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Game Analysis of Financial Regulation in International Financial Crisis using Multi-view Graph Convolutional Network

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Abstract: - The concept of "game analysis" generally refers to the study and assessment of video games, frequently from the viewpoints of player experience, story, mechanics, design, and other relevant variables. It can be used for a variety of games, such as sports, board, card, and video games. A sudden drop in the value of assets or financial institutions is referred to as a financial crisis. It frequently causes the regular operation of financial markets to be interrupted and may have negative impacts on the economy as a whole. In this manuscript, Game Analysis of Financial Regulation in International Financial Crisis using Multi-view Graph Convolutional Network (GA-FR-IFC-MGCN). The proposed method comprises of four phases: dataset, pre-processing, feature selection, classification. Initially, the data is taken from Analcat dataset. Then, Federated Neural Collaborative Filtering (FNCF) method is used to enhancing the networks data. For feature selection phase, the ideal features are chosen by Siberian Tiger Optimization (STO). After, the Multi-view graph convolutional network (MGCN) method is used to classifying international financial crisis as bankruptcy and Non-bankruptcy. In general, MGCN does not express some adaption of optimization strategies for determining optimal parameters to promise exact classification of International Financial Crisis. Therefore, Harbor Seal Whiskers Optimization Algorithm is proposed to enhance weight parameter of MGCN classifier, which precisely predicts the International Financial Crisis. The proposed technique is executed and efficiency of GA-FR-IFC-MGCN depend classification framework is assessed by support of numerous performances evaluating metrics likes accuracy, recall, precision, FI-score, specificity. Finally the performance of proposed GA-FR-IFC-MGCN methods provides 25.32%, 29.30% and 27.32% higher accuracy, 22.41%, 29.30% and 24.31% higher specificity and 25.71%, 27.12% and 25.31% higher precision though analyzed with existing method likes game analysis of financial supervision in international financial crisis(GA-FS-IFC), performance evaluation of clustering techniques for financial crisis prediction(PE-CT-FC) and modified grey wolf optimizer with sparse auto-encoder for financial crisis prediction in small marginal firms (MGWO-SA-FCP) respectively.

Keywords: Federated neural collaborative filtering, Harbor Seal Whiskers Optimization Algorithm, Multi view Graph Convolution Network, Siberian Tiger Optimization.

I. INTRODUCTION

Attacks that are hypothetical often exhibit temporal connection. They discovered that diseases seem to spread more quickly to nations that are connected by worldwide trade connections compared to nations with equal macroeconomic conditions using panel data covering thirty years from twenty industrialized nations investigated whether financial crises are similar by figuring out if a single modelling framework would handle a number of different crises in can link markets across national boundaries and asset types through contagion effects [1-4]. Considering that all correlations are statistically significant in every financial crisis, their empirical findings demonstrate that financial crises are, in fact, similar with the increase of global trade, the increasing pace of financial deregulation and global economic integration following the collapse [5-7]. The long-term cause of financial crisis is Soviet model, where financial supervision is lacking and progresses slowly. The United States financial crisis resulted from failures in financial regulation; yet, the disaster did not mean that the market process was invalid. Instead, the market system should definitely continue [8-10]. The government took charge of the financial supervision system's operation in China at the moment, developed a financial supervision analysis model, and developed a mode-based game analysis performed a comparison between multilateral and mega-regulation, noting the differences between the two with regard to of target conflicts [11-13]. Information transmission, regulation costs, and the scale effect are also investigated provides more analysis of the rent-seeking practices between regulatory bodies and the banking industry by using game theory based on reputation dynamics Financial organizations [14-17]. Financial supervision model and discovered that in order to increase regulation efficiency, reduce costs, and build a reliable system of financial control. To achieve the goal of stable operation, financial institutions should also create a variety of incentive and constraint mechanisms in line with pure strategy [18]. The combined approach of the Nash equilibrium and Nash equilibrium in the supervision game model. described the reasons for the high-risk actions that investment banks, as a standard representative of financial institutions, selected to execute all through the financial crisis while financial regulators continued to advocate for deregulation and put up pertinent ideas to reach the best potential balance believed the subprime crisis, ensuing global financial crisis were brought about a severe lack of financial supervision, which allowed participants too multiple chances for financial misconduct A recurrent game produced by market players and regulators is the regulated developing financial market.

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The reasoning behind market players' choice to select financial Unusualities is their high-risk actions intended to obtain an unlawful excess return [19]. Participants are more inclined to choose financial irregularities the higher the excess return. In the meantime, participants don't always choose financial irregularities since they know that if they are discovered by supervisors, they will face serious repercussions [20].

The major contribution of this research is abridge below,

- Initially the data is taken from Analcat. The UCI repository acquired the qualitative bankruptcy dataset in 2014 after it had been collected by internal experts.
- This study aims to offer International Financial Crisis that use algorithm from Multi View Graph convolutional Network to identify Bankruptcy and Non-bankruptcy through learning itself.
- It introduces Multi view graph convolutional method is used to avoid the noise contamination issue with the guidance of behaviour information.
- It introduces pre-processing segment, enhance the data by Federated Neural Collaborative Filtering (FNCF).
- Then, output of pre-processing given to feature selection step. In feature selection, ideal features are chosen utilizing STO.
- The performance metrics compared with existing methods like GA-FS-IFC, PE-CT-FC, and MGWO-SA-FCP respectively.

The remaining manuscript organized as: segment 2 defines literature survey, segment3 designates proposed technique, and segment 4 proves outcome and discussion, segment 5 offers conclusion.

II. LITERATURE REVIEW

Among frequent investigation work on International Financial Crisis depend on deep learning; some of the recent investigations were presented here.

Luo and Zhang [21] have presented GA of FS in IFC a few specific recommendations and guidelines that supervisors and participants can use to reduce financial risks, such as reducing supervision costs, increasing the effectiveness of to fully utilize the learning mechanisms and demonstration impact, provide oversight of finances, as well as incentive and limitations systems for supervisors and participants. It provides high precision and it provides low sensitivity.

Christy et al. [22] have presented PE of CT for FC Prediction analyse two methods for clustering for parsing different financial datasets that are pushed out of time periods to trades: k-means and farthest first clustering algorithms. The German, Polish, and Weislaw datasets completed evaluation processes. It provides high sensitivity and low precision.

Bhattacharya et al., [23] have presented MGWO with SA for FCP in Small Marginal Firms Small, marginal companies are essential to economy, closure has profound consequences. Thus, was essential that marginal small businesses able to anticipating financial crises to lessen the damage they do. The practice of predicting the probability of a financial crisis in the future is known as financial crisis prediction, or FCP. For financial institutions, legislators, and investors, financial crisis preparedness and mitigation were critical goals of financial crisis preparation and reduction. Machine learning (ML) techniques are employed in small and marginal businesses to predict financial crises. It provides high f1-score and it provides low precision.

Wang et al. [24] have presented Financial Crisis Analysis of Evergrande Group from Perspective of Game Theory Develop game theory method to examine relationship among government, businesses, along with best course of action for Evergrande to take in order to resolve its financial problem. Examine causes, effects of the financial crisis through looking at financial indicators. Researches illustrate how unaware expansion, a higher leverage ratio, weak cash flow managing, tougher national regulations are the reason for Evergrande's debt failure. It provides high precision and it provides low f1-score.

Castelblanco et al. [25] have presented remedies to PPP crisis in COVID-19 pandemic: Lessons from 2008 global financial crisis. The analysis emphases on revealing the semantic connections among keywords connected to PPP in order to fully understand the lessons that may be drawn from the Great Financial disaster and to provide suitable options for minimizing the effects of COVID-19 pandemic-associated global economic disaster. Results indicate that a comprehensive, self-contained, interconnected system linked to risk, funding, governance, procurement, institutional environment may be created by combining the PPP-crisis literature into five semantic communities. It provides higher accuracy, lower precision.

Batuman et al. [26] have presented the impact of the global financial crisis on corporate cash holdings: Evidence from Eastern European countries. Utilizing a sample of Eastern European businesses, this study analyzes how global financial crisis has affected factors that determine corporate cash holdings, changes towards objective cash levels. Based on panel fixed effects, GMM estimations, findings show a significant difference between pre- and post-crisis periods for firm-level determinants of cash holdings. It provides high precision and it provides low accuracy.

Matsuo et al. [27] have presented ideas for macroeconomic surveillance: relative text analysis of country reports with global and regional financial organizations. These results indicate that they use general and local economic concepts for multidimensional surveillance, resulting in informal coordination depend on focal-point effects. They also claim that informality gives them the ability to use discretion in defining the policy classifications for coordinated, independent acts, thus offering actual solution to the dispute between autonomy and coordination. It provides high specificity and it provides low accuracy.

III. PROPOSED METHODOLOGY

In this section, GA-FR-IFC-MGCN is discussed. The proposed is GA-FR-IFC-MGCN illustrated in Figure 1. It includes 4 stages likes data set, pre-processing, feature selection, classification. Thus, explanation about every phase is given as follows,

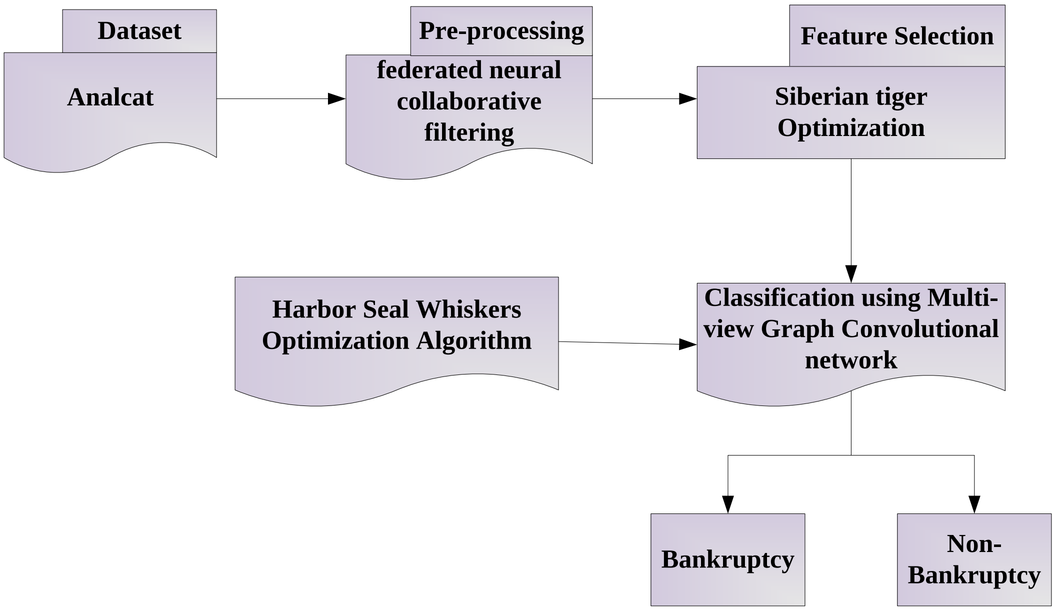

Figure 1: Proposed GA-FR-IFC-MGCN method.

A. Data collection

Initially, data is collect from Analcat dataset [28].The UCI repository acquired the qualitative bankruptcy dataset in 2014 after it had been collected by internal experts. For all of the datasets, the Analcat and UCI data repositories serve as benchmarks. Information collected by different financial organizations and institutions is included in the Qualitative_bankruptcy dataset. The qualitative information about risk factors is decisions that are collected from banks and financial institutions and are made by real specialists.

B. Pre-processing using Federated Neural Collaborative Filtering

In this section, they proposed Pre-processed using [29] Federated neural Collaborative Filtering (NCN). In pre-processed segment, enhancing the networks data using in the Federated Neural Collaborative Filtering demonstrate that modifications to the latent factor model are not appropriate, both conceptually and directly, with the aggregation algorithms used today propose enhancing it by splitting aggregation procedure into matrix factorization, averaging based on NNs. Thus, it is given in equation (1)

$$X_{y+1} \leftarrow \sum_{i=1}^{|b|} \frac{m_i}{m} x_{t+1}^{i} \tag{1}$$

here, $|b|$ represents number of selected participants in training round; m_i represents number of local training instances of participants; $m = \sum_{i=1}^{|b|} m_i$ represents local number of training instances, x_{t+1}^{i} represents local updates generated by participants i; Thus, it is given in equation (2)

$$\mathrm{I}_{t+1}^{sum} = \sum_{i \in b} \mathrm{HI}_{t+1}^{i} \tag{2}$$

where, I_{t+1}^{sum} is represent parameter contains sum of weight updates corresponds to item profile; Thus, it is given in equation (3)

$$\mathrm{HI}_{t+1}^{i} = \mathrm{I}_{t+1}^{i} + \sum_{i \in b: i<j} \mathrm{IP}_{ij} - \sum_{i \in b: i>j} \mathrm{IP}_{ji} \tag{3}$$

here, IP_{ij} represents generated random matrix using the agreed; i and user j in an ordered pairs of users; HI_{t+1}^{i} is represented the masked calculated weights. Thus, it is given in equation (4)

$$(|b|-1)\cdot\left(2B\cdot|\mathrm{I}| + 2B\cdot g1 + \left(\sum_{i=1}^{n-1} g_i \cdot g_{i+1}\right) + B + g_n + \left(\sum_{i=1}^{m} g_i\right) + 1 + |\mathrm{H}|\right) \tag{4}$$

where, B is represent the dimension; g_i is represent the processing unit; g_n is represent the negligible computational cost; H is represent the random vector; Finally, FNCN is utilized to enhance the networks data and this process will take to the next step for feature selection.

C. Feature Selection using Siberian Tiger Optimization

The proposed Feature Selection utilizing STO [30] is used. The Siberian tiger optimization is used to optimal features among the Analcat Dataset. The simulation of the Siberian tiger optimization, with high power in exploration and exploitation, as well as the creation of an optimal balance It produced better results than competitive algorithms, Siberian tigers, which make up the STO population, move all through the search space in search of better responses. Every individual Siberian tiger belongs to the STO population. It provides an option for the issue. Its location in search space relates to the problem's variable values. Thus, from a mathematical perspective, every Siberian tiger is represented by a vector, and the Siberian tiger population can be represented by a matrix.

Step 1: Initialization

The proposed feature selection using STO [30] is discussed. In feature selection, through a method of iteration that uses the population's search capacity, the proposed STO can offer a workable solution to the issue. Siberian tigers that make up the STO population move all through the search space in search of more accurate responses. Thus, it is given in equation (5)

$$Y = \begin{bmatrix} Y_1 \\ \vdots \\ Y_j \\ \vdots \\ Y_M \end{bmatrix}_{M\times n} = \begin{bmatrix} y_{1,1} & \cdots & y_{1,i} & \cdots & y_{1,n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ y_{i,1} & \cdots & y_{j,k} & \cdots & y_{i,n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ y_{M,1} & \cdots & y_{M,i} & \cdots & y_{M,n} \end{bmatrix}_{M\times n} \tag{5}$$

here, Y denotes population matrix of Siberian tiger's locations Y_i signifies i^{th} Siberian tiger and M implies total Siberian's tigers. n Signifies count of problem variables, i denotes algorithm iteration count. Siberian tigers' initial location in search space at the STO implementation initialization is determined randomly.

Step 2: Random generation

Input parameters produced at randomly. Ideal fitness values chosen depend on explicit hyper parameter condition.

Step 3: Fitness Function

First, a solution candidate matrix representing the starlings starting positional vectors is identified. The matrix is first assigned to random values inside a search space, the fitness function selects the ideal features is given in equation (6)

$$Fitnessfunction = [Selecting Optimal\ features] \tag{6}$$

Step 4: Prey Hunting

Each Siberian tiger's proposed prey sites have been selected from between other population members who have a higher objective function value than that member. Thus, it is given in equation (7)

$$SS_i = \{Y_k | k \in \{1,2...N\} \wedge G_k < G_i\} \cup \{X_{best}\} \tag{7}$$

here, X_{best} denotes the ideal candidate solution; N signifies total number of STO numbers. Then one member from this set SS_i is chosen randomly as attacked target by i^{th} Siberian tiger. Thus, it is given an equation (8)

$$X_{ij}^{PISI} = x_{i.j} + r_{ij} \cdot \left(PS_{i.j} - U_{ij} \cdot x_{ij}\right), \quad i = 1,2,........, N and j = 1,2,.......n, \tag{8}$$

here, PS_{ij} signifies j^{th} dimension of AP_i, X_i^{PISI} signifies novel position of i^{th} member depend on the phase of STO, r_{ij} signifies random numbers in [0, 1] interval, U_{ij} signifies random number. A new calculated location is permitted during the STO member update process if it increases the goal function's value.

Step 5: Fighting with a bear

In this section, Siberian tigers fight combat through brown as well as black bears to defend their lives and settle dissatisfaction over food, according to observations of their natural habitat. As a result, in the second stage, STO members receive updates depend on a simulation of the methods used by Siberian tigers to combat bears. The Siberian tiger ambushes the bear in this battle before killing it. Thus, it is given an equation (9)

$$H_i = \begin{cases} H_i^{O2D1}, G_i^{O2D1} \\ H_i \end{cases} \tag{9}$$

here, H_i^{O2D1} represents value of objective function of bear; H_i represents new position of the i^{th} Siberian tiger. Thus, it is given in equation (10)

$$H_{i,j}^{O2D2} = y_{i,j} + \frac{s_{i,j}}{p}\left(ibj - kbj\right) \tag{10}$$

where, $H_{i,j}^{O2D2}$ is represent the new position of the i^{th} Siberian tiger; $y_{i,j}$ is represent the random numbers in the interval; p is represent the iteration counter of the algorithm.

Step 6: Termination

Thus, the ideal features are selected utilizing STO, will repeat iteratively step 3 until halting $y = y + 1$ criteria is satisfies the features are selected by Siberian tiger optimization.

D. Classification using Multi View Graph Convolution Network

In this section, that proposed classification using Multi view Graph Convolution Network (MGCN) [31] is discussed. Multi View Graph Convolution Network is used to predict the international financial crisis more advanced form of GCNs; MAGCN comes with several trustable topologies that are possibly empirically constructed by some conventional graph construction techniques or already exist for a particular task. This has the potential to enhance the learning representation for tasks that are provided later. Thus, it is given in equation (11)

$$X = g\left(\hat{B}YZ\right) \tag{11}$$

where, g is represent the activation function; $\hat{B}$ is represent the self-loops in the adjacency matrix; Y is represent the pivotal idea in each layer; Z is represent the distinctive information; Thus, it is given in equation (12)

$$H\left(P; S_n \mid S_{m-1,........,} S_1\right) \geq \varepsilon_{info} \tag{12}$$

here, P is represent the information contained in P ; ε_{info} is a positive parameter; S_n is represent the distinctive information; S_{m-1} is represent the co-occurrence information. Thus, it is given in equation (13)

$$\hat{Y}_i = g_{GCN}(Y, B_i) = \mathrm{Re}\,Lu(\hat{B}_i YX_i) \quad (13)$$

where, $\hat{Y}_i$ is represent the i^{th} view; g is represent the dimension of the feature vector; $\hat{B}$ is represent the self-loops in the adjacency matrix; Y is represent the pivotal idea in each layer; Thus, it is given in equation (14)

$$g_i = g_{GAP}(G_i) = \frac{1}{g \times x}\sum_{j=1}^{h}\sum_{k=1}^{x} g_i, jk \quad (14)$$

where, g_i is represent the feature map of i^{th} channel; $g \times x$ is represent the spatial dimension; g_{GAP} is represent the simple arithmetic mean operation; g_i, kl is represent the equal contribution to the global feature; Thus, it is given in equation (15)

$$\hat{Y}_i = \frac{1}{M}\sum_{i=1}^{M}\frac{1}{|\mathrm{M}_{i,j}|}\sum_{l=1}^{|M_{i,j}|}(J + B_i)_{kl}\hat{Y}_{i,j,k} \quad (15)$$

here, $\mathrm{M}_{i,j}$ represents neighbour set of j^{th} node on i^{th} channel; M is represent the adjacency matrix with self-loops; B_i is represent all re-expressed node. Finally, the MGCN are classified into bankruptcy and Non-bankruptcy, because of its convenience, HSWOA is MGCN classifier. HSWOA is used to enhance MVGCN weight parameter $Y\ and\ B_i$ Here, HSWOA is used to tune weight and MGCN bias parameter.

E. Optimizing of MGCN using Harbor Seal Whiskers Optimization Algorithm

The proposed Optimization of MGCN using HSWOA [32] weight parameter $Y\ and\ B_i$ is optimized by HSWOA. Like humans, most mammals have whiskers. Because there are a lot of nerve endings at the base of each dense, wiry hair, they are very sensitive to any movement. A seal, being a water-based mammal, can feel and examine it can feel vibrations in the water, but it can also sense items with its whiskers. The whiskers on mammals are usually circular and uniformly formed.

1) Stepwise procedure for HSWOA

Here, step by step procedure is defined to get ideal value of MGCN based on HSWOA. Initially, HSWOA makes the equally distributing population to optimize the optimum parameter $Y\ and\ B_i$ of MGCN.

Step 1: Initialization Phase

Although having lateral lines, harbor seals utilize whiskers to identify underwater disturbances in form of oscillating spheres, track prey methods for tracking Harbor Seal prey. Thus, it is given in equation (16)

$$N = 1\pi\omega p d^2 \sin(\omega p) \quad (16)$$

here, $\omega p\ and\ d$ is represents angular frequency, displacement amplitude, oscillating sphere diameter, d represents distance among seal, prey; p represents time taken by Harbor seal to sense underwater disturbances of prey.

Step 2: Random generation phase

The pre-processed dataset features are selected at random utilizing HSWOA.

Step 3: Fitness function

The random solution is made from initialized assessments. It is calculated using equation (17)

$$FitnessFunction = Optimization([Y\ and\ B_i]) \quad (17)$$

Step 4: Exploration phase

Having certain identifying velocity, harbor seals utilize whiskers to detect and attack their prey. When monitoring vibrations under the surface, seal keeps its whiskers up, away from face. The water gets mixed by the movement of a prey. The seal's whiskers are capable of identifying the hydrodynamic tracks left by its prey. Thus, it is given in equation (18)

$$u_i = \frac{N}{2\pi}\frac{(2y_i^2 - B^2)}{(y_i^2 + B^2)^{5/2}} \quad (18)$$

here, B represents distance among seal, prey; y_i represent location of seal; thus, it is given in equation (19)

$$N = 2\pi\omega p d^3 \sin(\omega s) \quad (19)$$

where, $\omega, p\, and\, d$ denotes angular frequency; displacement amplitude, oscillating sphere diameter; s represents time taken by Harbor seal to sense underwater disturbances of prey. Figure 2 shows that the Flowchart for HSWOA optimizing of MAGCN.

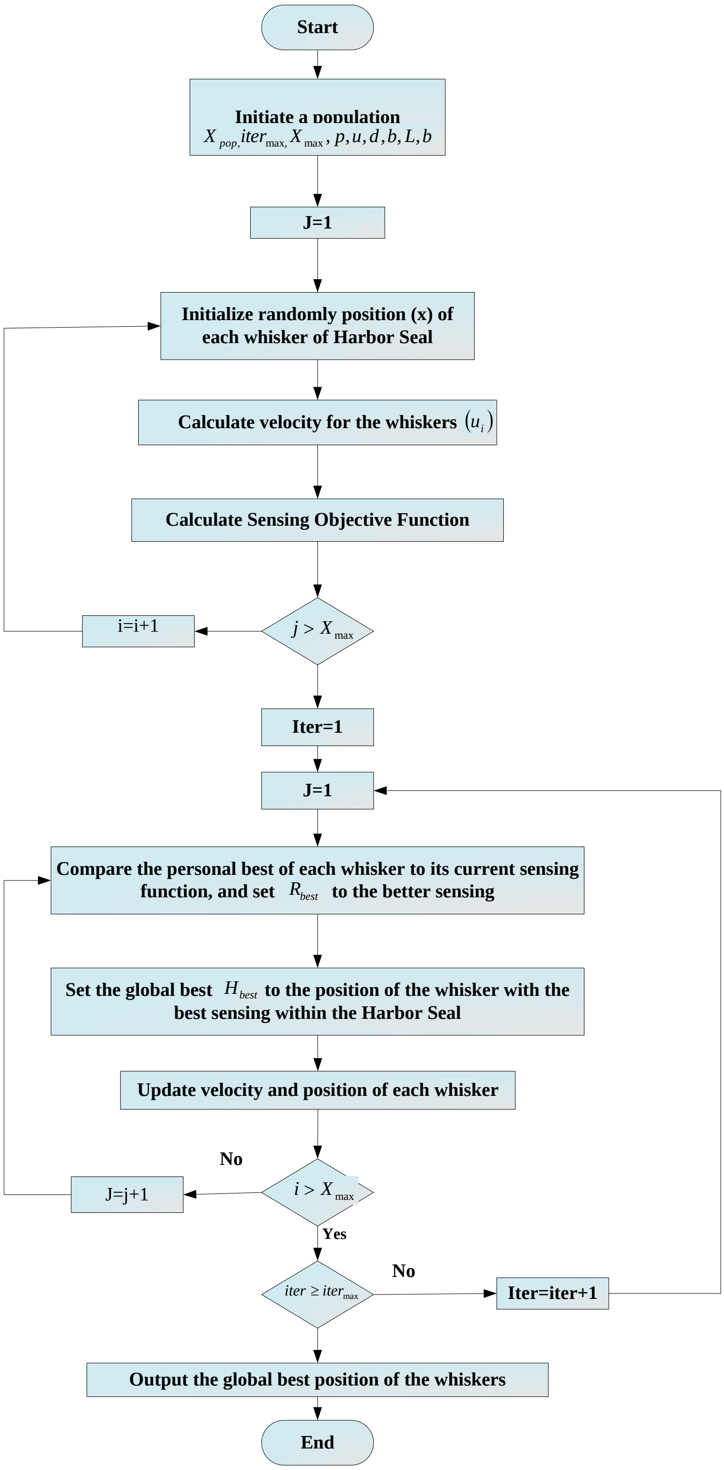

Figure 2: Flowchart for HSWOA optimizing of MAGCN

Step 5: Exploitation Phase

In this section, after an update to their whisker sensing velocity, the seals take advantage of the prey's possibly helpful positions. Thus, it is given in equation (20)

$$u_i^{l+1} = Kp_i u_i^l + cQp_2\left(BP_{best} - y_i^l\right) + bQp_3\left(KP_{best,i} - y_i^l\right) \quad (20)$$

here, K is represent the ellipse diameter; c represents length of major axis of ellipse; Q represents flowing water attack angle, ellipse main axis by flow velocity direction; thus, it given in equation (21)

$$M = ab^* \frac{1}{\sqrt{a^2 \sin^2 P + b^2 \cos^2 P}} \tag{21}$$

where, M is represent the ellipse diameter; P is represent the flowing water attack angle; a represents length of major axis of ellipse.

Step 6: Termination

The weight parameter value of $Y\,and\,B_i$ generator from MGCN is enhanced using HSWOA and it repeat step 3 until halting conditions $p = p + 1$ is satisfied. The GA-FR-IFC-MGCN effectively classifies the insider attacks such as bankruptcy and Non-bankruptcy by higher accuracy, less computational time.

IV. RESULT AND DISCUSSION

The outcome of GA-FR-IFC-MGCN method is discussed. The GA-FR-IFC-MGCN technique is executed in international Financial Crisis. The performance of GA-FR-IFC-MGCN method is evaluated under mentioned metrics are analyzed. The outcomes of the technique are analysed with existing technique likes GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP.

A. Performance measures

It is the significant task for best classifier section. Observe performance, performance such as accuracy, precision, sensitivity, FI- measure, computation time. RoC is studied. Measure performance metrics, confusion matrix is deemed. Measure the confusion matrix likes true negative, true positive, false negative, false positive values are needed to measure confusion matrix.

1) Accuracy

It is the capability to compute precise value. This is a metric generally defines method executes across each classes. It is given in equation (22)

$$Accuracy = \frac{(TP + TN)}{(TP + FP + TN + FN)} \tag{22}$$

In this step TP denotes True Negative, TN signifies True Negative, FP symbolizes False Positive, FN and implies False Negative.

2) Sensitivity

True positive rate or sensitivity is terms used to describe recall. It calculates the capability of a classification technique to effectively detect and capture each pertinent instance of a positive class. This is expressed in equation (23)

$$Sensitivity = \frac{TP}{(TP + FN)} \tag{23}$$

3) Precision

Precision estimation many positive labels had expected with greater accuracy. It is given in equation (24)

$$\Pr ecision = \frac{TP}{(TP + FP)} \tag{24}$$

4) FI-Measure

The f-measure, termed as F1 score which integrates precision and recall to a single result. It is beneficial to balance both false positives and false negatives. This is calculated by equation (25)

$$F - measure = 2 \times \frac{\Pr ecision \times recall}{\Pr ecision + \operatorname{Re} call} \tag{25}$$

5) RoC

Roc is ratio of false negative to the true positive region. Thus, it is given in equation (26)

$$FalsePostiveRate = \frac{FP}{FP + TN} \tag{26}$$

B. Performance Analysis

Figure 3 to 8 determines simulation outcomes of GA-FR-IFC-MGCN method. Then, GA-FR-IFC-MGCN is analysed to the existing analysed with GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

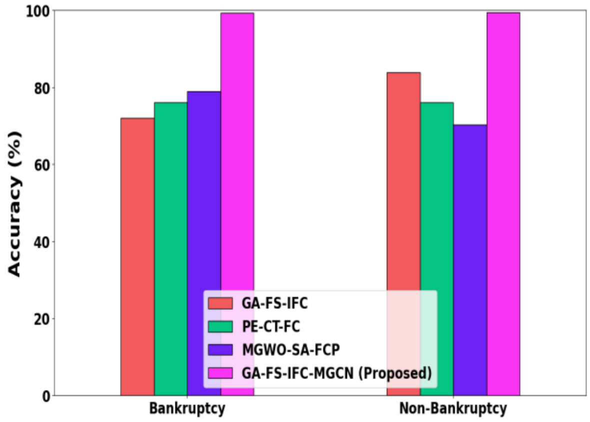

Figure 3: Accuracy analysis

Figure 3 determines accuracy analysis. Here, GA-FR-IFC-MGCN method attains 25.87%, 22.87%, and 24.45% higher accuracy for Bankruptcy ; 18.98%, 20.78%, 23.87% higher accuracy for Non-Bankruptcy; 27.98%, 26.65%, 25.77% analysed with existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

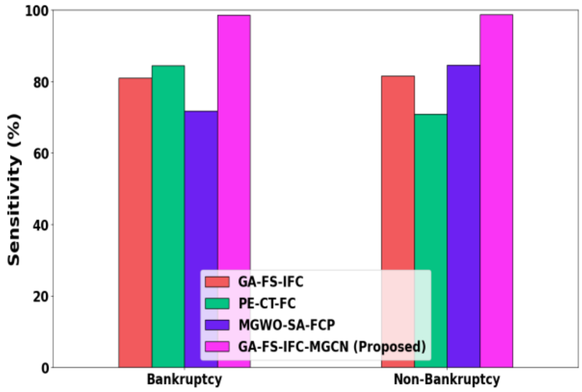

Figure 4: Sensitivity analysis

Figure 4 determines sensitivity analysis. Here, GA-FR-IFC-MGCN method attains 29.27%, 20.77%, and 26.55% higher sensitivity for Bankruptcy ; 18.98%, 20.78%, 23.87% higher sensitivity for Non-Bankruptcy; 20.88%, 23.65%, 28.77% analysed with existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

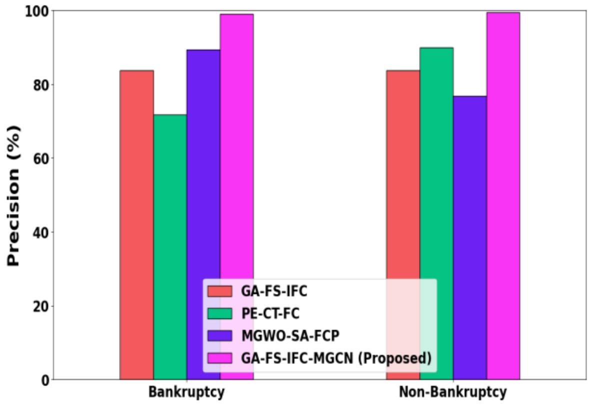

Figure 5: Precision analysis

Figure 5 determines precision analysis. Here, GA-FR-IFC-MGCN method attains 29.27%, 20.77%, and 26.55% higher precision for Bankruptcy; 21.98%, 20.78%, 21.87% greater precision for Non-Bankruptcy; 29.38%, 22.95%, 22.37% analysed with existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

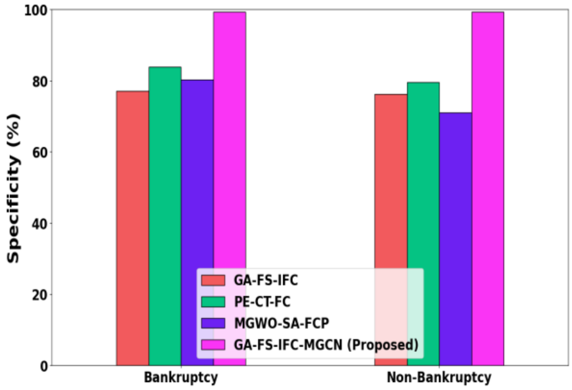

Figure 6: Specificity analysis

Figure 6 determines specificity analysis. Here, GA-FR-IFC-MGCN method attains 29.27%, 20.77%, and 26.55%higher specificity for Bankruptcy; 27.88%, 23.88%, 28.37% greater specificity for Non-Bankruptcy; 22.34%, 27.25%, 24.37% analysed with existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

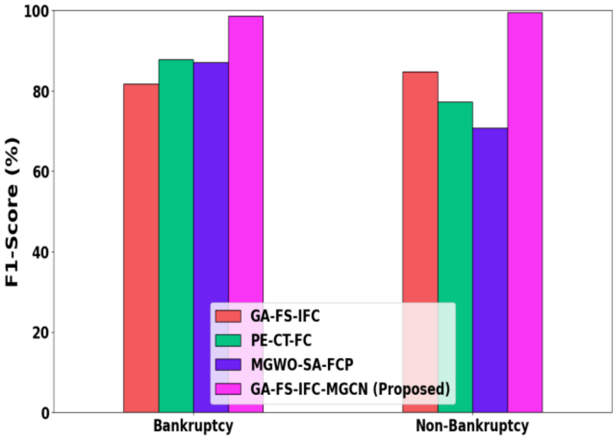

Figure 7: F1-score analysis

Figure 7 determines F1-score analysis. Here, GA-FR-IFC-MGCN method attains 23.27%, 20.77%, and 26.55% higher F1-score for Bankruptcy; 21.58%, 24.88%, 25.57% higher F1-score for Non-Bankruptcy; 28.44%, 29.55%, 26.35% analysed with existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

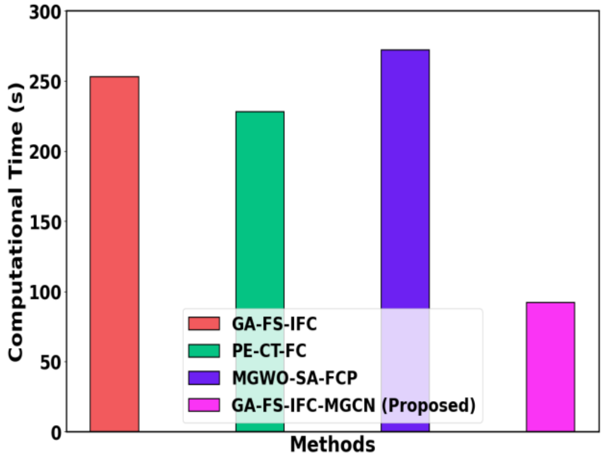

Figure 8: Computation time analysis

Figure 8 portrays computational time analysis. The GA-FS-IFC-MGCN method attains 25.20%, 28.25%, and 28.34% lower computational time analysed with existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP methods.

C. Discussion

An efficient Game Analysis of Financial Regulation in International Financial Crisis using Multi-view Graph Convolutional Network GA-FS-IFC-MGCN is proposed. The results of the proposed approach are used to predict the international financial for the efficient financial regulation. Utilize deep learning methods for game analysis in order to gain insight into the dynamics of financial supervision in the context of global financial crises. The goal is to identify strategies and regulatory actions that are beneficial in promoting global financial stability and resilience. The Accuracy values of GA-FS-IFC-MGCN are 22.34%, 20.15%, 25.12% higher than existing GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP techniques. Similar to this, the Accuracy of proposed technique is 98.92% analysed with average Accuracy of comparison techniques of 80.42%. The comparative methods are expensive than proposed method. Dataset is considered significant if, depending on the specific problem being investigated

V. CONCLUSION

In this section, Multi-view Graph Convolutional Neural Network(GA-FR-IFC-MGCN) is successfully implemented. Utilize Multi-view Graph Convolutional Neural Network methods for game analysis in order to gain insight into the dynamics of financial supervision in the context of global financial crises. The goal is to identify strategies and regulatory actions that are beneficial in promoting global financial stability and resilience. The results of the proposed approach are used to predict the international financial for the efficient financial regulation. According to the experimental results, GA-FS-IFC-MGCN performed better when used with the Co-training technique than when used separately regards FI-Score, precision and sensitivity. The proposed GA-FR-IFC-MGCN method is applied in Python with the dataset of Analcat. The performance of the proposed GA-FR-IFC-MGCN approach contains 28.69%, 25.64%, and 23.78% high recall; 26.34%, 29.78%, and 22.47% high Roc; 23.23%, 28.45% and 21.19% high F1-score are analysed with existing techniques likes GA-FS-IFC, PE-CT-FC and MGWO-SA-FCP respectively. Future research on the game analysis of financial regulation in international financial crises should concentrate on improving model architectures, adding temporal dynamics, investigating cross-domain learning, increasing explain ability, and assuring resilience against adversarial attacks.

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