8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

Fusion of intelligent systems based on information granulation approach to analysis of hydrocyclone performance

Hamed Owladeghaffari [1], Majid Ejtemaei* [2] and Mehdi Irannajad [3]

[1] Dept of Mining & Metallurgical Eng,Teharn,Iran
h.o.ghaffari@gmail.com

[2] Dept of Mining & Metallurgical Eng,Teharn,Iran
majidejtemaei@gmail.com

[3] Dept of Mining & Metallurgical Eng,Teharn,Iran
iranajad@aut.ac.ir

Key Words: *Information granulation theory, SOM, NFIS, hydrocyclone.*

ABSTRACT

This paper describes application of information granulation theory, on the analysis of hydrocyclone perforamance. In this manner, using fusion of Self Organizing Map (SOM) and Neuro-Fuzzy Inference System (NFIS), crisp and fuzzy granules are obtained. Balancing of crisp granules and sub fuzzy granules, within non fuzzy information (initial granulation), is rendered in an open-close iteration. Using two criteria, "simplicity of rules "and "adaptive threoshold error level", stability of algorithm is guaranteed. Validation of the proposed methods, on the data set of the hydrocyclone is rendered

In our algorithm, we use four basic axioms upon the balancing of the successive granules assumption:
Step (1): dividing the monitored data into groups of training and testing data
Step (2): first granulation (crisp) by SOM or other crisp granulation methods
Step (2-1): selecting the level of granularity randomly or depend on the obtained error from the NFIS or RST (regular neuron growth)
Step (2-2): construction of the granules (crisp).
Step (3): second granulation (fuzzy or rough IGs) by NFIS or RST
Step (3-1): crisp granules as a new data.
Step (3-2): selecting the level of granularity; (Error level, number of rules, strength threshold...)
Step (3-3): checking the suitability. (Close-open iteration: referring to the real data and reinspect closed world)
Step (3-4): construction of fuzzy/rough granules.
Step (4): extraction of knowledge rules
Balancing assumption is satisfied by the close-open iterations: this process is a guideline to balancing of crisp and sub fuzzy/rough granules by some random/regular selection of initial granules or other optimal structures and increment of supporting rules (fuzzy partitions or increasing of lower /upper approximations), gradually.
The overall schematic of Self Organizing Neuro-Fuzzy Inference System -Random and Regular neuron growth-: SONFIS-R, SONFIS-AR; has been shown in figure1.
In first regular granulation, we use a linear relation is given by:
$N_{t+1} = \alpha N_t + \Delta_t ; \Delta_t = \beta E_t + \gamma$

Where $N_t = n_1 \times n_2; |n_1 - n_2| = Min.$ is number of neurons in SOM; E_t is the obtained error (measured error) from second granulation on the test data and coefficients must be determined, depend on the used data set. Obviously, one can employ like manipulation in the rule (second granulation) generation part, i.e., number of rules.

Determination of granulation level is controlled with three main parameters: range of neuron growth, number of rules and error level. The main benefit of this algorithm is to looking for best structure and rules for two known intelligent system, while in independent situations each of them has some appropriate problems such: finding of spurious patterns for the large data sets, extra-time training of NFIS or SOM.

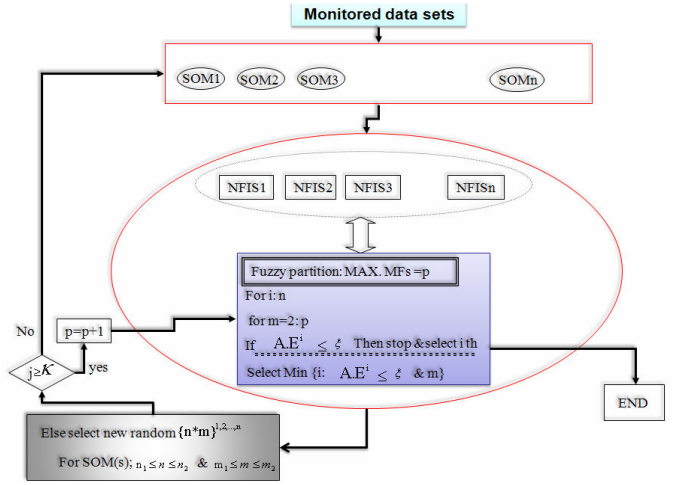

Figure.1. Self Organizing Neuro-Fuzzy Inference System (SONFIS)

The performance of the obtined fyzzy rules on the test data has been portrayed in figure2.

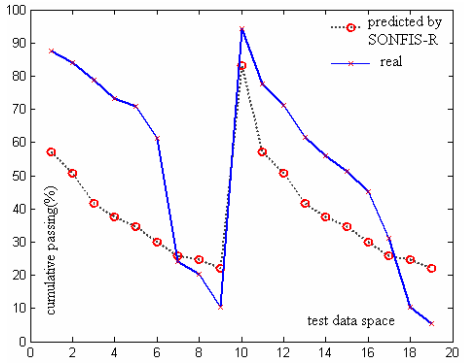

Figure2. the real and predicted decision on the testing data set with sub-fuzzy granulation

The main idea, behind the proposed methodologies, is based on the complexity of information and construction of humanity world cognition by using, as most as, simple rules (in overall structure and number).The competitive between close and open worlds, in a parallel road of the mentioned features, is the additional situation to balancing of the granules and to gain a stable answer.

REFERENCES

[1] A. Bargiela and W. Pedrycz, "Granular Computing: An Introduction, Kluwer Academic Publishers", Boston , 2003.

[2] M.T Carvalho and F.Durao, "Control of flotation column using fuzzy logic inference ,Fuzzy sets and systems", 125, pp:121-133, (2002).