

## *Retraction*

# **Retracted: Economic Structure Analysis Based on Neural Network and Bionic Algorithm**

### **Complexity**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] Y. Dai and L. Su, "Economic Structure Analysis Based on Neural Network and Bionic Algorithm," *Complexity*, vol. 2021, Article ID 9925823, 11 pages, 2021.

## Research Article

# Economic Structure Analysis Based on Neural Network and Bionic Algorithm

Yanjun Dai and Lin Su 

*School of Marxism, Dalian University of Technology, Dalian Liaoning 116023, China*

Correspondence should be addressed to Lin Su; [sulin@mail.dlut.edu.cn](mailto:sulin@mail.dlut.edu.cn)

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In this article, an in-depth study and analysis of economic structure are carried out using a neural network fusion release algorithm. The method system defines the weight space and structure space of neural networks from the perspective of optimization theory, proposes a bionic optimization algorithm under the weight space and structure space, and establishes a neuroevolutionary method with shallow neural network and deep neural network as the research objects. In the shallow neuroevolutionary, the improved genetic algorithm (IGA) based on elite heuristic operation and migration strategy and the improved coyote optimization algorithm (ICOA) based on adaptive influence weights are proposed, and the shallow neuroevolutionary method based on IGA and the shallow neuroevolutionary method based on ICOA are applied to the weight space of backpropagation (BP) neural networks. In deep neuroevolutionary method, the structure space of convolutional neural network is proposed to solve the search space design of neural structure search (NAS), and the GA-based deep neuroevolutionary method under the structure space of convolutional neural network is proposed to solve the problem that numerous hyperparameters and network structure parameters can produce explosive combinations when designing deep learning models. The neural network fusion bionic algorithm used has the application value of exploring the spatial structure and dynamics of the socioeconomic system, improving the perception of the socioeconomic situation, and understanding the development law of society, etc. The idea is also verifiable through the present computer technology.

## 1. Introduction

An artificial neural network (ANN) is a simplified system composed of many artificial neurons connected, which abstracts the neuronal network of the human brain from the perspective of information processing and builds some simple models to form different networks according to different connections. Each neuron represents a specific output function, and each connection between two neurons represents a weighted value of the signal passing through the connection, and the output of the network varies depending on the connection, weight, and output function of the network. From the perspective of global economic development, economic restructuring and upgrading have become the focus of attention of policymakers and the public in various countries [1]. The current international financial crisis has fully exposed the long-standing structural contradictions of

the world economy, including the hollowing out of industries and the bubble of a virtual economy in developed countries, the imbalance between investment and consumption, and the imbalance between external and domestic demand in developing countries [2]. At present, the global economy is recovering slowly and the economic performance among countries has become more differentiated; the original global economic cycle model has ended, but a new global economic cycle model has yet to take shape; developed countries such as the U.S. and Europe are vigorously promoting the “reindustrialization” strategy, scientific and technological innovation is bringing breakthroughs, and new trends in global trade and investment are quietly emerging. The world economic landscape is undergoing profound adjustments. The world economic landscape has been profoundly adjusted, and the issue of economic structure optimization has become the main theme of national policies.

The study of the problem of economic structural equilibrium and its development trend has far-reaching theoretical significance and important practical value. Theoretically, the study of economic structural equilibrium is an intuitive reflection and detailed elaboration of the current state of economic development and an extension and expansion of economic research theories. Practically, it provides data support for taking economic development initiatives and promotes sustainable and stable economic development [3]. Changes in the structure of the economy are very interesting and important. The development of industries is always fluctuating and unpredictable, and if we can predict which industry is in the wind of a booming rise in the future, it will be of great benefit to both individual career planning and investment and even government investment attraction [4]. At the same time, studying the structural equilibrium of the economy not only helps to locate the current stage of development and progress of the economy but also helps to identify the outstanding problems in the process of economic development. Therefore, it is very important to study the structural balance of the economy and economic development trend to have macro-control of the economic development status and trend.

In terms of economic development and structural evolution, there is an urgent need to reveal economic development paths, explore the paths that can quickly lead to industrial upgrading, and study the development strategies that can raise the level of the economy the fastest. Macro-level modelling of economic networks provides the basis for analysing economic development paths. Product space shows the proximity of products to each other, and it is easier for countries to develop products close to existing products, gradually occupy complex products located in the centre of product space, and continuously improve the level of economic development. Similarly, regions are more likely to develop industries that are technologically close to existing industries and tend to eliminate industries that are less technologically related to existing industries, thus achieving continuous optimization and upgrading of industrial structure. Studying the path of economic development and revealing the path-dependent effect of industrial development can help guide the regional economic restructuring scientifically.

As mentioned above, the complex structure of socio-economic systems makes it difficult for traditional methods to accurately perceive socioeconomic dynamics and to deeply reveal the laws of socioeconomic development. In recent years, the widespread use of new data and tools has given rise to computational socioeconomics, an emerging interdisciplinary research branch that uses quantitative means to study various phenomena in socioeconomic development. However, the complex behavioural dynamics patterns of individuals at the micro level make it difficult to accurately perceive and predict individual socioeconomic states; group behaviours at the meso level are interrelated and influenced by each other, and it is not easy to directly infer the overall state of socioeconomic systems; macro-level lacks methods to portray the spatial structure of socioeconomics and analyse economic complexity have insufficient

ability to perceive and predict regional economic development. The overall lack of deep insight into the paths and development dynamics mechanisms does not make it easy to propose optimal economic development strategies. Therefore, it is of great theoretical significance and application value to further study the spatial structure and dynamics of socioeconomic systems under the framework of computational socioeconomics and to provide support for the formulation of scientific socioeconomic policies.

*1.1. Status of Research.* Huang used a large number of predictor variables to forecast macroeconomic time series variables, first used the principal component analysis to construct a small number of indices to summarize the predictor variables, used an approximate dynamic factor model as a statistical framework for estimating indicators and forecasting structure, selected data from 1970 to 1998 to simulate real-time 215 predictor variables, where the predictions outperformed univariate autoregressive models [5]. Wang reviewed empirical evidence on the success of different econometric model-based economic forecasting methods in practice and found that models that allow for a reduction in VARs by starting with a relatively loose lag specification, by least-squares estimation, tested on constant data, had the best results on average [6]. Guo et al. suggested that the extensive use of cointegration-based equilibrium correction models (ECM) in macro-econometric forecasting may increase their sensitivity to deterministic shifts, with forecasting accuracy decreasing instead when the data show jumps [7]. Yao and Yi have simulated macroeconomic time series using ANN models. Although not using their models for forecasting, they analysed the basis on which neural networks can be used for forecasting. ANNs are general approximators; i.e., they can accurately approximate functions that satisfy certain regularity conditions [8]. Thus, one expects neural networks to be versatile tools for economic forecasting and to adapt quickly to complex and changing forecasting situations.

Computational socioeconomics is an emerging interdisciplinary research direction that uses advanced tools to analyse large-scale real data, aiming to accurately and timely perceive the socioeconomic state and reveal and understand the laws of socioeconomic operation [9]. It uses complex networks to portray the interactions in socioeconomic systems and analyse the spatial structure and dynamics of socioeconomics to provide deeper insight into socioeconomic phenomena. This article develops the study of the spatial structure of socioeconomic systems at micro, meso, and macro levels and further uses spatial networks and dynamics models to study the evolution of economic structures and optimal economic development strategies [10]. For the first time, we propose a severity index to characterize the regularity of individual behaviour and find that severity is significantly correlated with student performance and that the use of severity features can significantly improve the prediction of student performance by ranking learning algorithms [11]. The centrality features of

interactive and social networks were found to predict the likelihood of employee promotion and separation, and the interactive network had stronger predictive power than the features of social networks, and it was easier to predict separation than promotion. The influence of the spatial structure of the network on the types of phase transitions of boot loop percolation is revealed, and the power index -1 of the long-edge distribution is found to be the critical value: when it is greater than or equal to -1, a double-phase transition with constant primary and secondary phase transition points appears; when it is less than -1, only a second-phase transition with increasing phase transition points as the power index decreases appears [12]. A similar technology learning pathway and the near-neighbourhood learning pathway in the economic development process are proposed, and it is found that both learning pathways can increase the probability of developing new industries, but there is a substitution effect between them [13]. The introduction of high-speed rail is found to significantly increase regional industrial similarity and productivity; optimal development strategies exist for both learning pathways, namely, randomly selected industrial activation and randomly selected regional connectivity.

This article will systematically study the spatial structure and dynamics of socioeconomic systems in the framework of computational socioeconomics to provide insightful insights into socioeconomic phenomena. Based on an introduction to computational socioeconomics, this article will study the spatial structure modelling and state inference of socioeconomic systems at the micro, meso, and macro levels, respectively, and then use the spatial network and dynamics models to study economic structure evolution and optimal development strategies. Broadly speaking, the predictive management of socioeconomics is studied at the micro level, including the regularity of social behaviour to predict learning achievement, the structural characteristics of social networks to predict career development, and large-scale data to reveal socioeconomic phenomena.

## 1.2. Economic Structure Analysis of Neural Network Fusion Bionic Algorithm

### 1.2.1. Neural Network Fusion Bionic Algorithm Design.

In this section, the output layer weights of the Molecular Weight Distribution Elaboration Likelihood Model (MWD-ELM) neural network are derived by the BAS algorithm so that the input weights and output weights of the neural network are computationally derived, thus avoiding the errors caused by random selection. The neural network model derived by the bionic algorithm is called the dual-deterministic ELM neural network model with weights [14]. The model construction steps combined with the bionic algorithm are as follows: input data, initialization of the neural network, where the number of hidden layer nodes has been determined by the growth method in MWD-ELM. In the forward process, the ANN is computed layer by layer from the input layer to the output layer [15]. To compute the output layer weights, the input weights are randomly

generated during the initialization of the neural network. To create the direction vector required by the BAS algorithm, define the spatial dimension  $k$ , set the model structure as  $P$ ,  $P$  is set as the number of neurons in the input layer,  $Q$  is set as the hidden layer, and the number of neurons in the output layer is  $R$ . Then, the search space dimension  $k = P * Q - Q * R + Q + R$ . Set step factor 6 to control the area searchability of the aspen. The initial step size should be as large as possible to cover the current search area without falling into a local minimum. In this article, a linear decreasing weight strategy is used to ensure the refinement of the search.

$$\delta_1^{t+1} = \eta \delta_0^t. \quad (1)$$

The root means square error (RMSE) was chosen as the fitness function of the BAS algorithm. The RMSE of the test data is used as the fitness evaluation function to facilitate the search of spatial regions.

$$\text{fitness} = \frac{1}{T} \sum_{i=1}^T (t_{\text{sim}(i)} + y_i)^2, \quad (2)$$

$T$  is the number of samples in the training set;  $t_{\text{sim}(i)}$  is the output value of the  $i$ -th sample model;  $y_i$  is the actual value of the  $i$ -th sample. Therefore, when the algorithm iteration stops, the position with the minimum fitness value is the best solution. As shown in Figure 1, this neural network consists of three layers, which look simpler than the usual neural networks. In the input and output layers, there are  $J$  neurons and  $K$  neurons, respectively, and they use simple linear activation functions. The hidden layer has  $M$  neurons activated by a monotonic nonlinear activation function.

The BP algorithm is an algorithm designed with this idea. Its basic idea is that the learning process is composed of two processes: the forward propagation of the signal (seeking the loss) and the backpropagation of the error (error back-propagation). The selection operation simulates the natural evolution of organisms in which species with high adaptation to the environment have a greater chance of being inherited to the next generation, while species with low adaptation to the environment have less chance of being inherited. Therefore, the selection operation enables individuals with higher fitness values to have a greater chance of being selected for replication to the next generation, while individuals with lower fitness values have a smaller chance of being selected for replication to the next generation. The probability of selection for linear sorting is calculated as follows:

$$P_i = c(1+c)_{i-1}^3. \quad (3)$$

Crossover manipulation mimics the phenomenon of genetic recombination in organisms during natural evolution, where new individuals are formed by swapping some genes between paired chromosomes. The pairing problem before crossover is generally solved by random pairing. Suppose a real-valued crossover is performed between two individuals  $x_i^j$ ,  $x_i^k$ ; then, the two new individuals resulting from the crossover operation are as follows:

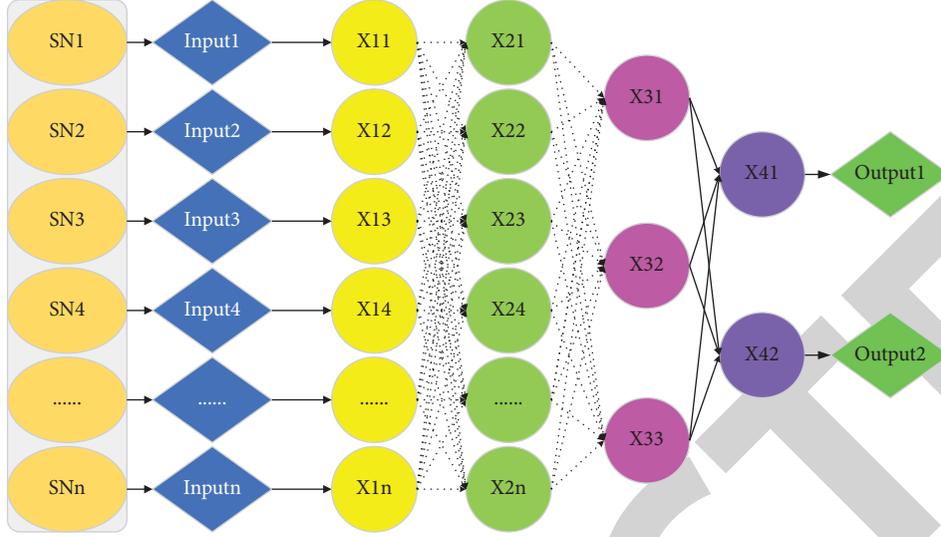


FIGURE 1: Neural network fusion bionic algorithm.

$$\begin{cases} x_{t+1}^i = \alpha x_t^i - (1 - \alpha)x_t^i, \\ x_{t+1}^j = \alpha x_t^j - (1 - \alpha)x_t^j. \end{cases} \quad (4)$$

The mutation operation simulates the genetic variation of organisms in the natural evolutionary process. In genetic algorithms, the mutation operation is useful in two ways: first, to improve the local search ability of the algorithm and, second, to maintain the diversity of the population and prevent the phenomenon of “premature maturity.” Assuming that the  $x_{t+1}^{ij}$  gene  $\alpha x_t^j$  in the  $i$ -th individual is mutated in real value, the new individual produced after the mutation operation is as follows:

$$x_{t+1}^{ij} = \begin{cases} x_{t+1}^{ij} + \alpha x_t^i - (1 - \alpha)x_t^i \times f(g), & r > 0.5, \\ x_{t+1}^{ij} - \alpha x_t^j - (1 - \alpha)x_t^j \times f(g), & r \leq 0.5. \end{cases} \quad (5)$$

It is important to note that the number of hidden layer neurons is determined using the growth method. If the classification accuracy remains unchanged, it is considered as the best classification accuracy, and the training of MWD-ELM is completed. The number of hidden layer neurons that reach the best classification accuracy first is the optimal number. To convert the known formula into the required matrix form, the number of experimental samples is set to  $N$ , and the output is obtained in matrix form.

$$Y = Bf(AX + H). \quad (6)$$

To facilitate comparison, half of the examples from each dataset were used as the training sample set and the remaining half was used as the test sample set during the experiments. Besides, the arctan function is used as the activation function of the neural network, while its inverse function is the tan function. The execution steps of the IGA algorithm are like the Yu algorithm, but there are two differences. One is that the IGA algorithm uses the expansion rate to measure the mutual influence between regular expressions, and the other is that the ICOA

algorithm sees that the regular expression is added to the group every time, will add a node representing the group from the original regular expression influence diagram, and update the expansion rate between other regular expressions and the group.

The weights and thresholds of shallow neural networks are commonly calculated by BP algorithm, and the process of calculating weights and thresholds is described as the training process. The essence of the process of calculating weights and thresholds of neural networks can be described as the optimization process represented by equation (6). As can be seen from Figure 2, the traditional BP algorithm starts from one point in the search space and follows the gradient descent to find the optimal solution of the target, which is very easy to fall into the local minima point, while the neuroevolutionary method uses the evolutionary algorithm to start from multiple points in the search space, which is relatively easy to find the global minima point; therefore, the global optimization algorithm, which is the evolutionary algorithm, can be used to achieve the fast network weights and thresholds computational capability and improve the search capability of the network. The dataset in this article is obtained by collating data from our own existing data and related articles.

The sample dataset was divided into training, validation, and test samples in the ratio of 1:1:1 using the stratified sampling method, and the samples were normalized separately for the divided samples; the number of  $n = a * b - b - b * c - c$  genetic loci per individual, individual  $x_t^i = [x_t^{i(1)}, x_t^{i(2)}, \dots, x_t^{i(n)}]$  was expressed as an  $n$ -dimensional row vector.

The BP neural network is initially trained to obtain the weights and thresholds of the network and encoded. The individuals are encoded with real values and consist of four parts: input layer and implicit layer connection weights, implicit layer thresholds, implicit layer and output layer connection weights, and output layer thresholds [16]. Each individual includes all the weights and thresholds of a neural

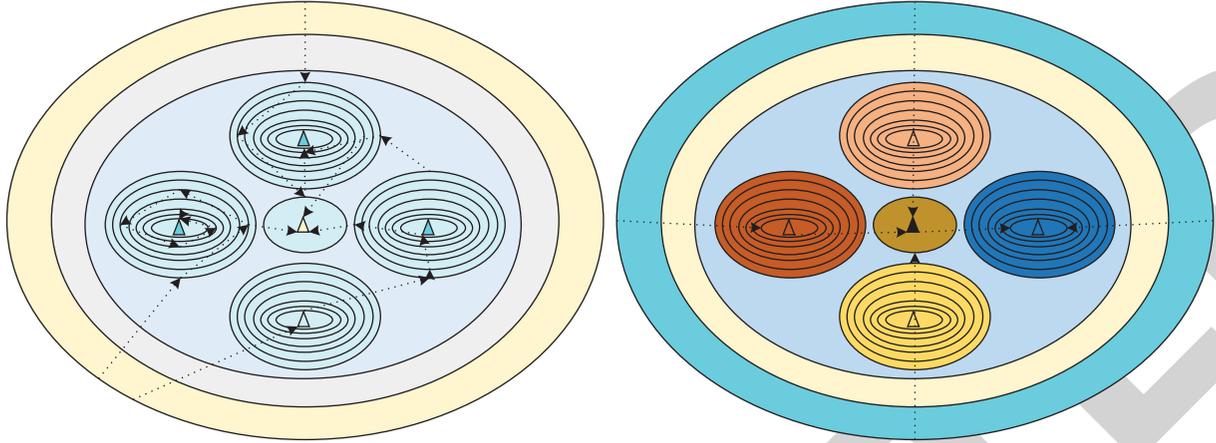


FIGURE 2: Schematic of BP algorithm and neuroevolutionary approach to search.

network, and if the network structure is known, a neural network with determined structure, weights, and thresholds can be formed; after encoding, a population is generated, and the  $t$ -th generation population  $X_t$  can be expressed as an  $n * m$  matrix as follows:

$$X_t = [x_t^{i(1)}, x_t^{i(2)}, \dots, x_t^{i(n)}]^T. \quad (7)$$

The weights and thresholds of the BP neural network are obtained from the individuals, and the output of the system is predicted after training the BP neural network with training samples, and the prediction classification accuracy is taken as the individual fitness value.

$$k_i = \begin{cases} 1, & y_i = 0, \\ 0, & y_i \neq 0, \end{cases} \quad (8)$$

$$f_i = \sum_{i=1}^l k_i * k * l.$$

A flowchart of the shallow neuroevolutionary method is shown in Figure 3.

We calculate the final output value and the loss value between the output value and the actual value according to the input sample, the given initialization weight value  $W$ , and the value  $b$  of the bias term. If the loss value is not within the given range, it will be reversed. Otherwise, the process of propagation, the update of  $W$  and  $b$ , is stopped. The output is transmitted back to the input layer through the hidden layer in some form, and the error is allocated to all the units of each layer to obtain the error signal of each layer unit. The error signal is used as the basis for correcting the weight of each unit. ELM is characterized by the random selection of parameters of the input layer neurons in the process of determining the network parameters. This network parameter determination process does not require any iterative steps, thus greatly reducing the network parameter tuning time. Compared with traditional training methods, this method has a fast learning speed and good generalization performance. It is worth pointing out that all ELM and ELM-like neural networks generate the input layer weights randomly and then calculate the output layer weights [17].

Therefore, the following question naturally arises: can we exchange the methods for determining the input and output weights? To solve this problem, a new method for determining weights is proposed in this section. In this improved ELM, the weights of the output layer are randomly generated and the weights of the input layer are determined by a pseudoinverse calculation. Compared with the traditional ELM, the novel neural network proposed in this section has a mirrored-weight-determination process and is therefore called mirrored-weight-determination (MWD-ELM) ELM for short. To test the effectiveness of the proposed MWD-ELM, comparative experiments based on real-world classification datasets are conducted.

The research of computational socioeconomics includes perceiving socioeconomic dynamics and understanding socioeconomic laws. The research on perceiving socioeconomic development is concerned with the relationship between individual behavioural characteristics and socioeconomic status at the micro level; the state of the socioeconomic system, urban landscape layout, and functional area status at the meso level; the inference, structure portrayal, and development trend prediction of national and regional socioeconomic levels at the macro level. Understanding the study of socioeconomic development laws, the micro level focuses on the temporal and spatial behavioural laws of individuals in daily life and the changes in behavioural laws in response to unexpected situations; the meso level focuses on group behavioural laws, urban socioeconomic scalar laws, and landscape layout evolution laws; the macro level focuses on the learning process and path dependence of national and regional economic development and the best economic development strategies.

## 2. Economic Structure Model Study

Socioeconomic development is gradually moving from simple and uniform to complex and diverse, a process in which the socioeconomic level is constantly increasing. Using network modelling methods to analyse large-scale real data, it is possible not only to perceive economic dynamics and portray the complexity emerging in the development

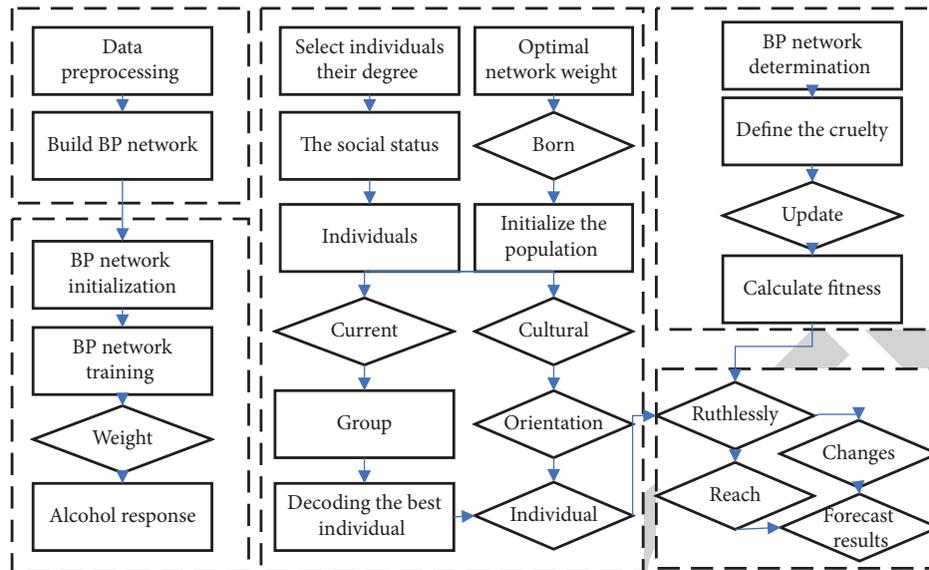


FIGURE 3: Flowchart of shallow neural evolution method.

process from the structural perspective, but also to predict economic development trends using the structural features of the network. The existence of complex interactions between subjects in socioeconomic systems leads to inferring the state of the system not only by considering individual behavioural characteristics but also by paying attention to individual interactions and relative relationships [18]. Complex networks can model subject interactions, and when it is not easy to infer the state of a socioeconomic system directly, the problem can be solved with the help of network structure-based ranking methods.

The most common approach in addressing the problem of false user ratings is to create online reputation evaluation systems that rate and rank users' reputations based on their rating behaviour. User reputation mechanisms have become the cornerstone of online socioeconomic systems, such as facilitating social e-commerce, helping companies evaluate job applicants, and improving the effectiveness of recommendation algorithms.

Concerning the principles of index system construction and experts' guidance, 90 indicators affecting macroeconomic equilibrium are selected from six comprehensive directions: market, government, society, science and technology, ecological environment, and internationalization. Under these six comprehensive indicators, there are secondary indicators, and under the secondary indicators, there are some tertiary indicators. Figure 4 shows the market indicator system.

The primary indicators market and the secondary indicators of output, investment, savings, consumption, institutions, and prices are all hidden variables, which are some comprehensive and unmeasurable indicators, and only the tertiary indicators are known indicators. Since there are many economic indicators, and many of them are highly correlated, some tertiary indicators are composite indicators obtained by combining some indicators with high correlation and through certain calculations. Economic

development is bound to be accompanied by energy consumption, and whether electricity consumption, which is an important expression of energy consumption, will promote economic growth has become a popular issue for many scholars to study. The increase in the level of electricity consumption can promote economic growth, so energy is a positive indicator for economic research.

The promotion effect of government debt on the economy is two-sided, a certain percentage of debt ratio can promote the development of the economy, but it may also have a negative effect, so whether this indicator has a positive effect or a negative correlation on the economy needs to be analysed specifically in the analysis process. The urban-rural income gap hurts economic growth; on the contrary, economic growth can reduce the urban-rural income gap and reducing the urban-rural gap can promote economic development, so the urban-rural income ratio is an inverse indicator for economic development. The level of economic development also affects the average life expectancy of human beings; the better the economic development, the greater the average life expectancy of people, so the length of the average life expectancy can reflect the development of the economy. Wastewater in the eco-environmental index system refers to the sewage treatment capacity, waste (solid waste) refers to the waste treatment rate, and pollution (pollution treatment) refers to the relevant investment completed in industrial pollution treatment, which are all positive indicators for reducing the environmental pollution. Exhaust gas, on the other hand, refers to the emission of sulphur dioxide, which can cause harm to the environment and is a negative indicator. The temperature will affect water resources, etc., so it will have an impact on the agricultural economy, and it can be said that temperature is correlated with the economy, but whether it is a positive or negative correlation, there is no clear judgment, and the indicators can be adjusted after correlation analysis in the analysis process.

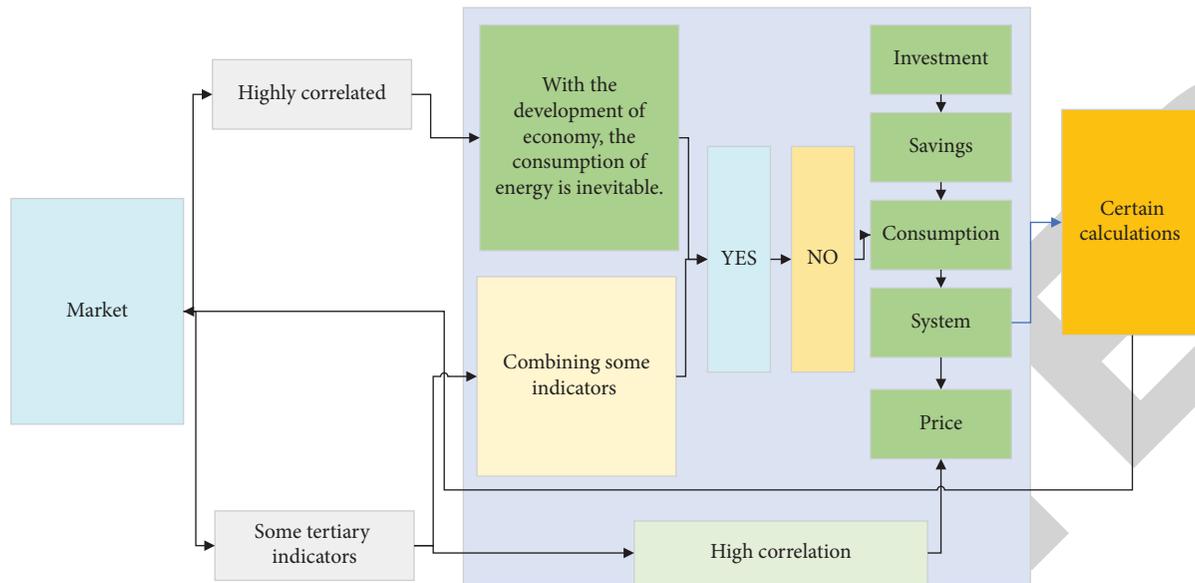


FIGURE 4: Market indicator system.

The reputation value of each user is calculated based on the reputation feedback matrix  $\eta'$ . If the mean value of users getting reputation feedback is small, then the rating behaviour deviates from the public, and the reputation should not be high; if the variance of getting reputation feedback is large, then the rating behaviour is unstable and the reputation should not be high. Finally, all users are sorted by reputation value  $\eta'$  to obtain the top  $\eta'$  users with the lowest reputation ranking, which are more likely to have cheating rating behaviour. Figure 5 shows a schematic diagram of the online user reputation ranking algorithm based on cluster clustering, where the serial numbers next to the arrows indicate the running flow of the algorithm.

From the perspective of the world economic cycle model, the old economic cycle model has ended, but a new economic cycle model has not yet been established. The developed countries, represented by the United States, are adjusting their debt consumption pattern, trying to accumulate savings, expand investment, and promote exports. Emerging economies try to get rid of the situation of relying too much on external demand and actively expand domestic demand [19]. Resource-based countries are also trying to change their industrial development model, which relies solely on the development of primary products. From the perspective of the global economic growth trend, the global economy is expected to remain in a period of low growth for a longer period. Developed economies maintain an uneven and weak recovery, with the follow-up effects of Japan's economic stimulus policies and structural reforms yet to be seen.

From the perspective of industrial patterns, developed countries vigorously promote "reindustrialization," implement economic rebalancing, attach importance to the development of the real economy, and promote the return of high-end manufacturing. Emerging economies generally attach importance to expanding domestic demand, and industrial development has diverged, with some countries

actively undertaking the low-end industrial transfer. In particular, the new scientific and technological revolution breeds breakthroughs, and innovations in new energy, new materials, life science and technology, and space and marine development are accelerated. In the future, the competition among countries in the world for industrial and technological heights will become more intense.

In terms of the global economic governance structure, the landscape is also gradually changing. Developed economies continue to dominate the international economic order, but their position of strength has relatively declined [20–26]. The voice and influence of emerging economies and developing countries have increased, but not enough to dominate the international rule-making process. The role of new mechanisms such as the G20 in global economic governance has increased. In terms of international finance, there has been a gradual recovery from the international financial crisis, but there are still more risks. In particular, the issue of macro policy coordination among major economies may bring about drastic fluctuations in international financial markets. In the increasingly complex international situation, China must be based on its development, make full use of its market, tap domestic demand, and expand effective supply while actively using international markets and resources and actively shaping a favourable development environment, while growing its economic strength.

To comprehensively evaluate the effectiveness of the ranking algorithm in detecting cheating scoring users, the proportion of manually added cheating scoring users  $\eta'$  and the proportion of cheating scores were varied to evaluate the algorithm performance under different parameter combinations. The parameters  $\eta'$  and  $\eta'$  are set in different ranges considering the different sparsity of the datasets. The GR algorithm performs well in detecting malicious-type cheating users in general, and especially for inactive cheating users. When the proportion of cheating rating users  $\eta'$

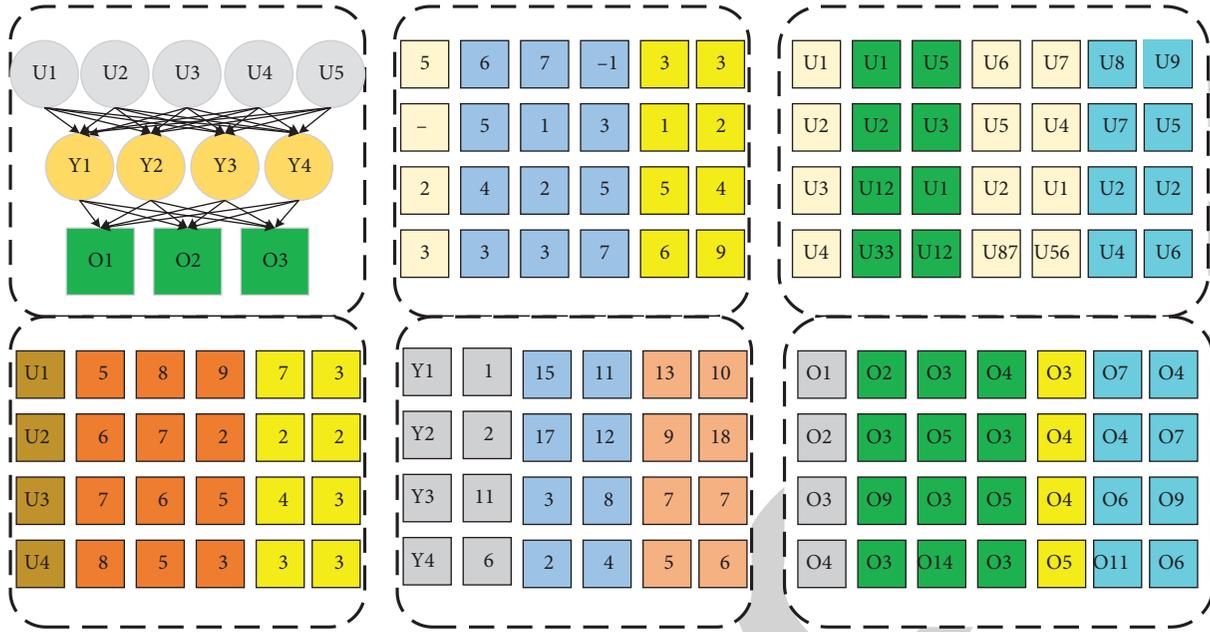


FIGURE 5: Experimental design of online user reputation ranking by cluster clustering.

is small, the GR algorithm has low accuracy in ranking random-type cheating rating users on the Movie Lens and Netflix datasets and low accuracy in ranking both cheating rating users on the Amazon dataset. Moreover, the ranking accuracy of the GR algorithm improves as  $\gamma$  increases. These results suggest that malicious cheating rating users are more likely to be detected; that there may be several cheating rating users in the Movie Lens and Netflix datasets originally; that the GR algorithm is better at detecting cheating rating users with low levels of activity.

### 3. Results and Analysis

**3.1. Algorithm Performance Results in Analysis.** According to the parameter settings of the algorithm and the sample settings of the dataset, 30 independent experiments were conducted on 10 experimental datasets under the same environment, and the mean value of prediction accuracy (test\_Avg), the maximum value of prediction accuracy (test\_Max), the standard deviation of prediction accuracy (test\_Std), and mean value of training accuracy (train\_Avg) in the 30 experiments were used as the evaluation indexes. Moreover, (train\_Avg) was used as evaluation metrics to compare and analyse the performance of shallow neural evolution methods based on IGA and ICOA algorithms with other algorithms, and the results are shown in Figure 6.

Comparing the mean and maximum values of classification accuracy on the test dataset, overall IGAN and ICOAN have higher average classification accuracy (test\_Avg) and maximum classification accuracy (test\_Max) than SNN, BDTE, ADTE, BNNE, and ANNE methods. It indicates that the IGA-based shallow neuroevolutionary method and the ICOA-based shallow neuroevolutionary method are two effective neuroevolutionary methods with good classification generalization ability. Comparing the mean classification

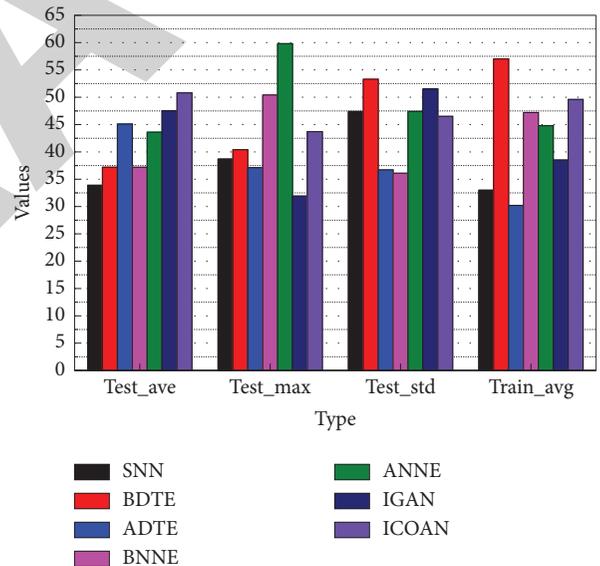


FIGURE 6: Comparison of classification accuracy.

accuracy on the training dataset and the mean classification accuracy on the test dataset, overall IGAN and ICOAN have a smaller gap between the mean prediction accuracy (test\_Avg) and the mean training accuracy (train\_Avg) than that between SNN, BDTE, ADTE, BNNE, and ANNE. This indicates that the IGA-based shallow neuroevolutionary method and the ICOA-based shallow neuroevolutionary method have improved the generalization ability of the network and effectively avoided the overfitting phenomenon during the training of the network.

Comparing BNNE, ANNE, and IGAN, and ICOAN four learning methods combining multiple neural network individuals, IGAN and ICOAN have higher classification

accuracy (test\_Avg) than BNNE and ANNE on the test dataset, while the difference between the results on the training set and the test set is smaller. It indicates that using the IGA algorithm and ICOA algorithm as the search strategy in the shallow neuroevolutionary method can explore better neural network weight positions in the weight space, and then using neuroevolutionary afterward can ensure that the final evolved network can better approximate the fitted target output, and this shallow neuroevolutionary method based on IGA and ICOA algorithm gives full play to the stronger advantages of genetic algorithm. This shallow neural evolution method based on IGA and ICOA algorithms fully utilizes the strong global search ability of genetic algorithm and coyote optimization algorithm to effectively find the best neural network.

The mean prediction accuracy of IGAN and ICOAN on the 10 datasets is higher than the other algorithms, which indicates that the shallow neural evolution method based on IGA and ICOA is effective in the image classification problem. The central position of the 30 experimental results of IGAN and ICOAN on the 10 datasets is relatively cantered compared with other algorithms, which indicates that the individual BP neural networks produced after continuous iterative evolution can have relatively stable classification accuracies. The shorter interquartile spacing indicates that the classification accuracy of BP neural network individuals is more concentrated after iterative evolution. From the central position and scattering of the box line diagram, the shallow neural evolution method based on IGA and ICOA has strong stability and high generalization performance in solving the classification problem, as shown in Figure 7.

The above experimental analysis shows that the shallow neural evolution method based on IGA and ICOA algorithms achieves better optimization results because the IGA algorithm optimizes the local search performance of the chromosome population and improves the convergence speed of the algorithm by using a combination of elite heuristic operations and migration strategies in the optimization of individuals in the population. The algorithm uses the adaptive influence weight strategy in the process of optimizing individuals in the population to improve the generalization performance of the algorithm, while effectively avoiding the problem of easily falling into local optimum and ensuring better global search ability and population diversity. Based on the shortcomings of the traditional genetic algorithm, for example, the crossover and variation operators are not conducive to the algorithm seeking and the original selection method is not conducive to the global search, the genetic algorithm is improved with the elite heuristic operation and migration strategy, and the IGA algorithm in the weight space is proposed, which effectively improves the convergence speed and the local search ability of the algorithm, and the IGA is combined with the BP algorithm to propose the IGA-based shallow neural evolution method. The shallow neural evolution method based on IGA is proposed to realize the optimization of BP neural network weights and thresholds.

To improve the global and local search ability of the algorithm, decreasing weights are introduced to propose

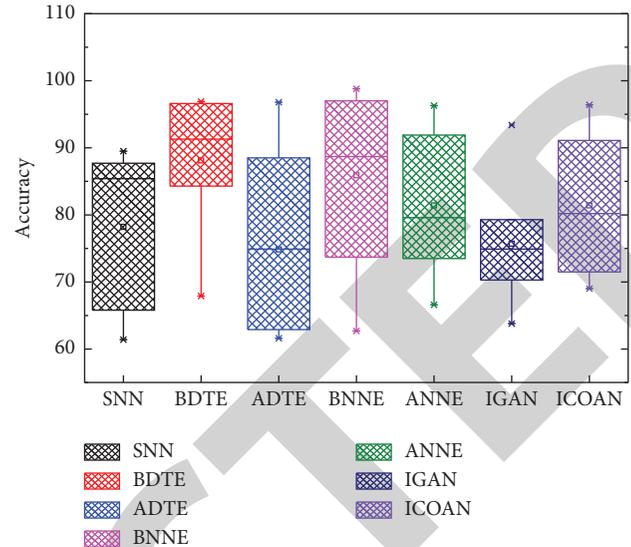


FIGURE 7: Comparison of the methods on the dataset.

adaptive influence weights, and the coyote algorithm under the weight space is further proposed, which improves the individual update process to facilitate the improvement of the convergence performance and the search performance of the algorithm. By combining the ICOA algorithm with the BP algorithm, a shallow neural evolution method based on ICOA is proposed to achieve the optimization of the weights and thresholds of the BP neural network. The IGA-based shallow neural evolution method and the ICOA-based shallow neural evolution method are numerically experimented on 10 classification datasets in the UCI dataset and compared with the experimental results of SNN, BDTE, ADTE, BNNE, ANNE, etc. The results show that IGAN and ICOAN are better with higher classification performance.

#### 4. Analysis of Economic Structure Model Test Results

The raw data are standardized according to the steps of factor analysis, the correlation coefficient matrix among the indicators is solved, and their eigenvalues and variance contribution rates are obtained through the correlation coefficient matrix, which is realized by using python. Factor 1 has a high explanation rate for nine indicators, namely, per capita consumption, food, clothing, and housing; per capita household consumption expenditure on household equipment and supplies and medical care; per capita household consumption expenditure on transportation and communication; per capita household consumption expenditure on cultural, educational, and recreational services; per capita household consumption expenditure on other consumption, and these nine indicators mainly reflect the consumption of residents in various aspects. Factor 2 explains 7 indicators, namely, regional GDP, social fixed asset investment, total number of employees, electricity consumption, total sown area of crops, total savings, and total retail sales of social consumer goods, and defines asset factor. Factor 3 most

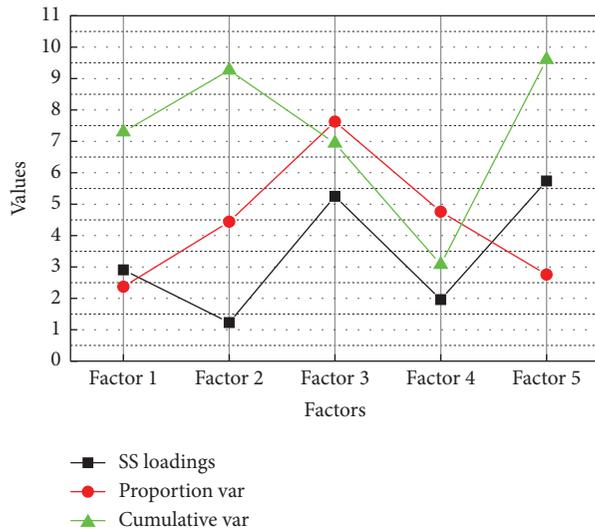


FIGURE 8: Variance contribution rate.

explains total water resources, so this factor can be defined as water resources factor. The explanation rate of factor 4 is higher for the indicators of nongovernment expenditure, nongovernment investment, labour force of nonstate industrial enterprises to total labour force, and the number of nonstate industrial enterprises to industrial enterprises above the scale, which are all indicators reflecting the government system, so factor 4 can be interpreted as the institutional factor. Factor 5 explains more the indicators of nonstate industrial capital to total industrial capital and retail price index. Therefore, factor 5 can be interpreted as the output factor, and the results are shown in Figure 8.

From Figure 8, we can see that the cumulative variance contribution of the first five features is 84.25%, which reflects most of the information of the original index, so it is reasonable to use these five as the main factors. Since the linear combination of these five factors also satisfies the model establishment condition, the factor loading matrix is not unique, and the loading matrix is orthogonally rotated. The improved IGR algorithm extends the idea of cluster clustering by calculating the cluster size through user reputation weighting, which not only focuses on the absolute number of users but also considers the reputation level of users. High reputation users have greater weights to determine the cluster size, and low reputation users have limited influence on the cluster size. In the framework of the GR algorithm, an iterative merit-seeking process is used to continuously update user reputation and group size until the reputation ranking remains stable. Testing the algorithm on two datasets reveals that the IGR algorithm has no significant user degree preference, is not influenced by user activity, and slightly prefers users who pursue popular products. The IGR algorithm has a more accurate overall ranking of user reputation and is good at detecting malicious and random cheating users. In particular, the IGR algorithm has significant improvement over the GR algorithm in terms of robustness when the proportion of cheating users is large.

## 5. Conclusion

The application of new data and methods has given rise to the emerging interdisciplinary research branch of computational socioeconomics, which aims to accurately perceive socioeconomic development and understand the laws of socioeconomic operation. The use of complex networks to portray the interactions in socioeconomic systems and to study the spatial structure and dynamics of socioeconomic provides deeper insight into many complex socioeconomic phenomena. On the one hand, the spatial structure of the network reflects the complexity emerging in the process of socioeconomic development, and the structural characteristics of the network can be used to infer socioeconomic development dynamics. On the other hand, the structural evolution of the network and the propagation dynamics model on the network can be used to analyse the economic development paths and learning processes and to explore the best economic development strategies by combining theory with empirical evidence. In this article, the spatial structure of the socioeconomic system is studied at the micro, meso, and macro levels under the framework of computational socioeconomics research, and the spatial network and propagation models are used to study the economic structure evolution and development strategies. The results of this article on the spatial structure and dynamics of socioeconomic systems have certain theoretical value and practical guidance. The collection of large-scale nonintervention behaviour data with the help of modern tools to analyse individual behaviour patterns and quantitatively understand socioeconomic phenomena helps to gradually realize predictive management at the micro level. We use complex networks to portray the interactions in socioeconomic systems and propose ranking algorithms to infer the overall state of the system using the network structure and group behavioural characteristics to better reveal the connection between the structure and state of socioeconomic systems. The network modelling approach is used to analyse socioeconomic data to portray the complexity emerging from economic development from a structural perspective to better grasp the macroeconomic structure and predict economic development. With the help of the spatial network and propagation dynamics models, we analyse the laws of economic development with theory combined with empirical evidence to help formulate scientific and optimal industrial development strategies.

## Data Availability

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

## Consent

Informed consent was obtained from all individual participants included in the study references.

## Conflicts of Interest

The authors declare that there are no conflicts of interest.

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