Quantifying Pitch Control in Soccer

Project Work I. Presentation

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Motivation Quote

"It is statistically proven that players actually have the ball 3 minutes on average. So, the most important thing is what you do during those 87 minutes when you do not have the ball. That is what determines whether you're a good player or not."

– Johan Cruyff

Background

- Soccer analytics has traditionally focused on on-ball events, such as pass and shot efficiency or the dribbling success rate
- Quantifying the pitch control ratio is crucial for analyzing teams' tactical approaches and evaluating players' abilities
- The methods discussed in this report were developed for soccer analytics, they also have potential applications in other fields as well, such as traffic management, marketing, and healthcare

Project Goals

- Pitch control refers to the ownership of space by teams
- In regions controlled by Team A, the players of that team can act quickly and occupy positions earlier than their opponents
- We aim to implement two approaches to pitch control:
  - A basic method using Voronoi tessellation
  - A more advanced method based on Javier Fernandez and Luke Bornn's concept of player influence area

Data Description

- One of the main challenges in this project is the limited availability of publicly accessible high-quality tracking data
- The dataset provided by Metrica Sports
- The GitHub repository contains three anonymized soccer matches

Basic Visualization

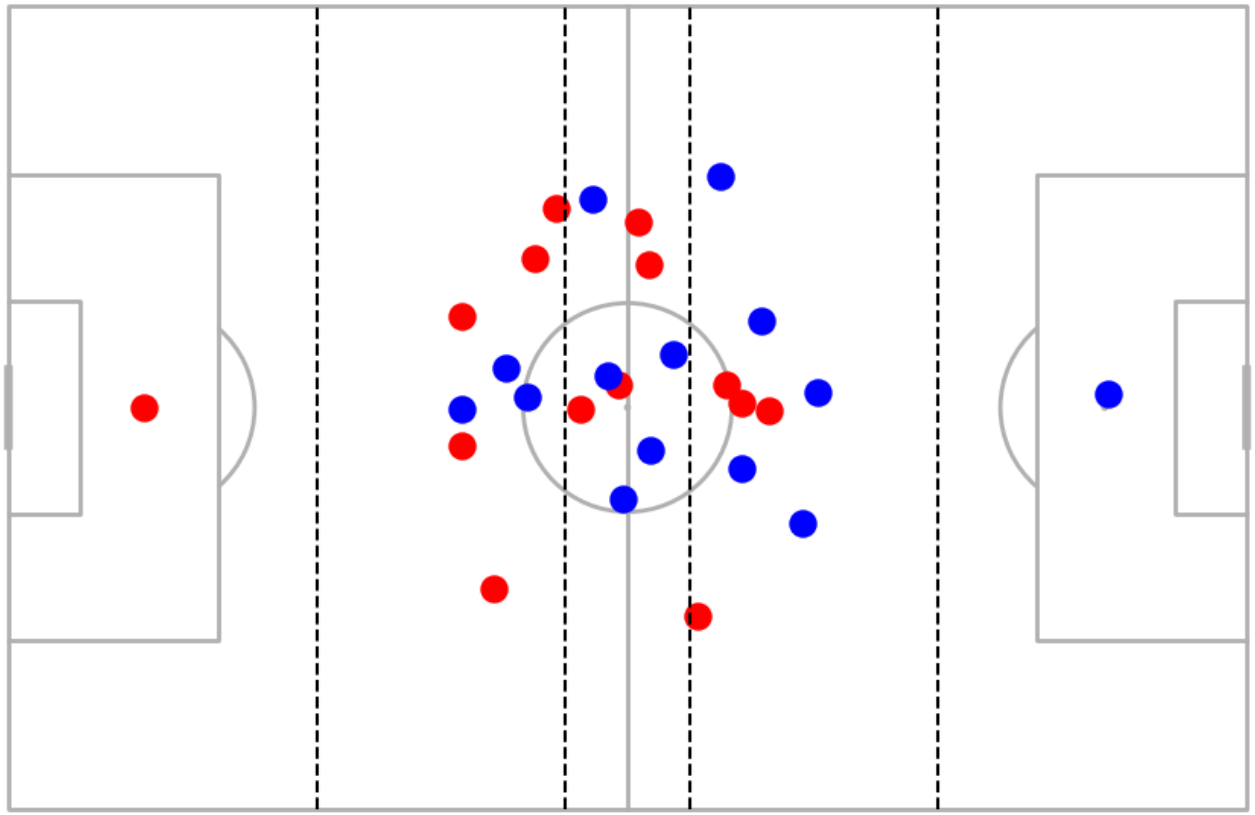

Figure: Player's Average Positions

Pitch Control Quantification with Voronoi Tessallation

- For each player, there is a corresponding region, called Voronoi region, which consists of all points on the pitch closer to that player than to any other.
- Let $P = \{p_1, p_2, ..., p_n\}$ be a set of points, where each p_k represents a pair of real numbers. The Voronoi region of $p_k \in P$ is defined as:

$$V(p_k) \doteq \{x \in \mathbb{R}^2 : d(x, p_k) < d(x, p_l), \forall l \in \{1, ..., n\}, l \neq k\},$$

where $d(x, p_k)$ denotes the Euclidean distance.

Voronoi Tessallation Visualization

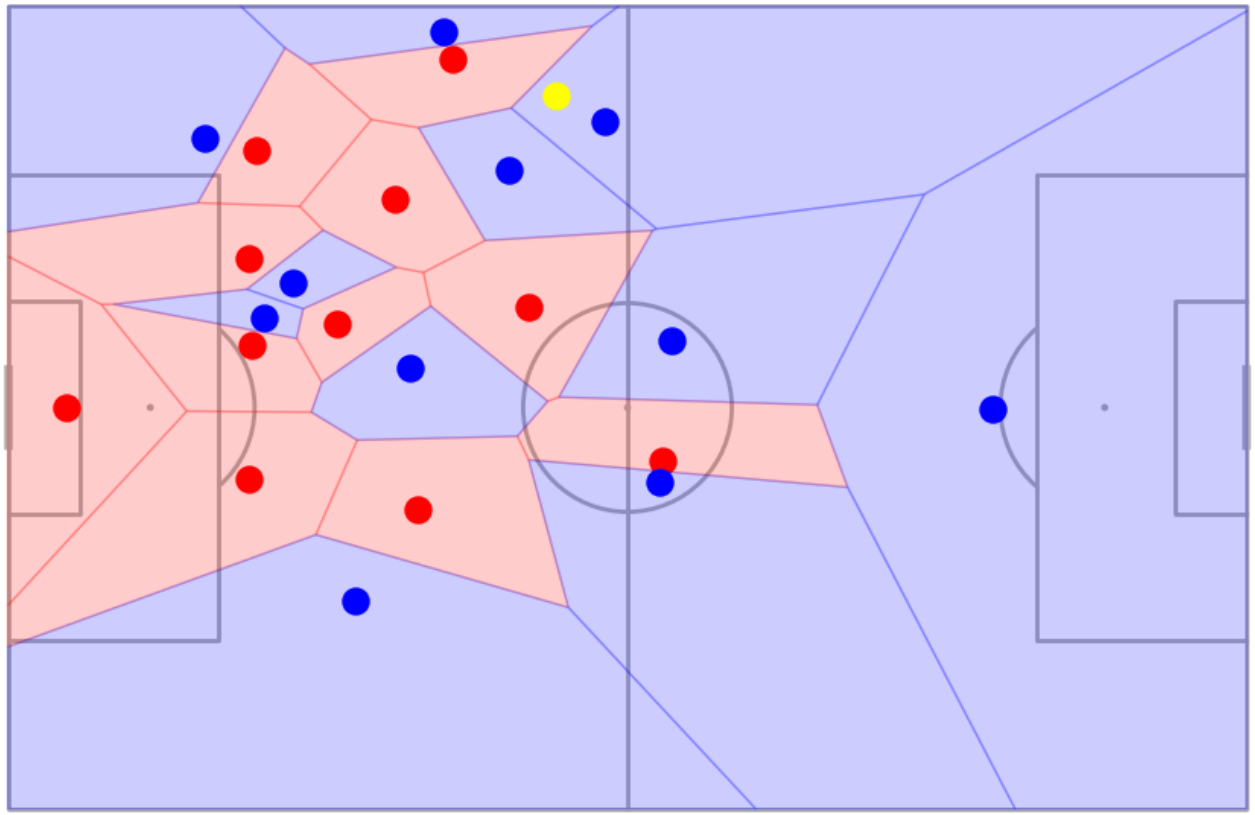

Figure: Voronoi Regions Visualization

Pitch Control Quantification with Player Influence Areas by Fernandez and Bornn

- A player's influence on nearby areas depends on several factors, such as their location, velocity, and distance to the ball
- The influence of player k at a given location x and time t is defined as

$$I_k(x,t) \doteq \frac{f_k(x,t)}{f_k(x_k(t),t)},$$

  where $x_k(t)$ refers to the position of player k at time t, and $f_k(x,t)$ is the density function of a bivariate normal distribution
- The covariance matrix and expected value dynamically change based on the player's velocity, direction, and distace from the ball

Player Influence Areas Visualization

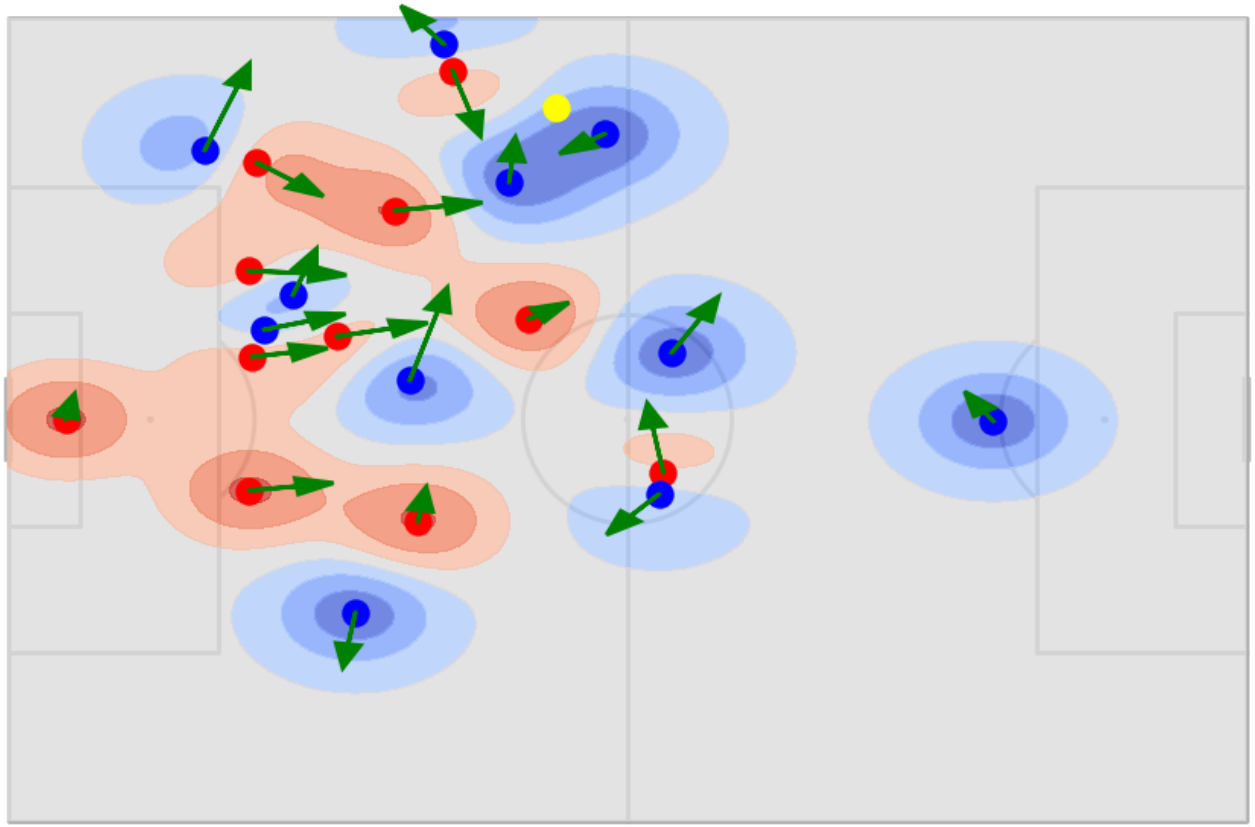

Figure: Player's Influence Regions

Match Analysis Visualization

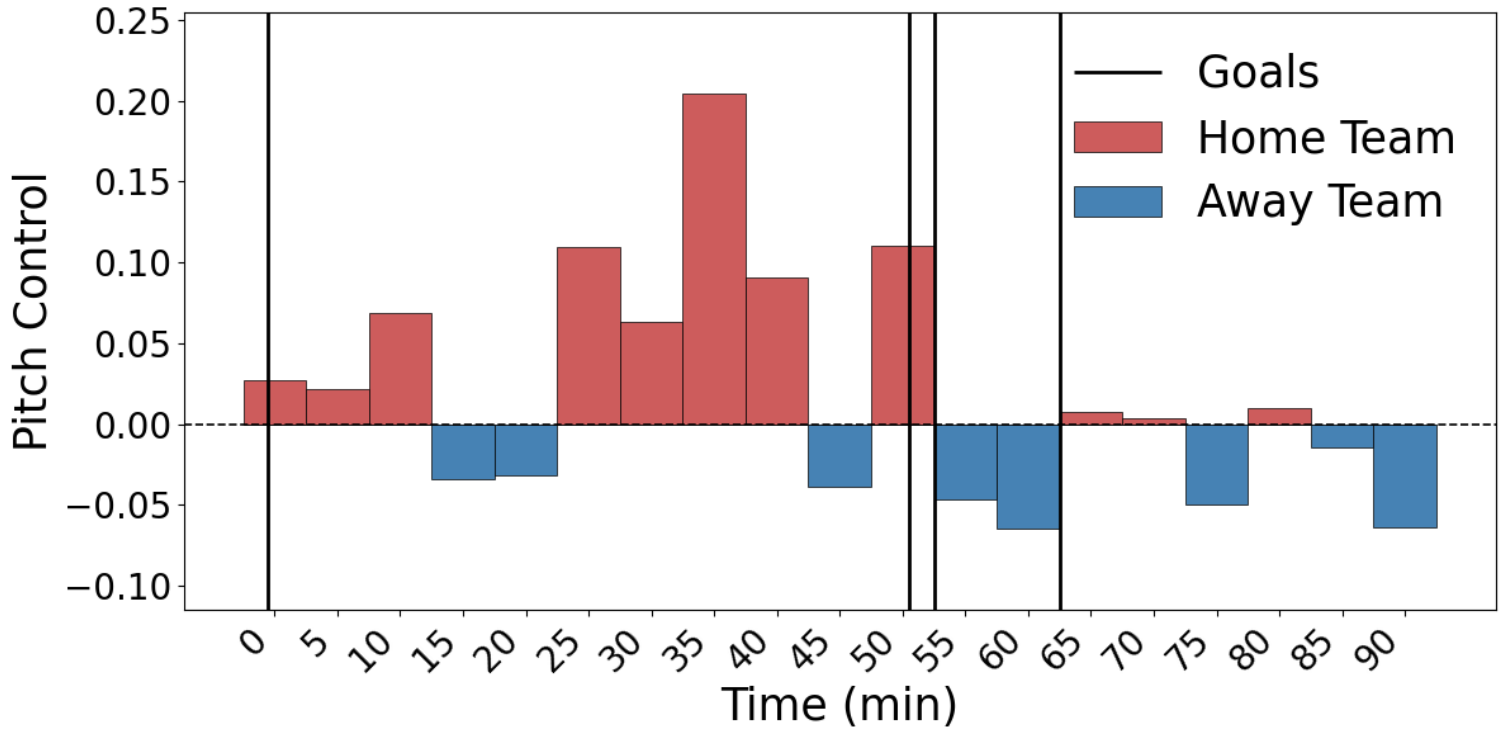

Figure: Pitch Control Ratio - Match Analysis

Limitations and Next Steps

- The bottleneck of this project could be the limited availability of publicly accessible high-quality tracking data. A goal for the next semester could be to train a machine learning model to generate tracking data from matches
- An alternative direction is to quantify the value the points of the pitch

References

- Fernandez, J., Bornn, L. (2018). Wide Open Spaces: A statistical technique for measuring space creation in professional soccer. *MIT Sloan Sports Analytics Conference*.
- Linke, D., Memmert, D. (2017). Spatial and temporal analysis of pitch control in football. *Journal of Sports Sciences, 35*(11), 1019-1026.
- Metrica Sports. (n.d.). Metrica Sports Sample Data. Retrieved from `https://github.com/metrica-sports/sample-data`.
- de Berg, M., van Kreveld, M., Overmars, M., Schwarzkopf, O. (2000). *Computational Geometry, Algorithms and Applications*. Springer.
- Taki, T., Hasegawa, J. (2000). Quantitative measurement of teamwork in ball games using dominant region. *International Archives of Photogrammetry and Remote Sensing, 5*, 125–131.