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Method for Treatment and its Incidence in the Change of Social Rehabilitation Regime using Neutrosophic Compensatory Logic

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Abstract. Throughout life, people can make mistakes that lead to custodial sentence. When people pay off their debt to society, they join a social rehabilitation regime. Unfortunately, in all cases a complete rehabilitation is not achieved. This research aims to develop a method for the treatment and its impact on changing social rehabilitation regimen. The uncertainty of this process is modeled using compensatory neutrosophic logic. This is an extension of fuzzy compensatory logic to the neutrosophic framework. A case study is implemented from which a group of people undergoing rehabilitation is analyzed to determine their best treatment. As a result, the status of compliance with the main treatment axes was obtained for the different cases analyzed.

Keywords: Social rehabilitation, compensatory fuzzy logic, compensatory neutrosophic logic.

1. Introduction

Deprivation of liberty constitutes the mechanism used by States to reduce criminal behavior. During the last years, a new legal concept has appeared, worldwide clear standards regarding the deprivation of liberty were obtained [1]. The fundamental objective of this measure is based on the search for a peaceful coexistence among its peoples.

If an individual violates the peace and harmony of a State, this will imperatively be brought before the jurisdictional entity [2, 3]. The jurisdictional entity will apply a sanction against that individual for undertaking an action classified as a criminal offense.

Someone who have been sanctioned to a custodial sentence have the opportunity to be beneficiaries [4, 5]. The benefits are described through the axes of treatment contemplated in the Integral Organic Penal Code. At present, however, it is not possible to quantify the treatment and its incidence in the change of rehabilitation regimen [6].

Problems like the one previously exposed have been addressed in the scientific literature with Soft Computing techniques. It represents a methodology widely used in situations where the data to be considered is not accurate but indeterminate. These indeterminate data are modeled using the fuzzy set theory. Especially Compensatory fuzzy logic results from an axiom obtained from two different theoretic sources: the decision theory and the logic. Its advantage is that it deals with natural language. However, it preserves the limitations of every fuzzy logic theory, where the indeterminacy is implicitly contained. This is why the compensatory neutrosophic logic extends the compensatory logic in the framework of Neutrosophy. In the 1980s, the international movement called Paradoxism [7], based on contradictions in science and literature, was founded by Florentin Smarandache, who then extended it to Neutrosophy, a science based on contradictions and their neutrals[8-10].

From the previous analysis, this research aims to develop a method for treatment and its impact on changing social rehabilitation regimen.

The present paper is divided into the following sections: section 2 contains the preliminary concepts, like compensatory fuzzy logic and compensatory neutrosophic logic. Section 3 is exposes the proposed model. Section 4 contains the application of the model in an actual case study. The paper ends with the conclusions.

2. Preliminaries

This section introduces the fundamental elements that facilitate the understanding of the research. The main theoretical references on the social rehabilitation regime and the treatment of the axes of social rehabilitation are proposed.

2.1 Social rehabilitation regime

The National Social Rehabilitation System is administered by the Ministry of Justice, Human Rights and Worship in Ecuador, represents the State in the regulation of custody, internal security and effective rehabilitation of persons deprived of liberty [11].

The Social Rehabilitation System (SRS) comprises a set of principles, regulations, policies, programs and processes that are fully correlated based on the execution of sentences. The penitentiary system seeks to execute programs that guarantee social rehabilitation before a person deprived of liberty can re-enter their family and social nucleus [12].

The treatment axes establish the set of social indicators that guarantee the social rehabilitation of the individual deprived of liberty. People under custodial sentence have the right to social reintegration and The State guarantees their fulfillment[13].

The treatment for persons deprived of liberty, with a view to their rehabilitation and social reintegration, will be based on the axes: labor, education, culture and sport, health, family and social ties, reintegration. The fundamental objective of the axes of rehabilitation is to guarantee comprehensive activities that generate full restoration in society[14-16].

2.2 Compensatory Fuzzy Logic

The Compensatory Fuzzy Logic (CFL) represents a logical model used for the simultaneous modeling of deductive and decision-making processes [17, 18]. The Compensatory Fuzzy Logic (CFL) represents a logical model used for the simultaneous modeling of deductive and decision-making processes[19], [20].

The CFL uses the Fuzzy Logic scale, which can vary from 0 to 1, to measure the degree of truth or falsehood of its propositions. Propositions can be expressed through predicates. A predicate is a function of the universe X in the interval $[0;1]$.

In order to process the CFL, conjunctive operators are used (\wedge), disjunction (\vee), negation (\neg) and implication (\rightarrow), defined in a way that restricts the domain $[0;1]$, [21, 22].

An essential property of this logic is the "principle of gradualness" which affirms that a proposition can be both true and false, as long as it is assigned a degree of truth and falsehood. One way to put the principle of gradualness into practice is to define logics where propositions can be expressed by predicates. Precisely the logic of predicates studies the declarative phrases with a degree of detail, considering the internal structure of the propositions.

The different ways of defining operations and their properties determine different multivalent logics that are part of the Fuzzy Logic paradigm [23]. Multivalent logics are generally defined as those that allow intermediate values between the absolute truth and the total falsehood of an expression. So 0 and 1 are both associated with certainty and accuracy of what is claimed or denied and 0.5 with maximum vagueness and uncertainty [24, 25].

3. Materials and methods

The present method is designed for the treatment and its incidence in the change of social rehabilitation regime. This method should show whether a person in the social rehabilitation process maintains socially responsible behavior or not. The method works through Compensatory Fuzzy Logic [18, 26, 27].

CFL is based on the following axioms:

Compensatory Fuzzy Logic (CFL) [15] is a multivalued logic axiomatic approach different from the one based on t-norms and t-conorms. They satisfy characteristics of descriptive approach of decision-making and the normative approaches of the decision-making.

This is based on four logic operators (c, d, n, o). Where c is the conjunction operator, d is the disjunction operator, n is the negation operator and o is a fuzzy-strict ordering.

The following axioms are postulated

- I. Compensation Axiom $\min(x_1, x_2, \dots, x_n) \leq c(x_1, x_2, \dots, x_n) \leq \max(x_1, x_2, \dots, x_n)$
- II. Symmetry or Commutativity Axiom $c(x_1, x_2, \dots, x_i, \dots, x_j, \dots, x_n) = c(x_1, x_2, \dots, x_j, \dots, x_i, \dots, x_n)$
- III. Strict Growth Axiom if $x_1=y_1, x_2=y_2, \dots, x_{i-1}=y_{i-1}, x_{i+1}=y_{i+1}, \dots, x_n=y_n$ are different to zero and $x_i > y_i$ then $c(x_1, x_2, \dots, x_n) > c(y_1, y_2, \dots, y_n)$
- IV. Veto Axiom If $x_i=0$ for any i then $c(x)=0$.
- V. Fuzzy Reciprocity Axiom $o(x, y) = n[o(y, x)]$.

VI. Fuzzy Transitivity Axiom If $o(x,y) \geq 0.5$ and $o(y,z) \geq 0.5$, then $o(x, z) \geq \max(o(x,y),o(y,z))$

VII. De Morgan's Laws:

$$n(c(x_1, x_2, \dots, x_n) = d(n(x_1), n(x_2), \dots, n(x_n))) \quad n(d(x_1, x_2, \dots, x_n) = c(n(x_1), n(x_2), \dots, n(x_n)))$$

Implications can be defined in different ways:

S-implication: $S(x,y)=d(n(x),y)$, where d and n are the disjunction and negation operators, respectively.

A particular system is the Geometric Mean Based Compensatory Logic (GMBCL), where conjunction and disjunction operators are expressed by (1) and (2), respectively, when the domain is discrete, [28-30].

$$c(x_1, x_2, \dots, x_n) = \sqrt[n]{\prod_{i=1}^n x_i} = \exp\left(\frac{1}{n} \sum_{i=1}^n \ln(x_i)\right) \quad (1)$$

Disjunction is the dual of the conjunction:

$$d(x_1, x_2, \dots, x_n) = 1 - \sqrt[n]{\prod_{i=1}^n (1 - x_i)} = 1 - \exp\left(\frac{1}{n} \sum_{i=1}^n \ln(1 - x_i)\right) \quad (2)$$

Paradoxism is an international movement in science and culture, founded by Romanian Scholar Florentin Smarandache in 1980s, based on excessive use of antitheses, oxymoron, contradictions, and paradoxes[31]. During three decades (1980-2020) hundreds of authors from tens of countries around the globe contributed papers to 15 international Paradoxist anthologies[32]. In 1995, the author extended the Paradoxism to a new branch of philosophy called Neutrosophy [33] (based on opposites and their neutral), that gave birth to many scientific branches, such as: neutrosophic logic [34], neutrosophic probability and statistics[35], neutrosophic multi-criteria methods [36]. All of them with multiple applications in engineering, computer science, soft sciences etc.[37-39].

Definition 1: A *neutrosophic number* N is defined as follows:

$$N = d + I \quad (3)$$

Where d is called *determinate part* and I is called *indeterminate part*.

Given $N_1 = a_1 + b_1I$ and $N_2 = a_2 + b_2I$ two neutrosophic numbers, some operations between them are defined as:

$$N_1 + N_2 = a_1 + a_2 + (b_1 + b_2)I \text{ (Addition);}$$

$$N_1 - N_2 = a_1 - a_2 + (b_1 - b_2)I \text{ (Difference),}$$

$$N_1 \times N_2 = a_1a_2 + (a_1b_2 + b_1a_2 + b_1b_2)I \text{ (Multiplication),}$$

$$\frac{N_1}{N_2} = \frac{a_1 + b_1I}{a_2 + b_2I} = \frac{a_1}{a_2} + \frac{a_2b_1 - a_1b_2}{a_2(a_2 + b_2)}I \text{ (Division).}$$

Definition 2: A Compensatory Neutrosophic Logic (CNL) extends the axiomatic of CFL to the domain of $[0, 1] \cup \{I\}$.

Description of second level compound predicates

SRS(x): The Social Rehabilitation Regime is well valued if it adequately complies with the current legal framework and the indicators of the axes of social rehabilitation. If the report of compliance with the legal framework is somewhat unsatisfactory, it must be compensated with very good compliance with the indexes of the rehabilitation axes.

Expression of compound (third level) predicates associated with second level compound predicates

IL(x): Labor and educational integration.

IC(x): Cultural and sports integration.

VF(x): Family integration.

Expression of second-level predicates in CFL predicates.

From natural or professional language to the CFL predicate, as seen in equation 3:

$$SRS_{(x)} = IL_{(x)} \wedge IE_{(x)}^2 \wedge VF_{(x)} \wedge (\neg VF_{(x)} \rightarrow (IL_{(x)})^2 \wedge (IE_{(x)})^3) \quad (4)$$

For this work, a relationship is considered $SRS_{(x)} \rightarrow$ "Satisfaction" if the truth of the predicate is ≥ 0.9 [40], [41], [20]. From this, the following steps are established:

1. Initial step: Reading the data to perform the discovery.
2. Execution of discovery task.

3. Evaluation of the results considering the sample.
4. Hypothesis approach: Definition of new discovery and evaluation projects under consideration.

Description of third level compound predicates.

IL(x): The prison system has an adequate labor and educational integration.

VF(x): The prison system has an adequate family integration.

Expression of compound (fourth level) and simple predicates associated with third level compound predicates

Associated Predicates *IL(X)*

PT(x): The system enhances access to decent work.

PE(x): The system promotes inclusion in education.

Associated Simple Predicates *VF(X)*:

IF(x): The system promotes an adequate family integration.

IS(x): The system promotes adequate social integration.

RS(x): The system promotes an adequate social reintegration.

Expression of third-level predicates in predicates of FCL

$$CIL_{(x)} = PT_{(x)} \wedge PE_{(x)} \tag{5}$$

$$CVF_{(x)} = IF_{(x)} \wedge IS_{(x)} \wedge RS_{(x)} \tag{6}$$

Simple Predicates Evaluation Form.

The simple predicates from which the compound predicates will be evaluated will be measured according to the fulfillment of the analyzed values that arise from the study of the behavior of the indicators of social rehabilitation.

The difference of our approach with the FCL is that we incorporate the indeterminacy, which permits more accuracy using CNL.

4. Results and discussions

The Fuzzy Tree associated with the FCL-based Social Rehabilitation Regime and reflects the relationships between the simple predicates to evaluate, the compound predicates and the final predicate. Figure 1 shows the resulting associated tree.

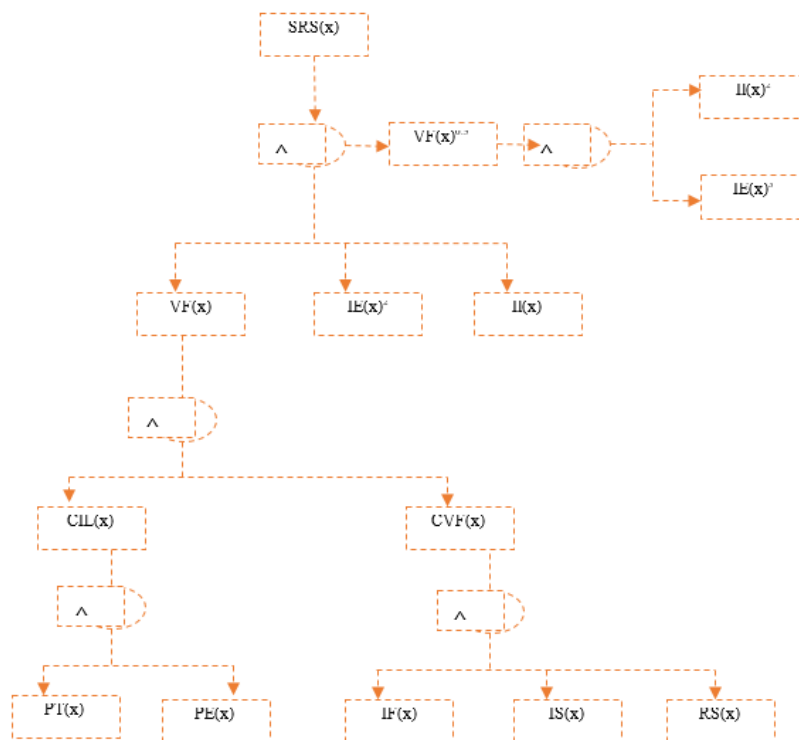


Figure 1. Fuzzy Tree associated with the FCL-based Social Rehabilitation Regime.

To obtain the data to be analyzed, the criteria of 7 penitentiary institutions was used.

Institutions	PT(x)	PE(x)	IF(x)	IS(x)	RS(x)
I ₁	[3.00, 3.5]	[2.88, 3.90]	[2.76, 2.78]	[2.92, 2.95]	[0.88, 0.89]
I ₂	[2.74, 2.76]	[2.95, 3.00]	[2.67, 3.00]	[2.63, 2.64]	[0.64, 0.65]
I ₃	[2.45, 2.46]	[2.13, 2.2]	[2.67, 2.68]	[2.89, 2.90]	[1.52, 1.53]
I ₄	[2.96, 3.00]	[1.79, 1.80]	[1.64, 1.67]	[1.85, 1.86]	[1.52, 2.00]
I ₅	[2.60, 2.65]	[2.35, 2.37]	[2.47, 2.50]	[2.29, 2.30]	[1.86, 1.90]
I ₆	[2.75, 2.79]	[2.92, 2.95]	[3.00, 3.01]	[3.00, 3.01]	[2.12, 2.14]
I ₇	[2.70, 2.75]	[2.90, 2.92]	[2.80, 2.81]	[2.60, 2.62]	[2.00, 2.02]

Table 1. Results of the predicates in the 7 institutions analyzed.

Legend:

I: People from penitentiary institutions.

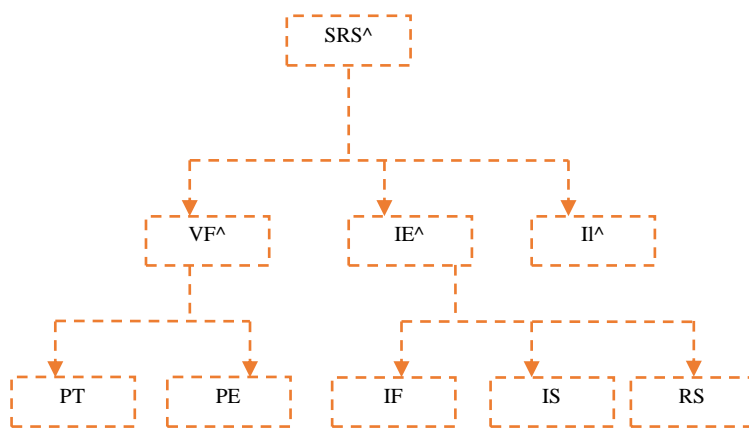


Figure 2. Fuzzy tree of Social Rehabilitation based on FCL.

Other results obtained from the modeling can be seen in Table 2 where the blocks of institutions are located according to their impact on social rehabilitation based on the truth scale determined in the FCL.

State	Scale	Incidence of the social rehabilitation regime	Institution per state of the social rehabilitation
1	0 - 0.2	Inadequate	14 % (1 institution)
2	0.2 - 0.4	Very low	14% (1 institution)
3	0.4 - 0.6	Appropriate	42.8 % (3 institutions)
4	0.6 - 0.8	Good	28.5 % (2 institutions)
5	0.8 - 1	Excellent	

Table 2. Social Rehabilitation Values obtained through data processing.

The analysis of the Social Rehabilitation Regime was developed through the modeling of the Compensatory Neutrosophic Logic that allowed us to evaluate the behavior of compliance with the fundamental axes. 5 penitentiary institutions were used as the object of study.

The use of the Compensatory Neutrosophic Logic for the analysis of Social Rehabilitation showed that:

- A value of 42.8%, representing 3 institutions, comply with Social Rehabilitation in an appropriate way.
- A value of 28.5%, representing 2 institutions, comply with the Social Rehabilitation in a good way.
- However, 14.4%, representing 1 institution, complies with Social Rehabilitation in a very low value.
- A value of 14.4%, representing 1 institution, comply with Social Rehabilitation in an inadequate way.

In the 5 institutions taken as an example for the proposed model, it can be noted that: although the results relation shows how a compound predicate seems to have a good behavior in its internal relations, some variations may occur. Variations are largely conditioned depending on the characteristics of the institution being modeled.

Conclusions

This work is based on the use of information obtained from the social rehabilitation process, for the evaluation of the status of the process. It is an interesting way to link the workers of the penitentiary institutions in the evaluation of the social rehabilitation regime.

The application of a mathematical model based on the Compensatory Neutrosophic Logic constitutes an effective instrument for evaluating the treatment of the Social Rehabilitation System.

For future research, it should result in the formation of knowledge bases on the behavior of treatment in social rehabilitation. This will promote the deepening of knowledge about the subject in question; reference patterns that serve to conduct behavioral analysis.

References

1. Betancourt, A.S.G., K.T.C. Núñez, J.R.C. Granda, and H.S.S. Ramos, *Derecho a la educación de las personas privadas de libertad en el "Centro de Privación de Libertad" de Santo Domingo*. UNIANDES EPISTEME, 2020. **6**: p. 952-965.
2. Argudo-González, E.A., L.E. Argudo-González, and F.M. Tamayo-Vásquez, *Derecho penal laboral. La tipificación de infracciones penales en materia laboral en la República del Ecuador*. Revista Científica FIPCAEC (Fomento de la investigación y publicación en Ciencias Administrativas, Económicas y Contables). ISSN: 2588-090X. Polo de Capacitación, Investigación y Publicación (POCAIP), 2020. **5**(16): p. 388-407.
3. Freire, J.M.P., *Responsabilidad Social Universitaria y su Aplicación a la Gestión de Herramientas Administrativas en el Centro de Privación Provisional de Libertad Sector Guayaquil-Ecuador, Una Mirada Reflexiva Humanística*. Estudios, 2018(36): p. 555-571.
4. Flores Vallejo, J.C., *La inserción laboral de las personas privadas de libertad con sentencia en el Sistema Penitenciario de Ambato*. 2020, Pontificia Universidad Católica del Ecuador.
5. Águila, M.R.F. and P.E.C. Fuentes, *Los derechos fundamentales de los sancionados a privación de libertad en el Ecuador*. Revista Metropolitana de Ciencias Aplicadas, 2019. **2**(3): p. 38-47.
6. Maliza, M.E.M., E.M.H. Gaibor, M.S.I. Jaramillo, and D.F.T. Torres, *Rehabilitación y reinserción social: Una quimera para los privados de libertad*. UNIANDES EPISTEME, 2020. **6**: p. 857-869.
7. Le, C., *Preamble to Neutrosophy and Neutrosophic Logic*. MULTIPLE VALUED LOGIC, 2002. **8**(3): p. 285-296.
8. Smarandache, F. and M. Ali, *Neutrosophic Triplet Group (revisited)*. Neutrosophic Sets and Systems, 2019. **26**(1): p. 2.
9. Smarandache, F., J.E. Ricardo, E.G. Caballero, M. Yelandí, L. Vázquez, and N.B. Hernández, *Delphi method for evaluating scientific research proposals in a neutrosophic environment*. Neutrosophic Sets and Systems, 2020: p. 204.
10. Ortega, R.G., M.D.O. Rodríguez, M.L. Vázquez, J.E. Ricardo, J.A.S. Figueiredo, and F. Smarandache, *Pestel analysis based on neutrosophic cognitive maps and neutrosophic numbers for the sinos river basin management*. 2019: Infinite Study.
11. Velásquez, S., *Prisión preventiva y Constitución del Ecuador 2008*. Universidad Santiago de Guayaquil, 2016: p. 283-292.
12. Gonzalez, J.P., *Los derechos humanos de las personas privadas de libertad. Una reflexión doctrinaria y normativa en contraste con la realidad penitenciaria en Ecuador*. Revista Latinoamericana de Derechos Humanos, 2018. **29**(2).
13. Ricardo, J.E., M.I.M. Villalva, Z.A.O. Padilla, and L.A.C. Hurtado, *FILOSOFÍA DE LA COMUNICACIÓN, COMPLEMENTO NECESARIO EN EL APRENDIZAJE DE LAS CIENCIAS SOCIALES*. Magazine de las Ciencias: Revista de Investigación e Innovación, 2018. **3**(2): p. 39-52.
14. Ricardo, J.E. and K. de Mora Litardo, *La influencia de la programación neurolingüística en estudiantes universitarios en la República de Ecuador*. LUZ, 2017. **16**(1): p. 104-113.
15. Ricardo, J.E., R.M. Peña, G.R. Zumba, and I.I.O. Fernández, *La Pedagogía como Instrumento de Gestión Social: Nuevos Caminos para la Aplicación de la Neutrosophía a la Pedagogía*. 2018: Infinite Study.

16. Vera, D.C., A.V.T. Suintaxi, G.C.I. Alcívar, J.E. Ricardo, and M.D.O. Rodríguez, *Políticas de inclusión social y el sistema de ingreso a las instituciones de educación superior del ecuador*. Dilemas Contemporáneos: Educación, Política y Valores, 2018. **6**(1).
17. Espin-Andrade, R.A., E. Gonzalez, W. Pedrycz, and E. Fernandez, *An interpretable logical theory: the case of compensatory fuzzy logic*. International Journal of Computational Intelligence Systems, 2016. **9**(4): p. 612-626.
18. Salas, F.G., R.J. del Toro, R. Espin, and J.M. Jimenez. *An Approach to Knowledge Discovery for Fault Detection by Using Compensatory Fuzzy Logic*. in *Mexican International Conference on Artificial Intelligence*. 2019. Springer.
19. Chen, C., H. Du, and S. Lin. *Mobile robot wall-following control by improved artificial bee colony algorithm to design a compensatory fuzzy logic controller*. in *2017 14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)*. 2017. IEEE.
20. Cruz-Reyes, L., R.A. Espin-Andrade, F.L. Irrarragorri, C. Medina-Trejo, J.F.P. Tristán, D.A. Martínez-Vega, and C.E.L. Peralta, *Use of Compensatory Fuzzy Logic for Knowledge Discovery Applied to the Warehouse Order Picking Problem for Real-Time Order Batching*, in *Handbook of Research on Metaheuristics for Order Picking Optimization in Warehouses to Smart Cities*. 2019, IGI Global. p. 62-88.
21. Bělohávek, R., J.W. Dauben, and G.J. Klir, *Fuzzy logic and mathematics: a historical perspective*. 2017: Oxford University Press.
22. Shreyas, J., H. Singh, J. Bhutani, S. Pandit, N. Srinidhi, and D.K. SM. *Congestion Aware Algorithm using Fuzzy Logic to Find an Optimal Routing Path for IoT Networks*. in *2019 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE)*. 2019. IEEE.
23. Xiang, X., C. Yu, L. Lapiere, J. Zhang, and Q. Zhang, *Survey on fuzzy-logic-based guidance and control of marine surface vehicles and underwater vehicles*. International Journal of Fuzzy Systems, 2018. **20**(2): p. 572-586.
24. Dhimish, M., V. Holmes, B. Mehrdadi, and M. Dales, *Comparing Mamdani Sugeno fuzzy logic and RBF ANN network for PV fault detection*. Renewable Energy, 2018. **117**: p. 257-274.
25. Nayak, P. and B. Vathasavai, *Energy efficient clustering algorithm for multi-hop wireless sensor network using type-2 fuzzy logic*. IEEE Sensors Journal, 2017. **17**(14): p. 4492-4499.
26. Solís, P.Y.J., B.A.A. Burgos, M.L.T. Palma, C.Y.M. Álvarez, and F.d.R.C. Paredes, *Compensatory fuzzy logic model for impact*. Neutrosophic Sets and Systems, Book Series, Vol. 26, 2019: An International Book Series in Information Science and Engineering, 2019: p. 40.
27. Bouchet, A., J.I. Pastore, M. Brun, and V.L. Ballarin, *Compensatory fuzzy mathematical morphology*. Signal, Image and Video Processing, 2017. **11**(6): p. 1065-1072.
28. Mellah, R., S. Guermah, and R. Toumi, *Adaptive control of bilateral teleoperation system with compensatory neural-fuzzy controllers*. International Journal of Control, Automation and Systems, 2017. **15**(4): p. 1949-1959.
29. Ferdaus, M.M., S.G. Anavatti, M. Pratama, and M.A. Garratt, *Towards the use of fuzzy logic systems in rotary wing unmanned aerial vehicle: a review*. Artificial Intelligence Review, 2020. **53**(1): p. 257-290.
30. Braiki, K. and H. Youssef, *Fuzzy-logic-based multi-objective best-fit-decreasing virtual machine reallocation*. The Journal of Supercomputing, 2019: p. 1-28.
31. Popescu, T., P. Georgelin, F. Smarandache, and L. Popescu, *The aesthetics of paradoxism*. 2002.
32. Smarandache, F., *Fifteenth International PhotoVideoAnthology on Paradoxism*. 2020: Infinite Study.
33. Smarandache, F., *A unifying field in logics: Neutrosophic logic. neutrosophy, neutrosophic set, neutrosophic probability: Neutrosophic logic: neutrosophy, neutrosophic set, neutrosophic probability*. 2003: Infinite Study.
34. Chamorro Valencia, D., T. de Jesús Molina Gutiérrez, L.H. Burbano Garcia, and A.A. Cadena Posso, *Cased-based reasoning and neutrosophic logic to identify the employment limitations for Law school graduates at UNIANDES Ibarra*. Neutrosophic Sets & Systems, 2019. **26**.
35. Sierra Morán, J.C., J.F. Enríquez Chuga, W.M. Arias Collaguazo, and C.W. Maldonado Gudiño, *Neutrosophic statistics applied to the analysis of socially responsible participation in the community*. Neutrosophic Sets and Systems, 2019. **26**(1): p. 4.
36. Ortega, R.G., M.L. Vazquez, J.A. Sganderla Figueiredo, and A. Guijarro-Rodríguez, *Sinos river basin social-environmental prospective assessment of water quality management using fuzzy cognitive maps and neutrosophic AHP-TOPSIS*. Neutrosophic Sets and Systems, 2018. **23**(1): p. 13.

37. Gómez, G.Á. and J.E. Ricardo, *Método para medir la formación de competencias pedagógicas mediante números neutrosóficos de valor único*. Neutrosophic Computing and Machine Learning, 2020. **11**.
38. Amat Abreu, M. and D. Cruz Velázquez, *Neutrosophic model based on the ideal distance to measure the strengthening of values in the students of Puyo university*. Neutrosophic Sets & Systems, 2019. **26**.
39. Arvelo, P.M.M., J.C.A. Zambrano, G.K.R. Zambrano, J.E.C. Piloso, G.F.V. Pita, D.C.A.-V. Nolivos, and C.E.P. Paucar, *Neutrosophic model for the analysis of criminal behaviour in Quevedo*. Ecuador, from a spatial econometric analysis, Neutrosophic Sets and Systems, 2019. **26**: p. 49-54.
40. Vázquez, M.L., E. Santos-Baquerizo, M.S. Delgado, B.C. Bolaños, and D.C. Giler, *Performance analysis of researchers using compensatory fuzzy logic*. International Journal of Innovation and Applied Studies, 2017. **19**(3): p. 482.
41. Cornelio, O.M., I.S. Ching, J.G. Gulín, and L. Rozhnova, *Competency assessment model for a virtual laboratory system at distance using fuzzy cognitive map*. Investigación Operacional, 2018. **38**(2): p. 169-177.

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