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Mathematical Design and Development of Fuzzy Logic Systems

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Abstract – Fuzzy logic gives a system to model vulnerability, the human state of mind, thinking, and the discernment procedure. A fuzzy master system is just a specialist system that uses an accumulation of fuzzy membership capacities and rules, rather than Boolean logic, to reason about data. Fuzzy rules are the foundation of fuzzy logic systems. The Fuzzy Logic or the Fuzzy Logic Control is an Artificial Intelligence approach/method, which is particularly utilized for designing and creating wise controlling frameworks. It gives a compelling and proficient strategy to recreate the human reasoning and practices so as to guarantee the related smart controlling structure. In this unique situation, this paper presents the FL-LAB v2: a software framework, which can be utilized to design and create various types of Fuzzy Logic derivation and controlling frameworks, by utilizing a simple to-utilize, interactive and compelling software condition.

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INTRODUCTION

Fuzzy systems supplant human administrator's activities in the plan of fuzzy control, fuzzy data and basic leadership, A detailed investigation of fuzzy systems and its application is talked about in Bezdek and Mendel. Regarding surmising process there are two primary classes of fuzzy induction system (FIS) the Mamdani write FIS and the Takagi-Sugeno compose FIS. Mamdani write FIS is taken for consider in this section. The different sorts of suggestion operators and total operators, which are important to process the fuzzy rules are talked about in Turksen , Weber and Yager . Fuzzy systems modeling and general guess of fuzzy rule based modeling is portrayed in Krienovich et al.,Fuzzy system has certain detriments like the approval procedure of the membership capacities, the conceivable costly calculation in the fuzzy derivation process and some surprising challenges and unpredictability in abstracting the fuzzy rules inside numerical data. The principle question regularly asked by fuzzy system creators is which one to utilize and under what conditions. The decision of suggestion operators, antecedent connectors, can't be described by the sort of the current issue; however it can be identified with the properties of the issue.

HYBRID SYSTEMS

Hybrid systems joining fuzzy logic, neural systems, and hereditary algorithms are ended up being compelling in a wide assortment of genuine issues. In this work, the accentuation of the half breed systems is given to the neural-fuzzy system, which is the most widely recognized and well known blend in mixture systems. A portion of the utilizations of neuro fuzzy systems and delicate processing model for machine insight can be found.

Fuzzy surmising or control system is connected in various issues and the membership capacities speaking to the linguistic deduction rules should be tuned to make rectify derivation comes about. On the off chance that there exists predefined rule system with appropriate membership capacities, suggestion operators, antecedent connector model, at that point they can be utilized to locate the right parameter for the bunches in choice emotionally supportive networks. Investigation of fitting antecedent connector model is an essential standard for a fuzzy system to deliver legitimate yield generally the choice yield of the system is a disappointment (Herrera-Viedma, et. al., 2004). It is critical to pick t-standard and t-conorm administrator appropriately. The reason being distinctive operator's prompt profoundly extraordinary outcome in fuzzy systems.

All the connector models were usable for singleton fuzzy logic systems, yet, for non singleton fuzzy logic systems just a single antecedent connector model, to be specific, multiplicative compensatory 'and' with product t-standard model was usable when Mamdani product suggestion was connected and when Mamdani least ramifications was taken none of the antecedent connector models were usable. In this section, for the compensatory and

SOWA collection operator's diverse blend of the t-standards and t-conorms were taken and tried for their ease of use.

FUZZY SET TASKS AND MEMBERSHIP CAPACITIES

Association, crossing point and supplement are the fundamental tasks on fresh sets. In fuzzy logic, the standard meanings of these operators are as per the following: For each x in the universe X of fuzzy sets A, B and C

Union: The Union of two fuzzy sets An and B is a fuzzy set C, composed as C=AuB , whose membership work is characterized by $\mu_C(x) = \max(\mu_A(x), \mu_B(x)) = \mu_A(x) \vee \mu_B(x)$.

Intersection: The Intersection of two fuzzy sets A and B is a fuzzy set C, Written as C =A ∩B, whose membership work is characterized by $\mu_c(x) = \min(\mu_A(x), \mu_B(x)) = \mu_A(x) \wedge \mu_B(x)$.

Complement: The complement of the fuzzy set A, denoted by $\bar{A}$, is characterized by $\mu\text{-}_A(x) = 1 - \mu_A(x)$.

In spite of the fact that the definitions above are exemplary set operators, they are by all account not the only method to characterize sensible and predictable tasks on fuzzy sets.

Fuzzy connection: A fuzzy connection speaks to a degree of essence or nonappearance of affiliation, association or interconnectedness between the components of at least two sets. A few cases of (twofold) fuzzy relations are: x is substantially bigger than y, y is near x, z is considerably greater than y. Give X and Y a chance to be two universes of talk (Jian, et. al., 2006).

A fuzzy connection R(XY) is a fuzzy set in the product space X * Y, i.e., it is a fuzzy subset of X, ×Y, and is portrayed by the membership work $\mu_R(x,y)$ where R(X,Y) = {(x, y), μ_R (x, y)/(x, y) ∈X × Y}.

Composition of fuzzy relations: Given two relations P(X,Y) and Q(Y,Z) and their related membership capacities $\mu_P(x,y)$and $\mu_Q(x,y)$, the composition of these two relations is denoted by R(X,Z) = P(X,Y)°Q(Y,Z) (or basically R = P ° Q) R(X, Z) a subset of x Z characterized by the membership work:

$$\mu_R(x, z) = \mu_{PoQ}(x, z) = \sup_y\{ T(\mu_P(x, y), \mu_Q(y, z))\}$$

$$= \sup_y\{ (\mu_P(x, y), \mu_Q(y, z))\} \quad (1)$$

This is additionally called sup star composition as a result of the utilization of image * for t-standard T. The most ordinarily utilized sup star compositions are sup min and sup product.

FUZZY LOGIC

Similarly as fuzzy set hypothesis acquires thought from fresh set hypothesis, fuzzy logic starts by getting notions from fresh logic. The IF-Then proclamation in fuzzy logic has the shape "On the off chance that x is A, at that point y is B," Where x ∈ X, y ∈ Y and the membership work is $\mu/_{A\to B}(x,y) \in [0,1]$ $\mu/_{A\to B}$ >B(x>y)measures degree of truth of the suggestion connection amongst x and y. In fuzzy logic, modus ponens is reached out to sum up modus ponens (Macin Detyneicki, et. al., 2002).

Premise 1: " x is A "

Premise 2: " If x is A then y is B"

Result : "y is B"

Where An and B are fuzzy sets.

In fuzzy logic, a rule is let go inasmuch as there is a non zero degree of similitude between the principal start and the antecedent of the rule, and the aftereffect of such rule terminating is a subsequent that has nonzero degree of closeness of the rule resulting. Summed up modus ponens is a fuzzy composition where the primary fuzzy connection is simply the fuzzy set A. Subsequently membership capacity of the yield $\mu_B(y)$ is gotten utilizing sup-star composition,

$$\mu_B(y) = \sup_{x \in A} \{\mu_A(x) * \mu_{A\to B}(x,y)\} \quad (2)$$

FUZZIFIER

Fuzzification is the task that maps a fresh question a fuzzy set. Fuzzifiers are for the most part singleton and non-singleton fuzzifier. Singleton fuzzifier. It is most well-known fuzzifier. A singleton fuzzifier maps a protest the singleton fuzzy set focused at the question itself .In this fuzzification scheme a perception X\ is changed into a fuzzy set being a singleton with help $\{x_1\}$, in this manner $\mu_A(x)$ is zero wherever aside from at $x = X_1$ (Min You and Chen and Linkens, 2004). Utilizing the way that solidarity and zero are separately the nonpartisan and the invalid component as for any t-standard, it gives the yield as,

$$\begin{aligned}\mu_B(y) = 1 * \mu_{A\to B}(x_1, y) &= \mu_{A\to B}(x_1, y)\\ &= 1 - \mu_{A\cap\bar{B}}(x_1, y)\\ &= 1 - \{\mu_A(x_1) * [1 - \mu_B(y)]\}\\ &= 1 - \{\mu_A(x_1) * [1 - \mu_B(y)]\}\end{aligned} \quad (3)$$

Non Singleton fuzzifier: A non-singleton fuzzifier maps a question into a non- singleton fuzzy set for the most part focused at the protest itself.

$$\mu_B(y) = \sup_{x \in A} [\mu_A(x)^* \mu_{A \to B}(x,y)] \quad (4)$$

The Mamdani least ramifications and Larsen product suggestions are the most broadly utilized inferences of fuzzy logic.

FUZZY RULE BASED SYSTEMS

FIS model can without much of a stretch join a bigger number of variables than the basic mathematical models and this will give more practical arrangement than the regular models.

A fuzzy rule base comprises of a gathering of IF-Then rules which can be communicated as R^1: if x_1 is F_1^l and x_2 is F_2^l and x_p is F^1_p then y is G^1 Where R^1 (/= 1, 2, ...m) is the I^{th} rule, F^i_p (i= 1,2,.....,p) is an antecedent of R^1 F_j^1 and Gl are fuzzy sets in the universe of talk X_k and Y individually which are subsets of genuine numbers R. x = [x_1,,x_2,....x]∈X_1, ×X_2 x....xX_p and y e Y are linguistic variables (Marques Pereria & Riberio, 2003).

In a fuzzy induction motor, fuzzy logic standards are utilized to join fuzzy IF-Then rules from the fuzzy rule base into a mapping from fuzzy info sets in X = $X_{1×}X_{2×}.....×X_p$ to fuzzy sets in Y. The various antecedents are associated by "and's" and accordingly by t-standards.

AGGREGATION PROCESS

Total is the procedure of unification of the yields of all rules. The membership elements of all rule consequents beforehand scaled and join them into a solitary fuzzy set. The contribution of the conglomeration procedure is the rundown of clipped or on the other hand scaled ensuing membership capacities, and the output is one fuzzy set for each output variable.

The t-standards sum up the conjunctive 'and' and the t-conorms sum up the disjunctive 'or'. Intriguing properties fulfilled by different t-standards T and its double t-conorms S are talked about in Detyniecki et al., Zimmermann and Zysno identified that both the operators do not have the compensatory conduct and it appears to be essential in the aggregation procedure (Shi-Jay, 2006). Keeping in mind the end goal to get nearer to the human aggregation process, Zimmermann and Zysno proposed an administrator on [0, 1] called as compensatory operators that depend on t-standards and t-conorms. Later Yager and Filev presented an uncommon group of aggregation operators called as soft requested weighted averaging operators (S-OWA). In this section the compensatory administrator and S-OWA administrator are taken as the aggregation operators.

USABILITY OF ANTECEDENT CONNECTOR MODELS

The firing degree can be inferred by applying t-standards for the numerous antecedents, contribution of the membership work, for sup-star composition and in the Mamdani suggestion. In this section the t-standard T for actualizing Mamdani suggestion and sup-star composition are thought to be the same (Timothy, 2004). In any case, the t-standard T for the linguistic connector word 'and' associating the numerous antecedents in each rule is spoken to as aggregation operators in particular compensatory models and also soft requested weighted averaging operators (S-OWA) (i.e.). The antecedent piece of each rule is then modeled as

$$\mu_{F_1^l \times F_2^l \times \ldots \times F_p^l}(x) = \varphi[\mu_{F_1^l}(x_1),\ldots,\mu_{F_p^l}(x_p)] \quad (5)$$

SINGLETON FUZZY LOGIC SYSTEMS

For singleton fuzzy logic systems since x^l_{max} = x_l i= 1,2,....,p every one of the models in usable. A singleton firing degree is constantly divisible for any model for the connector word 'and'. For each model given the firing degree is a shut shape capacity of the parameters and is piecewise differentiable as for the membership work parameters. Henceforth it takes after that every one of the models is usable for singleton fuzzy logic systems. The partial subsidiaries of the singleton firing degree, concerning membership work parameter and regarding the parameter portraying cp for the connector word 'and' considered (Bednar, et. al., 2013).

NON SINGLETON FUZZY LOGIC SYSTEMS

For NSFLS the talk is conveyed for two unique cases (I) product t standard model is utilized for both sup-star composition and for Mamdani suggestion and (ii) least t-standard model is utilized for both the sup-star composition and Mamdani suggestion.

Implemention of product t-standard model for sup-star composition and Mamdani suggestion

The firing degree in (3.19) for this situation takes the shape

$$f^l(X/\varphi) = \sup_x \{\prod_{i=1}^{p} \mu_{A_{x_i}}(x_i) \times \varphi[\mu_{F_1^l}(x_1),.....,\mu_{F_p^l}(x_p)]\} \quad (6)$$

Keeping in mind the end goal to infer a condition to decide if φ prompts distinct firing degree, the accompanying hypothesis is demonstrated by Hongwei Wu and Mendel.

Interactive Fuzzy Logic Control Software System

The FL-LAB v2 comes with effective using features and functions that enable computer users to work better on the Fuzzy Logic technique and so Fuzzy Logic Control approach, thanks to an easy-to-use, interactive software system environment. In order to learn more about FL-LAB v2 and its usability, both its programmatic infrastructure and using features and functions should be explained. Before explaining using features and functions of the FL-LAB v2, the programmatic infrastructure will be introduced.

Interface designs

Interfaces of the FL-LAB v2 has been designed meticulously via Visual Studio 2008 and also 2010 environment, in order to provide effective and efficient enough using experiences for computer users. At this point, special C# programming language components has been employed to realize the related objectives. Button, Text Box, List Box, Group View, and all of other remaining objects/components have been designed and located on the related software system interfaces carefully. Each interfaces of the related software system is associated with a Windows-form window platform. Design definitions of the listed FL-LAB v2 interfaces has been done via/under.cs files provided within the software system source code (project solution).

Fuzzy Logic codes

The most important infrastructure part of the FL-LAB v2 is the programming code structure associated with the category name: Fuzzy Logic Codes. The Fuzzy Logic technique and also Fuzzy Logic Control – Fuzzy Control infrastructure of the FL-LAB v2 has been coded in detail in order to provide a fast and flexible software system (working mechanism). The foremost object oriented programming approaches (via C#) has been used by authors to realize the mentioned objectives. The program code structure of the first version FL-LAB has been written flexible enough for future improvements, so it was easy for authors to improve using features and functions of the FL-LAB in the second development. Still, the programmatic code structure of the FL-LAB v2 is flexible enough for future additions and developments. Briefly, the Fuzzy Logic codes of the FL-LAB v2 has been written as appropriate for the common working mechanism flow of the Fuzzy Logic technique. In order to improve compiling and working performance, pipeline approaches has been used while writing the Fuzzy Logic codes.

Using Features or Functions of the FL-LAB v2 – Using FL-LAB v2

It is conceivable to examine and clarify utilizing features and elements of the FL-LAB v2 under three titles: Designing and Developing Fuzzy Logic Systems/Models, Working on an Active Fuzzy Logic System/Model, Connection with Other Applications and Additional Features or Functions. Blend of these titles characterizes a typical working session that can be performed through FL-LAB v2.

DESIGNING AND DEVELOPING FUZZY LOGIC SYSTEMS/MODELS

In the wake of executing the FL-LAB v2 application document, the Main Software System Interface is opened. As it very well may be comprehended, this is the fundamental software framework window, where the PC client can perform or reach to every single essential procedure related with the Fuzzy Logic strategy. The interface accompanies straightforward and quick controls guaranteeing an interactive, simple to-utilize working background.

With the controls gave on the Main Software System Interface, it is anything but difficult to perform straightforward File activities (New, Open, Save... and so forth.), examine and modify current features (info or yield variable(s), etymological rules, model choices, bolstering, controlling, making connection... and so on.) of the designed Fuzzy Logic framework/model. The Main Software System Interface likewise enables PC clients to modify fundamental utilizing features and functions of the FL-LAB v2 (Software System Options Interface) and furthermore achieve some extra assets (Fuzzy Logic Support Web Interface). By and large, each control gave on the Main Software Interface characterizes a specific mechanism identified with the general working mechanism of the FL-LAB v2. Now, so as to make the paper simpler to peruse and give more accentuation on progressively imperative and critical utilizing features and functions, insights concerning some basic controls are not clarified. In any case, perusers may comprehend jobs of a portion of these controls while perusing next sub-segments. It is too simple to even think about designing and build up another Fuzzy Logic framework/model by means of FL-LAB v2 controls. Right off the bat, another framework/model making direction can be given to the software framework with the gave File controls. After this, other residual design and improvement processes are identified with typical Fuzzy Logic framework/model shaping tasks, which were clarified in a roundabout way under the Foundations area.

For characterizing input – yield variable(s), enrollments functions of the related variables and phonetic rules of a framework/model and furthermore understand the related activities, it is conceivable to utilize the related controls included inside two gathering board controls called as the Fuzzy Logic Software System Tools and the Fuzzy Logic System/Model Definitions. The Fuzzy Logic System/Model Definitions board can likewise be utilized for displaying some data (dynamic

framework/model name, model sort, characterized variables... and so forth.) about the dynamic framework/model, because of some interactive and visual devices. Then again, it is additionally conceivable to perform other specific tasks like acknowledging controlling procedure or guaranteeing connection with different applications, through the Fuzzy Logic System/Model Definitions board.

On the Main Software System Interface, the catch named Variables can be utilized to open the Input – Output Variable Definition Interface, where the related information – yield variable(s) and their participation functions can be characterized, balanced or examined. Fig. 4 demonstrates a screen capture from the Input – Output Variable Definition Interface. Inside the interface, there are two distinctive tab controls that can be utilized for displaying the related controls for characterizing, modifying or inspecting input – yield variable(s). Quickly, the PC client can sort out variables and related participation functions of any factor, on account of the gave controls. Furthermore, it is additionally conceivable to alter esteem scope of every factor and parameters or sort of every enrollment function by means of the related controls. While looking at participation functions of a variable, their visual definitions are appeared. Now, each unique kind participation function is shown as in various visual shapes. Names of the related enrollment functions and esteem scope of the variable are likewise shown with these visual devices. In the wake of picking an enrollment function for displaying it or altering its features, its visual shape is additionally shown in red shading.

The FL-LAB v2 permits characterizing a wide range of kinds of enrollment functions. Moreover, the FL-LAB v2 empowers the PC client to characterize a participation function manually or naturally. In this sense, manual definition can be utilized to characterize every single essential parameter of the participation function while programmed definition makes another enrollment function in which the vital parameters are balanced in a reasonable, symmetric parameters stream. Obviously, it is likewise conceivable to change the consequently characterized parameters manually. Following the meaning of the related variable(s) and participation function structures, the semantic rules of the dynamic framework/model can be characterized by utilizing the Linguistic Rules Definition Interface. This interface can be opened by means of the Linguistic Rules catch gave on the Main Software System Interface. The referenced phonetic rule definitions can be made effectively by utilizing straightforward controls showed on the Linguistic Rules Definition Interface. Moreover, the FL-LAB v2 additionally enables PC clients to characterize the etymological rules consequently by utilizing the crossing approach. This approach can likewise be called as the symmetric rule coordinating approach for the frameworks/models having two inputs and one yield variables.

CONNECTION WITH OTHER APPLICATIONS

A standout amongst the most alluring, powerful, and imperative utilizing highlight/function of the FL-LAB v2 is guaranteeing a connection domain. Now, the FL-LAB v2 enables PC clients to shape cross breed frameworks with other Artificial Intelligence procedures by utilizing approaching or active connection kind of the software framework. This utilizing highlight/function is the greatest improvement for the FL-LAB software framework after the primary advancement. On account of this improvement, the code structure of the FL-LAB has been amended and reworked for guaranteeing the related approaches. The approaching and active connection approach of the FL-LAB v2 is acknowledged by utilizing an uncommon parameters correspondence and connection library, which was designed and created by the creators. The library presently incorporates numerous C# programming language-based codes, so it is smarter to clarify general structure and working mechanism of the library, so as to give more thought regarding the related utilizing highlight/function. With regards to approaching connections, the FL-LAB v2 peruses progressively or sequent sorted out record types. In this sense, it can peruse for instance XML or Excel type (.xls, .csv. . . and so on.) records. Given information inside these documents are naturally coordinated into the center of the correspondence (connection) library. The related information at that point assessed by the library as some sort of parameters and as per the work process, the dynamic Fuzzy Logic framework/model is utilized right away. Obviously, the related information must be composed as the type of the referenced documents. The greater part of Fuzzy Logic applications or software frameworks inside the writing enables PC clients to acquire these sorts of records. Then again, it is likewise conceivable to change over some other document types utilized by the related applications or software frameworks to the bolstered record types, because of the document converter applications.

The approaching connection task of the FL-LAB v2 is acknowledged by utilizing the Incoming Connector Interface, which can be opened by utilizing the Incoming Connection catch gave on the Main Software System Interface. With the assistance of the Incoming Connector Interface, approaching information is consequently perused by the FL-LAB v2 and nourished into the dynamic framework/model. As it was referenced previously, extraordinary sorts of crossover frameworks including the Fuzzy Logic strategy or the Fuzzy Logic Control approach are shaped effectively. For instance, it is feasible for the PC client to shape an ANFIS (Adaptive Neuro – Fuzzy Inference System)

by utilizing the related utilizing highlight/function. So as to give a model arrangement, the creators have shaped an ANFIS by utilizing the FL-LAB v2 and an Artificial Neural Networks device, which was designed and created previously.

The other connection interface; Outgoing Connector Interface is utilized to acquire the related Fuzzy Logic controller yields to encourage other Artificial Intelligence methods. Now, the FL-LAB v2 trades a document containing the got yield esteems for emphasess amid the performed control process. At that point, the document [XML or Excel-type (.xls, .csv. . . etc.)] can be utilized to nourish the other application or software framework related with an Artificial Intelligence procedure. It is likewise vital that automatically, the yield esteems can be effectively perused from the document and in this manner, any Artificial Intelligence procedure based application or software framework supporting information import can be effectively adjusted to shape a typical half breed framework. As like the other connection type, the active connection task of the FL-LAB v2 is likewise done by means of some basic controls. Now, the Outgoing Connector Interface (which is opened by utilizing the Outgoing Connection catch on the Main Software System Interface), can be utilized quick and effectively, on account of the gave controls.

Aside from the clarified utilizing features and functions, the FL-LAB v2 likewise accompanies some extra features and functions that are identified with the revealing, software framework settings or strong interfaces. For instance, it is conceivable to acquire a rundown of detailed data about the dynamic Fuzzy Logic framework/model. This should be possible by utilizing the Get System/Model Info catch gave on the Main Software System Interface. In the wake of tapping on the related catch, the Active System/Model Info Interface is opened. It is conceivable to spare this rundown as a document by means of gave controls.

CONCLUSION

The work additionally considers the utilization of proper decision of aggregation administrators in fuzzy systems and decision making. Two distinctive aggregation administrators in particular compensatory 'and' and delicate requested weighted averaging administrator are picked as aggregation administrators for forerunner connectors of Mamdani fuzzy logic systems and tested for distinguishableness (Walker & Walk, 2016). It was watched that for a singleton fuzzy logic systems every one of the models characterized are usable while when Mamdani item is utilized for non-singleton fuzzy logic systems just the multiplicative and added substance compensatory and connector models with t-standard as item and t-conorm as limited whole were detachable under certain condition. Decision of the t-standards and tconorms could be changed for the aggregation administrators and tested for ease of use.

Another conceivable approach would likewise be to utilize another fuzzy logic framework what's more, distinguish fitting connector demonstrate for the framework. Multi individual decision making is an intricate issue in decision making. An aggregation administrator gives an aggregate evaluation to every person of the assemble considering the individual suppositions. Diverse aggregation plans are accessible, the premier is requested weighted averaging with steady weights what's more, summed up blend administrators with weighting capacities (Walker & Walker, 2009). A similar investigation is made with these aggregation administrators utilizing illustrative cases. It is watched that since the OWA is having particular independence it neglects to rank the choices in specific circumstances.

REFERENCES

1. Herrera-Viedma E., Herrera F., Chilana F. and Luque L. (2004). "Some issues on consistency of fuzzy preference relation", European Journal of Operations Research, 154, pp. 98-109.

2. Jian Ma, Zhi-Ping Fan, Yang - Ping Jiang, Ji-Ye Mao, Louis Ma (2006). "A method for repairing the inconsistency of fuzzy preference relation", Fuzzy Sets and Systems, Vol 157, pp. 20-33.

3. Macin Detyneicki, Yager R.R, Bouchon-Meunier B. (2002). "Reducing t-norms and augmenting t-conorms", International Journal of General Systems, 3, pp. 265-276.

4. Min You and Chen and Linkens D.A. (2004). "Rule base self generation and simplification for data driven fuzzy models", Fuzzy Sets and Systems, 142, 243-265.

5. Ricardo Alberto Marques Pereria, Rita Almeida Riberio (2003). "Aggregation with Generalized Mixture Operator using weighting functions", Fuzzy sets and Systems,37, pp. 43-58.

6. Shi-Jay Chen (2006). "New Similarity measure of generalized fuzzy numbers based on geometric mean averaging operator," in Proc. IEEE International Conference on Fuzzy Systems, Fuzz-IEEE ,Vancouver, Canada, 2006.

7. Timothy, J. Ross (2004). "Fuzzy logic with engineering applications, John Wiley & Sons, Ltd.

8. BEDNAR J.: Fuzzy Metriky a Jejich Vlastnosti (2013). In Proceedings APLIMAT:SeconInternationalConference, 2013, pp. 12.812.90

9. C. Walker, E. Walk R. (2016). Automorphisms of Algebras of FuzzyTruth Valu s II, In rnational Journal of Uncertainty, Fuzziness and Knowl DGE-BASS d Systems, 16(5) pp. 627-643.

10. C. Walker & E. Walker (2009). Sets with Type-2 Operations, International Journal of Approximate Reasoning, 50, pp. 63-71.

11. U. Kose and O. Deperlioglu (2016). An educational, virtual laboratory system for fuzzy logic. In Proceedings of the International Symposium on Computing in Science and Engineering. 3-5 June. Gediz University.

12. O. Deperlioglu and U. Kose (2017). An educational tool for artificial neural networks. Computers and Electrical Engineering 37: pp. 392-402.

13. P. Shahmaleki, M. Mahzoon, A. Kazemi, M. Basiri (2010). Vision-based hierarchical fuzzy controller and real time results for a wheeled autonomous robot. In Tech (2010) http://www.intechopen.com/books/motion-control/visionbased-hierarchical-fuzzy-controller-and-real-time-resultsfor-a-wheeled-autonomous-robot Accessed 26 June 2012.

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