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主 論 文 の 要 旨

論文題目 Cooperative play classification and analysis
in team sports with machine learning
(チームスポーツにおける機械学習を用いた協力プレーの
分類と分析)

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論 文 内 容 の 要 旨

Recent advancements in measurement technologies, such as camera-based systems, give us an opportunity to improve our understanding of multi-agent behaviors in various fields. However, due to their complexity, modeling the intricacies of multi-agent behaviors remains a challenge. This has led to a shift towards model-free, data-driven approaches. Data-driven modeling, especially in machine learning with complex structures like neural networks, plays an important role in extracting insights and making predictions from real-world data. While these models offer enhanced expressiveness and predictive capability, the interpretability of their results poses a significant challenge. This is crucial in practical applications, such as team sports, where understanding the rationale behind actions and plays is essential for coaches and players. In particular, in team sports, the intricacies of multi-agent behaviors also lead to extremely high labor costs for manual labeling. These factors make the implementation of data-driven classification and analysis methods difficult in the field of team sports.

To address these problems, utilizing machine learning techniques, two approaches are proposed to classify and analyze cooperative play in team sports. In the first study, a classification approach based on semi-supervised learning methods is proposed for cooperative play classification in team sports. I examine this approach for classifying strategic cooperative plays called screen-play in basketball using a smaller labeled dataset and a larger unlabeled dataset. In the experiment, the classification performance of the semi-supervised learning approaches improved upon the conventional supervised approach for minor types of

screen-plays. For the interpretability, we found that self-training obtained similar or higher contribution of some features than the baseline.

In the second study, for cooperative play analysis in team sports, a deep learning-based comparative analysis method to analyze multi-agent trajectories in basketball games is proposed.

A neural network approach based on an attention mechanism using multi-agent motion characteristics (e.g., the distances between agents and objects) as the input is adopted, designed to detect distinct segments in trajectories of given classes. This enables us to understand differences between classes by highlighting segmented trajectories and which variables correlate with the given labels.

In this thesis, these approaches are validated by comparing them with other baseline methods, and the second approach is also validated by analyzing the attacking plays in an NBA dataset. In addition, these methods also reveal the relationship between some behaviors and certain cooperation plays, which can provide coaches and athletes with more information or guidance about the game.