Optimizing Paths of Off-Ball Runs Leading to Shots or Goals in Women's Soccer through Modern Optimization Techniques

Abstract   This research optimizes off-ball runs in soccer to improve scoring opportunities. Using various advanced optimization algorithms [3] on Skill-Corner's tracking data from women's soccer leagues, we aim to reveal effective movement patterns that lead to successful shots and goals, offering insights into optimal player positioning for enhanced offensive impact.

Background   In soccer, effective off-ball runs are essential for creating space, disrupting defenses, and enabling high-probability scoring chances. Using Skill-Corner's tracking and event data, this research seeks to deepen our understanding of spatial and temporal optimization in off-ball scenarios.

Research Questions

1. How can we quantitatively assess the paths of off-ball runs that lead to high-impact events (e.g., shots on target, goals)?

2. Which modern optimization methods (Nesterov Momentum, Adam, etc.) most effectively model these optimal paths?

3. How can this model be used to improve specific match-up outcomes in soccer, such as a forward making effective runs against a center-back or a midfielder finding spaces between defensive lines?

Objectives

- **Identify Optimal Trajectories**: Develop models to pinpoint optimal off-ball run paths that maximize scoring potential, with specific emphasis on run types such as Cross Receiver and Runs In Behind, identified by SkillCorner as particularly effective in generating high-probability scoring opportunities.

- **Evaluate Optimization Techniques**: Compare the effectiveness of various machine learning optimization methods [3]—Nesterov Momentum, Adagrad, RMSProp, Adam, and SGD—in accurately modeling off-ball runs that lead to shots or goals.

- **Generate Tactical Insights**: Provide actionable insights into player match-ups by examining how different run types impact defensive formations and scoring outcomes. This will include examining metrics such as Expected Threat (xT) and Dangerous Run frequency to inform team strategies and player positioning.

Literature Review Herold et al. (2022) introduced a model to quantify changes in defensive pressure during off-ball movements in soccer, focusing on deep runs (DRs) and changes of direction (CODs) as methods for creating space. Their findings demonstrate that these actions significantly reduce defensive pressure, providing valuable insights into attacking players' positioning without the ball [1]. Building on this, Llana et al. (2020) employed expected possession value (EPV) to highlight off-ball positions that exploit defensive gaps, linking spatial dynamics to overall team performance [2].

Methodology Apply and compare optimization techniques [3] (SGD, Nesterov Momentum, Adagrad, RMSprop, Adam) to model high-impact off-ball runs. Each method focuses on improving convergence and stability to predict effective run paths.

Experimentation: Simulate optimized runs under varying defensive pressures and formations, evaluating the tactical effectiveness and formation-specific advantages of these optimized paths.

Expected Outcomes

1. Identification of optimal off-ball run trajectories that maximize shot or goal probability.

2. Insights into match-up dynamics for specific player roles (e.g., forwards vs. defenders), contributing tactical knowledge to player training.

3. A comparative analysis of various optimization techniques for real-time path prediction in soccer match-ups.

Contribution This research enhances soccer tactics by identifying optimal off-ball positioning to increase scoring chances. Insights from this study can help coaches, analysts, and players refine offensive strategies, leading to improved team performance.

References

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[3] Sebastian Ruder. An overview of gradient descent optimization algorithms. *arXiv preprint arXiv:1609.04747*, 2016.