УДК 004.85:004.94:796.077 DOI 10.36910/775.24153966.2025.82.17

І.С. Ющук, О.С. Приходько
Луцький національний технічний університет

АНАЛІЗ ОБМЕЖЕНЬ МАШИННОГО НАВЧАННЯ У ПРОГНОЗУВАННІ СПОРТИВНИХ РЕЗУЛЬТАТІВ

У статті представлено експериментальну оцінку ефективності прогностичної моделі на основі алгоритмів машинного навчання. Ключовою метою був аналіз причин розбіжностей між прогнозованими та реальними результатами. Результати експериментів виявили суттєвий вплив динамічних та непередбачуваних факторів (раптові травми, зміни складу, мотивація команд, погодні умови) на точність прогнозів. Систематизовано основні обмеження існуючих статистичних підходів та визначено пріоритетні напрями для подальшого вдосконалення методів спортивної аналітики. Головним результатом роботи є виявлення ключових викликів та обґрунтування необхідності нових підходів до прогнозування в умовах високої динамічності спортивних подій.

Ключові слова: *Прогнозування спортивних результатів, штучний інтелект, аналітика даних, методи машинного навчання, спортивна статистика, ефективність прогнозування.*

I.S.Yushchuk, O.S. Prykhodko

ANALYSIS OF THE LIMITATIONS OF MACHINE LEARNING IN PREDICTING SPORTS RESULTS

This paper presents an experimental evaluation of the effectiveness of a predictive model based on machine learning algorithms. The key objective was to analyze the reasons for the discrepancies between predicted and actual results. The results of the experiments revealed a significant impact of dynamic and unpredictable factors (sudden injuries, changes in composition, team motivation, weather conditions) on the accuracy of predictions. The main limitations of existing statistical approaches were systematized and priority areas for further improvement of sports analytics methods were identified. The main result of the work is the identification of key challenges and justification of the need for new approaches to forecasting in the context of highly dynamic sporting events.

Keywords**:** *Sports results prediction, artificial intelligence, data analytics, machine learning methods, sports statistics, prediction efficiency..*

Introduction and problem statement. Predicting sports results is an important area of research that combines elements of statistics, machine learning, and data analytics. In today's sports environment, where competition is growing and the volume of information is increasing, the need for reliable predictions is relevant for athletes, coaches, and organizations. However, the dynamic nature of sporting events, the presence of numerous uncontrollable factors, and high uncertainty pose significant challenges to achieving high accuracy. Artificial intelligence (AI) opens up new possibilities for analysis, but its practical effectiveness needs to be critically evaluated in the context of real-world unpredictable events. The relevance of this study is due to the need for a deeper understanding of the limitations of modern AI-based forecasting methods and the identification of key factors that reduce their accuracy. This will allow us to identify priority areas for further improvement of the methodology, which has a direct impact on the quality of decision-making in sports.

Analysis of the latest research and publications. Predicting sports results is traditionally considered a classification task (win/loss/draw) [1]. However, recent studies reveal fundamental limitations of such approaches, especially when attempting to predict exact results (score, goal difference) [2]. Although regression methods can theoretically provide deeper analysis [3], their practical effectiveness is severely limited by the high stochasticity of sporting events and the difficulties of formalizing dynamic factors. Studies such as Puruker's work [4] demonstrate typical barriers even for simple models: the use of neural networks for NFL predictions yielded only 61% accuracy (compared to 72% for experts), despite the use of key features (yards, interceptions, bookmaker odds). This indicates a critical dependence of accuracy on the quality and completeness of data—a limited set of features did not allow overcoming the "noise" of real game conditions. More complex approaches (e.g., Tax and Joustra [5]) confirm the methodological complexity of integrating additional factors. An analysis of a thirteen-year sample of matches in the Dutch soccer league showed that betting odds often prove to be better predictors of the outcome than even detailed game statistics. Attempts to improve models by adding additional features, such as current team form or tactical characteristics, did not result in a stable increase in accuracy. The best result (only 56.1%) was demonstrated by the LogitBoost model with feature selection using the ReliefF method [6-8], which indicates the existence of a certain limit of effectiveness for models based solely on statistical

approaches. These works systematically highlight the main problem: existing models inadequately account for the impact of unpredictable events (injuries, motivation, tactical changes) and rely too heavily on historical patterns. Thus, our work focuses on the empirical analysis of these limitations, in particular for the task of predicting scores — the most vulnerable to dynamic changes.

The aim of the study. Analysis of modern methods of predicting sports results using artificial intelligence, in particular, the study of their limitations and challenges in the context of the high dynamism of sporting events. The aim of the study is not only to identify the main trends and approaches, but also, and more importantly, to critically assess the barriers to achieving high prediction accuracy, particularly those caused by the influence of unpredictable factors. The object of the study is the technologies and algorithms of artificial intelligence used to analyze sports data, while the subject of the study is the accuracy of predictions of sports results and the factors that cause them to diverge from reality. The practical significance of the study lies in identifying key areas for improving the methodology of sports analytics. The results obtained can serve as a basis for future developments aimed at improving the effectiveness of the use of analytical data by sports teams and organizations. The systematization of the identified limitations opens up new horizons for scientific research in the field of sports analytics, contributing to the further development of innovations and the development of more robust forecasting methods.

Experimental methodology. The experimental part of the study aimed to evaluate the capabilities and limitations of a statistical model for predicting the results of Premier League football matches, including the number of goals, the probability of victory, and the assessment of team form. The model took into account numerous factors that influence the outcome of a game (including historical form, potential weather conditions, and stadium attendance). The key task was not only to obtain predictions, but also to conduct a thorough analysis of the reasons for the discrepancies between the predicted and actual results, in order to identify the main barriers to improving accuracy, especially in light of dynamic and unpredictable events (e.g., injuries, lineup changes, motivational factors).

To implement the prediction system, historical data from the football-data.org API, which provides real-time information on football match results, was used. The algorithmic implementation covers several stages, from processing historical data to generating predictions for future matches. The main task is to build models that can reflect the current form of the team and predict its further development. The program code consists of several main components that work in close interaction:

- Data collection and processing: The program collects data on match results—for each season, information about the date of matches and results is stored.
- Team form assessment: The team's current form is assessed using the average points method for the last five matches, which allows the dynamics of the form to be modeled.
- Forecast generation: Based on this form, forecasts are generated for the likely results of the remaining matches of the current season, and results are also predicted for the next season. To ensure the realism of trends, random changes in form are used with certain restrictions (for example, changes within 0.7–2.7 points per match). The program generates 2–3 possible trends for the development of events.
- Application of machine learning methods: Machine learning methods, including linear regression, Random Forest, and Gradient Boosting, are used to process data and build predictive models.

Visualization of the model's results using graphs serves as a tool for visual analysis of its limitations. The graphs show how the indicators have changed over time. The indicators obtained using moving average methods allow us to clearly see trends and fluctuations in form, as well as instantaneous declines or rises. This allows us to visually assess the discrepancies between real data and model extrapolations, as well as analyze tendencies to generate unrealistic trends.

Presentation of the main research material. The results of the experimental model are presented in the form of graphs that visualize key aspects of forecasting for football teams. This approach allows us to clearly demonstrate the dynamics of indicators, artifacts, and limitations of algorithms.

Figure 1 shows the graph of points accumulated by the team for the 2023/24 and 2024/25 seasons and the extrapolation (trend) for the 2025/26 season. The 2023/24 season is characterized by stable points accumulation. In the 2024/25 season, there is a significant slowdown in the pace. The dotted line (2024/25) shows a slight improvement at the end of the season, as predicted by the model. The most significant finding is the forecast for 2025/26: the model predicts a sharp acceleration in points scored, which differs significantly from the trends of previous years. This anomaly highlights the risk of over-optimization of the model based on historical data and its inability to adequately take into account contextual changes (e.g.,

changes in the team's composition, the club's financial capabilities). Without additional context, such dynamics demonstrate the fundamental complexity of long-term forecasting in the highly dynamic environment of soccer.

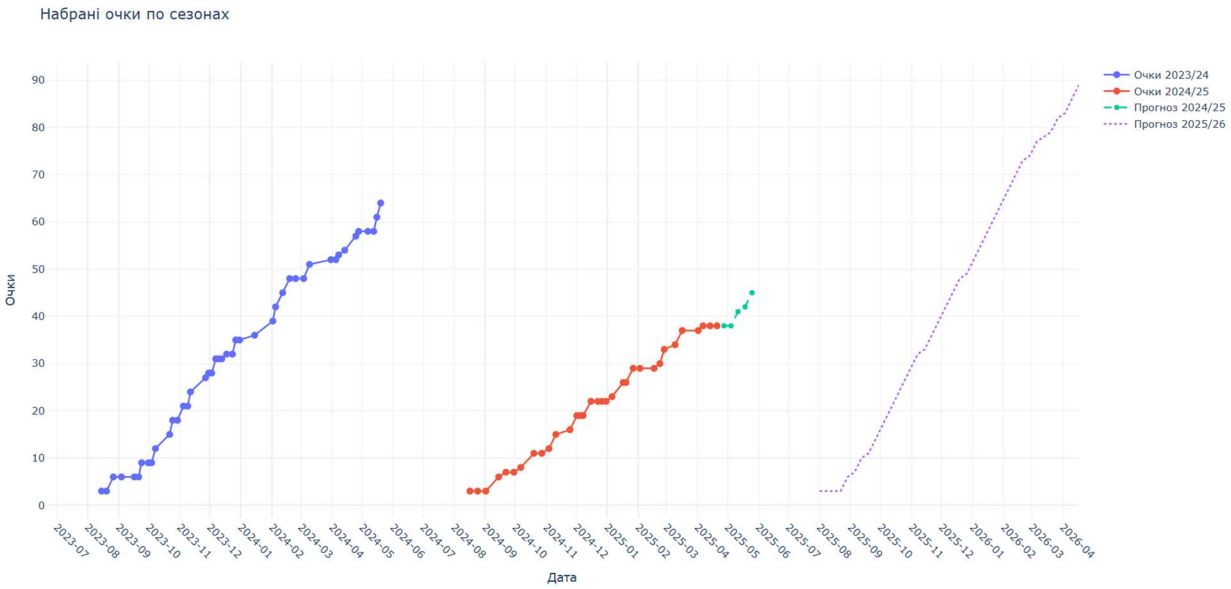

Fig. 1. **Graph of points scored by season and predictions for the next season**

Figure 2 illustrates the dynamics of the team's short-term form (average number of points in the last 5 matches). The 2023/24 season saw significant fluctuations with episodes of performance above the “good form” level (1.5 points). In the 2024/25 season, performance deteriorated significantly, remaining mostly at around 1 point. The forecast for the end of 2024/25 shows a short-term increase, and the forecast for 2025/26 shows a rapid increase to the theoretical maximum (2.5 points). This extremely optimistic trend, especially against the backdrop of previous fluctuations, raises doubts about the stability of the model: it may indicate an underestimation of the randomness factor, excessive sensitivity to local changes, or failure to take into account real-world constraints (injuries, fatigue, changes in opponents' tactics). Such extrapolation is a striking example of a fundamental challenge in forecasting – models tend to generate unrealistic trends when detached from the current context.

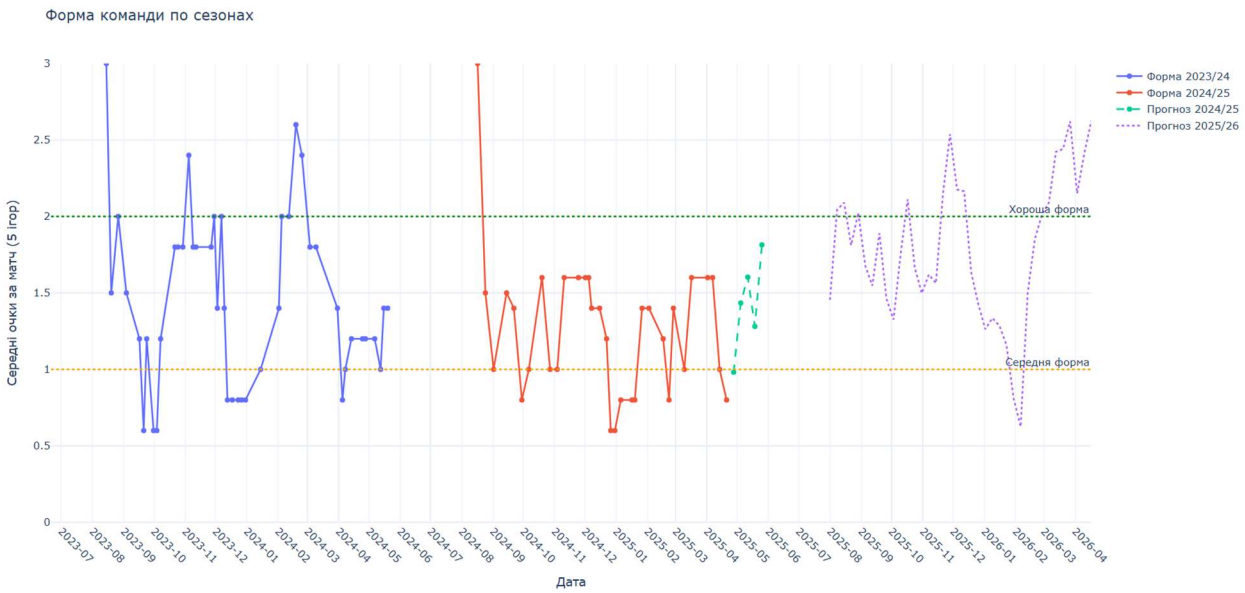

Fig. 2. **Team form chart based on the results of the last 5 games**

Analysis of the graphs confirms the key limitations identified in short-term forecasting experiments: the model tends to generate overly optimistic and stable trends in the long term, which differ significantly

from the dynamics of real seasons. This is particularly evident in the example of abnormal growth in Fig. 1 and unrealistic form improvement in Fig. 2 for the 2025/26 season.

Experimental evaluation. To verify the accuracy of the forecasting model, three experiments were conducted with predictions for English Premier League (EPL) matches. The prediction results are presented in Tables 1-3.

Table 1

Comparison of predicted and actual EPL match results (December 4-5, 2024)

Program forecast	Game results
Newcastle United – Liverpool 0:2 (90% chance of Liverpool winning)	Newcastle United – Liverpool 3:3
Arsenal – Manchester United 3:1 або 2:1	Arsenal – Manchester United 2:0
Southampton – Chelsea 0:1 (Chelsea win)	Southampton – Chelsea 1:5
Manchester City – Forest 2:2	Manchester City – Forest 3:0
Bournemouth – Tottenham 2:2 is possible, but 2:1 is more likely	Bournemouth – Tottenham 1:0

The results demonstrate moderate accuracy (60%) in predicting the winner, but a complete inability to predict the exact score. The main reason for the discrepancies is the model's limitation in accounting for sudden changes during matches (e.g., injuries, tactical changes), which highlights its vulnerability to dynamic factors.

An attempt was made to improve accuracy by entering data on the team's previous matches into the system immediately before the predicted ones. The results are shown in Table 2.

Table 2

Impact of data collection time on prediction accuracy (December 14–15, 2024)

Program forecast (December 9)	Program forecast (December 14)	Game results (December 14-15)
Liverpool – Fulham 2:1 (the graph also predicts 1:1)	Liverpool – Fulham 3:1	Liverpool – Fulham 2:2
Manchester City - Manchester United 2:2 or 2:1 (more likely to be a draw)	Manchester City - Manchester United 2:2 or 2:1 (more likely to be a Manchester City win)	Manchester City - Manchester United 1:2
Arsenal – Everton 1:0	Arsenal – Everton 2:1	Arsenal – Everton 0:0
Chelsea - Brentford 2:0	Chelsea - Brentford 2:1	Chelsea - Brentford 2:1
Southampton – Tottenham 1:1 or 1:0	Southampton – Tottenham 1:2 or 0:1	Southampton – Tottenham 0:5

The experiment confirmed that updating data closer to the match improves predictions, but accuracy remains low (40% for the winner, 20% for goals). This indicates that even real-time data did not overcome the influence of unpredictable events (sudden changes in the lineup, team motivation), limiting the practical reliability of the system.

Another attempt to enter the results of new matches into the model is shown in Table 3.

Table 3

Results of the third experiment (December 21–22, 2024)

Program forecast	Game results
Aston Villa - Manchester City 1-1	Aston Villa - Manchester City 2:1
Crystal Palace – Arsenal 1-1	Crystal Palace – Arsenal 1:5
Manchester United - Bournemouth 3:2	Manchester United – Bournemouth 0:3
Everton – Chelsea 1:2	Everton – Chelsea 0:0
Tottenham - Liverpool 0-1	Tottenham - Liverpool 3:6

Analysis of Table 3 showed a critical drop in accuracy (20%), indicating a systemic problem with the model: its inability to take into account key contextual factors (changes in the starting lineup, weather conditions, psychological state of the teams). This confirms the hypothesis about the inadequacy of a purely statistical approach in the dynamic environment of football matches.

Conclusions. The experimental evaluation of the proposed model for predicting Premier League match results clearly revealed its key limitations. The analysis confirmed that the high dynamism of football matches and the influence of unpredictable factors (such as sudden injuries, lineup changes, motivational aspects, and weather conditions) are fundamental obstacles to achieving consistently high prediction accuracy. Even the use of advanced machine learning methods (regression, decision trees, neural networks, ensembles) did not allow for the effective consideration of the impact of these dynamic changes in real time. The accuracy of the predictions was significantly lower than expected and unstable, which highlights the fundamental complexity of modeling sporting events. The practical significance of the study lies not in a ready-made solution, but in the systematization of challenges and a clear definition of priority areas for further research: integration of real-time data (news, lineups, weather), development of mechanisms for taking into account qualitative factors (psychology, motivation), and implementation of scenario analysis to manage uncertainty. The systematization of the identified limitations can be a starting point for the development of more robust methods of sports analytics.

List of references:

1. D. Prasitio, D. Harlili, Predicting football match results with logistic regression, in: Proceedings of the 2016 International Conference On Advanced Informatics: Concepts, Theory And Application (ICAICTA), 16–19 Aug. 2016, Penang, Malaysia, 2016.
2. D. Delen, D. Cogdell, N. Kasap A comparative analysis of data mining methods in predicting NCAA bowl outcomes Int. J. Forecast., 28 (2) (2012), pp. 543-552
3. Ulmer B, Fernandez M, Peterson M. Predicting soccer match results in the english premier league. Doctoral dissertation, Doctoral dissertation, Ph. D. dissertation, Stanford. 2013.
4. Purucker M.C. Neural network quarterbacking IEEE Potentials, 15 (1996), pp. 9-15
5. N. Tax, Y.P. Joustra Predicting the Dutch football competition using public data: A machine learning approach Trans. Knowl. Data Eng., 10 (10) (2015), pp. 1-13
6. I.T. Jolliffe Principal Component Analysis (second ed.), Springer-Verlag, Berlin (2002)
7. Marcano-Cedeno, J. Quintanilla-Dominguez, M. Cortina-Januchs, D. Andina, Feature selection using sequential forward selection and classification applying artificial metaplasticity neural network, in: 36th Annual Conference on IEEE Industrial Electronics Society, 2010, pp. 2845–2850
8. F. Kamalov, F. Thabtah A feature selection method based on ranked vector scores of features for classification Ann. Data Sci. (2017), pp. 1-20

Reviewer: Pasternak Yaroslav, Doctor of Physical and Mathematical Sciences, Professor of the Department of Computer Science and Cybersecurity at Lesya Ukrainka Volyn National University.