YuShan2025: Team Description Paper

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Abstract. This team description paper presents the direction and methodology of YuShan2025's optimization. In the soccer simulation 2D environment, we are faced with a complex real-time multi-intelligence challenge, evaluators play an important role in team implementation, so YuShan2025's main work this year focuses on evaluator optimization. In order to effectively cope with this dynamically changing game environment and make better decisions in real-time matches, we proposed an evaluator method based on Long short-term memory (LSTM) networks, and experimental results show the effectiveness of this aspect. Additionally, we analyzed the defensive behaviors of other teams' players and developed lightweight tools related to game logs and score records.

1 Introduction

Team YuShan, which belongs to the School of Computer Science and Technology of Anhui University of Technology, has participated in 10 Robotics World Cup competitions since 2012, all of which have reached the top eight. Among them, we won the third place for four consecutive years in Online World Cup 2021, Thailand World Cup 2022, France World Cup 2023 and Netherlands World Cup 2024. In the past 12 years, we have won Seven timeschampionships, four timesrunners-up and once third place in RoboCup China Open.

Recently, the YuShan team has reengineered their framework based on *Agent-2D* 3.1.0 [1] and the updated *librcsc* library [2]. This development led to the creation of the `YuShan_Base` platform, a functionally equivalent but enhanced alternative to the original *Agent-2D* codebase. Relying on the `YuShan_Base` base layer, the team further optimized and developed it. In 2019, the team innovatively proposed the concept of combining digital twin technology with the optimization and development of RoboCup 2D, based on the digital twin theory using data mining technology to deeply analyze the characteristics of each team. By adopting the methodology and process of the digital twin framework [3], we were able to guide the team's development work more effectively and clarify the key direction of R&D. Based on this, the team conducted an in-depth analysis and improvement of the team's formation layout, offensive and defensive transitions, players' running positions, as well as shoveling and passing strategies.

2 Related Works

This section highlights some of the innovative approaches developed by soccer simulation 2D teams in the past: The HELIOS team introduced the Tile Coding technique [4] to divide the soccer field into multiple sub-grids, and used low noise in each sub-grid to reduce the noise in the sub-grids. the CYRUS team proposed the Observation Noise Reduction Algorithm [5], through which it solved the problem of incomplete and noisy observation data that existed in the Football Simulation 2D environment, thus improving the accuracy of players' decisions and ultimately improve the team's overall performance; the FRA-UNIted team developed the Replayer tool [6], which allows the team to put the game into a specific cycle to test algorithms and logic optimization, and developed a continuous integration system to help the team conduct better testing and analysis; The OXSY team achieved better defensive results by making major improvements on the defensive side of the ball by dividing and defining defensive sub-phases and by improving the defensive strategies of individual players [7]. The ITAndroids team used the Rainbow algorithm to train a learning model [8] to cope with 1-on-1 defense in a match, and significantly increased the team's win rate against other teams, as well as developed a goalkeeper position adjustment algorithm to allow the goalkeeper to better cover the goal. The team also developed a goalie position adjustment algorithm to allow the goalie to better cover the goal and prevent opponents from scoring.

3 Evaluation Optimization

In the field of simulated soccer 2D, simulated players need to process noisy inputs from virtual sensors and achieve effective decision-making through rational strategies and coordination to cope with complex and dynamic match environments. However, in highly dynamic and uncertain match environments, existing evaluators usually rely on pre-designed evaluation mechanisms by expert systems, which are difficult to adapt to changes in the environment in real-time and may result in their inability to make optimal decisions, thus limiting the overall performance of the team.

Inspired by a paper published by the HELIOS team that used a multi-layer perceptron to construct the evaluation function [9], we try to use a long and short-term memory network, which is more sensitive to temporal data, to construct the evaluation function, aiming to capture the long-term dependencies in the court environment through the long and short-term memory network, and to effectively respond to rapid changes in the players' running position and game state. Meanwhile, we try to optimize the network parameters using genetic algorithm, which automatically searches and optimizes the key hyperparameters [10] (e.g., the number of LSTM layers, the number of hidden neurons, the number of Dense layers, and the number of neurons) of the long-short temporal memory network to reduce the tediousness of tuning parameters.

We evaluate the performance of the evaluation function modeled using the LSTM network optimized with genetic algorithms by calculating the number of

Table 1: Performance of the evaluation function before and after modification

Different Teams	Version	Number of Possessions	Number of Passes	Percentage of Accuracy
CYRUS	Before	1048	124	62.40
	After	1234	134	65.93
HELIOS2024	Before	961	135	57.35
	After	1201	151	67.76

possessions, the number of passes, and the percentage of accurate passes. In the simulation experiment, the evaluation function is implemented on the underlying code of `YuShan_Base`, and the training data, such as passing and dribbling, are extracted from the logs of YuShan2024's matches with HELIOS and CYRUS, so we use HELIOS and CYRUS from the Day 4 of the World Cup in Eindhoven, Netherlands, as the rival teams of `YuShan_Base`.

Table 1 shows that when the evaluation function proposed in this paper is used to replace the base evaluation function of `YuShan_Base`, the team improves in each evaluation metrics of the number of possessions, the number of passes, and the percentage of accurate passes. Therefore, we believe that effective expert team characteristics can be captured in the data extracted from the expert team's matches through learning for more effective decision making.

4 Lightweight Tools and Team Data Analysis Work

4.1 Match Winning Percentage Analysis Tool

Over the past year, we have developed several tools to help teams analyze test results more intuitively. First, we analyzed the content format of test result files and used string matching to accurately parse the results. Subsequently, we combined these analysis results for visual presentation. We started the process by loading the test result file and subsequently selecting the home team and the guest team. Just click the corresponding function buttons to generate the relevant effect figures (see Fig. 1).

At the same time, we developed a cross-platform win rate analysis tool using Qt. By opening a test log file or pasting the content of the test file into a blank text area, and then entering the team names, win rate analysis can be performed. Through this functionality, we are able to obtain a range of data.

4.2 Visualization of the Movement Trajectory of Defensive Players

In previous matches and various tests, we have found many times that the team's fullbacks always look messy when facing the opponents' fast attacks and crossing the ball, which leads to the team's loose defensive formation and thus scored

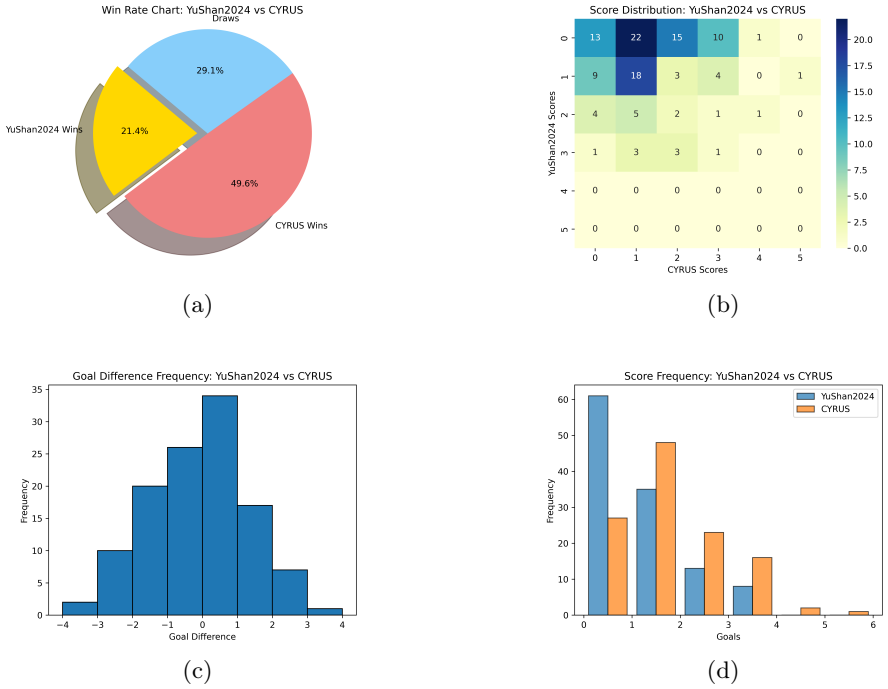


Fig. 1: Comparative visualization of the analysis: (a) a pie chart showing win rates (including wins, losses, and draws), (b) a heat map displaying the frequency of final scorelines, (c) a bar chart illustrating the distribution of goal differences, (d) a bar chart comparing the goals scored by each team.

by the opponents. Therefore, we would like to do some analytical work on the running position of fullbacks.

In this work, we consider the fullbacks and the six players are the players who are mainly involved in defensive blocking in front of the penalty area, so we choose to visualize the movement trajectories of these players who are mainly involved in defensive blocking in the 150 cycles before the goal is scored, and we hope to observe the movement trajectories of YuShan when facing the shots of different teams, and the movement trajectories of different teams when facing the shots of YuShan, in order to compare YuShan's defensive deficiencies when facing shots on goal and the running characteristics of different teams involved in defense. We chose the winner and runner-up of the World Cup Day4 in Eindhoven, the Netherlands, for the test, and visualized the movement trajectories of the defensive players of both teams when facing a shot on goal. Thus, we obtain the following results.

From Fig. 3, it can be observed that when YuShan's defenders face attacking shots from the players of HELIOS and CYRUS, player number 6 begins to engage

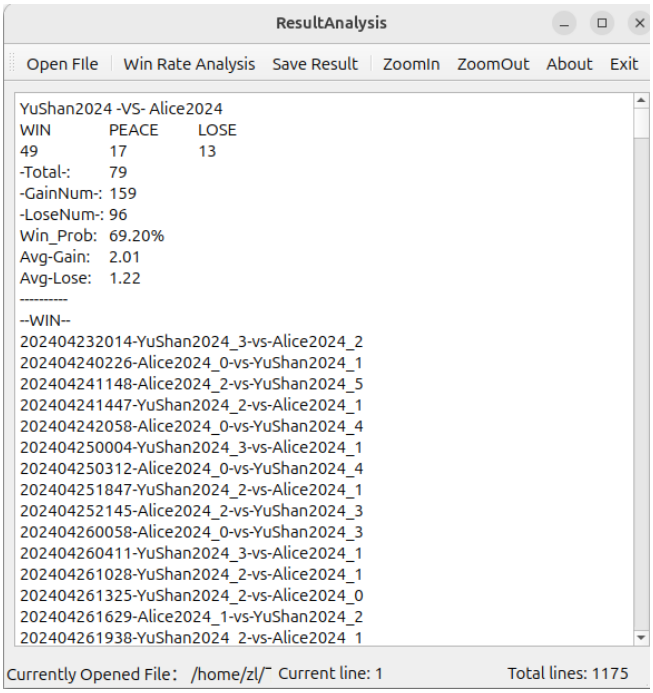
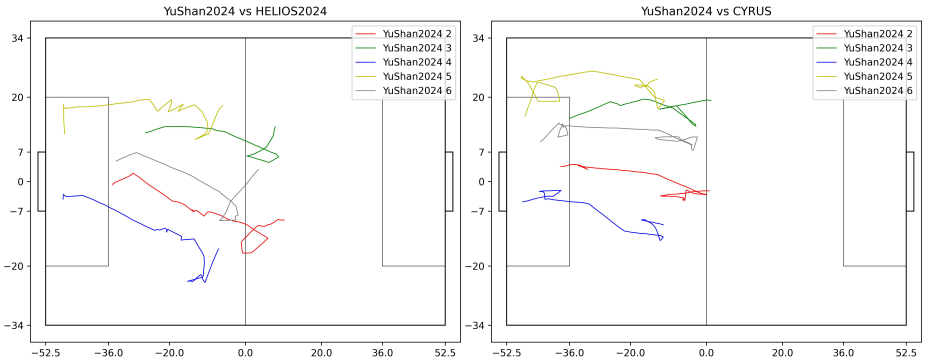


Fig. 2: Graphical user interface of the competitive analysis tool "ResultAnalysis", showcasing comparative performance metrics between the YuShan2024 and Alice2024 systems. The dashboard presents: (i) win-draw-loss distributions, (ii) aggregate statistics (total matches, winning percentage), (iii) average performance measures (points gained/conceded per match), and (iv) access to individual game records via an integrated file management system.

in defensive interception as soon as the opposing attackers cross the midfield line. Additionally, the defenders also initiate their defensive actions early. The overall defensive strategy is to intercept the opposing attackers outside the penalty area. Although this strategy applies pressure on the attackers early on, it may lead to an overly stretched defensive line. If the ball is successfully passed into the penalty area, this could result in defenders being unable to retreat in time to intercept within the penalty area, allowing the opposing team to score. From Fig. 4, it can be observed that HELIOS's defensive players exhibit a well-coordinated defensive system. When facing YuShan's attacks, the defenders are generally aligned in a single line to block the attack, which helps maintain the compactness of the defense and effectively reduces the individual burden on each defender, significantly alleviating physical exertion. CYRUS¡¯s defenders, when facing YuShan's attacks, demonstrate more frequent movement within the penalty area. Upon reviewing the video and visualizing the movement trajectories of CYRUS's other players, we observed that CYRUS's midfielders can typically retreat into



(a) First Subfigure Caption (b) Second Subfigure Caption

Fig. 3: The both diagrams show trajectory of YuShan'sdefensive players against HELIOS2024 and CYRUS¡¯s offense,the different colored lines represent players numbered 2 to 6 in the YuShan2024.

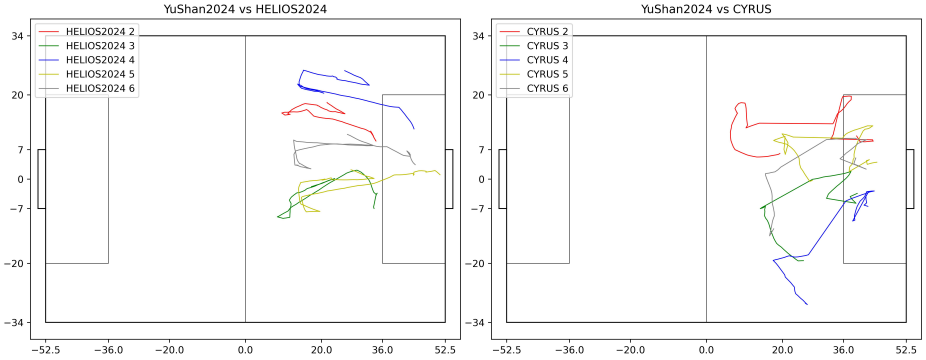


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Fig. 4: The left and right diagrams show trajectory of HELIOS2024 and CYRUS¡¯sdefensive players against YuShan'soffense, the different colored lines represent players numbered 2 to 6 in the HELIOS2024 and CYRUS.

the penalty area in time to assist with defense during shooting attempts, whereas YuShan's midfielders often fail to do so.

Therefore, based on the analysis above, we believe that YuShan's next step should involve adjusting the defensive strategies of its players, with a focus on modifying the defensive formation. This adjustment will help prevent overly dispersed defensive actions, allowing the defenders to form a more coordinated defensive system. Additionally, the positioning strategies of the midfield players need to be revised, particularly in situations where the opposing players approach

the penalty area. Midfielders should promptly retreat to provide support and collaborate with the defensive line in order to form a cohesive defense.

5 Summary and Future Work

In this paper, we propose a method to optimize the evaluation function using long and short-term memory networks and use genetic algorithms to optimize the parameters of long and short-term memory networks, which greatly improves the performance of the team in the competition with expert teams. At the same time, in order to make it more convenient for testing and reviewing, we have developed some analysis tools and carried out some data analysis work. Through the winning percentage analysis software, we can not only get the information of winning percentage, goal difference, goal loss, etc., but also visualize the test results to understand more intuitively the hidden problems behind a large number of test results, for example, whether there are a large number of losses, etc. In the work of visualizing the movement trajectory of the defensive players, we have developed some analysis tools and data analysis work. In the work on visualizing the movement trajectories of defensive players, we hope to develop different defensive strategies by comparing the running situations of different teams' defenses when facing a shot on goal. Furthermore, we shall also investigate to integrate real-time player tracking data from professional soccer matches, leveraging RFID [11,12] or alternative sensing technologies to enhance our experimental validation framework.

Thanks to HELIOS, CYRUS, WrightEagle, Glider and other teams for the open-source technical help and the excellent tournament team for the tournament support, we wish the 2D league is getting better and better.

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