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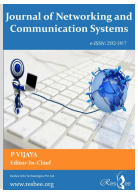

Artificial Neural Network Approach for Football Scores Prediction

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Abstract: It is obvious that football is the most popular sport in the world today, played in most countries in the world. The game provides a very large betting industry. The current estimations, which include both the illegal markets and the legal markets, suggest the sports match-betting industry is a multi-billion-dollar industry. This means the ability to accurately predict the outcomes of games can be very lucrative. Although various researches have employed statistical and mathematical models to predict match results, none of the models can predict the exact number of goals to be scored by each team in a football match at any given time. In this research, an Artificial Neural Network (ANN) model was developed following the Machine Learning (ML) Life Cycle. The dataset was obtained from Football-Data.co.uk, a reputable football data website. The backward Elimination technique was used to select the dataset features for the proposed neural network model. The features were extracted and the dataset was then split into training and testing sets at 75% and 25% respectively. The neural network developed is a multi-layer perceptron classifier implemented by the MLPClassifier class in sklearn. The model was compiled with different parameters to find the model with the highest accuracy relative to the Mean Squared Error (MSE). The graph for the accuracy score and mean squared error was plotted and it showed the mean squared error was relatively the same for all the models. The model with the highest accuracy score was selected. The selected model has three (3) hidden layers consisting of 10, 10, and 10 neurons with Sigmoid Optimizer and tanh activation function. The model ran 1000 epochs and got an accuracy score of 97.92% with an MSE of 2.8644, implying that real-life games with unknown results can indeed be predicted with a high level of accuracy using machine learning.

Keywords: Artificial Neural Network: Dataset: Features: Football: Machine Learning Model Scores.

Nomenclature

Abbreviation	Expansion
ANN	Artificial Neural Network
RNN	Recurrent Neural Networks
LSTM	Long Short-Term Memory
LR	Logistic Regression
DT	Decision tree
KNN	K-nearest Neighbor
SVM	Support Vector Machine
MNB	Multinomial Naïve Bayes
RF	Random Forest
ML	Machine Learning
EPL	English Premier League
AI	Artificial Intelligence
AFL	Australian Football League
NRL	National Rugby League
MLP	Multi-layer Perceptron
CNN	Convolution Neural Network
KDD	Knowledge Discovery in Database

1. Introduction

Football is a globally accepted sport that promotes unity amongst people and diverse nations. This has led to an entire industry built around the game, part of which is predicting match outcomes. The current

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estimations, which include both the illegal markets and the legal markets, suggest the sports match-betting industry is worth anywhere between $700bn and $1tn [1].ML has been applied in various manners and various fields for predictive purposes. It has been applied to weather predictions, stock market predictions, natural disaster predictions, and even health predictions. Another field that has seen a growing application of ML is sports. [2] state that ML has been applied in sports predictions ranging from basketball, rugby, cricket, swimming, and horse racing. However, it has mostly been used to predict win/lose outcomes, in other words, predicting who will win in a sports competition, but not exactly specifying the winning conditions (i.e., the specific score). [2]Went on to state that sports result prediction is nowadays very popular among fans around the world, mostly due to the expansion of sports betting.

Sports pundits make predictions on the outcome of matches and whole leagues using information and experience gathered from the past. Predicting the results of sports matches is interesting to many, from fans to punters. It is also interesting as a research problem, in part due to its difficulty, because the result of a sports match is dependent on many factors, such as the morale of a team (or a player), skills, current score, etc. So even for sports experts, it is very hard to predict the exact results of sports matches [3].

Mathematical and statistical models work well in the prediction of match outcomes [4]. However, with advancements in computing and computing power, computers can be made to make these predictions using ANN asthis moves the burden of going through large amounts of raw data from the human expert to the machine (computer). The authors in [5] predicted the competitive performance of an elite female swimmer (200-m backstroke) at the Olympic Games 2000 in Sydney using ANN. [6] applied decision tree induction for identifying characteristics in one-versus-one-player interactions that drive the outcome in hockey contests. [7] used LR and DT for explaining match outcomes in Australian Rules football. [8] presented a mixture of modeler's approaches to forecasting the 2014 NCAA men's basketball tournament.

ANN approach has been applied in predicting football match results by different researchers for different leagues. For example, [4] used ANN to predict the outcomes of one week of the Iran Pro League (IPL) 2013-2014 football matches, where the data obtained from the past matches in the seven last leagues were used to make better predictions for future matches. [9] did a study on "AI in Sports Prediction". In the study, they used a Multi-layer Perceptron to predict the outcome of sports games, among which was the EPL. [10] wrote a Thesis on 'Football Match Prediction using Deep Learning' which investigated the deep learning method RNNs for predicting the outcomes of football matches and the test results showed that deep learning may be used for successfully predicting the outcomes of football matches.This researchfocused on

- The prediction of the precise number of goals to be scored in a single football match there implication and predicts the winner.

The proposed method used ANN to predict the goal score of the individual football match. Initially, the data are gathered from the Leagues. Then the relevant features were identified using the Backward Elimination technique. Then the datasets are normalized and split for training and testing functions. Finally, the performance is evaluated. This method provides an accuracy score of 97.92%.

The organization of this paper is in this order: Section 2 presents the literature review, and Section 3 explains the methodology. Section 4 explains the result and discussion, Section 5 explains the advantages and disadvantages, and Section 6 concludes the paper.

2. Related Literature

Machine Learning is a major field in the field of computing that has become more popular as technology has advanced. According to the authors in[11] ML is a domain of AI that strives for enabling machines to carry out their jobs skillfully through the application of intelligent programs. It is a natural extension of the intersection of the fields of Statistics and Computer Science. ML uses a variety of algorithms that iteratively learn from data to improve, describe data, and predict outcomes. As training data are absorbed by the algorithms, it is then possible to produce more accurate models based on that data. AnML model is the output generated when you train your ML algorithm with data. After the model is trained, when you provide the model with an input, it gives you an output. According to [12], a predictive ML algorithm will create a predictive model. They further stated that when the predictive model is provided with data, it makes a prediction based on the data that trained the model.

[9] did a study on "Artificial Intelligence in Sports Prediction" which was a study on using a Multi-layer Perceptron to predict the outcome of sports games. The researchers obtained data from various sources which cover four major league sports: the AFL, Super Rugby (Super 12 and Super 14), the AustralianNRL, and EPL from way back as 2002. [9] pointed out that the data included noise such that

there were details that influenced the contest outside of those captured in the dataset. They used MLP to model the features, and for the learning algorithm, they chose back-propagation, which was pointed out to be "slightly more effective than the conjugate-gradient method". The MLP they used was three-layered with nineteen input units, one for each feature (or twenty, when Player Availability is included), ten hidden units, and a single output unit. The output unit was normalized to be a value between zero and one inclusive. The output values for the two teams competing in each game were calculated and the team which had the highest output value (i.e., the highest confidence that the team would be victorious) was taken as the predicted winner. Their results showed that for the EPL the best performance was at 58.9%, while the average and worst performance was at 54.6% and 51.8% respectively.

[12] conducted research to predict football match result Prediction using neural networks and deep learning. In the research, the authors deduced better features from the results of the previous matches that the team played and took into consideration the current form of the team to predict the accurate result of the game. Each dataset had around 380 records with around 60 attributes. The researchers then used an RNN to develop their model. They used basicLSTM cells from the TensorFlow library to perform experiments on the dataset. The model was run on various sets of hyper-parameters to find out the best model. The researchers found that the accuracy achieved by the prediction system that worked with the LSTM form of RNNs showed huge improvement with a test accuracy of 80.75%.

[13] did a study that applied a neural network algorithm in predicting football match outcomes based on player ability index. The researcher applied three algorithms that included ANN, RF, and SVM to predict the result of a football match, and then compared the accuracy of the algorithms. [13] found that the accuracy of these three methods is between 54% and 58%. The researcher further compared the result to the accuracy of the predictions of the famous football analyst of BBC, Mark Lawrenson, which is only 52%. In addition, the researcher also compared the accuracy of the CNN which is at 58% to the prediction accuracy of the authoritative football gambling organization Pinnacle Sports, which is only 55%. Showing that CNN is more accurate in the predictions.

[15] used uses ML algorithms to predict player substitutions in football matches. Used Kaggle dataset, which contains data of 51,738 substitutions from 9074 European league football matches in 5 leagues spanning 6 seasons. The data was preprocessed by cleaning and transforming it into a format suitable for ML algorithms. Then data were separated into training and testing sets using an 80-20 data split. Then prediction of player substitution was predicted through LR, DT, KNN, SVM, MNB, and RF classifiers. Finally, performance was evaluated using metrics such as accuracy, F1-score, and Precision.

[16] have implemented the Poisson distribution model to predict the winner of the match. Initially, collected data on the average goal scores and goals conceded for each team. Calculated the probability of winning and losing based on the average goal scores and goals conceded using the Poisson distribution model.Then evaluate the difference between the predicted and actual results using de Finetti distance. This method is used for successful predictions to rate the team's readiness for the FIFA World Cup 2022 knockout stage.

[17] have introduced hybrid classification methods that use clustering and classification algorithms together to predict the results of future football matches. Initially, data were collected on 6396 football matches played in European leagues, including fans' opinions gathered from social media platforms in addition to statistical information about the teams and players. Then transforming the raw data into suitable datasets through software developed by the authors.Using hybrid classification methods that used clustering and classification algorithms together to predict the results of future football matches. Finally, the performances were compared with the classification algorithms.

[18] have executed a generalized and interpretable ML model framework for forecasting football match results. The model also embeds historical match statistics, which consist of significant information, during the training process. The framework allowed football teams to adapt for tactical decision-making, strength and weakness identification, formation and player selection, and transfer target validation. The method achieved high performance and interpretability in forecasting football match results using five years of data from the English Premier League.

[19] have applied ANN and LR classifiers through KDD. Initially, dataset were colled and processed to make it suitable for analysis. A data mining tool was used to evaluate and predict the result of a football match. Mining football data with the aid of data mining software, such as Rapid Miner, creates room to include as many features as possible due to the scalability of the tool.

[20] have adopted ML applications in sports analytics to predict long-term team and player performance in football. Initially, data was collected and feature was extracted using backward elimination method. Multiple LR models was based on player attributes and statistics to predict team and player performance. The outcome was further predicted using the AccuracyM metric.

2.1 Review

Table 1 portrays the methodology, advantages, and disadvantages of the existing method. Each method has certain benefits and shortcomings, that were explained in detail.

Table 1: *Review Based on Existing Methods*

Author	Methodology	Advantage	Disadvantage
Mohandas *et al.* [15]	LR, DT, KNN, SVM, MNB, and RF classifiers	• Can accurately predict player substitutions in football matches. • Allow teams to alter the dynamics of a match and potentially influence the outcome. • Based on concrete data rather than instinct. • Enhance team performance. • Applicable to multiple leagues.	• This may not apply to all football leagues or matches because of different playing styles or rules. • Relied on historical data to make predictions. • The worst computation time was up to 2 min by the SVM model, which may not be practical in real-time scenarios.
Pinasthika, S.J. and Fudholi, D.R., [16]	Poisson distribution model	• Makes the prediction more accurate and relevant to the current FIFA World Cup. • Suitable for discrete probability distributions like the number of goals scored and conceded in a football match. • The method is simple and easy to understand, making it accessible to a wider audience. • The method can be used even with a limited dataset.	• Only uses the average goal scores and goals conceded for each team, which may not capture all the relevant factors that can affect the outcome of a football match.
Mccabes, A., & Trevathen [9]	Multi-layer perceptron	• Able to adapt quickly and perform well • Can be applied to different sports and various seasons. • More accurate predictions. • Used in live testing	• Limited to the accuracy of the model in certain situations. • Relied on the quality of the data and the features used.
Tiwari, E., *et al.* [13]	RNNs and LSTM	• Predict various information related to a particular football match. • The ability to remember not only the sequence in one instance but also the sequence of the various instances. • The ability to adjust hyper-parameters to improve the accuracy of the model. • The potential to reduce the reliance on human experts for predicting football match results.	• Predictions may not always be accurate.
KINALIOĞLU, İ.H. and KUŞ, C., [17]	Hybrid classification method	• Unique features were compared. • Used software to transform the raw data into suitable datasets. • Helpful for researchers working on similar problems.	• Based on the assumption of past performances and fans' opinions. • May not always be accurate in predicting the results of football matches.
Yeung *et al.*[18]	ML	• required only coaches' decisions and player quality features for forecasting. • More accurate in forecasting match results. • Achieved high performance and interpretability in forecasting football match results.	• The result depends on the quality and quantity of the data used for training. • May not apply to other football leagues or tournaments.
Igiri*et al.* [19]	ANN and LR	• An improved model with higher comprehensive prediction accuracy. • Added new feature sets.	• The result may vary bsed on the data • Complex process •
Pantzalis*et al.* [20]	ML and LR	• Reliable prediction. • Predict the final league table for certain leagues and other team performance metrics.	• Prediction may vary based on various factors. • Heavily relied on historical data and advanced statistics.

2.2 Challenges

The challenges experienced in the prediction of the goal score of the individual team are given as follows,

- The studies by [9] [12] [13] all discuss prediction models that predict the outcome of a football match as either win, lose, or draw. However, the studies do not explicitly specify the conditions for the victory or loss of one team over another.
- In [9][13][17][20] may provide a better result, but the results may vary based on its external factors. Additionally, it also relied based on its features.

Thus, this research explored the use of ANN to explicitly predict the number of goals to be scored in a football match. Thus, this paper goes a step further in showing how to predict in explicit terms, the number of goals to be scored by each team in a match using an ANN.

3. Methodology

The preliminary stages of building an ANN model involve the gathering of the data that will make up the dataset. Data was obtained from Football-data.co.uk, a reputable football data website known to have accurate data on all matches in the big leagues such as the EPL, UEFA Champions League, and other leagues.

The initial dataset consisted of 43 features but was reduced to 22 features after the Backward Elimination technique was applied to select the relevant features. The resulting dataset consisted of 22 features with 576 datapoints as shown in Table 2 and Table 3. The dataset included features that included: tot_goal (total goals the team has scored so far), tot_con (total goals the team has conceded so far), HtrgPerc (shot on target/total shots – Home), AtrgPerc (shot on target/total shots – Away),xG (expected goals), xGA (expected goals away team), etc.

Table 2: *Sample dataset showing the selected features*

	h_a	xG	xGA	npxG	npxGA	deep	scored	missed	result	date	wins	draws	loses	npxGD
1	h	2.23456	0.842407	2.23456	0.842407	11	4	1	w	2019-08-09 20:00:00	1	0	0	1.392153
2	a	0.842407	2.23456	0.842407	2.23456	5	1	4	l	2019-08-09 20:00:00	0	0	1	-1.392153
3	a	3.18377	1.2003	2.42264	1.2003	9	5	0	w	2019-08-10 12:30:00	1	0	0	1.22234
4	h	1.2003	3.18377	1.2003	2.42264	1	0	5	l	2019-08-10 12:30:00	0	0	1	-1.22234
5	h	1.34099	1.59864	1.34099	1.59864	4	1	1	d	2019-08-10 15:00:00	0	1	0	-0.25765
6	a	0.855516	0.670022	0.855516	0.670022	5	3	0	w	2019-08-10 15:00:00	1	0	0	0.185494
7	h	0.909241	1.08752	0.909241	1.08752	0	3	0	w	2019-08-10 15:00:00	1	0	0	-0.178279
8	h	0.87159	1.2246	0.87159	1.2246	5	0	0	d	2019-08-10 15:00:00	0	1	0	-0.35301
9	a	1.2246	0.87159	1.2246	0.87159	5	0	0	d	2019-08-10 15:00:00	0	1	0	0.35301
10	a	1.59864	1.34099	1.59864	1.34099	6	1	1	d	2019-08-10 15:00:00	0	1	0	0.25765

Table 3: *Sample dataset showing the selected features*

teamId	matchtime	tot_goal	tot_con	Referee.x	HtrgPerc	AtrgPerc	matchDay
Liverpool	20	4	1	M Oliver	0.466666666666667	0.416666666666667	Fri
Norwich	20	1	4	M Oliver	0.466666666666667	0.416666666666667	Fri
Man City	12	5	0	M Dean	0.6	0.642857142857143	Sat
West Ham	12	0	5	M Dean	0.6	0.642857142857143	Sat
Bournemouth	15	1	1	K Friend	0.230769230769231	0.375	Sat
Brighton	15	3	0	C Pawson	0.272727272727273	0.6	Sat
Burnley	15	3	0	G Scott	0.4	0.272727272727273	Sat
Crystal Palace	15	0	0	J Moss	0.333333333333333	0.3	Sat
Everton	15	0	0	J Moss	0.333333333333333	0.3	Sat
Sheffield United	15	1	1	K Friend	0.230769230769231	0.375	Sat

The dataset was normalized using the *MinMaxScaler* function in the SciKit Learn library. For training and testing the model, the dataset was split into training and testing datasets at 75% and 25% respectively.

ML libraries that include pandas, numpy, seaborn, matplotlib, Scikit Learn, and XGBoost were used for the data preprocessing and normalization, data visualization, model training and testing, and performance evaluation.

Initially, the inputs are fed into the ANN architecture along with its training patterns. It is then initialized along with its free parameters. When the process reaches its maximum iteration the display system shows the goal score of each team and it is stored.

When the process doesn't reach its maximum iteration, it will be passed to N/W and calculate the instantaneous error and backpropagates to update its synaptic weights. Furthermore, all the patterns are tested. If any error across the same process will be again repeated.

If no error occurs in the testing SSE will predefine the value and display it on the display screen along with the team score and store the results. The flow process is explained in Figure 1.

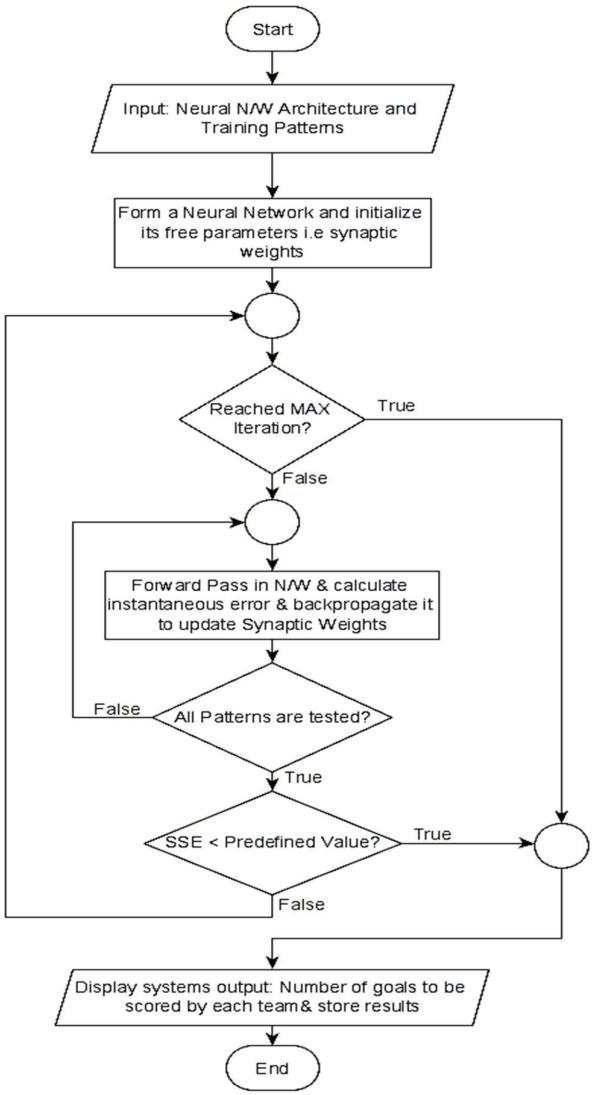


Figure 1. *Flowchart of the proposed system*

4. Results and Discussion

To test the model, it was compiled with varying parameters as shown in Table 2. The hidden layer was altered between 1,2,3, and 4 layers. The activation function for the hidden layer was alternated between relu and tanh. The optimizer used for the different runs is the Adam and Sigmoid optimizers. The number of iterations (epochs) ranged between 100 and 1000, with the learning rate either constant or adaptive. The model was fed in batches of 10, 20, 30, and 50. The model with the highest accuracy score of 97.92% consisted of 3 hidden layers of 10, 10, and 10 neurons each, compiled with the tanh activation function at 1000 epochs with a constant learning rate.

Figure 2 plots out the accuracy of each model against its Mean Squared Error (MSE). The graph shows a relative consistency in the MSE for all models tested, ranging from 2.7418 to 2.868. The accuracy of all the models ranged from 59.03% to 97.92%. This means the error margin for all the models tested remained relatively the same even as the accuracy varied more widely. Taking these factors into account, the model with the highest level of accuracy of 97.92% is selected.

Table 4: *ANN Trials with Different Parameters*

S/N	Hidden Layer	Number of Neurons	Hidden Layer Activation	Optimizer	Accuracy %	Epochs	Learning Rate	Batch	f'Mean Square Error
1	1	5	relu	Adam	84.03	100	Constant	10	2.7979
2	2	5 5	relu	Adam	93.75	100	Adaptive	10	2.8186
3	2	20 10	relu	Adam	93.75	1000	Adaptive	20	2.868
4	2	40 20	tanh	Adam	90.28	1000	Constant	30	2.8671
5	**3**	**10 10 10**	**tanh**	**sigmoid**	**97.92**	**1000**	**Constant**	**30**	**2.8644**
6	3	40 40 40	tanh	sigmoid	96.53	1000	Adaptive	50	2.8653
7	3	50 30 30	relu	sigmoid	59.03	100	Adaptive	50	2.7418
8	3	50 30 30	relu	sigmoid	96.53	1000	Adaptive	50	2.7418
9	4	40 40 30 20	tanh	sigmoid	85.42	100	Constant	50	2.8232

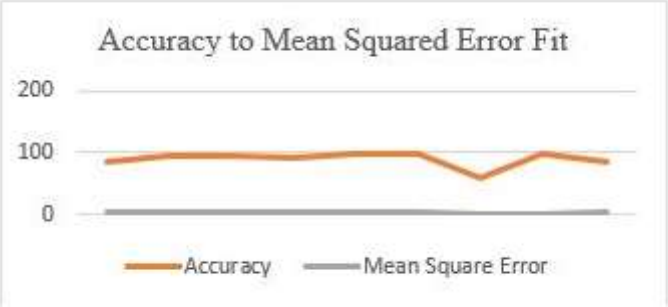


Figure2.*Accuracy to Mean Squared Error Fit.*

5. Advantages and Disadvantages

Advantage

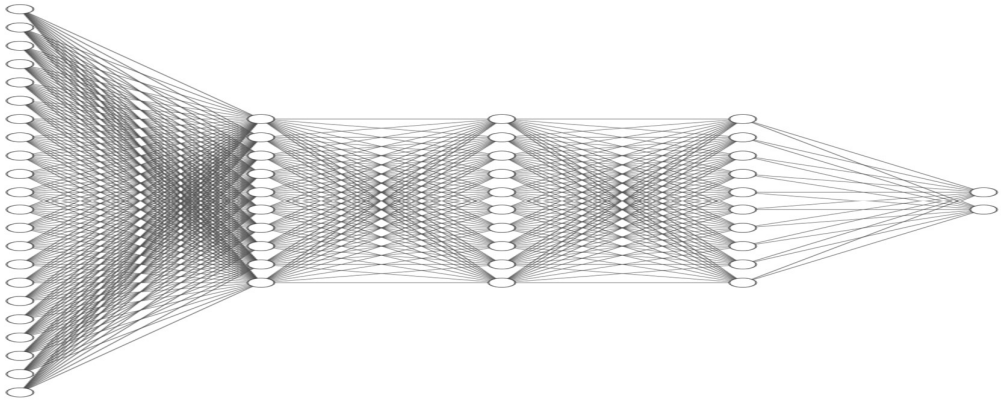
- Provide high accuracy compared to the existing model.
- This method predicts the exert number of goals to be scored by each team in a football match with a high level of accuracy.
- This method used to predict the outcomes of real-life football matches with unknown results, which can be very lucrative for the sports match-betting industry.

Disadvantages

- The physical conditions of the match and its features may affect the accuracy of the prediction models.
- The proposed ANN model can predict the number of goals to be scored in a football match, but it may not be able to predict other factors such as player injuries, weather conditions, or team strategies.

6. Conclusion

The selected Neural Network is a Multi-layer Perceptron classifier implemented by the MLPClassifier class in sklearn. It is an estimator available as a part of the Neural Network module of sklearn for performing classification tasks using a multi-layer perceptron. This model optimizes the log-loss function using LBFGS or stochastic gradient descent. The model consists of three hidden layers made up of 10, 10, 10 neurons. The activation function for the model is the tanh activation function. For the optimizer, the sigmoid function was used. In this model, weights were adjusted automatically depending on the number of neurons fed into the model and the activation function used after each iteration.



Input Layer ϵ R^{22} Input Layer ϵ R^{10} Input Layer ϵ R^{10} Input Layer ϵ R^{10} Input Layer ϵ R^{2}

Figure 3.*22-10-10-10-2 ANN Model Structure*

The chosen model performed very well with an accuracy score of 97.92% and a mean squared error of 2.8642. The model was timed at 9.1 seconds at 1000 epochs. This shows that ANNs can be applied to predict the exact number of goals to be scored in a football match with a high degree of accuracy.

Compliance with Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

References

[1] Keogh, F. and Rose, G., "Football betting-the global gambling industry worth billion"s. BBC, 2013.

[2] Stekler, H. O., Sendor, D., & Verlander, R,"Issues in sports forecasting", International Journal of Forecasting, Vol. 26, No.3, pp. 606-621, 2010.

[3] Arabzad, S. M., Araghi, M. T., Sadi-Nezhad, S., & Ghofrani, N,"Football Match Results Prediction Using Artificial Neural Networks; The Case of Iran Pro League", International Journal of Applied Research on Industrial Engineering, Vol. 1, No. 3, pp. 159–179, 2014.

[4] Schumaker, R. P., Solieman, O. K., & Chen, H,"Sports Data Mining", New York 2010: Springer.

[5] Edelmann-Nusser, J., Hohmann, A., & Henneberg, B,"Modeling and Prediction of Competitive Performance in Swimming Upon Neural Networks", European Journal of Sport Science, Vol. 2, No.2,pp.77-89, 2002.

[6] Morgan, S., Williams, M. D., & Barnes, C,"Applying decision tree induction for identification of important attributes in one-versus-one player interactions: A hockey exemplar", Journal of Sports Sciences, Vol. 31, No.10, pp. 1031-1037 2013.

[7] Robertson, S., Back, N., & Bartlett, J. D,"Explaining match outcome in elite Australian Rules football using team performance indicators", Journal of Sports Sciences, Vol. 34, No.1, pp.1-8, 2015.

[8] Yuan, L. H., Liu, A., Yeh, A., Kaufman, A., Reece, A., Bull, P., & Bornn, L,"A mixture-of-modelers approach to forecasting NCAA tournament outcomes", Journal of Quantitative Analysis in Sports, Vol. 11, No.1,pp. 13-27, 2015.

[9] Mccabes, A., & Trevathen,"Artificial intelligence in sport prediction", fifth international conference on information technology: New generation (itng 2008), pp. 1194 – 1197,2008.

[10] Petterson, D., & Nyquist, R,"Football Match Prediction using Deep Learning" [Master's thesis, Chalmers University Of Technology, Gothenburg],Chalmers Publication Library, 2017.

[11] Mohammed, M., Khan, M. B., Bashier, E., & Bashier, M,"Machine Learning: Algorithms and Applications". Boca Raton: CRC Press, 2017.

[12] Hurwitz, J., & Kirsch, D,"Machine Learning For Dummies", New Jersey, 2018.

[13] Tiwari, E., Sardar, P., & Jain, S,"Football Match Result Prediction Using Neural Networks and Deep Learning" 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2020.

[14] Chen, H. Z,"Neural Network Algorithm in Predicting Football Match Outcome Based on Player Ability Index", Advances in Physical Education, Vol. 9, pp.215-222 2020, 2019.

[15] Mohandas, A., Ahsan, M. and Haider, J., "Tactically Maximize Game Advantage by Predicting Football Substitutions Using Machine Learning", Big Data and Cognitive Computing, Vol. 7, No. 2, pp.117, 2023.

[16] Pinasthika, S.J. and Fudholi, D.R., "World Cup 2022 Knockout Stage Prediction Using Poisson Distribution Model", IJCCS (Indonesian Journal of Computing and Cybernetics Systems), Vol. 17, No. 2, 2022.

[17] KINALIOĞLU, İ.H. and KUŞ, C., "Prediction of football match results by using artificial intelligence-based methods and proposal of hybrid methods", International Journal of Nonlinear Analysis and Applications, Vol. 14, No.1, pp.2939-2969, 2023.
[18] Yeung, C.C., Bunker, R. and Fujii, K., "A framework of interpretable match results prediction in football with FIFA ratings and team formation", Plos one, Vol. 18, No. 4, pp.e0284318, 2023.
[19] Igiri, C.P. and Nwachukwu, E.O., "An improved prediction system for football a match result", 2014.
[20] Pantzalis, V.C. and Tjortjis, C., "Sports analytics for football league table and player performance prediction", In 2020 11th International Conference on Information, Intelligence, Systems and Applications (IISA), pp. 1-8,2020.