RECENT TRENDS IN PROPERTIES AND APPLICATIONS OFFUZZY GRAPH

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ABSTRACT

In this proposed paper, we have studied the composition and joining procedures on fuzzy graphs that are most frequently used. Numerous studies have been conducted on this subject since the beginning and development of fuzzy set theory, and one outcome is the fuzzy graph. In this new field of study known as "Fuzzy Graph Theory," we investigated the concept of several operations, such as null anti-fuzzy graphs and the relationship between full anti-fuzzy graphs and strong anti-fuzzy graphs. There is a study of the various fuzzy relation types. On a fuzzy graph, operations like the Cartesian product, union, and join are examined. A fuzzy graph's attributes are looked at, including its complement, its full and partial sub graphs, the degrees and total degrees of its vertices, its full and partial regularity, its completeness, and its status as a tree.

KEYWORDS: Regular, Irregular fuzzy graphs, Antipodal, Bipolar, Complementary

INTRODUCTION

Zadeh first put out fuzzy sets as a means to categorise and manage data and information with non-statistical ambiguity in 1965. The main goal of it was to provide a well-organized framework for handling the inherent ambiguity and uncertainty in many topics. Rosenfeld, however, is credited with developing the concept of fuzzy graphs in 1975 by taking into account fuzzy relations on fuzzy sets. Rosenfeld has gained the fuzzy counterparts of many important concepts in graph theory, including bridges, routes, cycles, trees, and connectedness. He has also developed some of their characteristics. A graph G is produced through several operations on and $V_1 \times V_2$ where V_1, V_2, is the point set of

Examples include the composition, tensor product, and cartesian product. Harary and Wilcox develop other procedures of this kind and investigate some of their invariant traits. Only a few of the (crisp) graph operations have been extended to fuzzy graphs, including combination, disjunction, rejection, and symmetric difference. A method is presented for finding the appropriate fuzzy graphs using the adjacency matrices of G_1 and G_2. Bhutani was the first to describe weak isomorphism and isomorphism between fuzzy graphs. Vertex sizes, degrees, and orders could vary in isomorphic fuzzy networks, according to both Nagoorgani and Malarvizhi. The extremely irregular fuzzy graphs that Nagoorgani and Latha described were compared to the neighboring irregular fuzzy graphs. The features of fuzzy graphs and $G_1:(1,1)$ and $G_2:(2,2)$ those of some operations, including the Cartesian product, the symmetric difference, the complement conjunction, the disjunction, and the rejection, are discussed.

Although numerous key open problems in combinatorics were resolved by Professors R.C. Bose, S.S. Shrikhande, and Menon in the early 1940s, the study of graph theory did not take off in India until the 1960s. Around 1970, graph theory was the subject of active research groups at the Indian Statistical Institute (I.S. I.) in Calcutta, the Indian Institute of Technology (IIT) in Madras (Dr. K.R.

Parthasarathy and others), Bombay University (Dr. Vansanthi N. BhatNayak and others), and Sourashtra University. (Dr. E. Sampath Kumar et al.) Dr. E. Sampathkumar and his students at Karnataka University in Dharward started producing ground-breaking graph theory research in the early 1970s.

Graph theory is used in many areas of system analysis, operations research, and economics, and its ideas are both practical and fascinating. Fuzzy logic can be used to solve problems involving unclear graph members. In his groundbreaking 1965 essay "Fuzzy sets,"Zadeh introduced the concept of a fuzzy relation, which has subsequently found extensive use in the discipline of pattern recognition. Rosenfeld introduced the idea of a fuzzy graph and some fuzzy versions of graph theory concepts in 1975.

LITERATURE REVIEW

Madhumangal, Pal, et al (2020) This book gives a complete set of methods for solving real-world problems with fuzzy mathematics and graph theory. This book covers topics like planarity in fuzzy graphs, fuzzy competition graphs, fuzzy threshold graphs, fuzzy tolerance graphs, fuzzy trees, colouring in fuzzy graphs, bipolar fuzzy graphs, intuitionistic fuzzy graphs, and m-polar fuzzies, striking a nice balance between basic information and cutting-edge research in the field of fuzzy graph theory. Each chapter includes numerous, excellent examples of how to apply the idea. For advanced undergraduate and graduate computer science, engineering, and mathematics students as well as researchers interested in recent advances in fuzzy logic and applied mathematics, this book is ideal. It is also a complete and motivating read onthe theory and modern applications of fuzzy graphs.

Rabiul Islam, Sk, et al (2022) Since the middle of the nineteenth century, India's railway network has been essential for the transportation of goods and people. In the two years between 2019 and 2020, this network carried an average of 3.32 million metric tonnes of goods and 22.15 million people daily. The national rail network comprised 126,366 kilometres of track spread throughout its 7,325 stations and 67,368 kilometres of overall length. Ahead of China, Russia, and the United States, it has the fourth-largest national railway network in the world. However, as a result of the passage, they pose a hazard to the general population while travelling because the number of crimes is increasing fourfold. Understandably, daily commuters are concerned about the ongoing criminal activity on the rails.

In an analysis of railway crimes in India, this study contrasts the F-index for fuzzy graphs with three other topological indices. For fuzzy graphs, both the F-index and the first Zagreb index are useful for identifying criminal activities, but the F-index provides more accurate findings. This index is also used to study a number of fuzzy graph operations, such as the Cartesian product, composition, union, and join. A fuzzy graph's transformation creates a number of fascinating interactions with the F-index. These transformations demonstrate that the n-vertex star has the highest F-index among all n-vertex trees. Additionally, the maximum n-vertex unicyclic fuzzy graph with a r cycle is established in relation to the F-index.

Anwar, Abida, et al (2021)A complicated intuitionistic fuzzy set can be used to model circumstances with intuitionistic uncertainty and periodicity (CIFS). A diagram composed of nodes connected by lines and labelled with specific information can be used to illustrate a wide variety of real-world and physical events. We also look into the effects of modularly multiplying two complex intuitionistic fuzzy graphs on a vertex's degree.

H. YI. AND X. LI (2017) Since graphs and matroids have a close link, matroids are a crucial combinatorial structure. Matroid and graph generalisations were included in fuzzy settings. Here, we study the connections between fuzzy matroids and fuzzy graphs. In order to create a series of matroids, we must first deduce a collection of crisp graphs, or "cuts," from a given fuzzy graph. We can construct a fuzzy matroid known as the graph fuzzy matroid using this set of matroids. Graphic fuzzy matroids are described similarly, and their capabilities as fuzzy bases and fuzzy circuits are examined.

Zuo, Cen, et al (2019) The image fuzzy set can be a useful mathematical model for dealing with ambiguous real-world problems where a more intuitionistic fuzzy set might not produce the desired results. The image fuzzy set stretches the boundaries of the classical fuzzy set and the intuitionistic fuzzy set. These kind of responses (yes/no/abstain/refuse) can be quite helpful in circumstances where it's not clear what to do. In this research, we introduce the idea of the picture fuzzy graph based on the picture fuzzy relation. In addition to the more prevalent "regular" variety, we also introduce and characterise the "strong,""complete," and "complement" varieties of picture fuzzy graphs.We also introduce the idea of an isomorphic picture fuzzy graph in this study. We also describe six operations, namely the Cartesian product, composition, join, direct product, lexicographic product, and strong product, on the picture fuzzy graph. The advantages of the photo fuzzy graph and its use in an online community are discussed in detail as we come to a conclusion.

PROPERTIES OF FUZZY GRAPHS

Fuzzy graphs may be operated on in a number of different ways. In this paper, we attempt to characterize a specific fuzzy subgraph of a graph. (xV, xX)through a Graph's Fuzzy Subgraph Partitioning Technique (V, X) where X are edges. If we have $G = (V, X)$.A graph representation of the partial fuzzy subgraph of G is the ordered pair $(\mu, \rho)$where $\mu$is a fuzzy subset of V and ρ is a fuzzy relation on V that is symmetric. Without loss of generality, we may have considered evaluating as the fuzzy subset of X as well, (μ, ρ) can be considered as a fuzzy subgraph of G.

To begin with, we will presume (μ_i, ρ_i)corresponds to a subgraph of the fuzzy graph $G_i = (V_i, X_i)$where $0 \cdot i \leq 2$.

Cartesian product, union, and join are all defined on. $(\mu_1, \rho_1)$and (μ_2, ρ_2). The line segment connecting two fixed points is called an edge u and v as (uv)due to the fact that an ordered pair is always the vertex of the graph resulting from a Cartesian product $i = 1,2$ if graph G is obtained from G_1 and G_2 For every arbitrary partial fuzzy subgraph of a graph, we derive the required and sufficient criteria using any of the join and union operations. G to be derived from subgraphs of a fuzzy graph G_1 and G_2 using the exact same methods.

Cartesian Product of Fuzzy Graphs

Here is a Cartesian product to think about.

$G = G_1 X G_2 = (V, X)$of graphs $G_1 = (V_1, X_1)$ and $G_2 = (V_2, X_2)$

Then $V = V_1 \times V_2$ and

$$X = \{(u, u_2)(u, v_2) / u \in V_1, u_2 v_2 \in X_2\} \cup \{(u_1, w)(v_1, w) / w \in V_2, u_1 v_1 \in X_1\}$$

μ_i is the fuzzy subset of V_i and ρ_i is also a fuzzy subset of X_i, where $0 \cdot i \leq 2$

The fuzzy subsets in $\mu_1 \times \mu_2$ of V and $\rho_1\ \rho_2$ of X are thus defined:

$$\forall (u_1, u_2) \in V, (\mu_1 \times \mu_2)((u_1, u_2)) = \mu_1(u_1) \wedge \mu_2(u_2)$$

$$\forall u \in V_1, \forall u_2 v_2 \in X_2,\ \rho_1\ \rho_2\ ((u, u_2)(u, v_2)) = \mu_1(u) \wedge \rho_2(u_2 v_2)$$

PROPERTIES OF PERFECT FUZZY GRAPHS

Theorem 1: Graphs with no impurities are called "σ -perfect"

That can be seen by imagining a scenario in which the fuzzy graph G on (V, E) is -perfect.

Then $\mu(u,v)=1$ for all $(u,v)\in E$

Proof:

We claim that $\sigma(v)=1$ for all $v\in V$

If possible, let $\sigma(v)\neq 1$ for some $v\in V$

Then $0<\sigma(v)<1\Rightarrow \sigma(u)\wedge\sigma(v)\leq \sigma(v)<1=\mu(u,v)\leq \sigma(u)\wedge\sigma(v)$ is a contradiction

Therefore, $\sigma(v)=1$ for all $v\in V$

Hence G is a σ -perfect graph.

Theorem 2 Each and every strong perfect graph is a perfect fuzzy graph.

Proof:

Let $G=(\sigma,\mu)$ on (V,E) be a perfect fuzzy graph

Then $\mu(u,v)=1, \sigma(u)=1$ and $\sigma(v)=1$ for all $u,v\in A$ and $(u,v)\in E$

Then $\mu(u,v)=1, \sigma(u)=1=\sigma(u)\wedge\sigma(v)$

Thus, G is a powerful perfect fuzzy graph.

Theorem 3 A perfect fuzzy graph has the same complement as a perfect fuzzy graph.

Proof:

Let $G=(\sigma,\mu)$ on (V,E) be a perfect fuzzy graph.

Then $\mu(u,v)=1, \sigma(u)=1$ and $\sigma(v)=1$ for all $u,v\in V$ and $(u,v)\in E$

Let $\overline{G}=(\overline{\sigma},\overline{\mu})$ be the complement of G

For $(u,v)\in E$, $\overline{\mu}(u,v)=\sigma(u)\wedge\sigma(v)-\mu(u,v)=1-1=0$

For $(u,v)\notin E$, $\overline{\mu}(u,v)=1-0=1$

Hence $\overline{G}$ is a perfect fuzzy graph

Theorem 4 A perfect fuzzy graph would have to be something other than a normal fuzzy graph, which does not exist.

Proof:

Let $G = (\sigma, \mu)$ and (V, E) represent the n-vertex subgraph of the complete perfect fuzzy graph K_n .

When this is done, the underlying graph consists of $\mu(u,v) = 1, (u,v) \in E(K_n)$

(Since every vertex is required) $v \in K_n, d(v) = n-1$

Now, $(fd)(v) = \sum_{u \neq v, u \in v} \mu(u, v)$

$= (n-1).1 = n-1$ a constant, for all $v \in V$

To conclude, G is a full regular fuzzy graph.

UNION AND JOIN OPERATIONS OF FUZZY GRAPHS

Union Operation: If $G_1 : (\sigma_1, \mu_1)$ and $G_2 : (\sigma_2, \mu_2)$ to what extent fuzzy graphs $G_1 : (\sigma_1, \mu_1)$ just as $G_2^* : (V_2, E_2), G = G_1 \cup G_2 : (\sigma_1 \cup \sigma_2, \mu_1 \cup \mu_2)$ a fuzzy graph that defines a union of other fuzzy graphs G_1 and G_2 , which can also be interpreted as

$$(\sigma_1 \cup \sigma_2)(u) = \begin{cases} \sigma_1(u) & if \quad u \in v_1 - v_2 \\ \sigma_2(u) & if \quad u \in v_2 - v_1 \end{cases}$$

and

$$(\mu_1 \cup \mu_2)(uv) = \begin{cases} \mu_1(u) & if \quad uv \in E_1 - E_2 \\ \mu_2(u) & if \quad uv \in E_2 - E_1 \end{cases}$$

Join Operation: When performing a join, $G_1^* + G_2^* = (V_1 \cup V_2, E_1 \cup E_2 \cup E')$ of connections between nodes in a graph where arcs of length E' are used V_1 and V_2 (assuming that $V_1 \cap V_2 = \phi$). In this way, a pair of fuzzy graphs can be joined to form a single fuzzy graph.

Connections in fuzzy graphs G_1 and $G_2 (G_1 + G_2)$ results in yet another fuzzy graph $G : (\sigma_1 + \sigma_2, \mu_1 + \mu_2)$ which may be specified as $(\sigma_1 + \sigma_2)(u) = (\sigma_1 \cup \sigma_2)(u)$, where

$u \in V_1 \cup V_2$ and as such

$$(\mu_1 + \mu_2)(uv) = \begin{cases} (\mu_1 \cup \mu_2)(u) & if \quad uv \in E_1 - E_2 \\ \sigma_1(u) \wedge \sigma_2(v) \mu_2(u) & if \quad uv \in E' \end{cases}$$

Fuzzy Subgraph and Partial Fuzzy Subgraph

$Q:(S,U)$ is a partial fuzzy subgraph of $G:(\sigma,\mu)$ if $S(u)\le\sigma(u)\ \forall\ u$ and $U(u,v)\le\mu(u,v)$ $\forall\ u\ and\ v$, and as such, any partial fuzzy subgraph $(Q:(S,U))$ is described to be a subgraph of $G:(\sigma,\mu)$ if for each u in S^* and $U(u,v)=\mu(u,v)$ for each $arc(u,v)$ in U^* , $S(u)=\sigma(u)$. The fuzzy subgraph $Q:(S,U)$ covers $G:(\sigma,\mu)$ if $S=\sigma$. By definition, $H=(C,D,f)$ is a fuzzy subgraph of $F=(A,B,f)$ if $C\subseteq A\ and\ D\subseteq B$.

In Figure 1 the fuzzy graph (a) and its possible fuzzy subgraph (b) are described.

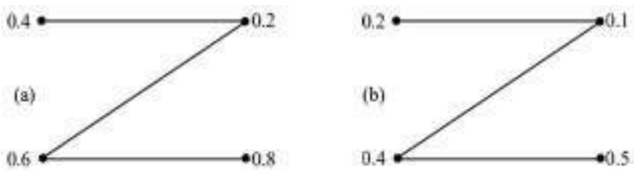

Figure 1: Fuzzy Graph (a) and Fuzzy Subgraph (b)

Complement of Fuzzy Graph

The complement of the fuzzy graph $G:(\sigma,\mu)$ is a fuzzy graph $\overline{G}=(\sigma,\overline{\mu})$, where $\sigma\equiv\overline{\sigma}$, and $\overline{\mu}(u,v)=\sigma(u)\wedge\sigma(v)-\mu(u,v)\quad\forall u,v\in V$

The fuzzy graph is depicted in Figure2 given below G_1 and its complement $\overline{G_1}$, and fuzzy graph G_2 and its complement $\overline{G_2}$, respectively.

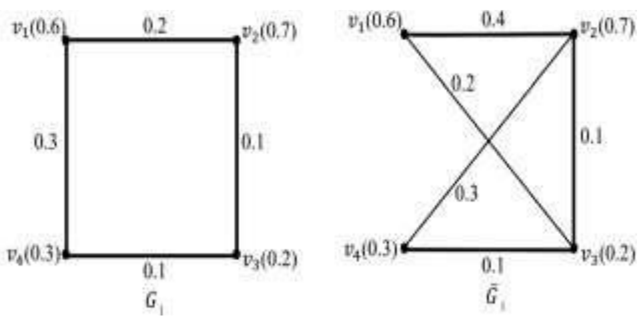

Figure 2: Fuzzy Graph G and its Complement $\overline{G}$

Operations Of Fuzzy Graph

Theorem: 5

If $G_1:(\sigma_1,\mu_1)$ and $G_2:(\sigma_2,\mu_2)$ fuzzy graphs are completely opposed to, then $G_1\oplus G_2$ anti-fuzzy graph that's very powerful.

PROOF:

Let $G_1\oplus G_2=G:(\sigma,\mu)$ where $\sigma=\sigma_1\oplus\sigma_2$ and $\mu=\mu_1\oplus\mu_2\,and$ $G:(V,X)$ where $V=V_1\times V_2\,and$

$$X=\{(u_1,v_1),(u_1,v_2)/u_1\in v_1,(v_1,v_2)\in X_2\}\cup\{((u_1,v_1)(u_2,v_1))\}$$

$\cup\{((u_1,v_1)(u_2,v_2)), u_1,u_2 \in V_1, u_1 \neq u_2, v_1,v_2 \in V, v_1 \neq v_2 / v_1 \in v_2, (u_1,u_2) \in X_1\}$

Either $\{(u_1,u_2) \in X_1 \ or (v_1,v_2) \in X_2\}$

Let $e = ((u_1,v_1)(u_1,v_2)) \ \forall u_1 \in V_1, (v_1,v_2) \in X_2$

Then, $(\mu_1 \oplus \mu_2)((u_1,v_1)(u_1,v_2)) = \min\{\sigma_1(u_1), \mu_2(v_1,v_2)\} = \sigma_1(u_1) \vee [\sigma_2(v_1) \vee \sigma_2(v_2)]$

Given that G_2 is a fully anti-fuzzy graph,

$= [\sigma_1(u_1) \vee \sigma_2(v_1)] \vee [\sigma_1(u_1) \vee \sigma_2(v_2)]$

$= (\sigma_1 \oplus \sigma_2)((u_1,v_1)) \vee (\sigma_1 \oplus \sigma_2)(u_1,v_2)$

APPLICATIONS IN VARIOUS FIELDS

Utility of Fuzzy Graph in Medical Field

Improvements have been made in many areas of medicine, including diagnosis, treatment, patient care, and the forecasting of disease prevalence. Examples of AI's Practical Use The fuzzy logic method uses a set of criteria and a set of rules that are more flexible and open to interpretation rather than employing a fixed or parallel set of criteria for generating decisions, as is the case with human reasoning. Clinical analyses enable the identification and quantification of a wide range of variables, also referred to as side effects in the medical community. A suitable upper bound on the number of created criteria cannot be given due to the complexity of the human body. We depend on fuzzy set theory reasoning's scientific accuracy every day, which leads us to the framework through which we make sense of our own habits. The values between "real" and "fake" are resolved in fuzzy set theory in a way that is partially correct and partially incorrect. The grey zones between extremes, such as "warm" and "cold," in the context of fuzzy sets, assist to depict the intricacies of life. To start therapy for a patient, a specialist draws on his own expertise, details from books, and mental prowess. The doctor notes the patient's symptoms and side effects, integrates this information with the patient's clinical history, does a physical examination, and analyses laboratory results before making a diagnosis. As a result, the fuzzy intelligent system's goal is to advise the expert by simulating his activities.

Telecommunication Framework Dependent on Fuzzy Graphs

The ability to communicate is essential to human existence. We cannot survive without telecommunications systems because they are now a necessary component of our daily life. Media transmission, sometimes known as telecommunication, is the process of sending information over a distance via a media transmission mechanism. The fuzzy idea is used to calculate the likelihood of the consumers winning. A "stir" in business lingo denotes a decline in clients. In order to distinguish agitated people, fuzzy telecommunication networks (FTNs) organised using fuzzy graph theory are introduced.

Exploit of Fuzzy Graph in Traffic Light Control

The traffic light's management approach is typically based on the number of cars at the crossing point line. If there is a lot of people using the crossing point line, an accident might happen. Whenever there are fewer cars waiting to cross, the risk of an accident decreasing. It could be difficult to get a clear picture of the potential for accidents and the total number of cars in each queue. The optimal amount of traffic security is tied to this, hence it shouldn't be a number.We use fuzzy edges to characterize all traffic streams, the value of whose membership depends on the total number of cars in that stream. If the related traffic streams of two fuzzy nodes cross one other, then those nodes are neighbors and an accident is possible. The value of a node's enrolment will determine how likely an accident is to be costly. For maximum safety, it's best to consider all roads as intersecting and to pack as many cars as possible into each lane. This means that the graph represented by Fuzzy Graph will be full. The current method of light management ensures that only a single progression is allowed at any given point in the cycle, and this is measured in terms of the chromatic number, which is the number of routes. However, when the edge set at the crossing point is empty, the minimum degree of security is reached; at this time, the chromatic number is 1, and any further development is allowed at any time.

Utilize of Fuzzy Graph in Neural Networks

Neural systems are inspired by the kind of registering done by the human mind since they are decoupled simulations of the biological sensory system. Neural systems are characterized by a number of distinctive features, including the capacity for mapping and example association, speculation, vigor, adaptability to internal failure, resemblance, and quick data processing. In a variety of computational and control settings, cutting-edge methods like neural fuzzy frameworks and fuzzy neural systems are revolutionizing the field. Both theoretical and practical research are still pouring into the area at an unprecedented rate. However, combining fuzziness with neural processing is not a straightforward process. Separating apart specifics of Neural Computing may be done with the use of fuzzy sets. Thus, a fuzzy neuron may have fuzziness included into its information-yield signals, synaptic loads, collection activity, and actuation capability. Fuzzy neurons have unique characteristics due to the wide range of data gathering activities and actuation capabilities that they must do. Thus, multiple opportunities exist for introducing noise into a synthetic neuron. A major push toward neuron-fuzzy computing is established by incorporating fuzzy methods into the operations of neural networks. The basic construction of a fuzzy neuron is identical to that of a fake neuron, with the difference that its segments and parameters are represented using the mathematics of fuzzy logic. Since there are several ways a synthetic neuron might be made fuzzy, it's possible that a wide variety of fuzzy neurons already exist in the scientific literature.

Social Network Theory

In recent years, online social networks have expanded rapidly as a means of communication, information dissemination, and the propagation of effects. Use of online informal communities to address offline social problems including substance abuse, smoking, and excessive drinking has been well researched. In analyzing how a replication of an online informal organization's information index could be affected, the dominant set plays a crucial role. Using the dominance set concept, we may determine the extent to which a single individual is able to exert positive influence on their connected neighbors in a social network graph. Since relationships of kinship in an online informal community are often two-way, we may express the interpersonal structure of the internet using the notation of an f-graph G= (,, c). Social networks as arcs, individuals as vertices, and C as the sparse partition vector between each pair of vertices may all be used to describe the structure of an informal online organization. The positive or negative influence that a person's social problems have on their neighbors is determined by the vertex's partition.

CONCLUSION

Since (crisp) graph operations like conjunction, disjunction, rejection, and symmetric difference are easily generalised to fuzzy graphs, we studied the characteristics and operations of fuzzy graphs in this paper. We then present a method for locating the corresponding fuzzy graphs by inverting the adjacency matrices of G1 and G2. The study also takes into account fuzzy graphs' characteristics and functions. Cartesian product, union, and join operations can be performed on fuzzy graphs. We discuss fuzzy subgraphs, partial fuzzy subgraphs, and the complement of the fuzzy graph. In a fuzzy graph, the definitions of the degree and total degree of the vertices are given. A basic foundation for communities has been built using fuzzy graph theory. Using fuzzy diagrams to discuss a system's design of a media transmission network or a telecommunications network. Utility of Fuzzy Graph in Traffic light Control, Neural Networks and Social Network are explained.

REFERENCES

1. Pal, madhumangal & samanta, sovan & ghorai, ganesh. (2020). Modern trends in fuzzy graph theory. 10.1007/978-981-15-8803-7.

2. Islam, s.r., pal, m. Further development of f-index for fuzzy graph and its application in indian railway crime. J. Appl. Math. Comput. (2022). Https://doi.org/10.1007/s12190-022-01748-5

3. Abida anwar, faryal chaudhry, "on certain products of complex intuitionistic fuzzy graphs", journal of function spaces, vol. 2021, article id 6515646, 9 pages, 2021. Https://doi.org/10.1155/2021/6515646

4. X. Li and h. Yi (2017) structural properties of fuzzy graphs

5. Cen zuo et.al cen zuo ,anita pal and arindam dey (2019) new concepts of picture fuzzy graphswith application

6. Akram m, younas hr (2015) certain types of irregular m-polar fuzzy graphs. J appl math comput. Doi:10.1007/s12190-015-0972-9

7. Akram m, akmal r, alsheri n (2016) on m-polar fuzzy graph structures. Springerplus 5:1448. Doi:10.1186/s40064-016-3066-8

8. S. Samanta and m. Pal, bipolar fuzzy hypergraphs, international journal of fuzzy logic systems, 2(1)(2012), 1-8.

9. Nagoorgani and s.r. Latha, on irregular fuzzy graphs, applied mathematical sciences, 6(11)(2012), 517-523.

10. S. Samanta, and m. Pal, irregular bipolar fuzzy graphs, international journal of application of fuzzy sets, 2(2012), 91-102.

11. Nagoor gani and d. Rajalaxmi subahashini, properties of fuzzy labeling graph, applied mathematical sciences, 670(2012), 3461-3466.

12. Akram, muhammad and davvaz, bijan, strong intuitionistic fuzzy graphs, filomat, 26(1)(2012), 177-196.

13. Akram, muhammad and dudek, a. Wieslaw, intervalvalued fuzzy graphs, arxiv, 2012.

14. T. Dinesh and t. V. Ramakrishnan, on generalised fuzzy graph structures, applied mathematical sciences, 5(4)(2011), 173-180.

15. N. Vinoth kumar and g. Geetharamani, product intuitionisticfuzzy graph, international journal of computer applications, 28(1)(2011), 1-11.