Turkish Journal of Computer and Mathematics Education Vol.12 No.9 (2021),1393-1402

Research Article

Article Review: Survey Fuzzy Logic and Aprior Algorithms Employed for E-learning Environment

Prof.Dr. Enas Mohammed Hussein Saeed[1], Batool Ali Hammood[2]

[1]Department of Computer Science, College of Education, Al-Mustansiriya University.
[2]Department of Computer Science, College of Education, Al-Mustansiriya University.
[1]enas.saeed38@gmail.com ,[2]batool.ali.hmood@gmail.com

Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 20 April 2021

Abstract: The adaptive education frameworks within e-learning platforms are designed to ensure that each learner's learning experience differs. To provide adaptive e-learning programs and research materials adapted to adaptive learning, this type of educational approach attempts to integrate the ability to understand and identify the unique needs of an individual in the context of learning with the skills needed to use suitable learning pedagogy and to improve the learning process. Thus, designing realistic student profiles and templates based on an overview of their affective states, level of experience, and individual personality traits and abilities is essential. The data collected can then be used and used effectively for the creation of an adaptive learning system. These learner models can be used in two ways once learned. The first is to educate the pedagogy of the integrated educational method suggested by the experts and designers. The second objective is to provide the framework dynamic self-learning ability based on teachers and students' behaviours to build effective pedagogy and adapt e-learning environments automatically according to pedagogies. Artificial intelligence algorithms can, for various reasons, be useful, including their ability to improve and mimic human reasoning and decision-making (learning-teaching model) and to reduce the source of uncertainty in order to achieve an effective background of learning. These leadership skills ensure progress for both the learner and the system over the lifelong learning process. In the following document, we present a survey on growing and relevant issues in the field of artificial intelligence algorithms, their advantages and drawbacks (fuzzy logic and A prior algorithm), as well as the importance of using these strategies to make e-learning system smarter and more efficient.

Keywords: e-learning, educational systems, artificial intelligence, fuzzy logic and Apriori algorithm.

1. Introduction

Often researchers in education technologies use social media knowledge to address questions about patterns, teamwork or learning networks. The field of study in education data mining is emerging with a variety of analytical and psychological tools and analysis approaches to understanding students' knowledge [1]

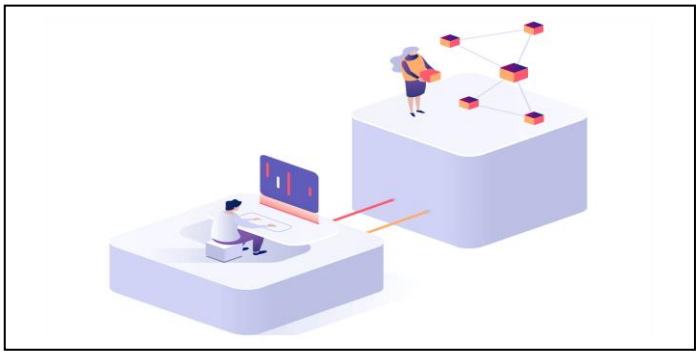


Figure (1): E-learning system [1]

A new machine assisted immersive learning approaches and cognitive learning software, simulations and games have made it easier for student knowledge to be obtained and analyzed, patterns and innovations found in these data and new ideas about how to identify and interpret students. Online learning data may be aggregated over vast numbers of students and can contain several variables to be tested for model structures by data mining algorithms **[2].** Just as early as online output identification, data mining included mining website log data **[3]** before time efforts to learn, but now more advanced, mechanical and complicated online learning methods offer more variety of knowledge. The mining of educational data typically leads to the reduction of learning to small parts, which can be evaluated and then shaped by adapting applications to the learner [4].

Student learning data obtained by online learning systems was explored to build statistical models by using educational methods of data mining to identify data or discover links. These interpretations led to a role of framework integrated learning structures in which modifications or strategies based on model standards can be used to alter the behaviors of students or also to suggest additional instructional resources to improve the learning of students. The fact that education data are hierarchical is a significant and special aspect. Data are accompanied by the keystroke stage, the response process, the session stage, the student stage, the teacher stage, the professorial and the teacher level[5],[6].

Figure (2): Simulation of E-learning [5]

Artificial intelligence (AI) techniques are seen as useful instruments because they are able to build and mimic people's decision-making processes. Related AI methods are used in integrated education programs. There are Fuzzy Logic, Decision Trees, Neural Networks, Bayesian Networks and Genetic Algorithms and Models of Hidden Markov [7]. In this article we address several approaches in A.I that are used for e-learning such as fuzzy logic (FL) and A prior algorithms

2. Techniques of Fuzzy Logic

Fuzzy logic emerges as a tool for interpreting and controlling data more tightly than other mathematical and analytical methods [8].

When they become fuzzy, i.e. all that basically belongs to a category, the values are no longer smooth (i.e. precise). Such logic uses Fuzzy Sets, which are collections whose membership degrees are elements of [9], to represent and exploit this type of ambiguity. With this base, fuzzy logic makes close abstract reasoning and programming to other types of human thought. This is a good function for learning environments, because their details and findings of study are related to individual behavior. Effective statistical representation of them allows it simpler to get more accurate and understandable performance. The best established Fuzzy approaches used in e-learning programs are briefly discussed in this chapter. It analyzes their core properties in terms of explanation, information handling and overall implementation. [10]

2.1 Fuzzy Inferences: The system that maps its inputs to outputs using the fuzzy set theory. It seeks to represent the rationale behind personal language interpretation for the representation of questions of judgment, make choices and behave, consequently. A FIS has whimsical guidelines for designing the problem to be solved. These laws are of the IF-THEN type, which are connected to sets inclusion. A standard fuzzy rule is: "if u is A then v is C," Here A and C become fuzzy sets defined in the u and v ranges respectively. [11]

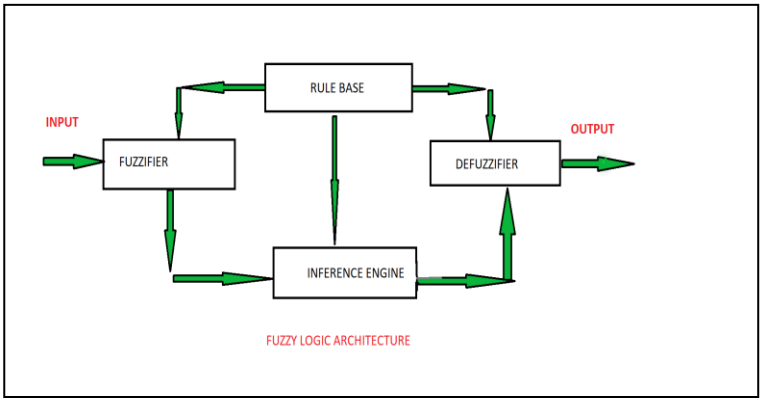
2.2 Fuzzy Logic: Fuzzy Logic for simulation Concept theory explores the creation and classification of constructs under mathematical logic. Various approaches and families have been applied for constructing these frameworks; one of them is the fuzzy logic. Fuzzy computing is a relatively recent approach to the design of simulation structures. It uses metaphors based on Fuzzy logic predicates to explain machine behavior in a qualitative manner. A fuzzy model describes the structure of Fuzzy sets, represented as Fuzzy numbers and correlated of linguistic definitions. See models promote the integration of established knowledge into the modeling framework. At the same time, human experts will quickly understand their expertise and result s. [11]

2.3 Fuzzy Recommendation logic: Recommendation frameworks were designed to include suggestions. Typically, they function with many clients, processing domain related artifacts and user profiles for metadata [12][13]. Using this knowledge, able proposes a set of D={d1, ... ,dn} objects to a user, which may be the most

important according to the interests of the user. There must be a way to process details about users' interests in order to build a suggestion framework. Such preferences are based on a collection of basic assumptions A = {A1, ... An}. For any item in collection D the truth of each of these statements may be calculated.

2.4 Fuzzy Ontology: Ontology is a Topic Conceptualization specificities. It describes to knowledge using multiple forms of definition hierarchies. These definitions are defined as classes of properties, becoming the instances of certain classes of unique objects. Because ontology was condensed Description of Domain Objects, it's useful to reflect and argue with the context of e-learning systems. [14]

2.5 Fuzzy Logic for Clustering: the clustering in fuzzy is used in a variety of areas to accomplish fuzzy data structures. Any data component has to be grouped into one cluster in a classical clustering method. With the fuzzy view that data is collectively a part of more than one cluster. Fuzzy clustering algorithms by minimizing objective function determine an optimal grouping. This feature builds on a reference cluster. The model is a clusters center which is an example of the properties used to describe the architecture underlying it. That gap between the cluster center and a given data is the degree to which the later's membership: it increases as the distance from the cluster center decreases. [15][16][17]



3. Fuzzy Logic for E-learning systems

Often learning environments face several challenges when it comes to adjusting the learning process to and student's individual needs, usability and value. This section explores how in current systems, various fuzzy methods shown in the above section were implemented to address some of these issues.

In e-learning applications, *Fuzzy inference* is implemented to provide data processing that is more similar to human rationale. As both teachers and students are not inherently data processing and interpretation experts, this is a critical feature of these classes. One of the first approaches used for Fuzzy logic in e-learning models was [18].This learning experience was designed to reflect an appraisal framework. This evaluation was administered by educators with assistances from their learners. All of this material is rather imprecise and the fuzzy logic helps it to be computationally set out. This novel emphasis was analyzed in [19] by the same writers several years later.

They proposed a method called TAPS for assessing candidates, which, through fuzzy logic, adds affiliation degrees to the language marks. In this way too, structures such as Sherlock II[20] and the MDF tutor[21use fuzzy representations and rules set to classify, articulate and change the ambiguity in the actions of students. The implementation of the BSS1 tutoring method in [22] and SYPROS[23] was developed with a fuzzy logic engine. It provides enhanced student learning management based on those strategies. Fuzzy connection rules are use in [24] to explain relationships within the various behavior habits of a learner, the measures regarded include the number of questions asked, the number of hours spent online and the number of articles viewed and written, inter alia. This research is achieved with the use of the Fuzzy technique to alter standard web logs. Fuzzy inferences are added which represent the assessments of the instructor. [25]

It helps conclude the knowledge-level and cognitive ability of students through the collection and analysis of membership features. Most ranking job is [26]. It reviewed the perspectives of experts to create a new approach for measuring academic achievement of the students. They applied data-driven fuzzy rule induction for this role, providing a fuzzy inference process and a related algorithm for rule induction. Most ranking job is [26]. It reviewed the perspectives of experts to create a new approach for measuring academic achievement of the students. They

applied data-driven fuzzy rule induction for this role, providing a fuzzy inference process and a related algorithm for rule induction. Further valuable tools in this sense are idea maps. It suggests a new approach for automatically constructing them in. [27]

It was eventually implemented in several methods of integrated learning. Fuzzy principles and logic methods are used in this work. It builds definition maps with them and assesses the degrees of significance of relationships between concepts. In this line too, several articles [28][29][30][31] directed to student assessment were provided by the same scientists. Their key aim is to create the membership feature automatically, and fuzzy sets to fuzzy grading algorithms. [32][33],The writers suggest a Two-Stage Concepts Map Creation (TP-CMC) method to create the concept map automatically using the educators' historical test data. In the first step, the fuzzy logic has importance; where it is implemented for transform the values of the test records into symbolic results. The Data Mining method is used in this process to identify the laws of grade fuzzy interaction. In the second step, the writers apply several laws in actual learning scenarios according to their findings.

In [34], separate fuzzy models were introduced by the authors for students to receive two measures to determine an intelligent learning technology. In this analysis, fuzzy sets of rules determine the importance of the learning strength of cognitive components, which define of change the fuzzy values. In [35] the researchers define a new hierarchical model for expressing user position during navigation in multimedia tutoring systems. A fluid algebraic structure that relies on cognitive variables is the basis of this model. It allows the creation of an use interface that can be viewed whatever the final mission.

More researcher paradigm is implemented in [36]. A typical implementation of fuzzy techniques is the suggestion method. As noted earlier, this reasoning is well adapted to answer the needs of the consumers. Also used fuzzy logic in [37] to model the material of the learners and an e-learning scheme. The writers have recommended using the rationale to actively propose learning experiences like personalization and interactive functionality in this educational framework. The modeling of student clusters is another method. To this end, for the representation of each category, the analysis in [38] considers fuzzy numbers linked to student attributes defined by their cardinality. Consider the resemblance between a student 's dominant characteristics and the top graded category attributes to build customized recommender framework for new applicants.

The use of fuzzy ontology is an example of in [39]. The developers suggested a contribution within fuzzy domain ontology with a novel definition of a map-generating method. Fuzzy connections are defined for these reasons the relationships between objects, classes, and attributes. This questionable ontology requires model maps to be created automatically. The feedback for them comes from the details in various pedagogical systems provided by the students. The resulting maps help the educators to research the success of the students.

Another consideration for e-learning systems in the field of educational data mining is the classification of learners according to their behavior. The aim is classified them into particular groups that are described by profiles of the learner. In e-learning environments this approach facilitates decision-making. An example of such work occurs in [40]. The researcher used various fuzzy clustering methods (e.g. fuzzy c-means) to determine the groups of the learners and estimate the profiles of them. They also build their experiments in used the Fuzzy Clustering Models. It should be noticed in the review of their findings that fuzzy methods performed better than traditional methods.in table **(1)** we comparison between the many fuzzy logic techniques in e-learning and summaries of those.

Table (1): E-learning applications comparison using the related Fuzzy method

Researchers	Fuzzy Methods	E-learning systems
[18], [19], [28], [29], [30], [31], [21], [22], [48]	Fuzzy inference, bubbling set theory, bubbling distributions, bubbling rules, bubbling rule deduction, bubbling reasoning strategies	Structures of assessment, adaptive learning structures, systems of collective learning
[24], [25]	Fuzzy inference of engine, fuzzy mining, fuzzy set theory	Information networks, learning algorithms, IT networks, interactive curriculum systems
[27], [28], [29], [30], [31], [32] , [33]	Networks of intelligence, algorithms of learning, IT networks, immersive curriculum systems	Concept Maps, data mining

[34], [35]	Fuzzy modeling, fuzzy epistemic logic, the philosophy of fuzzy sets, fuzzy rules	Modeling systems, efficient learning systems , automated tutoring systems , information structures, subcategories, systems for assessment and classification
[31]	Fuzzy models, fuzzy theory in theory	System for intelligent tutoring, simulation systems
[36], [38], [24]	Fuzzy simulation, fussy set theory, fuzzy inferences, fuzzy laws	Intelligent system for tutoring, Modeling systems
[39]	Fuzzy ontologies, fuzzy relations	Intelligent Tutoring Framework, Applications Simulation

4- Apriori Algorithms

The Apriori algorithm is used to identify teacher-subject relationships, teacher and class, etc. For association rule mining, Apriori is an algorithm. It was planned in 1994 by Rakesh Agrawal [41]. This algorithm is known to function on databases which Had multiple transactions and Entity Sets. To find relationships between different objects, the Apriori algorithm is used. It is called Study of the Consumer Basket. A collection of data has a lot of things, and is called an operation. Apriori 's output is the collection that tell us how of rules popular in sets are certain things. Apriori uses first quest for Breadth and allows a tree-like structure to powerfully count nominated item sets. Using the transaction database, Apriori carries out regular object sets after measuring the candidates. The apriori algorithm has three stages:

- ***Generation of Candidates***
- ***Finding frequent in the item sets***
- ***Generation of Rules***

In the algorithm of Apriori for finding connections, few changes are made. The table Item Collection is split according to the target entry. The Apriori algorithm is implemented to find the relation for each sub-table [42]. Those goal entry item sets (e.g. instructor) and all other items that are best for the instructor are selected for which class, subject, semester, etc. Teacher-to-class associations, teacher-to-subject, teacher-to-semester associations and teacher-to-discipline associations are found using this algorithm. A database [43] is used for algorithm manipulation.

To find the frequent trend, connection or similarity in the transaction database, association rules are used. Basket Data Processing, Educational Data Mining, Sorting, Clustering etc. can be used in association rule mining. Apriori, Sampling, Partitioning & Parallel Algorithm are Association Rule algorithms. This section briefly mentions the Apriori Association Rule, Predictive Apriori Association Rule, Tertius Association Rule & Filtered Associator algorithm:

4.1 Apriori Association Rule: Apriori Association rule is used to mine patterns that are widely included in databases. The standard method used to quantify the principle of relation continuity is Support & trust:

• The X->Y association rule is endorsed by the percentage of transactions in the database containing XUY[44].

• Trust in the affiliation law is X->Y, the ratio of the number of transactions containing XUY to that containing X[45].

The words connected with this algorithm are [46] as follows:

• Daily collections of items: collections of items with limited assistance and Li for ith itemset.

Apriori Property: Every frequent item set sub-set must be frequent.

Join Operation: A set of candidate k-itemsets is generated by joining Lk-1 itself in order to find Lk.

• Join Step: Candidate item Ck is formed by joining Lk-1.

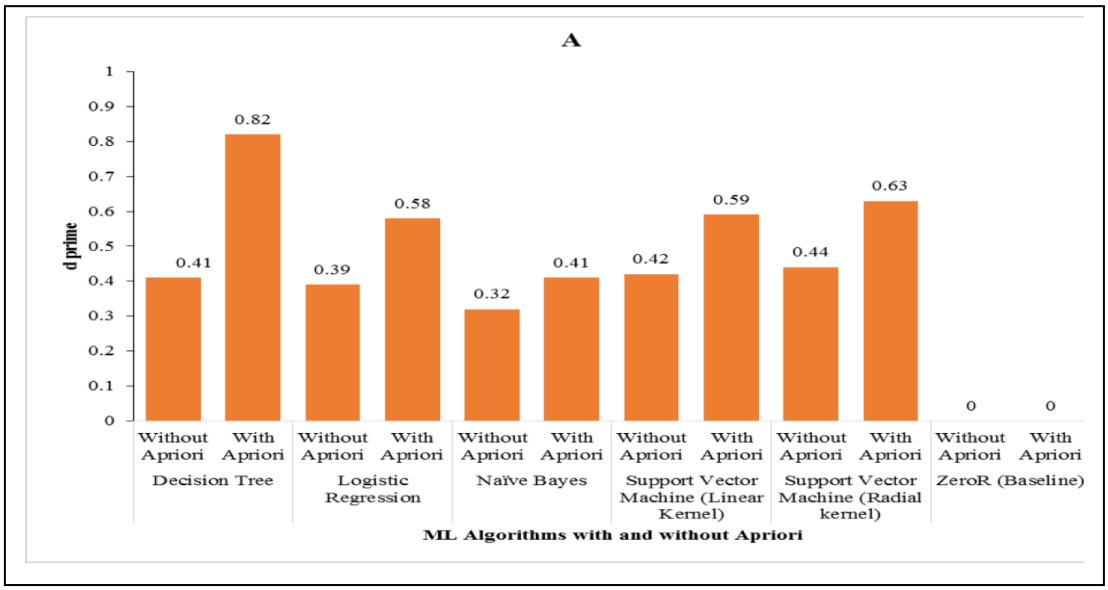
• **Prune Step:** Any (k-1)-itemset that is not frequent can not be a subset of a frequent kitemset The Apriori Association algorithm is given below[46]: in this section we use the Apriori Association algorithm to figure out the results , i.e. the best combination of courses, after the data stage has been pre-processed; The options available with the Apriori association rule algorithm are Weka, vehicle, class index, delta, lower bound minimum support, metric form, minimum metric, number of rules, output item sets, delete all missing columns, importance level, upper bound minimum support, verbose.

3.2 Predictive Apriori Association Rule: Support & confidence is merged into a single metric called predictive accuracy in a predictive Apriori rule algorithm. In order to generate the Apriori law of connection, this predictive accuracy is used. In Weka, this algorithm creates the best n association rule based on the chosen n person.

4.3 Tertius Association Rule: This algorithm considers the norm, in compliance with the validation measures [47]. It utilizes First Order Logic representation. It includes a variety of choices such as class index, description, validation threshold values, frequency threshold, horn clauses, missing values, negation, noise threshold, literal numbers, repeat literals, roc analysis, output values, etc.

4.4 Filtered Associator : This algorithm is a class for arbitrary associator execution on data passed through an arbitrary filter. The filter structure, like the associator, is based entirely on the training results, and the filter processes analyze instances without altering their layout. Here in this algorithm, the Apriori, Predictive Apriori & Tertius interaction rule algorithm can be considered

All algorithms except the Filtered Associator, which uses the Apriori association rule algorithm, also give the association rules containing 'no.' The association rule containing 'yes' is given only by the filtered associator using the Apriori association rule algorithm, because we use the Apriori association law, that is to say the same outcome as the law algorithm for the Apriori community. Therefore we use the Apriori association law: algorithm to recommend the course to the student depending on the different choices taken by the student. The following figure will clarify such similarities between several algorithms with and without the Apriori algorithm.



4. Conclusions

The emphasis of this paper's analysis was used of fuzzy rule in these systems for E-learning and prior algorithms. Under the fuzzy model, we have chosen to research these structures as it is considered one of the principles that best reflect some element of human comprehension and purpose. Considering the context in which we function and the origins of the data, The justification that better addresses the personal way of thinking is supposed to be only one offers the best description of the topic at hand. We can find various methods under the paradigm of fuzzy logic, and all of them have been used in different parts of eLearning systems which promise good results. Observations are difficult to evaluate in the scope where we operate; there are no statistics or objective data. This also helps the e-learning data manipulation mechanisms work with qualitative performance. The parameters that define the attributes of a pupil can only be grouped into precisely one category in a traditional approach for classroom systems. Therefore a student will interpret actions in various forms, something that can be solved by muddled reasoning. That is why this logic suits so well with this kind of method, as it offers teachers and students the ability to reflect what they have historically worked with computational terms. The similarities between e-learning programs and the related Fuzzy framework can be explained.

Law of Association, Predictive Apriori Law of Association, Tertius Rule of Association & Filtered Associates. We need the algorithm as we propose the course, where the association rules consist only of "yes". So we compare these results using these four association rule algorithms & find that the Apriori Association Rule algorithm performs better than other association rule algorithms as it gives the association rule containing "yes" only.

Table (2): Evaluation of E-learning applications comparison using the related Fuzzy and Apriori method

Researchers	year	Methods	Dataset	Accuracy
Ouafae and et al.[48]	2018	To perform our approach they use Felder-Silverman Model as LSM and Fuzzy C-Means (FCM) as a clustering algorithm	The learners' behavior data was collected from the E-learning platform of Sup' Management Group. A total of 126 students participated to this study we collected 1235 sequences from the E-learning platform, which represent the learners' behavior. The number of sequences varied from 1 to 35 sequences per students.	Accuracy of FCM algorithm is 96.89% for 200 iteration
Magdalena and et al.,[49]	2019	they implemented the Hadoop MapReduce Apriori algorithm to obtain association rules for student events in the Sakai LMS	they studied and analyzed a database containing 70 GB of UCAM student behavior information, including all available degree and master data	----
Antonio and et al., [50]	2020	They using decision trees and n fuzzy inference systems	an ex-post-facto research methodology was applied to 1084 university students,	In this study Standard error 0.011 and estimation was 0.149 , the accuracy compute by (1-Standard error) was 98.9
Mohammed Megahed and Ammar Mohammed, [51],	2020	convolutional neural network (CNN) and a fuzzy system	The corpora of 12 learners contain 72 learning activities and 1735 data points of distinct emotional states	Accuracy of CNN was 67.15%

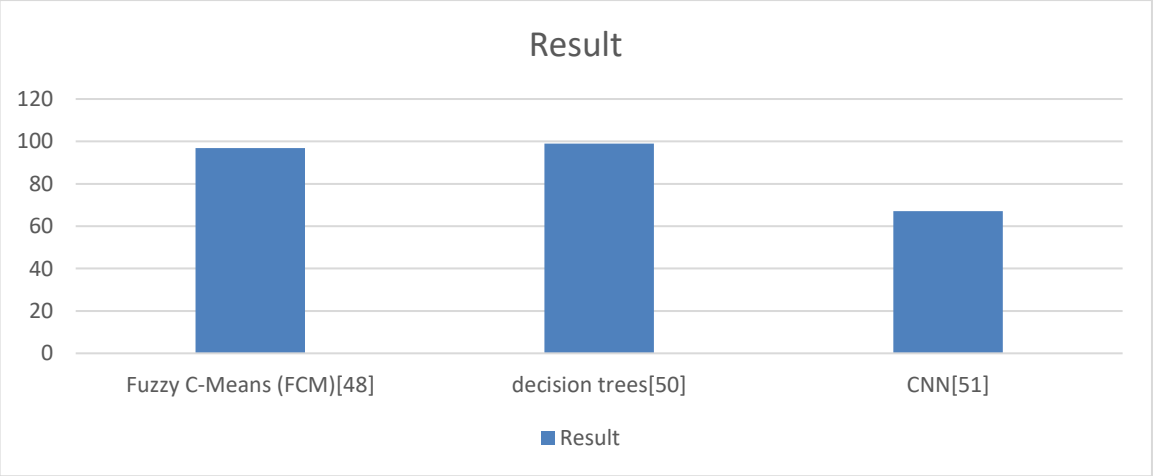


Figure (5): the result of accuracy

References

A. G.J. Hwang, C.L. Hsiao, C.R. Tseng, "A Computer Assisted Approach to Diagnosing Student Learning Journal of Applied Computer Science & Mathematics", Issue 2/2016, vol.10, No.22, Suceava 31 Problems in Science Courses, Journal of Information Science and Engineering 19, 2003, pp. 229-248.

B. .H. Witten, M. Frank, M.A. Hall, Data Mining, "Practical Machine Learning Tool and Technique with Java Implementation", Morgan Kaufmann, San Francisco, USA, 3rd edition, 2011.

C. Baker, R. S. J. D., and K. Yacef. ,"The State of Educational Data Mining in 2009: A Review and Future Visions",Journal of Educational Data Mining 1 (1):2016.

D. Siemens, G., and R. S. J. d. Baker, "Learning Analytics and Educational Data Mining: Towards Communication and Collaboration", In Proceedings of LAK12: 2nd International Conference on Learning Analytics & Knowledge, York, NY: Association for Computing Machinery,2012, 252–254.

E. Baker, R. S. J. d,"Data Mining for Education", In International Encyclopedia of Education, 3rd ed., edited by B. McGaw, P. Peterson, and E. Baker. Oxford, UK: Elsevier,2012.

F. Romero, C. R., and S. Ventura,"Educational Data Mining: A Review of the State of the Art", IEEE Transactions on Systems, Man and Cybernetics, Part C: Applications and Reviews 40 (6):2011, 601–618.

G. Colchester K, Hagras H, Alghazzawi D, Aldabbagh G."A survey of artificial intelligence techniques employed for adaptive educational systems within E-learning platforms", Journal of Artificial Intelligence and Soft Computing Research. 2017 Jan 1;7(1):47-64.

H. Zadeh, L. A.," Fuzzy algorithms. Information and control", 12(2),1986, 94-102.

I. Roshandeh, A. M., Puan, O. C., & Joshani, M.," Data analysis application for variable message signs using fuzzy logic in Kuala Lumpur", International Journal of Systems Applications, Engineering & Development,3(1),2015, 18-27.

J. Van Leekwijck, W.; Kerre, E. E. ," "Defuzzification: criteria and classification" ,Fuzzy Sets and Systems 108 (2):1996, 159–178.

K. M. Sugeno and T. Yasukawa, "A fuzzy logic based approach to qualitative modeling",IEEE Transactions on Fuzzy Systems,1993, no. 1, 7–31.

L. Xiaowei, S. ,"An Intelligent Recommendation System Based on Fuzzy Logic". In Informatics in Control, Automation and Robotics I (pp. 105-109). Springer Netherlands,2015.

M. Yager, R. R.," Fuzzy logic methods in recommender systems", Fuzzy Sets and Systems, 136(2), 133-149,2003

N. Calegari, S., and Ciucci, D." Fuzzy ontology, fuzzy description logics and fuzzy-owl". In Applications of fuzzy sets theory (pp. 118-126). Springer Berlin Heidelberg.2006.

O. Duda, R.O., Hart, P.E. and Stork, D.G."Pattern Classification", Jhon Willey and Sons, New York (2001)

P. Bezdek, J.C."Pattern Recognition with Fuzzy Objective Function Algorithms", Kluwer, Plenum Press, New York ,1981.

Q. Zimmermann, H.J."Fuzzy Set Theory and its Applications", Kluwer Academic Publishers, Norwell ,1991.

R. Hawkes, L. W., Derry, S. J., & Rundensteiner, E. A. " Individualized tutoring using an intelligent fuzzy temporal relational database". International Journal of Man–Machines Studies, 33, 409–429,1999.

S. Hawkes, L. W., & Derry, S. J." Advances in local student modeling using informal fuzzy reasoning". International Journal of Human–Computer Studies, 45, 697–722.2003.

T. Katz, S., Lesgold, A., Eggan, G., & Gordin, M." Modeling the student in Sherlock II". In Student Modelling: The Key to Individualized Knowledge-Based Instruction (pp. 99- 125). Springer Berlin Heidelberg,2013.

U. Beck, J., Stern, M., & Woolf, B. P,"Using the student model to control problem difficulty". In User Modeling (pp. 277-288). Springer Vienna.1997.

V. Warendorf, K., & Tsao, S. J." Application of fuzzy logic techniques in the BSS1 tutoring system". Journal of Artificial Intelligence in Education, 8, 113-146,2006.

W. Herzog, C, "Fuzzy techniques for understanding student solutions in intelligent tutoring systems", Papers for the Seventh Meeting of GI Section 1.1.5/7.0.1, Intelligent Tutoring Systems, Research Institute for Application-Oriented Knowledge Processing (FAW), Germany.2000

X. Yu, P., Own, C., & Lin, L." On learning behavior analysis of web based interactive environment". In Proceedings of ICCEE, Oslo/Bergen, Norway. 2001

Y. Mihalis, P., & Maria, G. "An application of fuzzy logic to student modeling". In World Conference on Computers in Education VI (pp. 87-96). Springer US.1995.

Z. Rasmani, K. A., & Shen, Q." Data-driven fuzzy rule generation and its application for student academic performance evaluation". Applied Intelligence, 25, 305–319. 2006.

AA. Bai, S. M., & Chen, S. M." Automatically constructing concept maps based on fuzzy rules for adapting learning systems". Expert systems with Applications, 35(1), 41-49,2001.

BB. Bai, S. M., & Chen, S. M." Automatically constructing grade membership functions for students evaluation for fuzzy grading systems". In Proceedings of the 2006 world automation congress, Budapest, Hungary.2006

CC. Bai, S. M., & Chen, S. M. "A new method for students' learning achievement evaluation using fuzzy membership functions". In Proceedings of the 11th conference of artificial intelligence and applications, Kaohsiung, Taiwan, Republic of China (pp. 177–184). (2006b).

DD. Bai, S. M., & Chen, S. M. "Evaluating students' learning achievement using fuzzy membership functions and fuzzy rules". Expert Systems with Applications, 34, 339–410. (2007a).

EE. Bai, S. M., & Chen, S. M. "A new approach for constructing concept maps based on fuzzy rules". In Proceedings of the 20th international conference on industrial, engineering and other applications of applied intelligent systems, Kyoto, Japan (pp. 155–165). (2007b).

FF. Sue, P. C., Weng, J. F., Su, J. M., & Tseng, S. SA," new approach for constructing the concept map". In Proceedings of the 2004 IEEE international conference on advanced learning technologies (pp. 76–80). . (2004).

GG. Tseng, S. S., Sue, P. C., Su, J. M., Weng, J. F., & Tsai, W. N. "A new approach for constructing the concept map". Computers & Education, 49(3), 691-707. (2007).

HH. de Arriaga, F., El Alami, M., Arriaga, A." Evaluation of Fuzzy Intelligent Learning Systems". In: Mendez-Vilas, A., GonzalezPereira, B., Mesa Gonzalez, J., Mesa Gonzalez, J.A. (eds.) Recent Research Developments in Learning Technologies, FORMATEX, Badajoz, Spain (2005)

II. Lascio, D., Gisolfi, A., Loia, V."Uncertainty processing in user modeling activity". Information Sciences 106, 25–47 (1998)

JJ. Xu, D., Wang, H., & Su, K. "Intelligent student profiling with fuzzy models". In System Sciences,HICSS. Proceedings of the 35th Annual Hawaii International Conference on (pp. 8-pp). IEEE. (2002, January).

KK. Fazlollahtabar, H., & Mahdavi, I. "User/tutor optimal learning path in e-learning using comprehensive neuro-fuzzy approach". Educational Research Review, 4(2), 142-155. (2009).

LL. Myszkorowski, K., & Zakrzewska, D. "Using fuzzy logic for recommending groups in e-learning systems". In Computational Collective Intelligence. Technologies and Applications (pp. 671-680). Springer Berlin Heidelberg. (2013).

MM. Lau, R., Song, D., Li, Y., Cheung, T., Hao, J."Towards A Fuzzy Domain Ontology Extraction". IEEE Transactions on Knowledge and Data Engineering 21(6), 800–813 (2009)

NN. Hogo, M. A. "Evaluation of e-learners behaviour using different fuzzy clustering models: a comparative study". arXiv preprint arXiv:1003.1499. (2010).

OO. Agrawal, R and Srikant. "Fast Algorithm for Mining Association Rule." Proc. of the 20th Int'l Conference on Very Large Databases, Santiago, Chile, Sept. 1994

PP. Mazid, M.M. Shawkat Ali, A.B.M. Tickle, K.S. "Finding a unique Association Rule Mining algorithm based on data characteristics", Electrical and Computer Engineering, 2008. ICECE 2008. International Conference Issue Date: 20-22 Dec. 2008 On page(s): 902 - 908 Location: Dhaka E-ISBN: 978-1-4244-2015-5 Print ISBN: 978-1-4244-2014-8

QQ. Castro, F., Vellido, A., Nebot, A., & Mugica, F. "Applying data mining techniques to e-learning problems: A survey and state of the art ". In L. C. Jain, R. Tedman, & D. Tedman (Eds.), Evolution of Teaching and learning paradigms in intelligent environment. Studies in Computational Intelligence (Vol. 62). Springer-Verlag.2006

RR. Sunita B Aher and Lobo L.M.R.J., "Data Mining in Educational System using WEKA". IJCA Proceedings on International Conference on Emerging Technology Trends (ICETT) (3):20-25. Published by Foundation of Computer Science, New York, USA (ISBN: 978-93-80864-71-13), 2011

SS. http://www.cs.sunysb.edu/~cse634/lecture_notes/ 07apriori.pdf accessed on date 02-02-2012

TT. Margaret H. Dunham, "Data Mining Introductory and Advanced Topics",springer, 2003

UU. Aman Kumar Sharma, Suruchi Sahni:" A Comparative Study of Classification Algorithms for Spam Email Data Analysis" in International Journal of computer science & Engineering ISSN: 0975-3397 Vol. 3 No. 5 May 2011.

VV. Ouafae El Aissaoui1 , Yasser El Alami El Madani, Lahcen Oughdir and Youssouf El Allioui, "A fuzzy classification approach for learning style prediction based on web mining technique in e-learning environments", Springer, Education and Information Technologies,2018.

WW. Magdalena Cantabella, Raquel Martínez-España, Belén López Ayuso, Juan Antonio Yáñez and Andrés Muñoz " Analysis of student behavior in learning management systems through a Big Data framework" , ELSEVIER, Future Generation Computer Systems Volume 90, January 2019, Pages 262-272.

XX. Antonio Cervero1, Adria´n Castro-LopezID2, Lucı´a A´ lvarez-Blanco, Marı´a Esteban1, Ana Bernardo "Evaluation of educational quality performance on virtual campuses using fuzzy inference systems" PLOS ONE, 2020.

YY. Mohammed Megahed and Ammar Mohammed, "Modeling adaptive E-Learning environment using facial expressions and fuzzy logic", ELSEVIER, International Journal in Expert Systems with Applications Volume 157, 1 November 2020, 113460