Project Proposal: Predicting NBA Game Outcomes by Understanding Quarter-to-Quarter Performance Trajectories

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Project Motivation
Basketball games are dynamic and strategic: team performance ebbs and flows as players adjust tactics, manage fatigue, and respond to their opponents' in real time. From a coach's perspective, decomposing a complex NBA game into granular, high-stake decisions is a meticulous and unpredictable responsibility. Players need to adapt and shift strategies across quarters based on opponent behavior, score differentials, and play-by-play outcomes. It is these intentional adjustments–player positioning, pass orientations, or shot selection–that can heighten performance and drive the upwards trajectory of the entire game.

Current forecasting approaches on NBA game outcomes rely on aggregate or pre-game statistics, many of which overlook how within-game dynamics evolve. Quarter-level patterns better capture deviations from optimal play, informing coaches of actionable manipulations to player rotations and timeouts to stabilize performance and counter opponent momentum. Hence, by examining play-by-play point deviations and result of each attempted shot, we can train a machine learning model to measure real-time estimates of win probability of games under different strategic scenarios. This ultimately motivates our research question: *to what extent do quarter-level performance dynamics of teams (e.g., degradation or improvement across quarters) predict final game outcomes?*

Data Source
As this project will seek to predict outcomes on the game-level, the primary source of data will be the nba_api package where the playbyplayV3 endpoint will be leveraged. Each dataset fetched from this endpoint represents a single game where records represent an action made by players across both teams. Metrics such as clock, teamId, shotResult, actionType, and shotValue will be used to represent time-ordered trajectory of features and quarter-by-quarter performance. The final value of the pointsTotal variable will be used to create a binary outcome variable that represents if a team has won/lost. To ensure we have a sufficient dataset size, this project will utilize games over the past three NBA seasons (n = 3,960). This will also allow us to impose a time-aware train/validation/test split, where models are trained on earlier games and evaluated on more recent, unseen games to avoid temporal leakage.

Related Work
Recent studies in sports analytics show a growing trend in using machine learning models to predict game outcomes based on in-game performance data. Prior research has demonstrated that team-level statistics and time-evolving game information can be used to model and forecast final results of basketball games. In particular, existing studies focus on outcome prediction using historical game data and on analyzing performance changes within games, such as momentum or performance under pressure. These works highlight the potential of data-driven

approaches to capture meaningful patterns in team performance across different stages of a game.

Our project aims to build on these studies by specifically investigating whether quarter-level performance dynamics of teams, such as improvement or degradation across quarters, can predict final game outcomes. By using quarter-level metrics as features and treating each team in each game as a machine learning unit, we seek to extend prior outcome prediction models by incorporating within-game temporal structure and evaluating its predictive value.

[Predicting Results for Professional Basketball Using NBA API Data](#)
[Predicting the Outcome of NBA Games](#)
[All About Momentum: Investigating High-Pressure Situations in the NBA](#)

Project Github repo: https://github.com/jyoon0808/nba-game-outcome-prediction