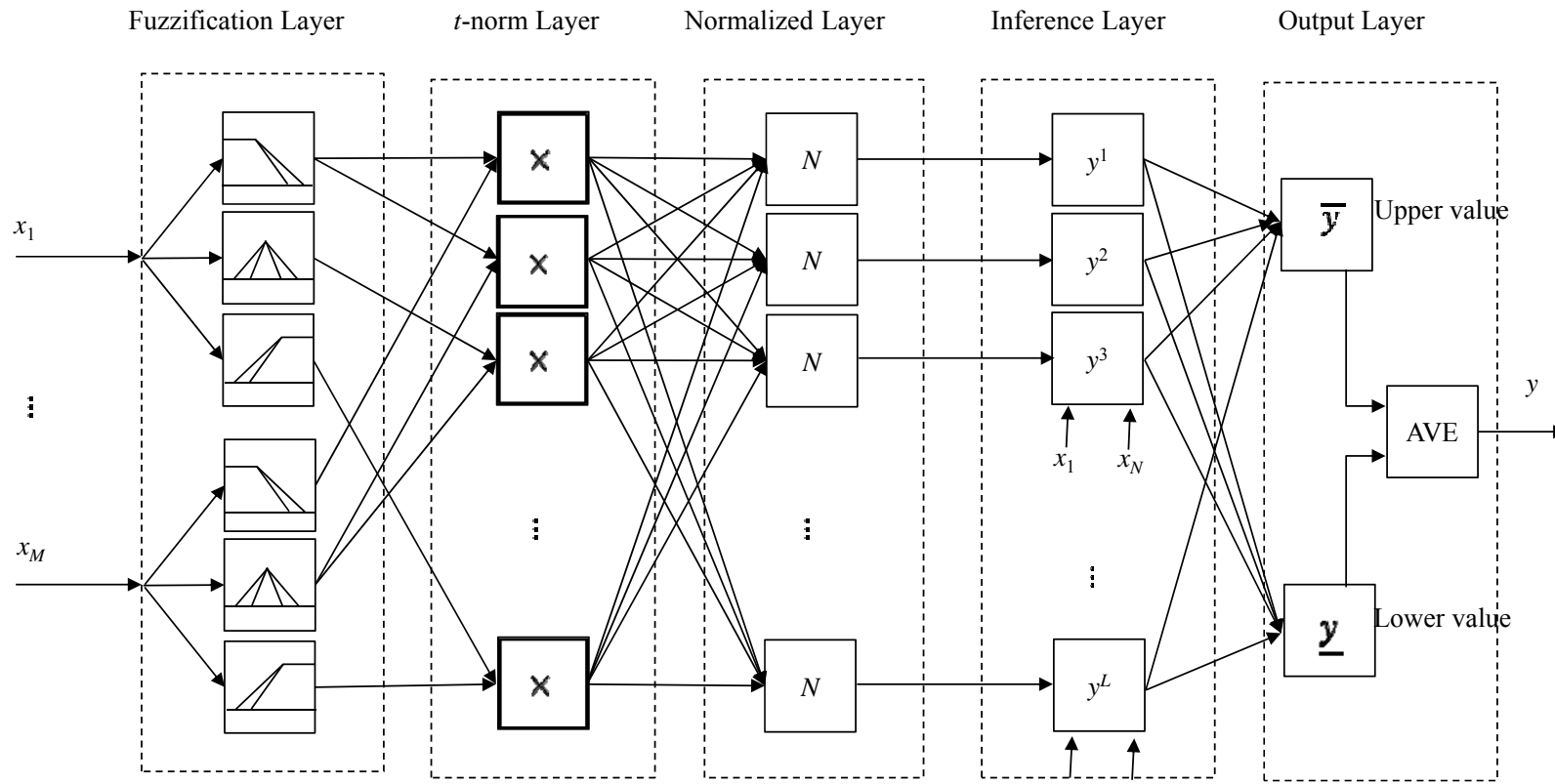
Lofti A. Zadeh





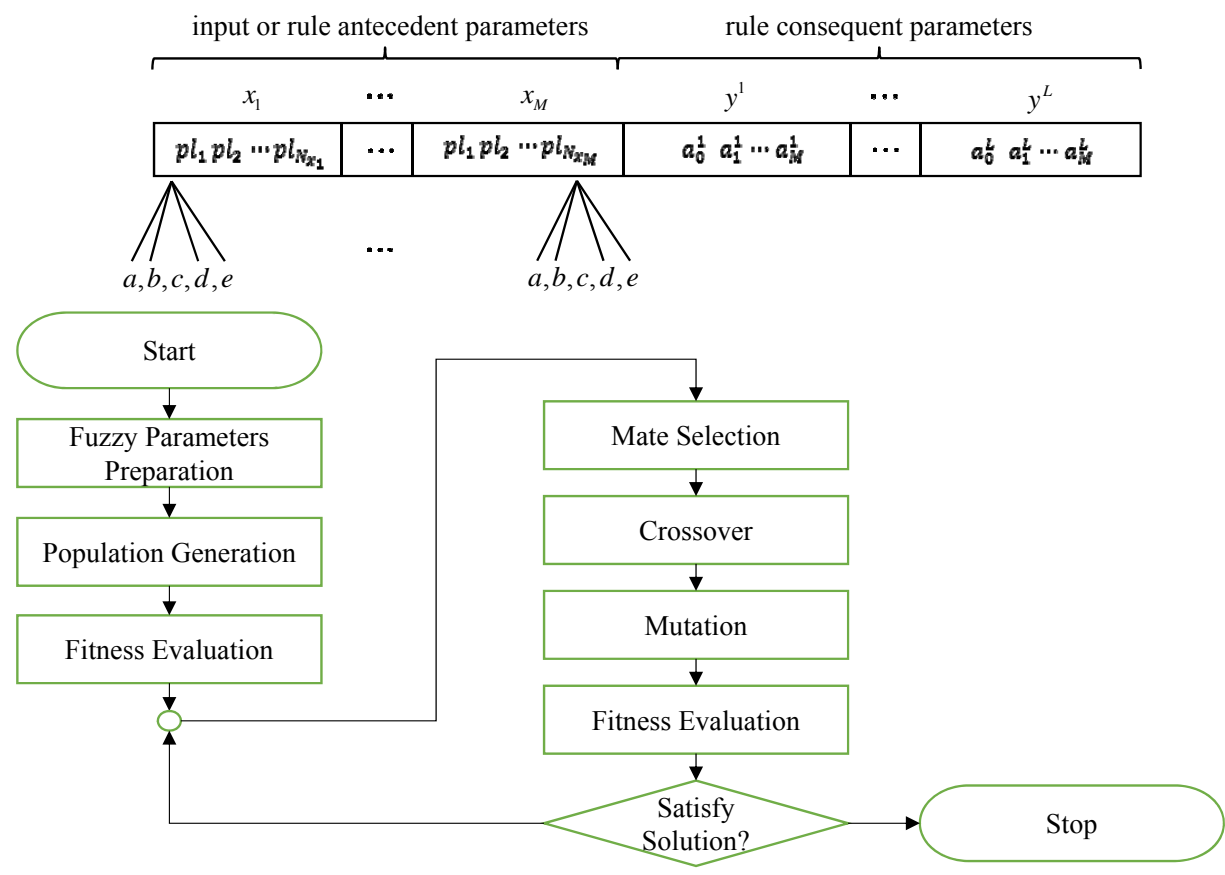
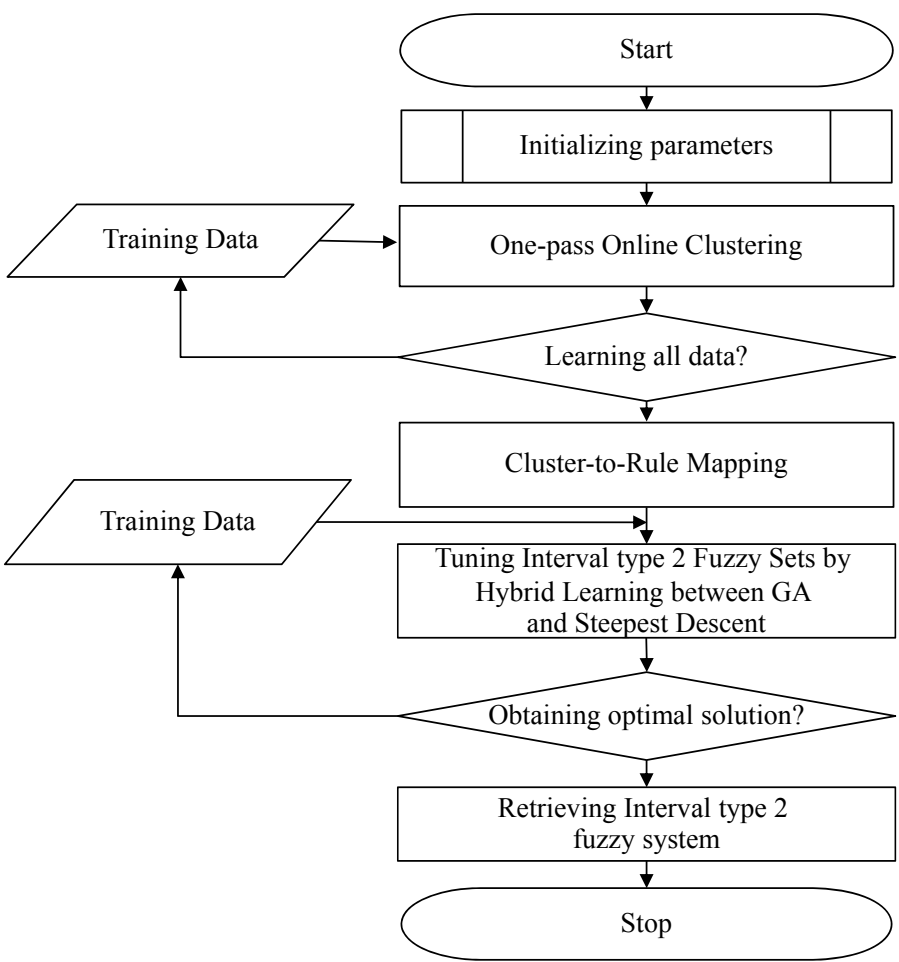
- Grid partitioning method → Too many fuzzy rules.
- Clustering techniques can be used but mostly need to identify the number of rules.
- Complicated type reduction from type-2 to type-1 fuzzy set.
- The reduction procedures takes too long in finding left and right points.
- This work proposes:
 - 1) modification of interval type-2 fuzzy logic system
 - 2) hybrid intelligent learning to create interval type-2 fuzzy logic system and to optimize fuzzy parameters.

The Proposed Framework of IT2FLS

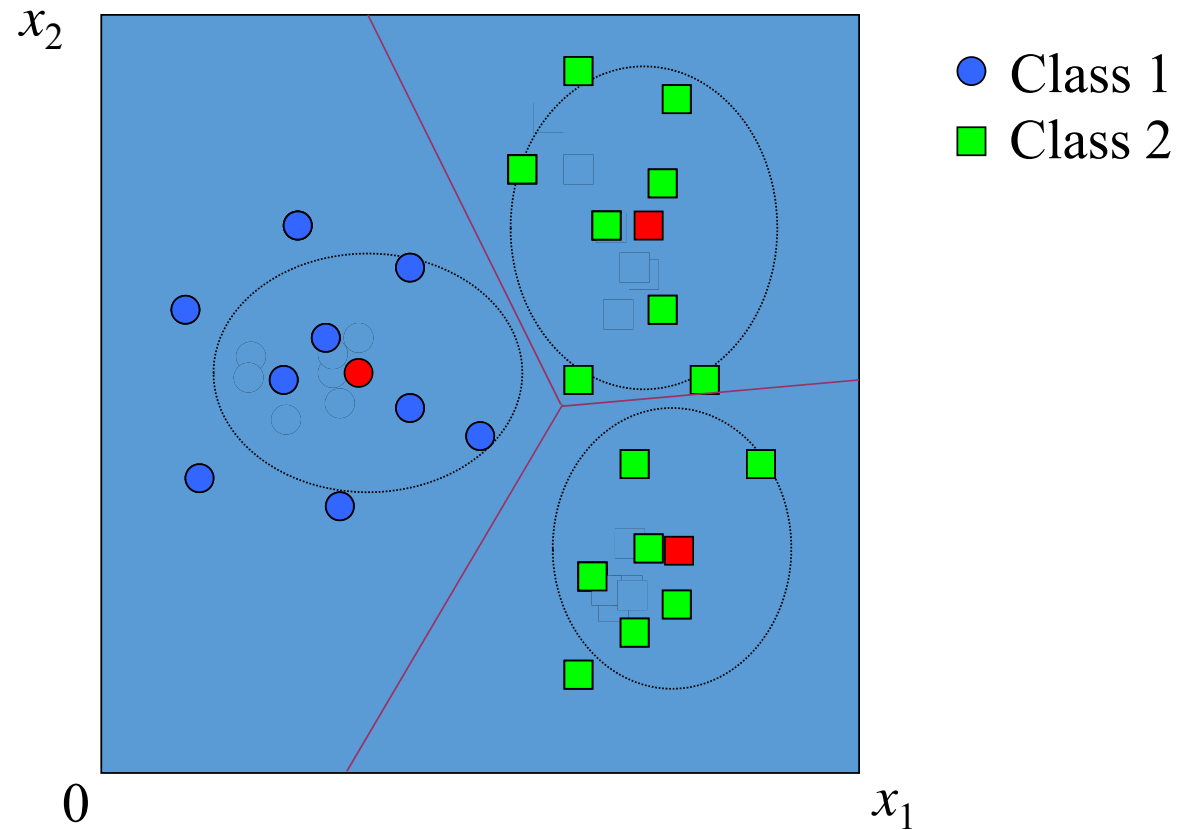


$$\mu_{\tilde{A}_j^i}(\mathbf{x}) = \left[\underline{\mu}_{\tilde{A}_j^i}(x_j), \bar{\mu}_{\tilde{A}_j^i}(x_j) \right] \quad \underline{f}^i = \prod_{j=1}^n \underline{\mu}_{\tilde{A}_j^i}(x_j) \quad \hat{f}^i = \frac{\underline{f}^i}{\sum_{i=1}^M \underline{f}^i} \quad \underline{y}^i = \underline{f}^i \times (a_0^i + \sum_{j=1}^M a_j^i x_j)$$

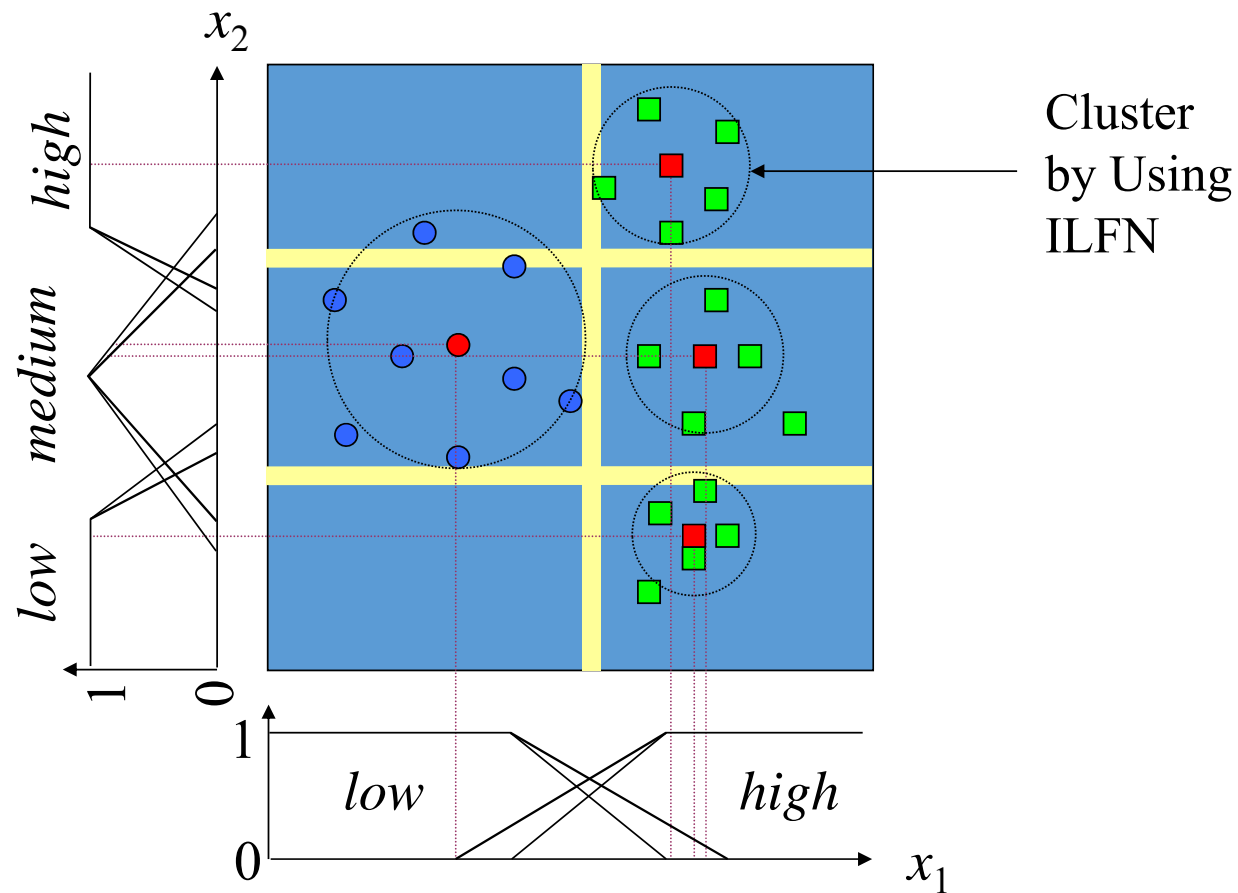
Constructing IT2FLS



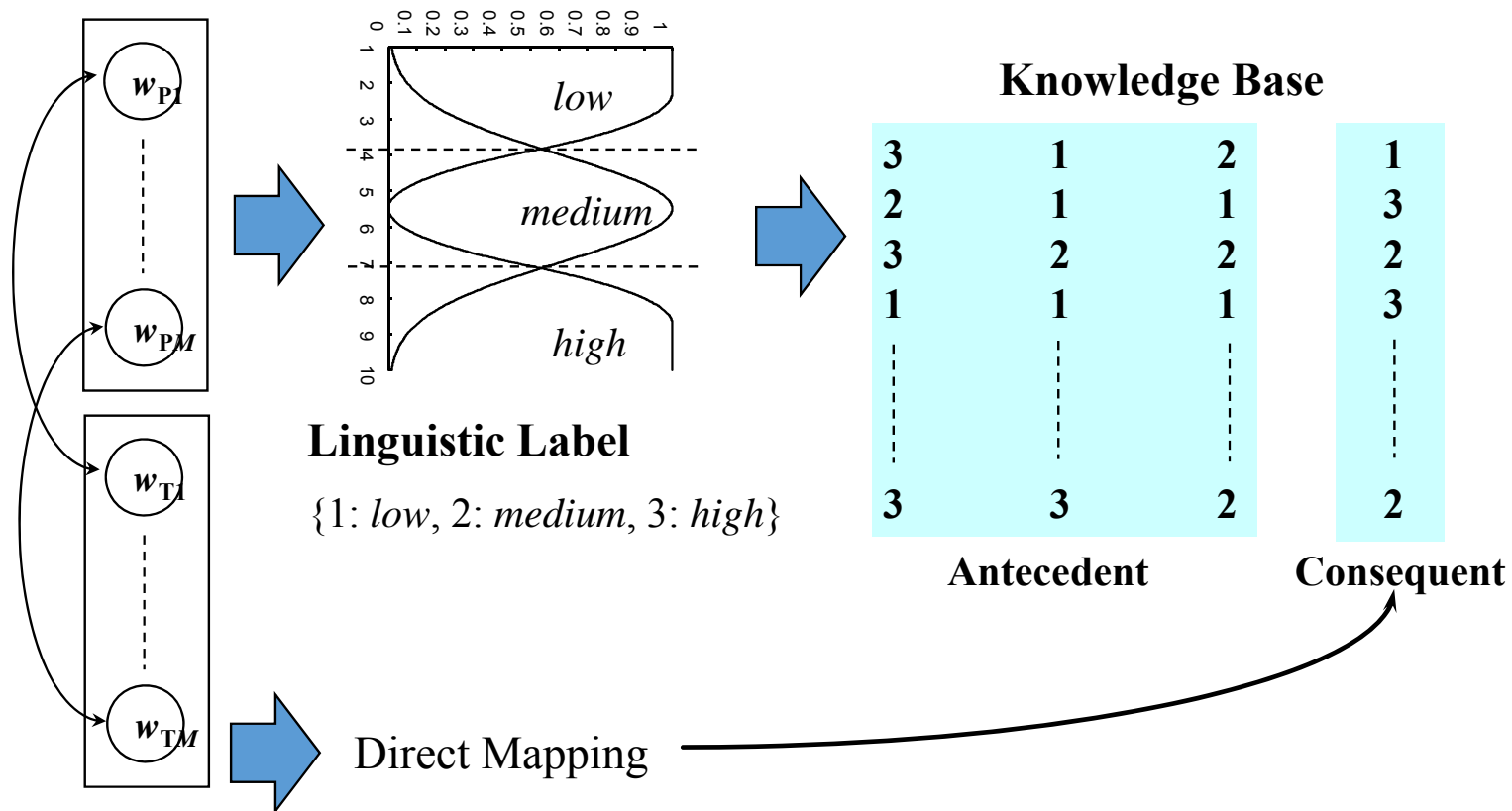
Incremental Fuzzy Neural Network (ILFN)



Cluster-to-Rule Mapping



ILFN2RULE Algorithm

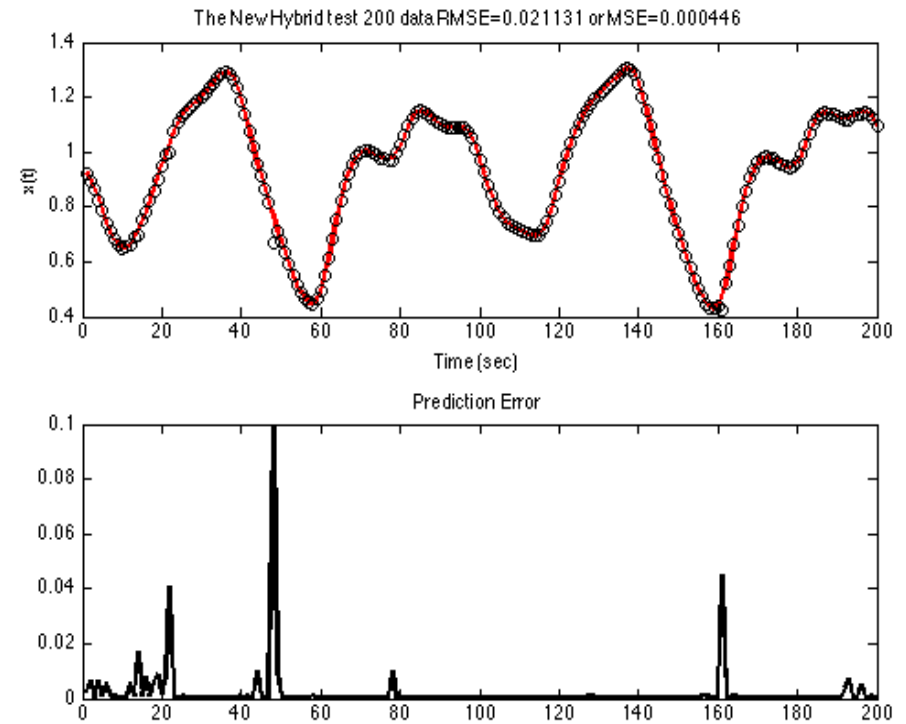
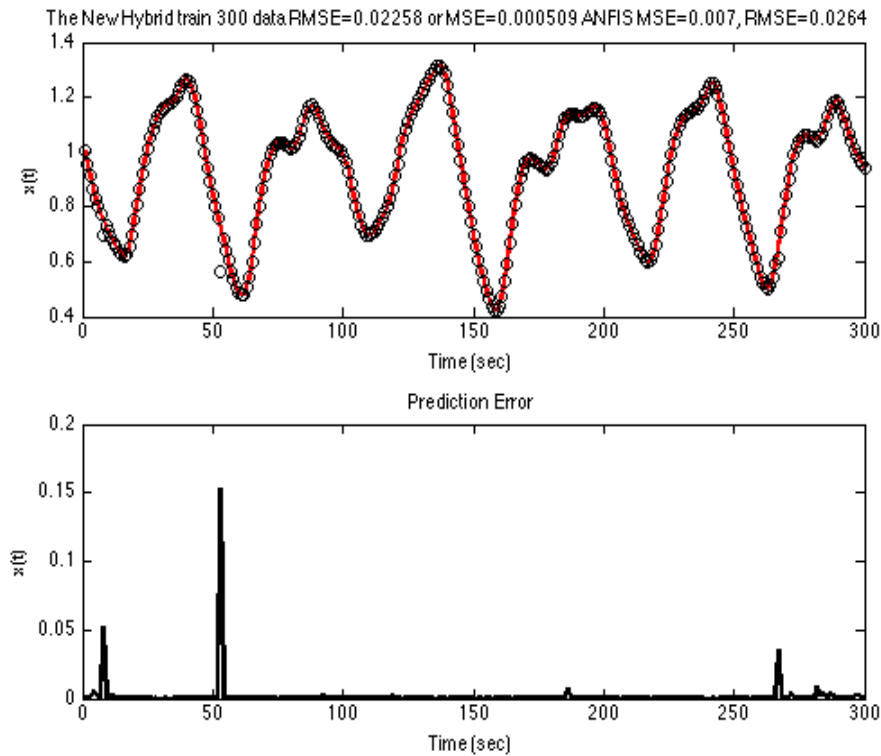


Data Set	Summary Data		
	Attribute Type	Number of Records (used)	Number of Features (used)
Bank Market	Real	41188 (4119)	17 (7)
Banknote Authen	Real	1372	5
Car Evaluation	Categorical	1728	6
Wilt	Real	4889	6

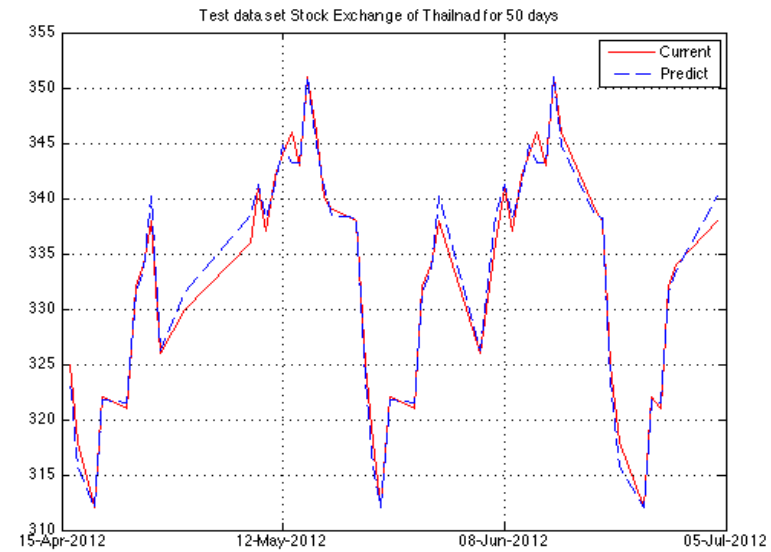
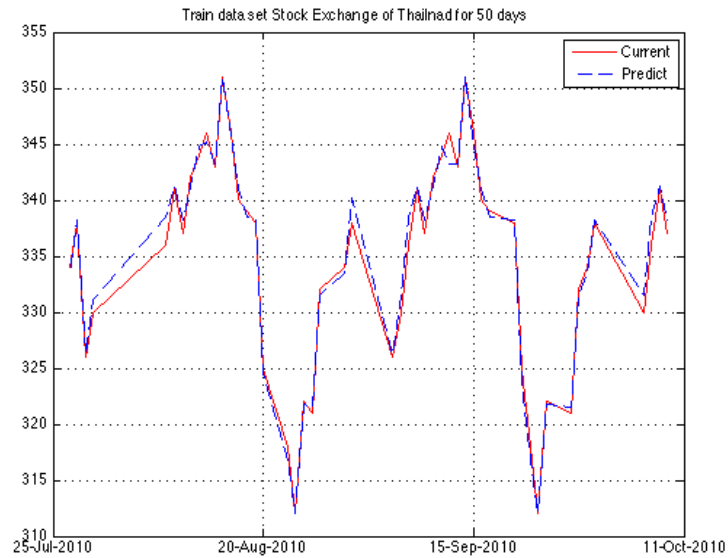
Experimental Results

Data Set	% accuracy of each technique				
	C4.5	MLP	SVM	ANFIS	IT2FIS
Bank Market	84.58	87.34	87.91	89.02	88.58
Banknote Authen	93.70	98.12	94.07	97.376	97.95
Car Evaluation	76.90	81.47	82.16	90.97	82.20
Wilt Data	86.40	89.40	83.80	96.02	98.70

Mackey-Glass Time Series



Stock Exchange of Thailand



- Modification of Interval Type-2 Fuzzy Logic System is proposed.
- A method to create and optimize Interval Type-2 Fuzzy Logic System is proposed.
- Online one-pass clustering is first performed; incremental learning fuzzy neural network (ILFN) is used.
- Then clusters are mapped to rules, including all fuzzy parameters.
- The fuzzy parameters are then optimized by hybrid learning genetic algorithm and steepest decent.
- Experimental results showed that the proposed technique is comparable to existing works.
- For future work, hardware implementation in real time on FPGA for control system.



**Thank you
for your attention
Questions or Suggestions?**