# Final Project by George Vayner Mafia analysis

## Introduction

The game of Mafia is a social deduction game that combines logic, psychology, and teamwork. 10 players are secretly divided into two sides —3 Mafias (one of them is Don) and 7 Citizens (one of them is sheriff) — whose objectives directly oppose each other. The Mafia members aim to eliminate the Citizens during the night phases, while the Citizens must identify and vote out the Mafia during the day discussions. In more advanced versions, special roles such as Sheriff and Don introduce investigative and counterintelligence abilities, making the gameplay more strategic and unpredictable.   
(For a general overview of the rules, see Wikipedia: [Mafia\_(party\_game)](https://en.wikipedia.org/wiki/Mafia_(party_game)))  
Over the last decade, Mafia has evolved from a casual party game into a structured competitive sport. The Mafia Sport Federation (FIIM - <https://mafiaworldtour.com>) organizes international tournaments where every match is recorded, scored, and broadcast online. Each game involves ten players whose individual performances are tracked through metrics such as game outcome, role, position, and awarded points. These records capture not only the results but also the dynamics of teamwork, deception, and player experience — all of which can be quantitatively analyzed. This project explores whether machine learning models can predict the outcome of Mafia games based on historical data.

## Data description

The original dataset contained detailed player-level records from competitive Mafia games organized by the Mafia Sport Federation. Each row represented a single player’s performance in one game, identified by a unique id. The key columns were:

|  |  |
| --- | --- |
| game\_id | Unique identifier for each game |
| player\_id | Unique player identifier |
| original\_nickname | Player’s in-game nickname |
| role | Assigned role in the game (e.g., *red*, *black*, *sheriff*, *don*) |
| place | Player’s physical placement in the game (1–10) |
| team | Team name (*citizens* or *mafia*) |
| team\_win | Binary indicator of whether the player’s team won |
| game\_points, game\_bonus, penalty, fouls | Numerical performance metrics show performance of each player after the game |
| created\_at, updated\_at | Game timestamps (that are mostly missing) |

## Research questions

This project explores how well machine learning models can predict the outcome of a Mafia game using available player and match pre data. Based on the information contained in the original dataset — such as player roles, previous performance scores, placement etc. the study focuses on two main questions:

1. *Which team is more likely to win a given game — Mafia or Citizens?*
2. *Which recorded factors have the strongest influence on team success?*

## Data Engineering and Feature Construction

The original dataset, while rich in gameplay information, required extensive preprocessing before it could be used for predictive modeling. Several challenges were identified:

1. *Player-based format*  
   Each game consisted of ten player records, but the prediction target was the team’s win or loss. The data therefore had to be aggregated from player-level to team-level using the game\_id and team identifiers.
2. *Missing and inconsistent timestamps*The created\_at and updated\_at fields were largely empty or unreliable.  
   To preserve temporal order, the unique per each game record ID (id) was used as a proxy for game chronology (assumption is that time between two adjacent games is at most 1 week).
3. *Data imbalance and temporal drift*The relative win rates of Mafia and Citizens shifted across seasons. The dataset was split chronologically (train → calibration → test) to avoid information leakage between past and future games. Calibration was needed to correct mismatch between predicted probability and observed frequency since statistically mafia win is more probable (about 65-70%).

After aggregation, several derived features were created to capture long-term player and team behavior that were based on pre-game information only to ensure fair, leak-free predictions.

|  |  |  |
| --- | --- | --- |
| **Feature Type** | **Description** | **Purpose** |
| Elo-based statistics | Average and standard deviation of player Elo before each game (calculated for each player chronologically) | Measures overall team strength |
| Role-specific performance | Mean performance of Don, Sheriff, and Mafia roles in recent matches | Captures influence of strategic roles |
| Recency and breaks | Computed from ID gaps between games | Models “rust” or warm-up effects after long breaks |
| Win/Loss streaks | Rolling recent results per player | Identifies momentum patterns |
| Synergy and enemy familiarity | How often players appeared together or against each other | Quantifies coordination and experience |
| Temporal normalization (“meta eras”) | Groups games by time periods and normalizes Elo | Adjusts for rating inflation across seasons |

All features were aggregated at the team level (Mafia vs. Citizens), and differences between teams (e.g., \_\_delta\_maf\_minus\_cit where “maf” is mafia and “cit” is a citizen) were computed to represent relative advantages.