SQL Processor based on Intelligence Technique:Fuzzy Petri Net Database Applications

Nawroz Fadhil Ahmed[(1)],Shokhan Ali Omar[(2)],Rizhin Nuree Othman[(3)],Zana Azeez Kakarash[(4)]

[(1,4)]Department of Information Technology, Kurdistan Technical Institute, Sulaymaniyah, KRG, Iraq
[(2)]Directorate of Information Technology and Statistics, University of Sulaimany, KRG, Iraq
[(3)]College of Computer Science and Engineering, Lebanese French University, Erbil, KRG, Iraq

Abstract
Fuzzy concepts with databases have been proposed by numerous scientists for taking care of fuzziness in databases. Fuzzy Petri net (FPN) expressions are utilized rather than the brittle value of them. However, they discover implementations in areas where correct or exact value can't generally be acquired. In this paper, to represent the data, we need to specify the field, column, and table for every fuzzy data are used. Data representation and retrieval in a fuzzy database (F-DB) with the intelligent technique was invented for the SQL processor of a fuzzy database. The benefits of using the object-oriented databases as the basis in the fuzzy databases are very significant with SQL schema and using FPN, become an active model tool in the database process. Also, we investigate the properties of their process by using the FPNs. In our paper outlines the designation of an F-DB language is called Fuzzy SQL (F-SQL) with FPN, which is used to execute the F-SQL processor. The conventional methods based on SQL processor is a significant challenge of modeling SQL processor of a fuzzy database which requires a data that is not easy to accurately gain using either conventional queries, which typically produce noisy or semi-quantitative data. Many studies have been done in the F-DB in this area, and many valuable approaches have been made. However, the main point is formally recognized as a critique of an F-DB system's design using the following concept of fuzzy model, must be easy to apply F-DB applications.
Keywords: Fuzzy Petri net, Fuzzy DB, SQL processor, fuzzy reasoning, database applications.

1. Introduction

FPN model is a dynamics and graphical modeling tool to process fuzzy systems problems of expert mechanism [1, 2, 3, 4, 5,15]. A new method has been proposed to deal with incomplete information to expand the apple of conventional databases in our work. This research area is crucial with the fuzzy database, which results from combining the database concept with fuzzy theory. However, a relation could be defined as a fuzzy value of crisp tuples, with this relation, the attribute (fields) values in record stay crisp; still, the record is assigned a membership degree (M.D.), in the range of [0, 1] to point the relevancy of the record concerning to the table relation [6,7,18]. In this case, a fuzzy form may have insufficient data (attribute) values, appeared by potential distributions, and with membership degree (M.D.), there is no membership associated with the record [8, 9]. The Petri net model is the most accurate when giving the SQL processor's dynamic detail of a fuzzy database. When dealing with the SQL processor of fuzzy database data, the problem is even more complicated because no expert exists to decide the crisp value of the fuzzy database and noise in the fuzzy database values. Therefore, we are looking for a unifying modeling approach supporting diverse models for different aspects of the SQL processor of a fuzzy database. They used to be for the fuzzy knowledge representing and reasoning [10, 11, 16].

The goal for developing the fuzzy Petri net model is to effectively manage vague or corrupted input values and natural linguistic structure. The investigation of a more complex SQL processor of fuzzy database data gives us the motivation to use the FPN to solve more complex problems [13]. To make our research aim, developing a complete framework for determining SQL processors of fuzzy database data, we need to define the characteristics of the fuzzy database's SQL processors. This paper aims to present a new approach based on the fuzzy techniques to model the SQL processors. There are many challenges in developing a model for SQL processors of fuzzy database data. Firstly, one challenge is used to choose the good or right modeling method that can explain the details of the fuzzy database. So it is imperative to become a balance between the computational complication and model precisely to describe different model concepts. The second challenge can be able to compose the different models for other components of SQL processors by integrated system models, where the central problem is to understand the functioning of a complex SQL processor and the roles of various aspects in a fuzzy database [13, 17, 19]. This problem has been the driving force behind the work presented in this paper. The field of FPN has a significant effect on understanding how the fuzzy database work, given at the same time away to describing, manipulate, and finally analyses them.

Figure1 indicates that reasoning algorithms using FPN enable full advantages for the P.N. model, such as graphical description, parallel operations by algebraic theory, and extensive capabilities offered by ANN and other HLPNs.

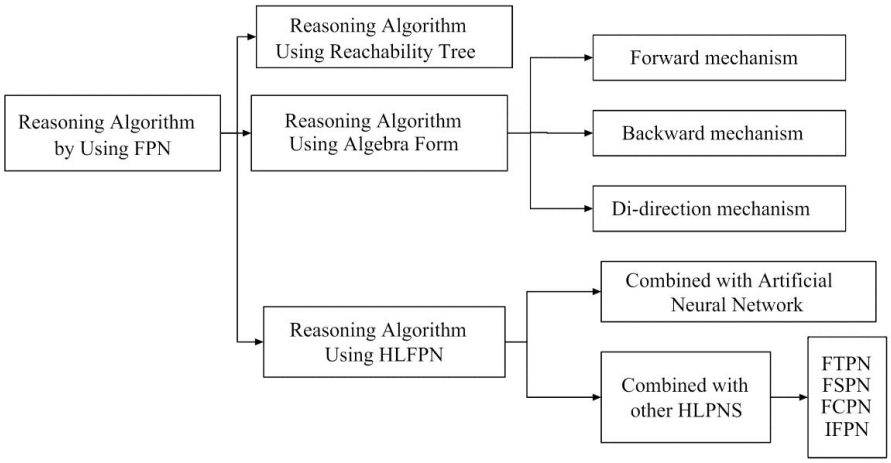

Figure1. Classification of existing reasoning algorithms

The structure of this paper is as shown below:
In Section 2, the fuzzy concepts of min and max are explained. In Section 3, the fuzzy relation database and linguistic variables of attributes and SELECT of linguistic variables are approached. Section 4, I described the details of the FPN model of the SQL processor system. Section 5 explained the experimental results and simulations. Finally, I gave the conclusions and recommendations of my model in the last Section (6).

2. Fuzzy Concept of Min and Max

Looney [1, 13] reviewed logics by method for changes of the certainty factor states by rule matrices and take on FPNs by different applications of Boolean matrices to test and simulate current situations. The Fuzzy logic concept of the network can be used to modulate PN. It allows rule-based inference decision systems to be given and show the results. The idea of fuzzy simulation embraces or adopted the "MIN" operation to handle the "AND" concept of the fuzzy model and the "Max" operation to take the ''OR" concept of the fuzzy model. In 1990 Shyi-Ming Chen et al. [2] showed a new knowledge mechanism using, an FPNs. An FPN model allows us to represent a structure of a knowledge and has got a systematicprocedure for providing a fuzzy system; reasoning process [3, 12,15]. Based on the FPN model, an efficient algorithm is offered to perform reasoning of fuzzy automatically.

Generally, an FPN framework is defined as follows [2].

The tuple FPN = (P, T, D, I, O, f, α, β) is known as a fuzzy Petri net if:

$$P = \{pl, p2 , ..., pn\} \quad (1)$$

It's a finite set of places, corresponding to the propositions of fuzzy production rules,

$$T = \{tl, t2 , ..., tm\} \quad (2)$$

It's a finite set of transitions, $P \cap T = \emptyset$, corresponding to the execution of fuzzy production rules,

$$D = \{d1, d2, ..., dn\} \quad (3)$$

It's a finite set of propositions of fuzzy production rules.

$$P \cap T \cap D = \emptyset, |P| = |D| \quad (4)$$

It's (i= 1,2,...,n) denotes the proposition that interprets fuzzy linguistic variables, such as:
"low" "medium", "high", as in our model,

$$I: P \times T \rightarrow [0, 1] \quad (5)$$

It's an n × m input matrix defining the directed arcs from propositions to rules.

$$I(pi, tj) = 1 \quad (6)$$

if there is a directed arc from pi to tj,

$$\text{and } I(pi, tj) = 0 \quad (7)$$

if there is no directed arcs from pi to tj for i=1,2,…,n, and j=1,2,…,m,

$$O: P \times T \rightarrow [0, 1] \quad (8)$$

is an n × m output matrix defining the directed arcs from rules to propositions.

$$O(pi, tj) = 1 \quad (9)$$

if there is a directed arc from tj to pi ,

$$\text{and } O(pi, tj) = 0 \quad (10)$$

if there is no directed arcs from tj to pi for i=1,2,…,n, and j=1,2,…,m,

f = {μ1, μ2,..., μm} where μi denotes the certainty factor (CF) of Ri, which indicates the reliability of the rule Ri , and μi ∈ [0,1],

α: is a truth degree vector. α = (α1,α2,…, αn)T, where αi ∈ [0,1] means the truth degree of pi, i=1,2,…,n. denotes the initial truth degree vector.

β : P → D is an association function, a bijective mapping from a set of places to a set of propositions.

Over and above, this model will be promoted or grow by including a new function Th :
T →[0, 1] which assigns a threshold value Th(tj) = λj ∈ [0, 1] to each transition tj, where j=1,…,m.

Furthermore, a transition Tn is qualified and could be enabled in the FPN model when the value of tokens in all the input places Pn of the rule or transition Tn are more significantthan its values assigned to each threshold. Carefully associating related PN place P and are assigning sensible values of CF to changes T, we can present with an FPN that can make decisions making based or depending on the scientists we will represent during its final results. Most of the ways of the actionare giving to modeling the steps of approximate thinking. The principal payment of these processes is in proper measures of the semantics of the implicit reasoning method.

3. Unsupervised Fuzzy Relational Database

In fig. 2, we will explain the concept of a membership function graph of fuzzy inputs, and outputs of attributes and SELECT of linguistic variables VF (very flat), F (flat), M (medium), S (sharp) and VS (very sharp). The fuzzy sets VF, F, M, S, and VS, contain as a full member of any values between [0, 1] to describe the select operation of SQL processor with any membership degree greater than this range we can use standardization process. However, there are several capable candidates available for the kind of MF, such as Trapezoidal, Triangular, or MF. In this research paper, a Gaussian membership function is used, and represented in the below figure.

The Gaussian MF is defined generally as.

$$\text{Gaussian } (x;c,\sigma) = e^{\frac{1}{2}\left(\frac{x-c}{\sigma}\right)^2} \quad (11)$$

Where c is a function center and σ represents the function width. A Gaussian function is a popular function considered among the most membership functions for many reasons.Moreover, the Gaussian function, has many advantages, but it's not applicable in matters that need to be Asymmetric Membership Functions which, are necessary for many applications. More specifically, the membership function Gaussian (x; c, σ) for the fuzzy set represents the FPN place's token is roughly valid.

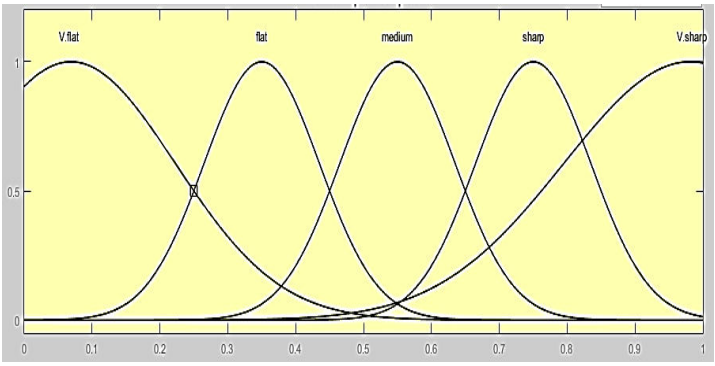

Figure 2: A Gaussian membership function graph of fuzzy inputs, and outputs of Attributes and SELECT

In the previous studies using FPNs do not activate the model tool in the database process. Also, they do not investigate the properties of their process by using the FPNs. The paper aims is to fill these gaps and propose a fuzzy Petri net model for SQL process and the behavior in an intelligent object-oriented database process that integrates SQL database, and database objects.

4. Experimental Fuzzy Model of SQL Processor

Depending on the F-DB's case, a question may be ambiguous or vague and the problem's data may be unknown well. In a case with the standard SQL question, the answers are a related or connected where each record completely accepts the query with the condition, the answers to an F-SQL question is a fuzzy concept where each record agrees with the question with needs to the scope as denoted by its membership function. In fact, the answers to questions are a fuzzy concept of a relationship that may primarilyaffect the questions processing in an F-DB. A traditional delineation of question processing optimization is to disband a complex of any query, such as that one, into sub-queries and store the answers to a subquery in a moderate relation for a subsequent estimate. For a reasonable, fuzzy concept of relations, the membership function of records must be preserving from one process step, to the next step as shown in Fig.3, fuzzy layer framework of the Gaussian membership of FPN.

To explain a simple example for a specific question, the MF grade of a tuple in the result indicates to what extent the record accepts the question with the condition [4, 12, 20]. Like standard SQL statement, queries in F-SQL are specifying in the SELECT view of the following such form:

SELECT "columnname1", "columnname2"

FROM "table_name"

WHERE "condition"

In case we want to calculate the value of the token after had been troughed to the result place depending on the indicated functions are specified by the rule transition. However, the below operations are performed by both of AND OR operations.

AND transition:

$$M'_{\Omega\alpha_i \in output\_place} = \underset{\alpha_j input\_place}{Min} M'_{\Omega\alpha_i} \tag{12}$$

OR transition:

$$M'_{\Omega\alpha_i \in output\_place} = \underset{\alpha_j input\_place}{Max} M'_{\Omega\alpha_i} \tag{13}$$

Where Ω denotes the state of a set of the places where the values have traveled, and the value in an area of the model pi, where pi ∈ P, is referred to by α(pi) ∈ [0, 1].

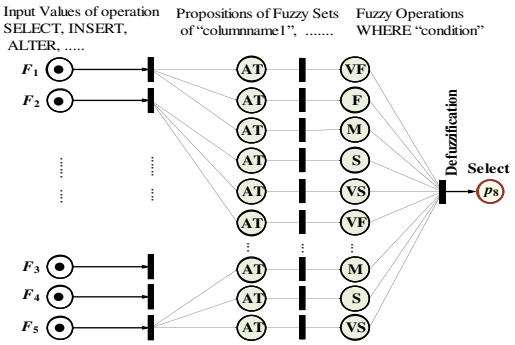

Figure 3: A fuzzy layer framework or structure of Gaussian membership of FPN for VF (very flat), F (flat), M (medium), S (sharp) and VS (very sharp)

To explain our method an all the fuzzy rules of FPN are presented Table 1. Table 1 shows the attribute-1, attribute-2 and Select for the 25 rules.

Table 1:SQL processor of a fuzzy database fuzzy if-then rules for fuzzy inference system

	Attribute 2				
Attribute 1	SELECT	VF	F	M	S	VS
	VF	F	VF	VF	VF	VF
	F	F	VF	VF	VF	VF
	M	VS	S	M	F	VF
	S	S	S	S	M	M
	VS	VS	VS	S	M	M

5. Experimental and Simulation Results

As we explained in the model Fig. 4, showing the logic process's fuzzy model is a part of the systems to define the value of SQL processor of a fuzzy database system fuzzy construct model system. Fuzzy MF of input variables attribute-1 = 0.9 and attribute-2 = 0.47 are explained in section 3. I input a brittle data (i.e. attribute-1 = 0.9 and attribute-2 = 0.47 into this corresponding membership functions, and got the membership grade for all inputs. To describe our method, the values of such input variables are given. For example, the values of our model will be normalized for every data, as shown below:

The attribute-1 = 0.9 and attribute-2 = 0.47.

The Fuzzy MF values could be used as the specific degree of such previous proposition rules in our fuzzy methods. For every input data, every activate direction's firing strength was computed or calculated by the operation MIN and MAX operators of the SQL processor of a fuzzy database system.

It yields SELECT:

Depending on each max operator's final result, as explained above the defuzzification operation of output is used to build an idea about the final results. We take on the traditional method is to solve the problem. Then, the process of defuzzification of SELECT is computed as SELECT = 0.772, by the mid-point of the aggregate output MF in each FPNs model. Depending on the different steps of the thinking process for SQL processor of a fuzzy database system, the final winning rule is winning.

The Gaussian membership function graph FPN method of the tools of MATLAB tool is also used to compare or show the inference or deduction results with the current condition. The fuzzy rules of the FPN model are aggregated to has the brittle value of SELECT= 0.772. The predicted values for the SQL processor of a fuzzy database system of the outputs SELECT are shown in Fig. 4. The x-axis represents the values of different values for attribute-1, and attribute-2 and the y-axis represents the different values of SELECT works. The results proved both of the accuracy and more accepting of our model in successfully treating the interactions between the attribute-1 and attribute-2 considered using the fuzzy model with a new algorithm, the small set of samples in the data.

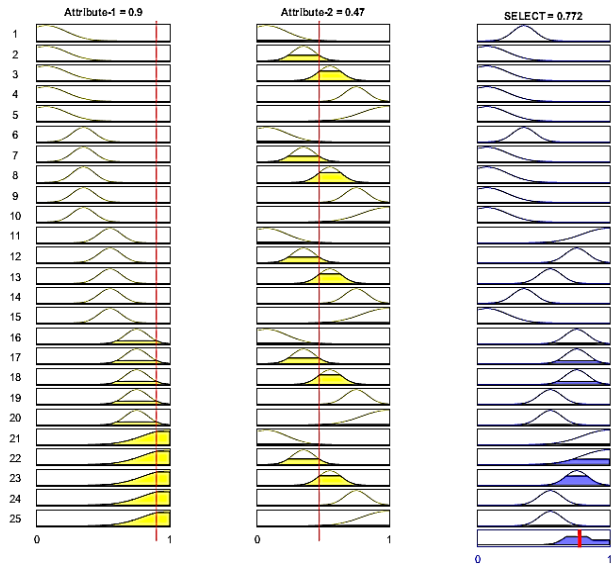

Figure 4: Final result of SELECT query with attribute-1 = 0.9 and attribute-2 = 0.47

To show the fuzzy inference model that has been constructed to understand the SQL processor of a fuzzy database system dynamics of the relationship being modeled with the values of information attribute-1 = 0.9 and attribute-2 = 0.47. We can process the response of the FPN model for the entire range of inputs that the model in Fig. 3 is configured to work for this purpose of the SQL processor of a fuzzy database. After that, the output or the FPN model's response to the information is plotted against the inputs shown in Fig. 5. In Figure 4, the surface rules show the output model for two inputs attribute-1 and attribute-2 of SQL processor, of a fuzzy database. As we can see, the number of auto trips an increase with increase in two inputs attribute-1 and attribute-2 of SQL processors of a fuzzy database, which sounds very rational.

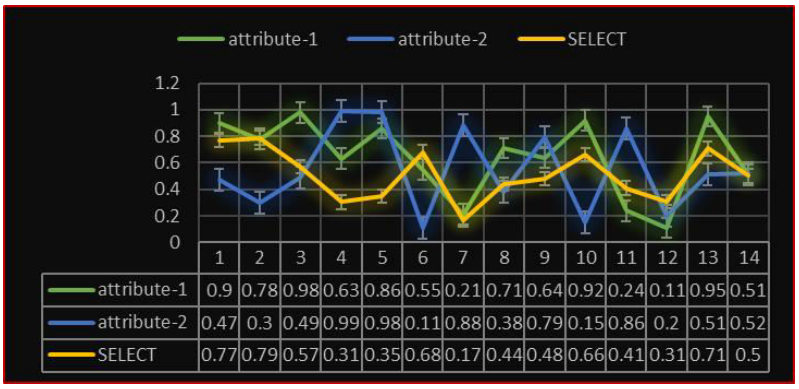

Figure 5: Plotted against the different inputs of attribute-1 and attribute-2

Table 2, shows the results of inferred by using the FPN model Gaussian membership function graph. The calculations time was comparatively short. Hence this method can handle the SQL processor of a fuzzy database datasets at a lower calculation time.

Table 2: The results inferred from the FPN model of a Gaussian membership function graph

Crisp Value		Results
attribute-1	attribute-2	SELECT
0.9	0.47	0.77
0.78	0.30	0.788
0.98	0.49	0.57
0.63	0.99	0.305
0.86	0.98	0.35
0.55	0.11	0.68
0.21	0.88	0.166
0.71	0.38	0.44
0.64	0.79	0.48
0.92	0.15	0.66
0.24	0.86	0.41
0.11	0.20	0.307
0.95	0.51	0.708
0.51	0.52	0.502

6. Conclusions

In this paper concept of FPN terms is presented. FPN concepts, and a fuzzy concept are familiarized to valid the state of each table. The paper introduces a fuzzy concept, for fuzzy rule-based reasoning for a Fuzzy SQL query. A set of rules are used to construct the rules for the SQL processor. The conventional methods based on SQL processor is a significant challenge of modeling SQL processor of a fuzzy database which requires a data that is not easy to accurately gain using either conventional queries, which typically produce noisy or semi-quantitative data. Data representation and retrieval in a fuzzy database (F-DB) with the intelligent technique was invented for SQL processor of a fuzzy database. The benefits of using the object-oriented database as the basic in the fuzzy database are significant with the SQL schema. The ability to interpret numeric data into linguistic constructs is a motivation for using fuzzy models, which can be easily changed into testable hypotheses. The FPN model can be represented as a new modeling technique tool in the SQL processors of a fuzzy database. It is also essential to state that the quality values given by the FPN model to determine the SQL processor of a fuzzy database are much more missionary and informatively. In the previous studies using FPNs do not the active model tool in the database process. Also, they do not investigate the properties of their process by using the FPNs. This paper aim is to fill these gaps and propose a fuzzy Petri net model to SQL process and the behavior in an intelligent object-oriented database process which that integrates SQL database, and database objects. In this paper, a similar precision performance of tools can be reached

as the fuzzy model is quite suitable. Obtaining results by comparing the FPN and fuzzy logic we achieved results by using MATLAB Toolbox, which we have the same reasoning results.

References

[1] C.G. Looney. Fuzzy Petri nets for rule-based decision making. IEEE Transactions on System, Man and Cybernetics, Vol. 18(1), pp. 178-183, 1988.

[2] S.M. Chen, J.S. Ke, and J.F. Chang. Knowledge representation using fuzzy Petri nets. IEEE Transactions on Knowledge Data Engineering, Mar., Vol. 2(3), pp. 311– 319, 1990.

[3] B. Fryc, K. Pancerz, J.F. Peters, and Z. Suraj. On fuzzy reasoning using matrix representation of extended fuzzy Petri nets. Fundamenta Informaticae, IOS Press, Amsterdam, Vol. 60 (1-4), pp. 143-157, 2004.

[4] T. Akutsu, S. Miyano, and S. Kuhara. Algorithms for inferring qualitative models of biological networks. In Pacific Symposium on Biocomputing, Vol. 5, pp. 293-304, 2000.

[5] T. Akutsu, S. Miyano, and S. Kuhara. Inferring qualitative relations in genetic networks and metabolic pathways. Bioinformatics, 16(8), pp. 727-734, 2000.

[6] P. Bosc and O. Pivert, SQLf: A Relational Database Language for Fuzzy Querying, IEEE Trans. on Fuzzy Systems, 3(1), 1995.

[7] J. Galindo, et al, Fuzzy Database Modeling, Design and Implementation, Idea Group Publishing, 2006

[8] J. Kacpryzyk and S. Zadrozny. Fuzzy Queries in Microsoft AccessTM v.2, Proceedings of Fuzzy IEEE'95 Workshop on Fuzzy Database Systems and Information Retrieval, 61-66, 1995.

[9] G. Loo and K. Lee, An Interface to Databases for Flexible Query Answering: A Fuzzy-Set Approach. Lecture Notes in Computer Science, 1873. 2000.

[10] Z.M. Ma and L. Yan, Generalization of Strategies for Fuzzy Query Translation in Classical Relational Databases. Information and Software Technology, 49(2), Feb 2007.

[11] G. Bordogna and G. Psaila. Customizable Flexible Querying for Classical Relational Databases. In Galindo, J. (Ed.), Handbook of Research on Fuzzy Information Processing in Databases, Vol. I, pp. 191-217, Hershey, PA, USA: Information Science Reference, 2008.

[12] T. Imielinski and W. Lipski Jr., Incomplete Information in Relational Databases, Journal. ACM, vol. 31, 1984.

[13] P.F. Fisher, First Experiments in Viewshed Uncertainty-Simulating Fuzzy Viewsheds, Photogrammetric Eng. And Remote Sensing, vol. 58, no. 3, pp. 345-352, Mar. 1992.

[14] Hamed, Raed Ibraheem, and Zana Azeez Kakara. "Evaluate The Asphalt Pavement Performance Of Rut Depth Based On Intelligent Method." International Journal of Engineering and Computer Science 5.1 (2016)

[15] Zhou, K. Q., & Zain, A. M. (2016). Fuzzy Petri nets and industrial applications: a review. Artificial Intelligence Review, 45(4), 405-446.

[16] Kučera, E., Haffner, O., Drahoš, P., Leskovský, R., & Cigánek, J. (2020). PetriNet Editor PetriNet Engine: New Software Tool For Modelling and Control of Discrete Event Systems Using Petri Nets and Code Generation+. Applied Sciences, 10(21), 7662.

[17] Zhou, J. (2020). A fuzzy Petri-net approach for fault analysis considering factor influences. IEEE Access, 8, 72229-72238.

[18] Hamed, R. I., & Kakarash, Z. A. (2016). Evaluate the asphalt pavement performance of rut depth based on intelligent method. International Journal of Engineering and Computer Science, 5(1), 15474-15481.

[19] AHMED, O. H., KAKARASH, Z. A., & AHMED, A. (2017). THE DIMENSIONS OF PETRI NETS: MODELLING STRATEGIES FOR BIOLOGICAL ASPECTS APPLICATION TO E. COLI. Journal of Theoretical & Applied Information Technology, 95(19).

[20] Pourbahrami, S., Balafar, M. A., Khanli, L. M., & Kakarash, Z. A. (2020). A survey of neighborhood construction algorithms for clustering and classifying data points. Computer Science Review, 38, 100315.