International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 19 No. 3 Feb. 2017, pp. 482-486

http://www.ijias.issr-journals.org/

Performance analysis of researchers using compensatory fuzzy logic

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ABSTRACT: In this paper, a proposal for extending the fuzzy logic framework to researcher's performance evaluation using the good properties of robustness and interpretability of compensatory fuzzy logic is presented. Results obtained with our model are more consistent with the way human make decisions. Additionally a case study to illustrate the applicability of the proposal is developed. Our main outcome is a new researcher's evaluation based on compensatory fuzzy logic that gives results that are more robust and allows compensation. Moreover, this approach makes emphasis in using language in line with the computing with words paradigm.

KEYWORDS: fuzzy logic compensatory fuzzy logic, Performance evaluation, computing with words.

1 INTRODUCTION

In this paper we propose a model for researchers performance evaluation[1] and ranking using compensatory fuzzy logic (CFL) [3]. Fuzzy logic is a multivalent logic system introduced by Zadeh [5] at the University of Berkeley (California) in 1965. However, the many advantages of fuzzy logic to model ambiguous or vague knowledge it have certain drawbacks. The mains limitations in the modeling of knowledge can be summarized as [6]:

- The associative property of conjunction and disjunction operators.
- The lack of sensitivity to changes in the values of truth of the basic predicates when calculating the truth-value of compound predicates.
- The lack of compensation for the truth values of basic predicates when calculating the accuracy of compound predicates.

CFL is s a variant of fuzzy logic that overcomes the previous limitations limitation in traditional fuzzy logic. The principal advantage our approach is the use the language as an element of communication and modeling in the analysis of the performance evaluation creating an explicit model of the knowledge;

The outline of this paper is as follows: Section 2 is dedicated to compensatory fuzzy logic. The intelligent fuzzy researcher performance evaluation frameworks presented in Section 3. A case study is discussed in Section 4. The paper closes with concluding remarks, and discussion of future work in Section 5.

2 COMPENSATORY FUZZY LOGIC

A CFL system is a quartet of operators: a conjunction, a disjunction, a negation and a strict fuzzy order that satisfies the axioms of compensation, commutativity, strict growth, veto, fuzzy reciprocity, fuzzy transitivity and the Morgan's laws [3, 7].

In this work Geometric Mean Based Compensatory Logic (GBCFL) is used due to the robustness and relative simplicity of its operators [8].

GBCFL defined conjunction as follows:

$$c(x_1, x_2, \dots, x_n) = (x_1 x_2, \dots, x_n)^{\frac{1}{n}} \quad (1)$$

The disjunction is defined as the dual of the conjunction:

$$d(x_1, x_2, \dots, x_n) = 1 - [(1 - x_1)(1 - x_2) \dots (1 - x_n)]^{\frac{1}{n}} \quad (2)$$

The fuzzy negation defined as is:

$$n(x) = 1 - x \quad (3)$$

and the fuzzy strict order is:

$$o(x, y) = 0.5[c(x) - c(y)] + 0.5 \quad (4)$$

At any fuzzy predicate p over the universe U, universal and existential propositions are defined respectively as [9] :

$$\underset{x \in U}{\forall} p(x) = \wedge_{x \in U}\, p(x) \quad (5)$$

$$\underset{x \in U}{\exists} p(x) = \vee_{x \in U}\, p(x) \quad (6)$$

With CFL we can express an “appealing” sensibility and attaint more reliable operators according to the way that human make decisions.

3 RESEARCHER PERFORMANCE EVALUATION BASED ON CFL

Performance analysis aims at evaluating groups of scientific actors (countries, universities, departments, researchers) and the impact of their activity on the basis of available data [1]. Assessing the impact and output of scientists is essential and has largely depended on peer review [2]. Our approach is based in the construction of predicates based on experts knowledge. Below are verbal expressions used and their translation to the language of predicate:

A researcher has a good performer if: 1) is very productive 2) his research has s impact a 3) is collaborative.

For researcher performance, evaluation the compound predicate is as follows:

$$R(r) = P(n)^2 \wedge I(x) \wedge C(x) \quad (6)$$

Where:

$R(x)$: researcher performance

$P(p)$: productive with a modifier ^{2} representing the hedge “very” and

$I(c)$: researcher impact

C(co): researcher collaborativeness.

r:reserher.

p: number of papers.

c: number of cites.

co: number of coauthors.

The sigmoid membership function is used

$$S(x, \alpha, \gamma) = \frac{1}{1 + e^{-\alpha(x - \gamma)}} \quad (7)$$

$$\alpha = \frac{\ln(0.9) - \ln(0.1)}{\gamma - \beta} \quad (8)$$

where

Gamma (γ) : Value acceptable. It would be equal to the value at which the indicator is considered acceptable.

Beta (β): Value almost unacceptable.

Let us note that $S(\gamma, \alpha, \gamma)$=0.5 and (β, α, γ)=0.1.

4 CASE STUDY

The parameters of the sigmoid function used for fuzzification are shown

Table 1. Parameters of the sigmoid function

Predicate	x	γ	β
$P(p)$	Number of papers	6	2
$I(c)$	Number of citations	4	2
C(co):	Numbers of Coauthors	4	2

To implement the solution de orange tool[10] was use using feature construction widget for fuzzification and truth value calculation.

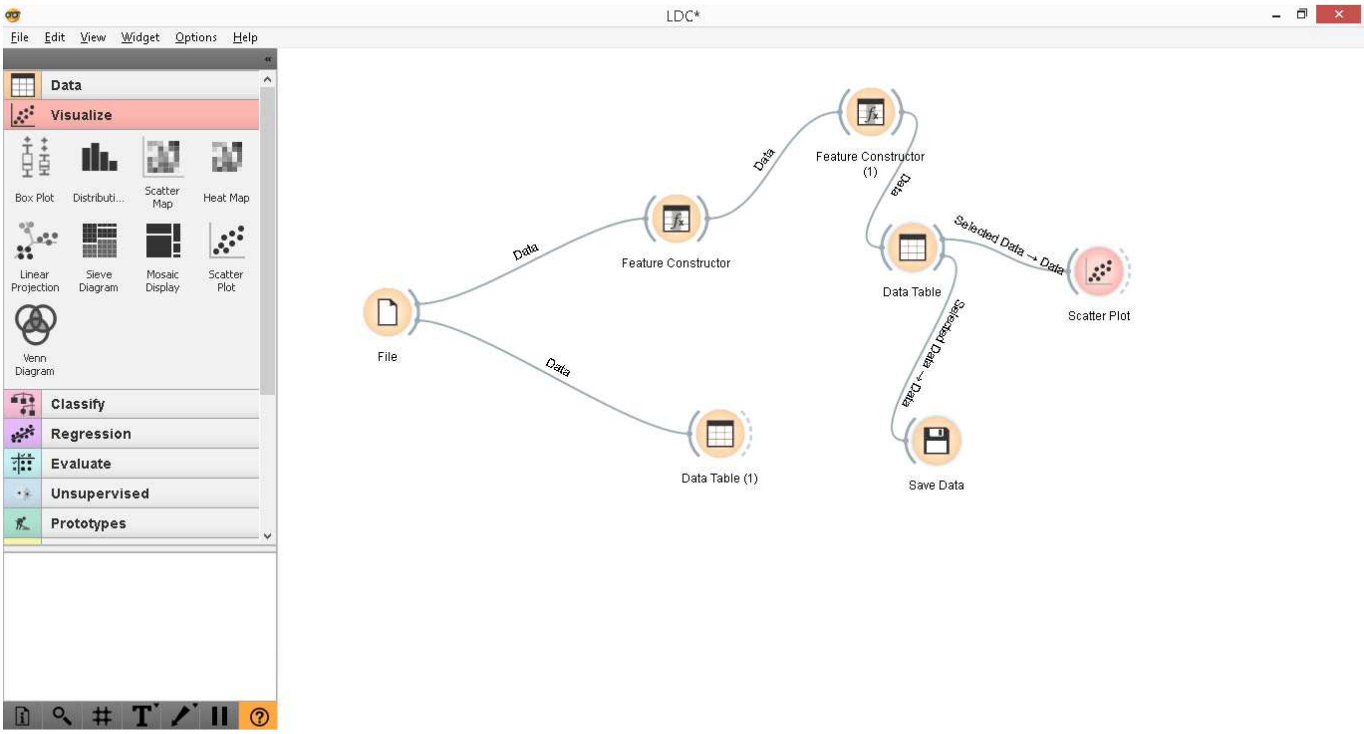

Fig. 1. Orange workflow

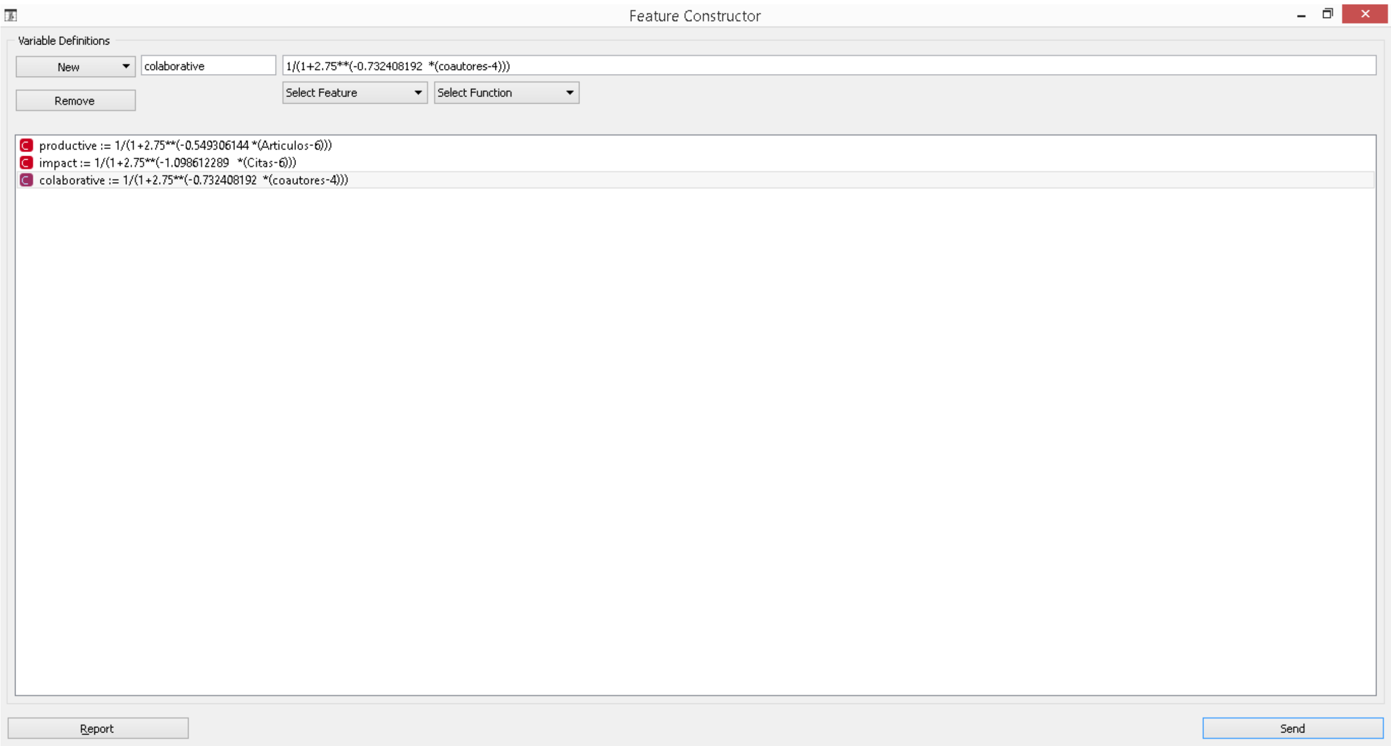

Fig. 2. ***Feature constructor widget***

Results are shown in data table widget

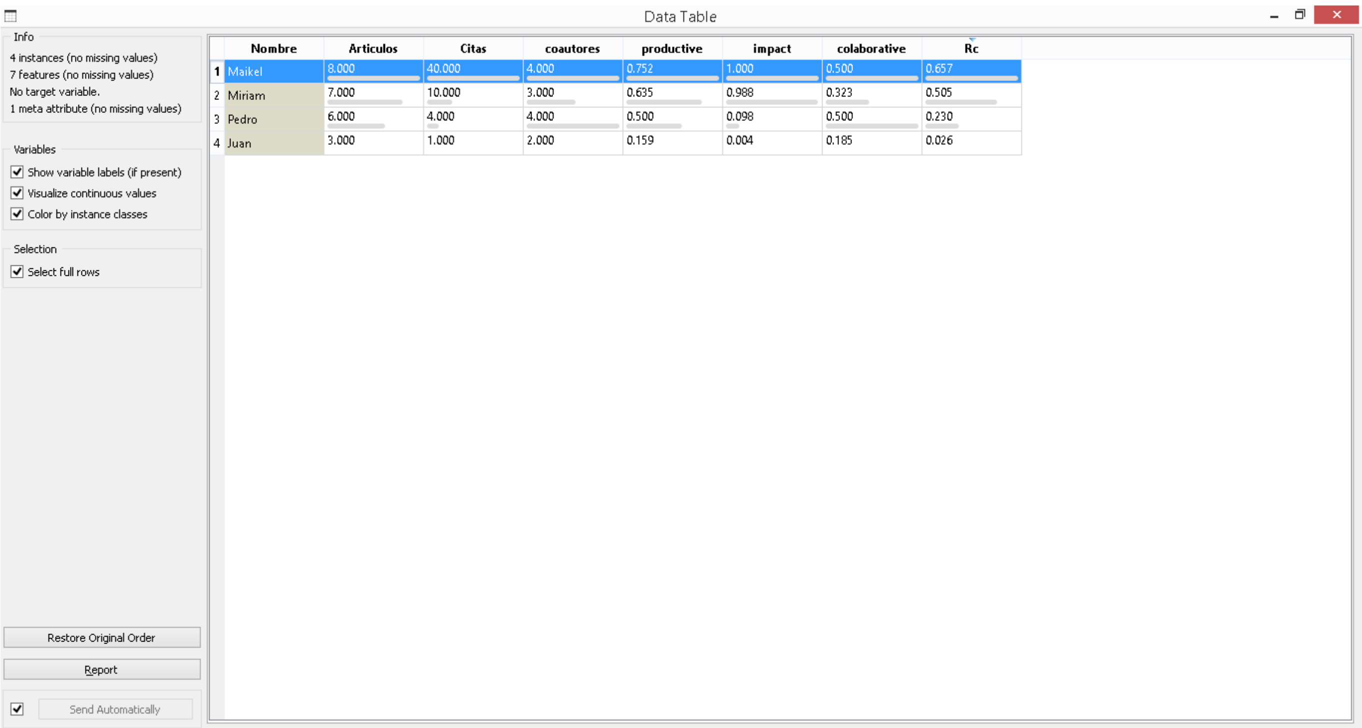

Fig. 3. ***Results***

Our approach is an opportunity to use the language as key element of communication in the construction of semantic. It is closer to the objective to make reasoning processes in environments of uncertainty and imprecision with words [11].

5 Conclusions

Compensatory fuzzy logic was introduced and we discussed how these technologies could provide the analyst further flexibility researcher evaluation. The new model for intelligent social network analysis based on CFL gives outcomes that are more robust and allow expressing compensation. The sensibility of the operators in our proposal gives more consistent results with the way that human make decisions. Moreover it bring closer the opportunity to use the language as crucial component in the construction of semantic models. The preference model constructed by means of language can be very rich and varied.

As future research, we intend to develop models for combining decision making and coauthorship networks. The mining of social relation networks in scientific research, the development of more flexible ways for querying social networks, and the development of a software tool are other areas of future work.

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