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On the Flower Graph Related to the Difference Square Mean Fuzzy Labeling

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Abstract:
Label learning is a fundamental task in machine learning that aims to construct intelligent models using labeled data, encompassing traditional single-label and multi-label classification models. Traditional methods typically rely on logical labels, such as binary indicators (e.g., "yes/no") that specify whether an instance belongs to a given category. The present research uses the difference square mean fuzzy values of neighboring vertices to construct an integrated fuzzy edge-labeling strategy for unpredictable graph architectures. Four structurally different graphs are subjected to the suggested fuzzy edge labeling. Rose flowers, sunflower, lily flowers, and Ammi Majus graphs are flower families. The explicit edge-labeling processes are generated for each category, and a series of theorems and examples are used to show the existence and consistency of the Difference Square Mean Fuzzy labeling (DSMFL). The findings demonstrate that all four graphs have distinctive replication processes controlled by their structural characteristics and accept the suggested fuzzy labeling. A compressed analytical method for analyzing fuzzy edge labeling in various and unpredictable network components is presented in this article.

KEYWORDS: Difference Square Mean Fuzzy, Rose flower, Sun flower, Lilly flower, Ammi Majus flower.

Introduction

Graph theory is an important area in many disciplines. Graph labeling involves assigning numbers between one and n to the vertices, edges, and each graph, accordingly. Graph labeling, which has various uses, is one of the major areas of graph theory [2,3,9].

The fuzzy set is a novel mathematical construct that illustrates the process of Lack of clarity in global circumstances. It was presented by Zadeh in 1965, and its principles were initially developed by other separate investigators, including Rosenfeld and Bhutani and Battou in the 1970s [6,7,8]. Bhattacharya proposed the connectivity notions connecting fuzzy divided nodes and fuzzy junctions in his paper "Some remarks on fuzzy graphs" [10,17].They investigated many fuzzy resemblances of graph-theoretical notions, including routes, cycles, and interconnectedness. Fuzzy graphs can help solve a wide range of problems [1,4,5].

Considering it is still relatively new, it is rapidly expanding and has several uses in a wide range of industries. Furthermore, studies into fuzzy graphs have grown at an exponential rate, both inside mathematical disciplines and in their various uses in scientific and technological fields [11,12,13]. A fuzzy structure is a variant of the crisp diagram. As a result, it is inevitable that many attributes are comparable to crisp graphs, but they also diverge in numerous locations. Labeling is a bijection from $V \cup E$ implies N of the fact that generates an extra integer value for every vertex along with an edge if $G = (V, E)$ [14,15].

Fuzzy graphs are more useful than crisp graphs because of the unpredictable nature of the world.Howeve r, the two structures are similar.Fuzzy graph theory can bestudiedin a wide range of contexts[16,18].In pa rticular, fuzzy graph labeling, a developing field of study in graph theory,can be found in many realworl d scenarios, including biological systems, pulse
radar, missile guidance, social systems like computer networks, communication networks, etc.
Due to its remarkable practical uses, it has been receiving a lot of attention lately.
When data discrepancies occur, it is specifically utilized in the networking model [19.20].

Basic Preliminaries:

Subgraph

A graph whose set of vertices and set of edges are subsets of a graph known as G is called a subgraph.

Connected Graph

A graph with a path of edges and notes joining every two nodes.

Graph Labeling
The assignment of labels, represented by numerical values, to the conventional edges, corners, or both, according to certain criteria, is known as graph labeling.

Labeling of vertices
A vertex labeling is an assignment of V to a set throughout labels in a graph G. A graph that has this function specified is referred to as a vertex-labeled graph.

Labeling of Edges
A function of E to a set of labels is called an edge labeling. The graph is referred to as an edge-labeled graph in this instance.

Fuzzy Labelling Graph:
If σ: V → [0, 1] and μ: V×V → [0, 1] are bijective so that each of the membership values of corresponding edges and vertex positions are unique and μ (u, v) < σ (u) ÷ σ (v) for every u, v V, then a graph with G = (σ, μ) is considered a fuzzy labeling graph.

Difference Mean Square Labelling:
If η:$V \rightarrow [0,1]$ and γ:$VxV \rightarrow [0,1]$ are bijective and $\eta(u,v) < \eta(u) \wedge \eta(v)$ and $G(u,v) = |\eta(u) - \eta(v)|^2/2|$ Forever $(u,v) \in E$ are all different.

Rose Flower:
Combining n replications of a cycle C_4 with one vertex that is common results in a rose flower graph R_m.

Sunflower:
A circular graph with points $U_1, U_2, U_3, \ldots, U_n$, & added vertices $V_1, V_2, V_3, \ldots V_n$ is transformed into a sunflower planar graph $S(k_n \odot nC_3)$, where bj is linked to aj and $aj+1$ is derived factor n.

Lilly Flower:
Consider G to be a graph along with an assigned vertex v, and assume that represents the structure of the graph generated by For 1≤i ≤6, connect u1, u2, u3,..., um to the vertices of size v of the ith reproduction of G using an edge.

Ammi Majus Flower:
On attaching c_3 to the star graph S_{n+1} maximum vertex and K3 to each of its pendant vertices, an Ammi Majus flower graph $AM[S_n \odot C_3]$ is generated.

Theorem 1:
The Rose Flower graph.
$R(m \cup c_4)$ is DSMF graph, if

Proof:
Rose flower graph $R(m \cup c_4)$. Then point $g = mn + 1$ and distance $h = (n+1)m$. Assume m is a number of Rose petals.
Let $Vertices\ of\ \{u, u_1, u_2, \ldots . u_m, v_1, v_2 \ldots . v_m\}$
U be the centre of vertex & $\{u_1, u_2, \ldots . u_m\}$ be the vertices attached of centre of the vertex $\{v_1, v_2 \ldots . v_m\}$ vertices connected to the $\{u_1, u_2, u_3, \ldots . u_m\}$
Let edge set $\{e_1, e_2, \ldots e_n, f_1, f_2, f_3 \ldots f_n\}$
$E(G) = \{e_i = \frac{|u-u_i|^2}{2}\}$ if $1 \le i \le m$
$E(G) = \{f_i = \frac{|u_i-v_i|^2}{2}\}$ if $1 \le i \le m$, As seen in the figure 1.
For the vertices membership value
$\eta: v \longrightarrow [0,1]$
$\eta(u) = (mn+1)0.1$ if $n = 3$
$\eta(u_{2i-1}) = (n+1+i)0.1$, {if $i = 1,2, \ldots . m$ if $n = 3$
For the edges , membership value
$\gamma: \in \longrightarrow [0,1]$
$\gamma(e_i) = [|u - u_i|^2/2]0.1$, if $i = 1,2, \ldots . m$
$\gamma(f_i) = [|u_i - v_i|^2/2]0.1$ if $i = 1,2, \ldots . m$
Important rules $\gamma(e_i) < \min(\eta(u_i), \eta(u_{i+1}))$

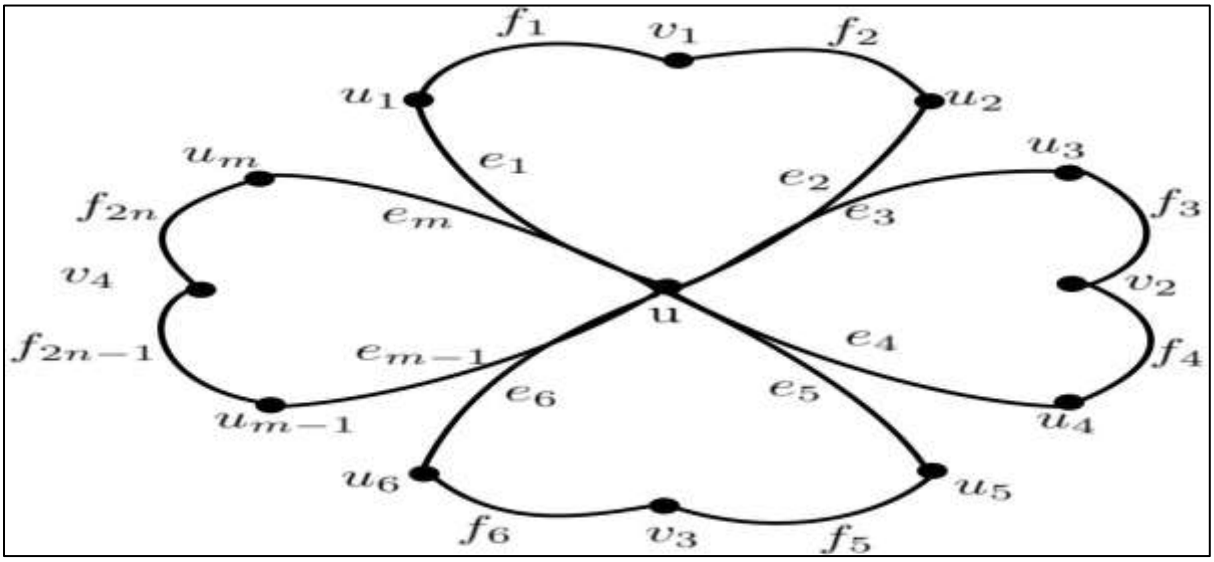

Fig: 1 Rose flower $R(m \cup c_4)$ graph of DSMFG.

Example:

The Rose flower graph $R(4 \cup c_4)$ in figure 2. The point and distance 13, 16 for the vertex labels are:

$\eta(u) = 0.13$

$\eta(u_1) = 0.09$ $\eta(u_2) = 0.05$
$\eta(u_3) = 0.10$ $\eta(u_4) = 0.06$
$\eta(u_5) = 0.11$ $\eta(u_6) = 0.07$
$\eta(u_7) = 0.12$ $\eta(u_8) = 0.08$

$\eta(v_1) = 0.26$
$\eta(v_2) = 0.28$
$\eta(v_3) = 0.30$
$\eta(v_4) = 0.32$

For the Edge labels are:
$\gamma(e_1) = 0.0005$ $\gamma(e_2) = 0.00125$
$\gamma(e_3) = 0.0002$ $\gamma(e_4) = 0.0018$
$\gamma(e_5) = 0.00045 \gamma(e_6) = 0.000245$
$\gamma(e_7) = 0.0008$ $\gamma(e_8) = 0.0032$

$\gamma(f_1) = 0.002$ $\gamma(f_2) = 0.0288$
$\gamma(f_3) = 0.01805 \gamma(f_4) = 0.02645$
$\gamma(f_5) = 0.0162$ $\gamma(f_6) = 0.0242$
$\gamma(f_7) = 0.01445 \gamma(f_8) = 0.02205$

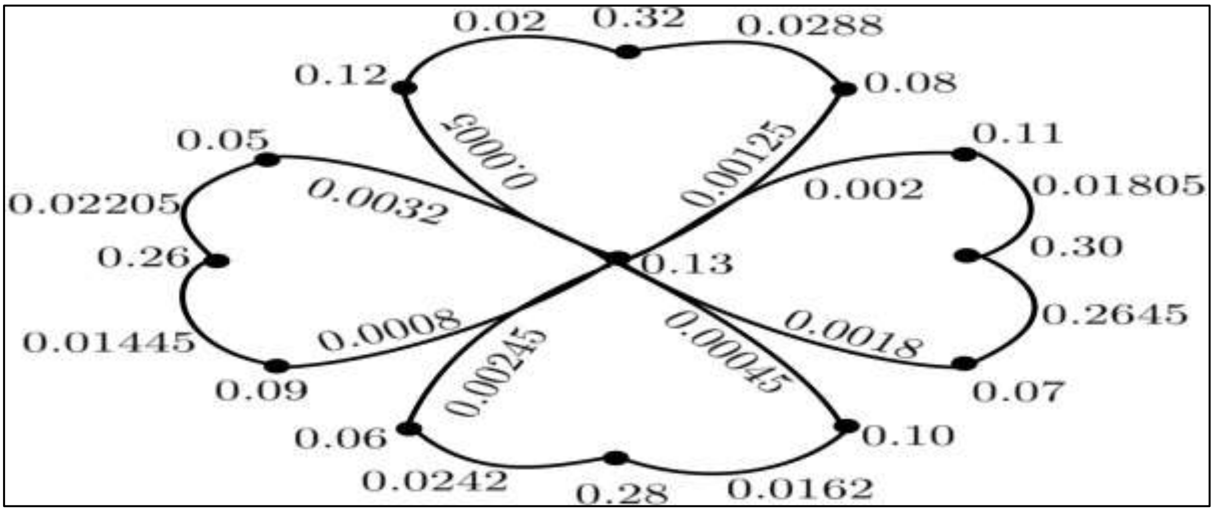

Fig .2 Rose flower $R(4 \cup c_4)$ of DSMFG

Theorem:2

The Sunflower graph $S(k_n \odot nC_3)$ is DSMF labelling (DSMFL)

Proof:

The sunflower graph of $\delta(k_n \odot nC_3)$

The point of the vertices $g = 2n + 1$ and the distance of the Edges $h = 4n$

Let the set of vertices $V(G)$: $\{u, u_1, u_2, u_3 \dots . u_n, v_1, v_2, \dots . v_n\}$. The vertex u attached to the vertices of $\{u_1, u_2, u_3, u_4 \dots . u_n\}$ and , The vertices are $\{u_1, u_2 \dots . u_n\}$ attached to the vertices $\{v_1, v_2, v_3, v_4 \dots . v_n\}$.

$\{v_1, v_2, \dots . v_n\}$ be the vertices common to the set of two vertices

Let, $E(G) = \{e_1, e_2, \dots . e_i, f_1, f_2, \dots f_i, g_1, g_2, \dots g_i\}$

$e_i = \{u, u_i\}$, $f_i = \{u, u_{i+1}\}$, $g_i = \{u, u_{i+1}, v_i\}$ seen in the figure 3.

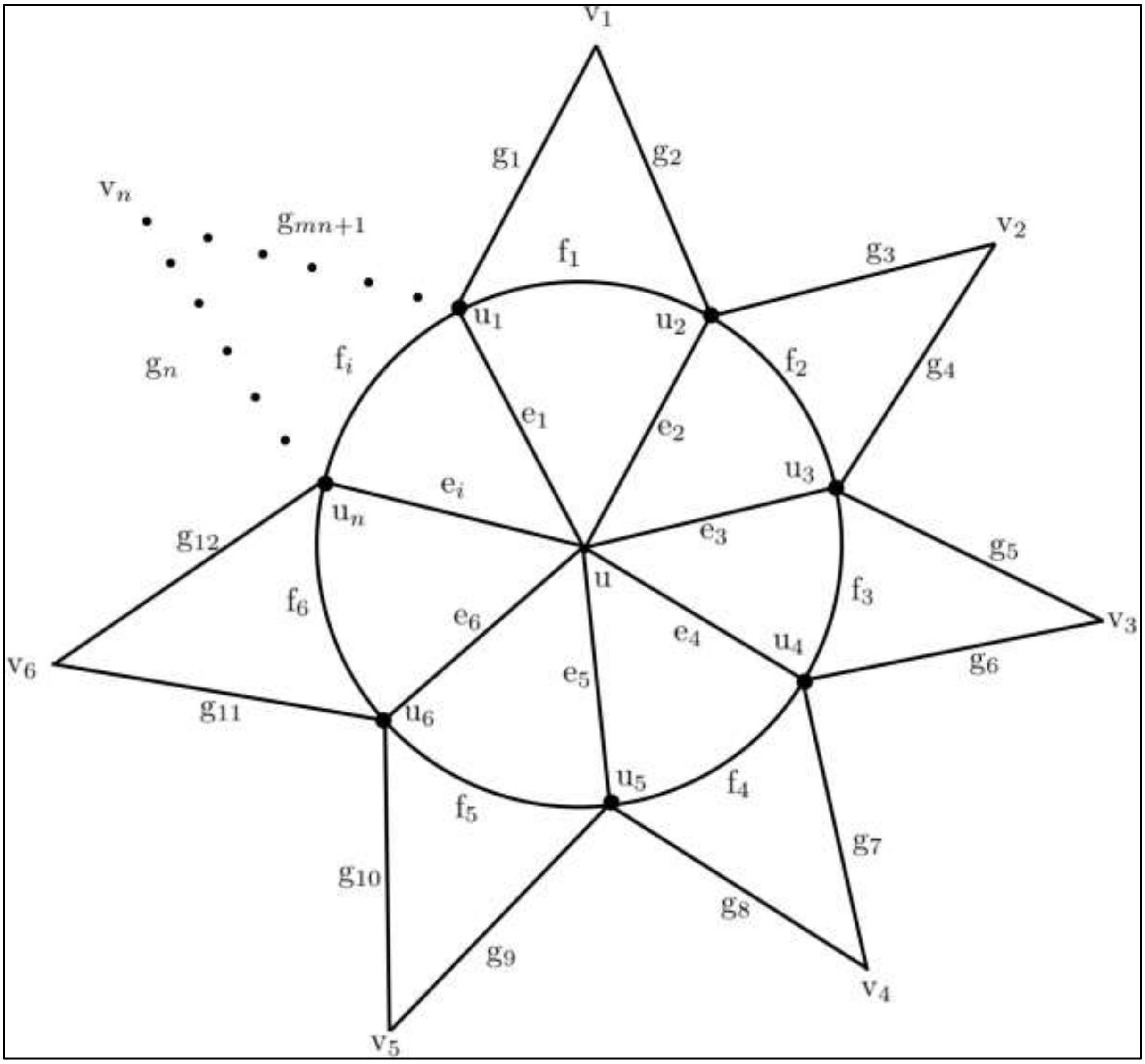

Fig.3. Sun flower graph of $S(k_n \odot nC_3)$

The vertex Membership values are

$\eta(u) = (2n + 2)0.1$

$\eta(u_i) = (i)0.1$, $i = 1\ (mod\ 2)$ $i = 1,2,3,4,5 \dots n$

$\eta(u_i) = (2n + 3 - i)0.1$, $i = 0\ (mod\ 2)$ $i = 1,2,3,4,5 \dots n$

$\eta(v_{2i-1})(5n + 2 - 3i)0.1$, $i = 1,2,3, \dots n/2$

$\eta(v_{2i}) = (7n + 1 - 3i)0.1$, $i = 1,2,3, \dots n/2$

the Edge membership values are,

$\gamma(e_i) = |(u - u_i|^2/2$, if $i = 1,2,3 \dots n$

$\gamma(f_i) = |(u - u_{i+1}|^2/2$, if $i = 1,2,3 \dots n$

$\gamma(g_i) = |(u_i - v_i|^2/2$, if $i = 1,2,3,4,5 \dots n$ $i = 1\ (mod\ 2)$

$\gamma(g_i) = |(u_{i+1} - v_i|^2/2$, if $i = 1,2,3,4,5 \ldots n \;\; i = 0\ (mod\ 2)$
So, the fuzzy membership value for the important rules, $\gamma(e_i) < \eta(u_i) \wedge \eta(u_{i+1})$

Example:
The sunflower graph $S[k_6 \odot c_3]$ is shown in figure 4. The point of the graph 13 and distance of the graph 24
The labels are:
$\eta(u) = 0.14$
$\eta(u_1) = 0.1$
$\eta(u_2) = 0.13$
$\eta(u_3) = 0.3$
$\eta(u_4) = 0.11$
$\eta(u_5) = 0.5$
$\eta(u_6) = 0.09$

$\eta(v_1) = 0.35$
$\eta(v_2) = 0.40$
$\eta(v_3) = 0.38$
$\eta(v_4) = 0.37$
$\eta(v_5) = 0.41$
$\eta(v_6) = 0.34$

The Edge labels:
$\gamma(e_1) = 0.0008$ $\gamma(f_1) = 0.0045$
$\gamma(e_2) = 0.00005$ $\gamma(f_2) = 0.01445$
$\gamma(e_3) = 0.0128$ $\gamma(f_3) = 0.01805$
$\gamma(e_4) = 0.00045$ $\gamma(f_4) = 0.07605$
$\gamma(e_5) = 0.0648$ $\gamma(f_5) = 0.08$
$\gamma(e_6) = 0.00125$ $\gamma(f_6) = 0.0005$

$\gamma(g_1) = 0.03125$ $\gamma(g_7) = 0.0338$
$\gamma(g_2) = 0.0242$ $\gamma(g_8) = 0.00845$
$\gamma(g_3) = 0.03645$ $\gamma(g_9) = 0.00405$
$\gamma(g_4) = 0.005$ $\gamma(g_{10}) = 0.0512$
$\gamma(g_5) = 0.0032$ $\gamma(g_{11}) = 0.03125$
$\gamma(g_6) = 0.03645$ $\gamma(g_{10}) = 0.0288$

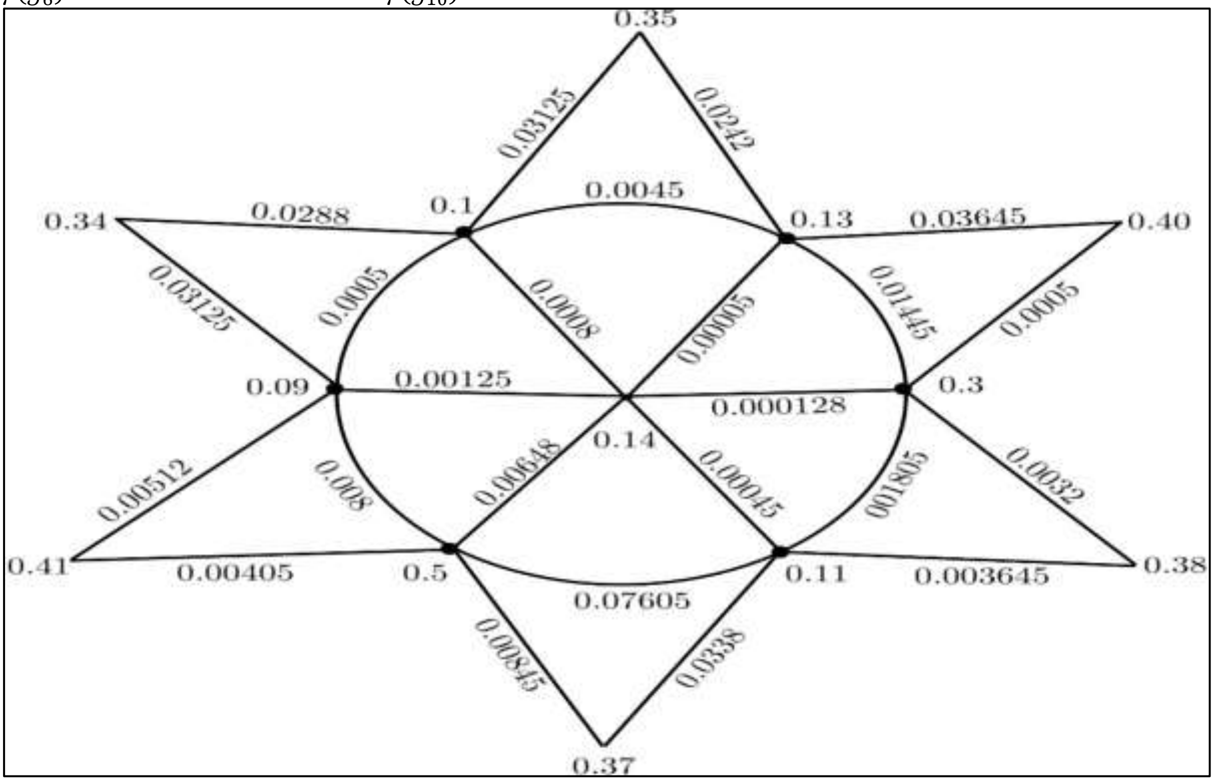

Fig.4. Sunflower graph $S[k_6 \odot c_3]$ of DSMFG

Theorem: 3

Lilly flower graph $P_m \odot K_{1,6}$ is a DSMF graph, if $n \geq 1$

Proof:

Let graph $P_m \odot K_{1,6}$ be the Lilly flower graph. The point of the vertex $g = m(n+2)$ and, distance of the edge $n = m(n+2) - 1$

Let, the vertex set $V(G)$: $\{u_1, u_2, u_3, u_4 \dots . u_m, v_1, v_2, v_3, v_4 \dots . v_m, w_1, w_2, w_3 \dots . w_{6m}\}$. where, $\{u_1, u_2, \dots . u_m\}$ be vertices attached to the $\{v_1, v_2, v_3, v_4 \dots . v_m\}$ and $\{v_1, v_2, v_3, v_4, v_5 \dots . v_m\}$ be the vertices attached to the $\{w_{11}, w_{12}, \dots . w_{m6}\}$

Let, the edge set $E(G)$: $\{e_1, e_2, \dots . e_{m-1}, f_1, f_2, f_3 \dots . f_m, g_1, g_2, \dots . g_{6m}\}$

$e_i = \{u_i, u_{i+1}\}$, $f_i = \{u_i, v_i\}$, $g_i = \{v_i, w_i\}$, as seen in the figure 5.

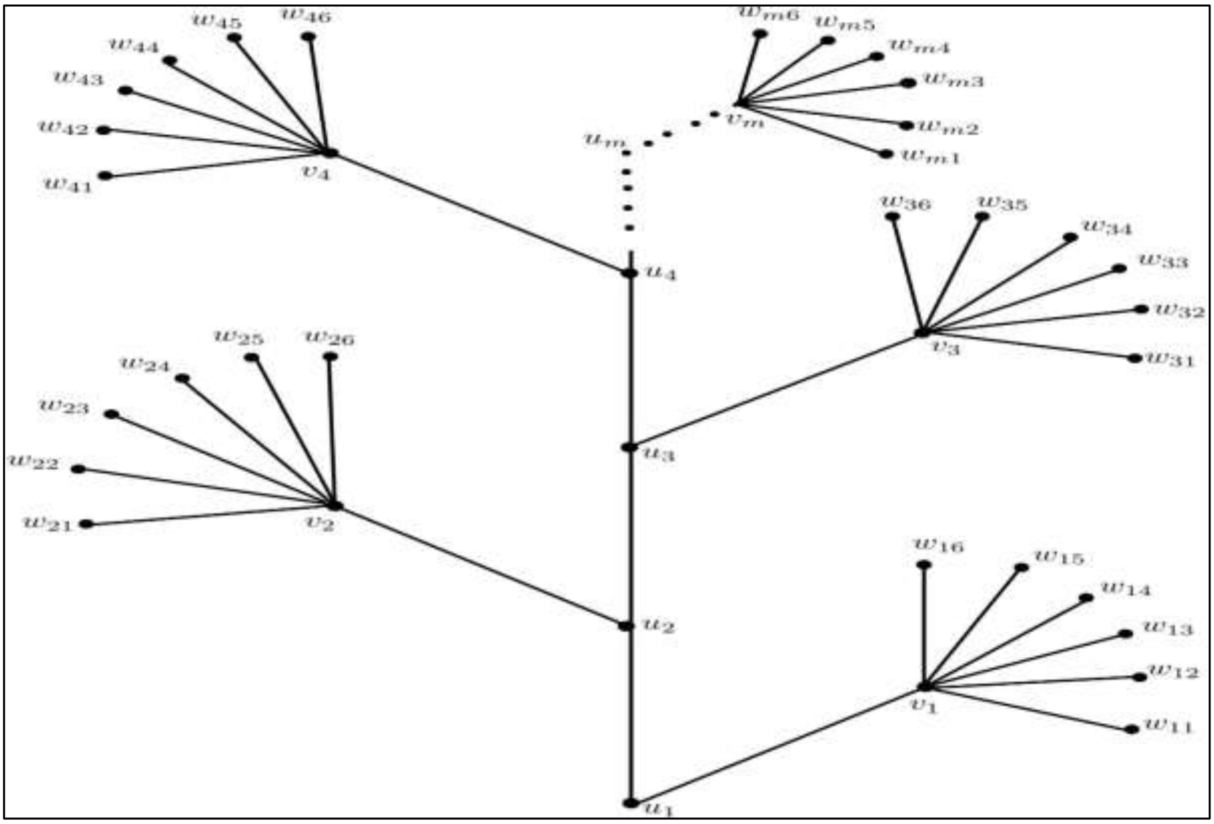

Fig.5 Lilly flower graph $P_m \odot K_{1,6}$ of DSMFL.

Vertex Labels

$\eta(u_{2i-1}) = (6(n+m+1) + 3 - 16i)0.1$, {if $n = 6$, $i \equiv 1(mod2)$, for $i = 1,2,3,4,5 \dots . m$

$\eta(u_{2i}) = (16i - 1)0.1$, {if $i \equiv 0(mod2)$, for $i = 1,2, \dots . m$

$\eta(v_i) = (1 + 16i)0.1$, {if , $i \equiv 1(mod2)$, for $i = 1,2, \dots . m$

$\eta(v_i) = (6m + 5n + 1 + 16i)0.1$, {if , $i \equiv 0(mod2)$, for $i = 1,2, \dots . m$

$\eta(w_{ij}) = (5(n+m+1) + 3 - 6i - 2j)0.1$, {if , $i \equiv 1(mod2)$, $i = 1,2, \dots . m$, $j = 1,2, \dots 6$

$\eta(w_{ij}) = (6i + 2j - m - n - 2)0.1$, {if , $i \equiv 0(mod2)$, i *Equal to* $1,2, \dots . m$, $j = 1,2, \dots 6$

Edge Labels

$\gamma(e_i) = (|(u_i, u_{i+1}|^2/2)0.1$, if i *Equal to* $1,2,3 \dots n$

$\gamma(f_i) = (|(u_i, v_i|^2/2)0.1$, if i *Equal to* $1,2,3 \dots n$

$\gamma(g_i) = (|(v_i w_i|^2/2)0.1$, if i *Equal to* $1,2,3 \dots n$

Hence, Lilly flower graph $P_m \odot K_{1,6}$ is a difference square mean fuzzy graph.

Therefore Fuzzy membership value for the important rules satisfied $\gamma(e_i) < \eta(v_i) \wedge \eta(v_{i+1})$

Example:

The graph $P_4 \odot K_{1,6}$ is shown in diagram 6. In, Lilly flower graph point and distance are 32 and 31.

The labels are:

$\eta(u_1) = 0.63\ \eta(u_2) = 0.15\ \eta(u_3) = 0.47\ \eta(u_4) = 0.31$
$\eta(v_1) = 0.1 \quad \eta(v_2) = 0.49$
$\eta(v_3) = 0.17 \quad \eta(v_4) = 0.33$
$\eta(w_{11}) = 0.61 \quad \eta(w_{21}) = 0.3$
$\eta(w_{12}) = 0.59 \quad \eta(w_{22}) = 0.5$
$\eta(w_{13}) = 0.57 \quad \eta(w_{23}) = 0.7$
$\eta(w_{14}) = 0.55 \quad \eta(w_{24}) = 0.9$
$\eta(w_{15}) = 0.53 \quad \eta(w_{25}) = 0.11$
$\eta(w_{16}) = 0.51 \quad \eta(w_{26}) = 0.13$
$\eta(w_{31}) = 0.45 \quad \eta(w_{41}) = 0.19$
$\eta(w_{32}) = 0.43 \quad \eta(w_{42}) = 0.21$
$\eta(w_{33}) = 0.41 \quad \eta(w_{43}) = 0.23$
$\eta(w_{34}) = 0.39 \quad \eta(w_{44}) = 0.25$
$\eta(w_{35}) = 0.37 \quad \eta(w_{45}) = 0.27$
$\eta(w_{36}) = 0.35 \quad \eta(w_{46}) = 0.29$

Edge Labels

$\gamma(e_1) = 0.113 \quad \gamma(e_2) = 0.0512$
$\gamma(e_3) = 0.128$
$\gamma(f_1) = 0.1001 \quad \gamma(f_2) = 0.0518$
$\gamma(f_3) = 0.045 \quad \gamma(f_4) = 0.0002$
$\gamma(g_{11}) = 0.093005 \quad \gamma(g_{21}) = 0.01805$
$\gamma(g_{12}) = 0.0912\,\gamma(g_{22}) = 0.0005$
$\gamma(g_{13}) = 0.09045 \quad \gamma(g_{23}) = 0.02205$
$\gamma(g_{14}) = 0.0882\,\gamma(g_{24}) = 0.08405$
$\gamma(g_{15}) = 0.086 \quad \gamma(g_{25}) = 0.0722$
$\gamma(g_{16}) = 0.0084\,\gamma(g_{26}) = 0.0648$
$\gamma(g_{31}) = 0.0392\,\gamma(g_{41}) = 0.0098$
$\gamma(g_{32}) = 0.0338\,\gamma(g_{42}) = 0.00845$
$\gamma(g_{33}) = 0.0288\,\gamma(g_{43}) = 0.005$
$\gamma(g_{34}) = 0.0242\,\gamma(g_{44}) = 0.0032$
$\gamma(g_{35}) = 0.002 \quad \gamma(g_{45}) = 0.0018$
$\gamma(g_{36}) = 0.0162\,\gamma(g_{46}) = 0.008$

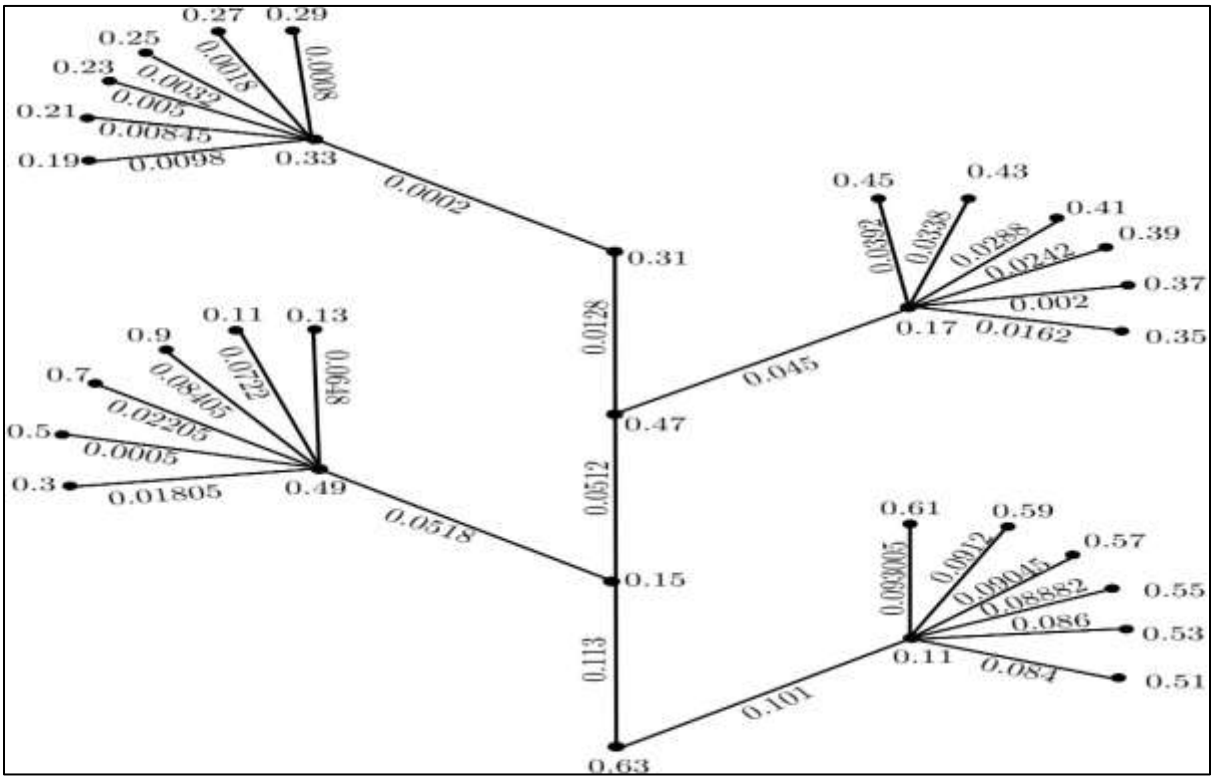

Fig.6 Lilly flower graph $P_4 \odot K_{1,6}$ of DSMFL

Hence, Lilly flower graph $P_4 \odot K_{1,6}$ is a difference square mean fuzzy graph.

Theorem:4
Ammi majus flower graph $AM[S_n \odot C_3]$ is DSMF graph.

Proof:
$AM[S_n \odot C_3]$ be the ammi majus flower graph. The point of the flower graph $g = 3n + 1$, the distance of the flower graph, the point of the flower graph $n = 4n$.
The vertex set $V(G) = \{v, v_1, v_2, v_3, v_4, v_5 \dots v_n, u_1, u_2, u_3, u_4 \dots u_{2n}\}$.
The vertex v attached by the vertices $\{v_1, v_2, \dots v_n\}$ and the vertices $\{v_1, v_2, v_3, v_4, v_5 \dots v_n\}$ attached by the vertices $\{u_1, u_2, u_3, u_4 \dots u_{2n}\}$
Let
The edge set $E(G)$ $Equal\ to$ $\{e_1, e_2, \dots e_n, f_1, f_2, f_3, \dots f_{2n}, g_1, g_2, \dots g_n\}$.
$e_i = \{v, v_i\}$, $f_i = \{v_i, u_i\}$, $g_i = \{u_i, u_{i+1}\}$,
As shown in figure .7

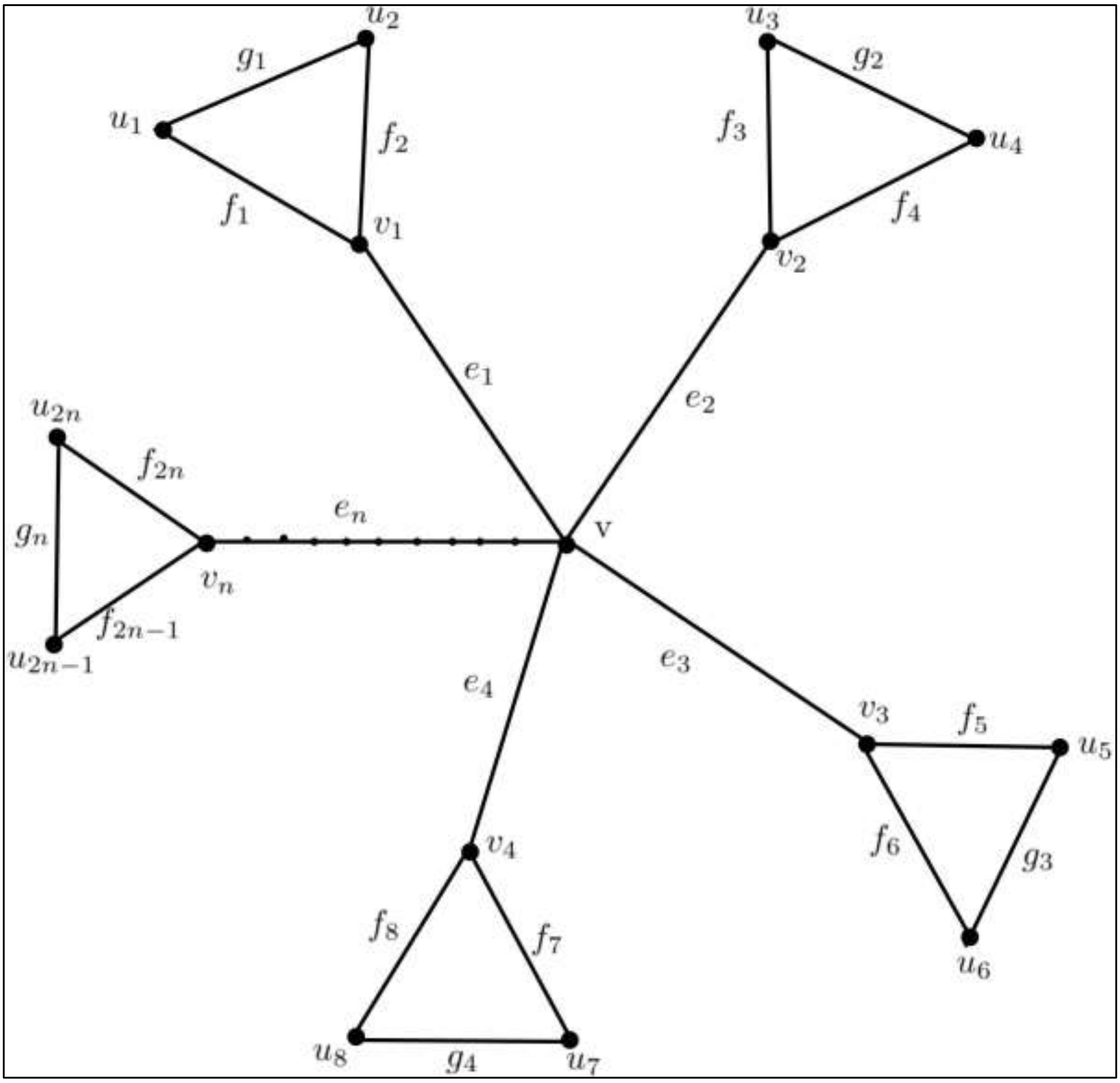

Fig.7 Ammi Majus flower graph $AM[S_n \odot C_3]$ of DSMFL.

Vertex Labels
$\eta(v) = (2nm + 2)0.1$ {if $m = 3$,
$\eta(v_i) = (2nm + 2 - i)0.1$ {if $m = 3, i = 1,2, \dots n$
$\eta(u_{2i-1}) = (m + i)0.1$ {if $m = 3, i = 1,2, \dots n$
$\eta(u_{2i}) = (2mn + 5 + 2i)0.1$, {if $m = 3, i = 1,2, \dots n$

Edge Labels
$\gamma(e_i) = (|(v_i - v_i|^2/2)0.1$, if $i = 1,2,3 \dots n$

$\gamma(f_i) = (|(v_i - u_i|^2/2)0.1$, if $i = 1,2,3 \dots n$
$\gamma(g_i) = (|(u_i - u_{i+1}|^2/2)0.1$, if $i = 1,2,3 \dots n$
Hence, $AM[S_n \odot C_3]$ of difference square mean fuzzy labelling.

Example:
The graph $[S_4 \odot C_3]$ is shown in figure 8.
In, the Ammi manju flower graph, pointing 13 & distance $n = 16$.

The labels are:
$\eta(v) = 0.26$

$\eta(v_i) = 0.25$	$\eta(v_3) = 0.23$
$\eta(v_2) = 0.24$	$\eta(v_4) = 0.22$
$\eta(u_1) = 0.31$	$\eta(u_2) = 0.5$
$\eta(u_3) = 0.33$	$\eta(u_4) = 0.6$
$\eta(u_5) = 0.35$	$\eta(u_6) = 0.7$
$\eta(u_7) = 0.37$	$\eta(u_8) = 0.8$

Edge Labels

$\gamma(e_1) = 0.00005$	$\gamma(e_2) = 0.0002$
$\gamma(e_3) = 0.00045$	$\gamma(e_4) = 0.00125$
$\gamma(f_1) = 0.0018$	$\gamma(f_2) = 0.03125$
$\gamma(f_3) = 0.00405$	$\gamma(f_4) = 0.0162$
$\gamma(f_5) = 0.11045$	$\gamma(f_6) = 0.0072$
$\gamma(f_7) = 0.1682$	$\gamma(f_8) = 0.01125$
$\gamma(g_1) = 0.01805$	$\gamma(g_2) = 0.03645$
$\gamma(g_3) = 0.06125$	$\gamma(g_4) = 0.09245$

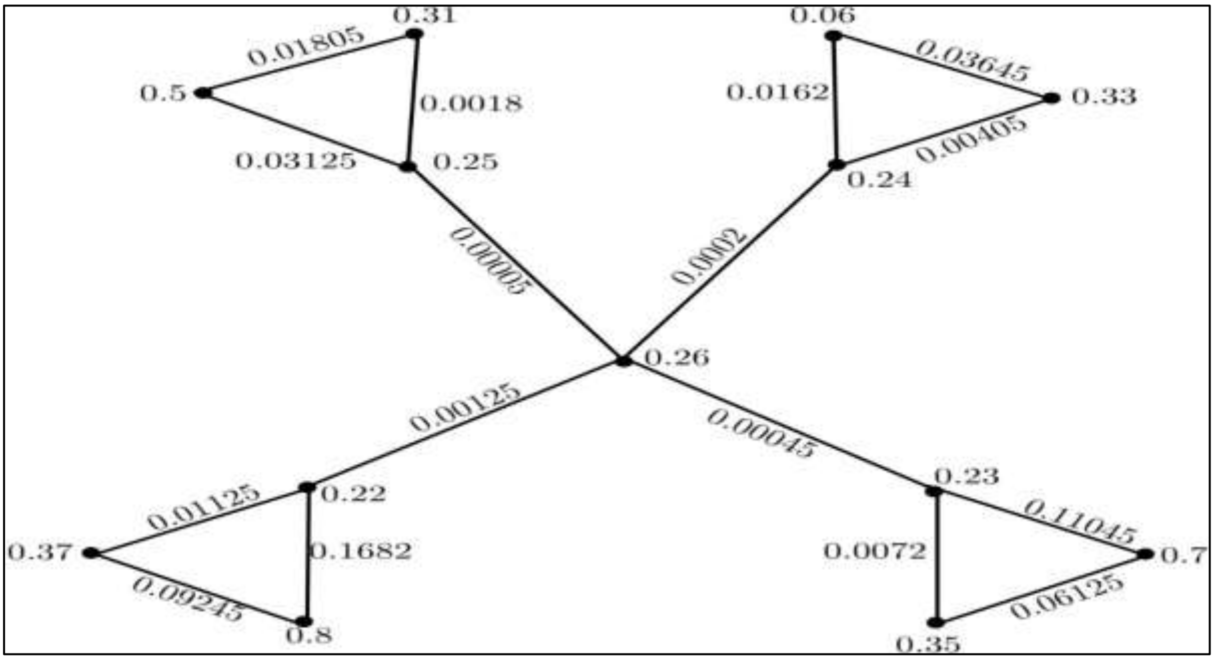

Fig.8 Ammi manju flower graph $[S_4 \odot C_3]$ of DSMFL

Conclusion

In this study, four structurally different graphs are subjected to the suggested fuzzy edge labeling: rose flowers, sunflowers, lily flowers, and Ammimajus graphs are flower families. We introduce the notion of difference square mean fuzzy labeling. Because it is a new one, much more effort could be done to find numerous fuzzy graphs and deduce various attributes. The work that remains will be explored in the next articles.

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