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Research paper

An Intelligent Model for Prediction of In-Vitro Fertilization Success using MLP Neural Network and GA Optimization

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Abstract

In-Vitro Fertilization (IVF) is one of the scientifically known methods of infertility treatment. This work aims at improving the performance of predicting the success of IVF using machine learning and its optimization through evolutionary algorithms. The Multi-layer Perceptron (MLP) neural network is proposed in order to classify the infertility dataset. The Genetic algorithm (GA) is used to improve the performance of the MLP model. The proposed model is applied to a dataset including 594 eggs from 94 patients undergoing IVF, of which 318 are of good quality embryos and 276 are of lower quality embryos. For performance evaluation of the MLP model, an ROC curve analysis is conducted, and a 10-fold cross-validation is performed. The results reveal that this intelligent model has a high efficiency with an accuracy of 96% for MLP, which is promising compared to the counterpart methods.

1. Introduction

Infertility is a global problem that affects the couples. Some couples do not have children even after several cycles of In Vitro Fertilization (IVF). Women who experience IVF face more financial risks and problems. The method of using IVF is a method of infertility treatment that is well-known. However, the problem is that this method does not have a satisfactory performance, and this requires a more accurate analysis of the information. In medical science, successful treatment chances are significant for both the infertile couples and the physicians in deciding to begin the treatment. If initial assessments indicate low fertility in the couples, the decision to operate may change. Due to the rising medical costs in the today's society, the diseases such as infertility have created significant couples' problems. IVF is one of the infertility treatment methods that help to treat human infertility with a relatively sophisticated technology. Due to this method evolution, the fertility rate has not changed, and in the best case for women under 30, this rate is about 40% [1]. There are many influential factors in the discussion of infertility. Considering all these factors is a challenging and time-consuming task; therefore, the physicians make their predictions by considering only a few factors and the success rate of the work only by considering that the limited factors cannot reduce the accurate results.The physicians believe that the patient's age takes precedence over the other characteristics, and is considered as an essential feature in infertile patients but age alone cannot be prioritized since other influential variables are also involved. The focus of this research work is on oocytes because oocyte evaluation, in many cases, predicts the results of IVF better than embryo evaluations [2]. Embryology is a practice that is ultimately responsible for the success of IVF but the quality of the embryo is primarily related to the egg. Most IVF programs select suitable embryos for transplantation based on the fetal morphology. Due to the decrease in ovarian parameters, ovarian storage somewhat can be predictive of fetal outcomes. An intelligent prediction and decision-making system can help the physicians consider

the influential variables and discover their infertility treatment relationships in order to improve the success rates [3]. In the last decade, the use of intelligent models in the field of medical advancement has been the subject of much research [23-28].

Due to the multiplicity of the influential factors in predicting the IVF practice, the use of data mining techniques and intelligent automated methods facilitate this process. The data mining methods and artificial intelligence techniques are suitable for the problems, and it is possible to predict the process of selecting appropriate features and fertilization results more accurately. Using the classification models to predict and make intelligent decisions can help the physicians to identify the relationship between the existing variables and the effectiveness of each variable, and increase the success rate of IVF. Therefore, this research has proposed a model that considers all factors that predict it with high accuracy.

2. Overview of Related Works

This section provides an overview of the related articles on using the data mining models and predictions in infertility and IVF. Using the data mining techniques to identify the most important causes of infertility to improve the success rate of IVF treatment, Gowramma *et al*. have designed a model in which the primary dataset is supervised filtering. Furthermore, three different feature selection methods were processed before prediction, and then classified the data using the neural network-based classification algorithms such as perceptron, which performed better than other algorithms [4]. In another study, using the modern data mining methods, data analysis of the couples' infertility data was applied to increase accuracy in predicting the treatment process. A good selection of features increases the classification accuracy. In this work, the high effectiveness of classification methods using neural networks (NNs) and the random forest was considered. Interestingly, the support vector machine (SVM) classifier could not achieve the desired accuracy [5]. In [6], the process of using the data mining techniques to determine the success rate of IVF was proposed by practical experiments for the infertile couples. They used the data mining techniques to reduce the data and normalize and pre-process. The filter monitors the existing dataset before processing, and the feature selection algorithm is processed. By reducing the data and eliminating the noise, they increased the accuracy of the prediction [6]. The selected available characteristics adapt the referring couples' characteristics to its data and predict fertility probability [7]. Bo Zhang *et al*. have also proposed three methods for predicting the cumulative pregnancy rates after different ovulation cycles. Using the clustering and SVM, the results showed that clustering the patients into different groups and then building an SVM model for each group could be a quick and economical approach to estimate the pregnancy rates based on the initial information before the procedure Be IVF [8]. Different types of Bayesian classifiers have been used in order to predict the IVF's outcome to select embryos with the highest implantation potential. The Bayesian classifiers have proven to be able to predict the embryo implantation [9] successfully.

Also, the linear logistic regression models for controlling the effect of age for stratified and continuous variables and the number of retrieved eggs due to abnormality were compared using the Pearson correlation test in order to evaluate the oocytes for a better embryo selection. The comparative operation was performed using the Mann-Whitney test [10]. The classifiers including SVMs, recursive partitioning, random forest, adaptive reinforcement, and nearest-neighbor showed that random forest and recursive partitioning were better than the other predicting IVF method results. [11]. The ranking algorithm in order to estimate the chances of success in IVF using the random forest classification methods and naïve Bayes was proposed in [12]. The results showed that the Sera algorithm was better in estimating the probability of the IVF success. The Sera algorithm has three critical features for medical applications. In the first step, it learns the data rules, which the physicians can further analyze. Secondly, no parameter can be optimized after adding a new patient record, and is ultimately resistant to the loss of specificity values common in the medical datasets [12]. In order to determine the classification of a group of researchers based on pregnancy, they used the average samples of embryo culture in IVF using the chemical methods to study the embryo's culture medium. They used the hierarchical clustering algorithms and artificial NNs in order to classify and separate the data, and also used GA as a variable reduction to develop a diagnostic model. The results showed that the artificial intelligence and the Cimka algorithms were more accurate than the GA method as a classifier. The proposed method's advantages can be mentioned as a reliable, fast, new, low-cost method for detecting the IVF samples [13]. In [14] machine learning methods were used in order to make

comparative analyzes of the predictive models for the risk of infertility in women.

Table 1. Articles predicting probability of IVF success.

	Article name	Models used	Input	Advantages	Dataset	Accuracy
1	An Automatic System for IVF Data Classification by Utilizing Multilayer Perceptron Algorithm [4]	MLP, logistic regression	Gestational age, quality of life, severe follicle depletion, ovulation timing, embryo transfer, sperm	High accuracy of MLP algorithm compared to other algorithms	Includes informational results during IVF and laboratory tests	71%
2	Use of data mining methods to predict the result of infertility treatment using the IVF ET method [5]	SVM artificial neural network, random forest algorithm, SIMBAF MIMBA	43 ftest	Training network was very effective in identifying negative cases. with 90% accuracy of the time, But the correct positive result was slightly less than 50%.	Parsed dataset in this research work has more than 1000 cycles of fertility treatment	79%
3	Data mining application on IVF data for selection of influential parameters on fertility [6]	MLP	Age, previous pregnancy, body mass index, sperm factors, hormone factors	The proposed method is multi-layered for classification according to accuracy of the perceptron network	From pediatric examination laboratories and IVF research centers in tamilandy	84%
4	Deep learning of Markov model-based machines for determination of better treatment option decisions for infertile women [7]	Markov model	Examples of clinical variables and potential genetic variables are the couple's family history	Variables such as anxiety, depression, and education level can reduce the chances of accurate information and predicting types of treatment.	A child's success was achieved with one of the available treatment options, either IVF or polycystic ovary stimulation during ovulation	Not reported
5	In vitro Fertilization (IVF) Cumulative pregnancy rate prediction from basic patient characteristics [8]	Machine learning, clustering algorithm	Number of embryos transferred, women's age, female body mass index, AFC hormone, AMH, FSH, 30 pathogenic factors	IVF is very expensive and time-consuming in today's society, so these methods help	11190 Chinese couple in Tangji hospital	70%
6	Are computational applications of the B crystal ball^ in the IVF laboratory? The evolution from mathematics to artificial intelligence [9]	logistic regression, Naive Bayes algorithm	Input: evaluation of optimal cytoplasmic vol., fetal characteristics, evaluation of 24 morphological features of a zygote	Advantage: practical embryology, which is ultimately responsible for the success of IVF	Digital images were taken from 249 embryos with known data for transplantation 50-40 hours after fertilization	82%
7	Age, body weight, and ovarian function affect oocyte size and morphology in non-PCOS patients undergoing intracytoplasmic sperm injection (ICSI) [10]	My Whitney test logistic regression Linear regression	AMH Hormone, age, enlarged peritoneal space PVS, ovulation granules in 308 MII eggs, body mass index, egg diameter FSH, fetal transfer, fetal quality	Embryo's quality is primarily related to the egg, not to the parameters of the sperm. Therefore, considering the egg's characteristics, we will see the possibility of further improving the embryo's choice.	The dataset includes 77 couples surveyed in the United States	Not reported
8	Predicting implantation outcome of in vitro fertilization and intracytoplasmic sperm injection using data mining techniques [11]	SVM recursive partitioning, random forest, AdaBoost, nearest neighbor	Input: women's age, number of developing fetuses, serum estradiol level, human chorionic gonadotropin administration	According to the results from the random forest algorithm, recursive partitioning is better than the other comparable methods	The database consisting of 486 patients was collected by the census method, and the dataset includes 29 variables with identifiers for each patient in positive and negative	84%
9	Estimating chance of success in IVF treatment using a ranking algorithm [12]	SERA ranking, remark ranking, Naive bayes random forest	age, blood type, height, weight, BMI, follicle-stimulating hormone, luteinizing hormone, estradiol, abortion, polycystic ovary syndrome, sperm extraction, diabetes, hypertension	Results show that the proposed SERA algorithm can be used successfully to estimate medical treatment success probability	Includes 1456 patients by the IVF unit of Ankara hospital. Includes 64 independent features, of which 52 are for women and 12 for men.	85%
10	Diagnosis of pregnancy-based classification of embryo culture by infrared spectrometry and chemometrics [13]	GA, BNN. SIMCA. CP-ANN	Input: division speed, cell number, ECM samples	Detection of a fetus with high speed, accuracy, and highest fertility potential to aid in IVF	44 ECM samples, to build the calibration model and 14 samples to predict	93%

The prediction model was designed using supervised machine learning algorithms–naïve Bayes, decision tree, and MLP algorithm. Furthermore, the evaluation results showed that the machine learning algorithms' performance for decision trees C4.5 and perceptron was multi-layer with an accuracy of 74.4%. He has used a genetic classification in order to classify the semen samples from the embryonic network, which often suffered from an imbalance problem. Compared to the other classification methods in this study, the proposed algorithm's performance in a fertility detection dataset is 86 with accuracy. 93 showed a good progress [15]. Ms. Babitha machine learning techniques was used in IVF therapy to improve success. This study found that the machine learning techniques could be used in various IVF treatment stages. The model discussed in this study is whether the couples decide whether to undergo IVF? Another group of cases took into account some additional features such as the number of recovered eggs, number of transferred embryos, and developed a model that says what the probability of pregnancy is in treatment. This helps the patients to prepare their minds for the outcome. Another set of tasks is to help the physicians to select the most appropriate embryos by observing the morphological features or images over time. Using this technique, the embryologist can make the right decision in choosing the fetus that leads to pregnancy [16]. Another group examined the fertility analysis methods based on the supervised and semi-supervised data mining techniques. In this study, the data mining techniques such as decision trees, SVMs, Bayesian networks, and nearest neighbor were used; the proposed method could be used to determine the fertility rate in patients, significant efficiency, and accuracy [17]. Also a prediction model for diagnosing the infertility factors using data mining algorithms was presented. In this method, the clustering method and then the SVM and artificial NN methods were used. Finally, the results of these two algorithms were compared with each other. The results showed that the back-up vector machine was significantly more efficient than the other algorithm [18]. From the characteristics studied in the study [19], only three cases of age, body mass index, and education were examined. The results showed that education affected the age of marriage of women. Therefore, the age of those over 30 years affects their body mass index and increases the hormone levels due to infertility.

In general, predicting the factors in infertility and the chance of success in IVF treatment using the data mining techniques can be a more accurate analysis of information than the traditional methods that are no longer able to detect more quickly and efficiently, and provided cost reductions.

According to Table 1, the articles that used the MLP algorithm in order to classify the data had much a higher accuracy and speed than the other artificial intelligence classification models. In the field of infertility, diagnosis and prediction are the success rates of IVF.

3. Neural Network Model to Predict Success of IVF

In this work, a MLP NN model was used. The multi-layer perceptron NN consists of three general layers including the input, output, and hidden layer.

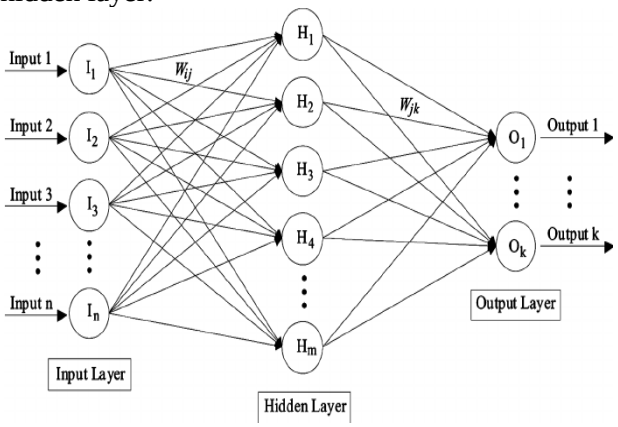

Figure 2. Structure of the NN layers.

In this network structure, the number of input layer neurons ($X_1+X_2,\cdots,X_d$) is equal to the number of properties available to decide on each one of the data samples. In other words, the input of the network is the properties of the samples. Also the number of neurons in the network's output layer ($t_1+t_2,\cdots,t_c$) is equal to the number of data classes, and each node in the output layer corresponds to a specific class in the dataset. The other part of this network structure is the hidden layer or its middle layer ($y_1+y_2,\cdots,y_c$). The number of hidden layers is usually considered as one layer because, in most cases, one layer is responsible for solving the problem. In this work, three hidden layers were used for the NN, and the output with one neuron was selected as the answer, and this node corresponds to two positive and negative classes. The MLP neural network uses the post-diffusion training rule. This algorithm requires non-linear functions that can be derived continuously. In other words, the functions must be smooth. The use of the sigmoid

function is usually chosen due to its simplicity of derivative:

$$f(net) = \frac{1}{1+e^{-knet}} \quad (1)$$

The steps of the algorithm are as follow: First, the initial values of weighting coefficients and thresholds are selected. (All weights and thresholds must be equal to small random numbers.) The desired number of inputs and outputs are supplied to the network (n is the number of input elements and m is the number of elements of the output vectors. The weight factor w0 is equal to the threshold's negative value x0). In the classification problem, all output elements are set to zero, and then the outputs are calculated; each layer calculates the values and moves them to the next layer:

$$y_{pj} = f\left|\sum_{i=0}^{n-1} w_i x_i\right| \quad (2)$$

The weight coefficients are adjusted. In this way, it starts from the outer layer and goes back.

$$Sensitivity = \frac{TP}{(TP+FN)} \times 100 \quad (3)$$

w_{ij} represents the weight coefficient from node I to node j at time t, and η represents the coefficient of interest and represents the error related to the pattern P in node j. About the output layer is as follows:

$$\delta_{pj} = {}^{k}o_{pj}(1-o_{pj})(t_{pj}-o_{pj}) \quad (4)$$

In the case of the hidden layers, it is as follows:

$$\delta_{pj} = {}^{k}o_{pj}(1-o_{pj})\sum_{k}\delta_{pk}w_{jk} \quad (5)$$

In this case, an addition operation is performed on the k units located in the layer after unit j.

The hidden unit acts as a locator. The hidden unit recodes the input vectors so that the network can adequately learn the connection of the inputs to the outputs. This internal encoding or representation is essential in how the network operates. With a sufficient number of hidden units, the internal representation of each input pattern can be formed in the network so that the output units can produce the desired output for each input.

4. Proposed Method

This section represents the proposed method that predicts the success of IVF based on the NN and evolutionary GAs.

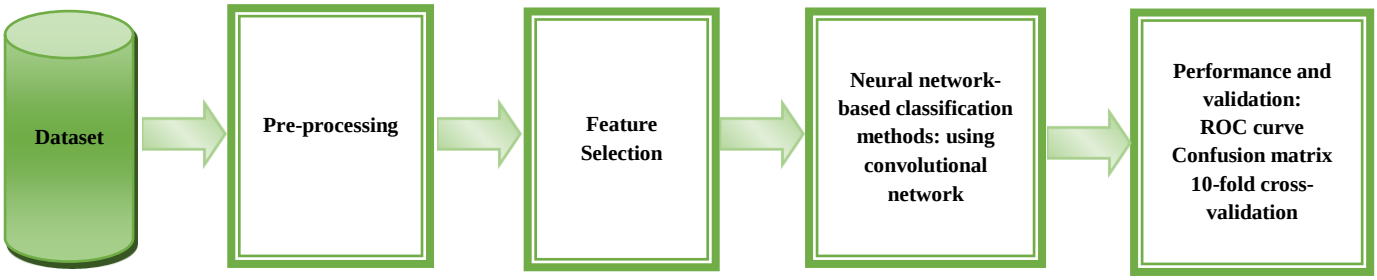

Figure 1. Diagram of proposed method.

5. Experimental Results and Performance Evaluation

In this section, the proposed method's results in the Python software environment are reviewed and analyzed. First, the statistical community and the evaluation method are discussed, and then the results are presented.

5.1. Dataset

The present study's dataset includes 94 patients treated between November 1, 2015 and January 31, 2016. This work included 594 mature eggs from 94 patients undergoing IVF. The mean age of the patients was 39 to 56 years with 318 good quality embryos and 276 lower quality embryos in the analysis. The patients of all races and ages were evaluated. Women with an endometrial thickness less than 7. 0 mm on the day of embryo transfer were excluded from the work. The patients with less than two mature eggs were excluded. Ovum evaluation, in many cases, predicts the results of IVF better than the embryo evaluations. We hypothesized that determining the potential for pregnancy in the egg rather than the fetus's surface might provide more insight into the embryo's selection for transfer.

5.2. Data Pre-processing

In the present work, one or more samples of values maybe invalid, which can be due to various reasons such as noise in the recorded data, non-registration or invalidity. In order to manage such lost or missing data, the method of the average value of features was used. In this method, for each one of the available properties, the average

value was calculated using the samples whose values were known and was used to place the values related to that feature. The method used in this work was that the average of each category was calculated separately, and the averages obtained for each category were used to fill in the non-existent data of the samples belonging to the same category in the column. This method is more efficient than the other methods.

In the next step, the tillers were deleted. Also in the pre-processing section, the columns' non-numeric values were converted into numeric values to be used in the future steps for future calculations. Two nominal features race and smoker were converted to numeric to be applicable as the inputs for the NN.

Another critical step performed in the data normalization section in the present work was using the min-max method of normalization, in which each dataset was mapped in the desired range, the maximum and minimum values of which were known. In the next step in the feature reduction process, the principal component analysis algorithm was used.

The PCA algorithm was used in order to reduce the dimensionality of a dataset that consisted of a large number of features. PCA finds a set of new variables whose projection to lower dimensions represents much more data variations. With the help of the standard PCA algorithm, 20 features that represented the most variation in the dataset were selected. In this work, there were initially 52 features that were reduced to 39 features. Table 3 lists the effective features.

Table 3. List of effective features.

Age	Smoker
Hcg	MII
Race	Oocyte_source-age
Total oocyte	HT
FHB	WT
Gravidity	AMHI
Sacs	Atretic
Donor01	Immature
rfaMale	prFullTerm Birth
PrSABS	MaxFSH
rfapco	rfaother
rfaTubal	rfaUterine

5.3. Evaluation and Validation Methods

The ROC curve analysis method used to evaluate the proposed method is as what follows.

One way to evaluate the binary classification performance is the performance receiver operating characteristic curve (ROC curve). The ROC curves are often used to test the performance of classification algorithms or to generate string data. One method used to obtain an experimental ROC curve is to select a sample of healthy and sick individuals and measure their test, and then determine the amplitude of the test variable changes and at consecutive cutting points in this false sensitivity and positive range. At each point, the cut is determined, and the points obtained are connected. Now, the area under the curve indicates the detection power. The higher the detection power, the closer the ROC curve will be to the ideal. Accuracy, specificity, and sensitivity can be calculated from the following equations [21]:

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN} \times 100 \quad (6)$$

$$Specifity = \frac{TN}{(TN + FP)} \times 100 \quad (7)$$

$$Sensitivity = \frac{TP}{(TP + FN)} \times 100 \quad (8)$$

5.4. Results of Implementing Proposed Model to IVF Dataset

In this section, the steps of implementing the proposed method based on the GA and multi-layer perceptron NN with their related results are given.

First, train the network with a hidden layer to increase the number of hidden layers in case of an improper operation because the number of hidden layers should be as small as possible, and it has been proven that each function can be approximated with a maximum of three hidden layers. Three hidden layers were used in the present work because they had a better performance by using three hidden layers. The Adam's training method was also used in the MLP NN. Then the relu and sigmoid activator function was used in the multi-layer perceptron NN; the reason for using the relu function is that it does not saturate in the positive region, which, in turn, causes the weights to be better updated and the network learning process faster, and see a less computational load. In this work, 75% of the test data and 25% of the training data were divided into two categories to prevent over-training the artificial NNs from deciding when to stop data training. Execution time was 34 s, on device with CPU of Intel Xenon 2.3GHz and GPU of Nvidia Tesla T4 16GB specifications. The parameters of the multi-layer perceptron NN model are explained in Table 4:

Table 4. Parameters related to the proposed multi-layer perceptron NN model.

Activation function	Relu, sigmoid
Number of hidden layers	3
Number of neurons in the first layer	22
Number of neurons in the second layer	12
Number of neurons in the third layer	1
Type of training	Adam

Then a GA was used to optimize the NN. The population determined in the present work was 100, and the individuals constituting the populations were binary values. Also the considered cost function was the NN error rate, and the considered termination condition was the completion of the population of 100.

Table 2. Parameters related to genetic algorithm.

Population size	100
Fitness function	NN error rate
Termination condition	100 repetitions
Mutation rate	0.1
Cross-over rate	0.7

Figure 3 shows the ROC diagram for the multi-layer perceptron artificial NN model.

Figure 3. ROC diagram of multi-layer perceptron artificial NN.

In the next step, the results of the proposed model were evaluated using a confusion matrix.
Figure 4 shows the confusion matrix for the multi-layer perceptron NN.

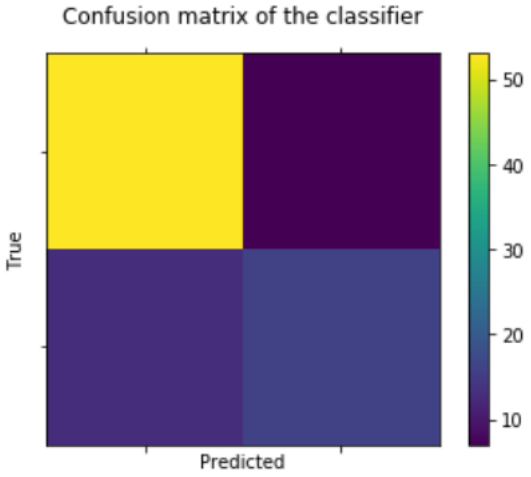

Figure 4. Confusion matrix of classifier.

As shown in Figure 4, the values of TN, FP, FN, and TP in the multi-layer perceptron lattice matrix are as follows: TN = 59, FP = 1, FN = 2, TP = 27
In order to validate the proposed method, the k-fold cross-validation was used. Furthermore, the value of k was considered to be equal to 10. After applying the 10-fold cross validation, the average results of 10 runs on the training and testing datasets were computed. The mean represents the average accuracy of ten runs.

Table 5. Results of training and test data performance in 10 multi-layer perceptron NN performances.

Test accuracy	Train accuracy	
100 %	0.95%	
100%	100%	
0.94%	100%	
100%	0.97%	
0.94%	0.93%	
0.88%	0.95%	
0.94%	100%	
0.88%	0.95%	
100%	0.95%	
100%	100%	
0.95%	0.97%	Mean

According to Table 6, the performed methods' results in the present work are displayed.

Table 6. Comparison of results of methods used.

Methods	Criteria		
	Sensitivity (%)	Specificity (%)	AUC (%)
MLP-GA	93	95	96
MLP	58	91	87

According to Table 6, the results show that the proposed method uses a GA to improve the NN model's performance and uses a multi-layer perceptron NN to classify the practical features of better performance than the MLP NN models. The GA was used to optimize the NN.

Table 7. Performance of proposed model based on AUC, specificity, and sensitivity of method.

Methods	Criteria		
	Sensitivity (%)	Specificity (%)	AUC (%)
MLP-GA	93	95	96

The performance of the proposed method in the present work is shown in Table 7. In order to compare the efficiency of the proposed method, a two-sample t-test was used. H_0 indicates no relationship, no difference; and the alternative hypothesis, H_1, suggests the relationship and difference between the MLP and MLP-GA mean results. The results of the t-test with 95% CI (at p-value = 0.04365023) show that there is a strong evidence against the null hypothesis, and therefore, the null hypothesis is rejected and the alternative hypothesis is accepted. Therefore, GA-MLP outperforms MLP for the IVF success prediction.

According to Ttable 8, it can be concluded that in the present work, due to the multiplicity of practical features in the practice of IVF, in addition to improve performance, the GA was used, and the results revealed an accuracy in terms of the area under the ROC curve showing that the proposed method had performed better than the previous studies.

Table 8. Comparison of proposed methods with previous studies.

	Number of data	Sensitivity (%)	Specificity (%)	AUC (%)	methods
Robert Milewski [5]	77 patients	–	–	80	logistic regression
Shima Zandbaafa [13]	46 ECM samples	–	–	91	counter-propagation NN PCA
Gowramma [4]	114 patients with 24 charact eristics	–	–	83	Multi-layer perceptron logistic regression
Proposed method [this research]	94 patients with 52 features	93	95	96	MLP-GA

6. Conclusions

In this work, an intelligent method based on the multi-layer perceptron NNs was presented in order to predict the success of IVF by examining the influential factors. Due to the high dimensions of the problem and the practical features, the principal component method was used to extract the optimal subset. Then in order to improve the efficiency of the multi-layer perceptron NN, the evolutionary GA was used. This work aimed to increase the intelligent forecasting model's performance accuracy by optimizing the influential factors and parameters. The data studied in this work included 94 patients. Ono of limitations of this was lack of technical databases. In this regard, with the physicians' help, the pre-processing steps were performed in order to determine the required features and eliminate the irrelevant items. Using the data mining techniques to identify the most important causes of infertility in order to improve the success rate of IVF treatment, using the available data about IVF patients, they designed a model in which the primary data set was monitored by a filter, and three different feature selection methods were processed before prediction and then categorized the data using a NN-based classification algorithm such as the perceptron algorithm, which performed better here than the other algorithms. The findings are also consistent with the research in [5]. They used modern data mining methods to apply data analysis of couples' infertility data in order to increase accuracy in predicting the treatment process. A good selection of the features increases the classification accuracy. In this work, the high effectiveness of classification methods using NNs and the random forest was considered. Interestingly, the SVM classifier could not achieve the desired accuracy. These results are also consistent with counterpart method. Finally, the results were compared and showed that the SVM was significantly more efficient than the other algorithms.

Future studies are suggested to examine the proposed method based on more exact details such as the patient's clinical condition and graphic images. The fuzzy models can be applied to manage the uncertainty in the practical features and increase the number of different images in the proposed method.

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ارایه مدلی هوشمند پیش بینی موفقیت عمل لقاح مصنوعی با استفاده از شبکه عصبی پرسپترون چند لایه و بهینه سازی الگوریتم ژنتیک

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چکیده:

یکی از روش‌های درمان ناباروری لقاح مصنوعی(IVF) است. این مطالعه با هدف بهبود عملکرد پیش بینی موفقیت IVF با استفاده از یادگیری عمیق و بهینه سازی آن از طریق الگوریتم‌های تکاملی انجام شده است. برای طبقه بندی مجموعه داده های ناباروری از الگوریتم ژنتیک و شبکه عصبی پرسپترون چند لایه استفاده شد همچنین از الگوریتم ژنتیک برای بهبود عملکرد مدل شبکه عصبی پرسپترون چند لایه (MLP) استفاده شد. مدل پیشنهادی نیز بر روی مجموعه داده ای شامل ۵۹۴ تخمک از ۹۴ بیمار تحت IVF اعمال شد، که ۳۱۸ از آنها دارای جنین با کیفیت خوب و ۲۷۶ جنین با کیفیت پایین بودند. برای ارزیابی عملکرد مدل شبکه عصبی پرسپترون چند لایه پیشنهادی (MLP)، تجزیه و تحلیل منحنی ROC انجام شد و اعتبار سنجی ۱۰ بخشی انجام گردید. در ادامه نتایج نشان داد که این مدل هوشمند دارای کارآیی بالا با دقت ۹۶ درصد به کمک شبکه عصبی چند لایه پرسپترون است که در مقایسه با روشهای مشابه امیدوار کننده است.

کلمات کلیدی: شبکه عصبی پرسپترون چندلایه، الگوریتم ژنتیک، پیش بینی موفقیت عمل لقاح مصنوعی.