Data 400: Capstone in Data Analytics

Idea Proposal 2

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**Optimal Bluffing Strategies in Poker Using Game Theory**

1. **Introduction:**

Poker is a game of skill, psychology, and probability where bluffing plays a crucial role in strategic decision-making. Successful bluffing requires players to balance deception with unpredictability while considering opponent tendencies. From a game theory perspective, bluffing can be analyzed using Nash equilibrium and Bayesian updating, while machine learning can model bluffing frequencies based on historical gameplay data. This study aims to examine the optimal bluffing strategies in No-Limit Texas Hold’em by analyzing whether players deviate from theoretically optimal bluffing frequencies and whether certain player archetypes bluff more effectively. The research will explore how bluffing behavior changes depending on opponent skill level, stack size, and hand strength, helping identify strategic inefficiencies that can be exploited.

1. **Metadata:**

The dataset will consist of hand history logs from online poker platforms and publicly available sources. Since many poker hands are not readily available in structured datasets, web scraping will be used where necessary to extract data from hand history forums and poker tracking sites.

* Poker Hand History Databases (e.g., PokerStars, 888Poker, HandHQ): Automate the extraction of publicly shared hand histories from poker forums using Selenium or Regex
* World Series of Poker (WSOP) Hand Data:Extract hand histories from live reporting sites such as WSOP.com using Python scripts to collect betting patterns.

1. **Analysis**

* Game Theory Approach: Use Bayesian Nash Equilibrium to model how rational players should bluff optimally and apply Mixed Strategy Equilibrium to analyze optimal bluffing frequencies at different stack sizes.
* Regression Analysis: Examine how bluffing frequency is influenced by stack size, hand strength, and opponent tendencies. Test whether players over-bluff or under-bluff compared to game-theoretic expectations.
* Machine Learning Approach: Train a decision tree classifier to predict whether a player is bluffing based on available game-state features.
* Data Visualization: Use heatmaps to show bluffing tendencies across different game scenarios. Create interactive dashboards to explore bluffing frequencies dynamically.

1. **Implications for Stakeholders**

* Poker Players: Improve decision-making by understanding when bluffs are most effective.
* AI Poker Bots: Train poker bots to bluff optimally in competitive online environments.
* Game Theorists: Contribute to research on equilibrium strategies in imperfect information games.
* Casinos & Online Poker Sites: Identify behavioral biases that influence betting patterns.

1. **Ethical, Legal, and Societal Implications**

* Ethical: Ensuring that AI-based poker strategies are used for research rather than exploitation.
* Legal: Compliance with regulations regarding data collection from online poker sites; ensuring web scraping follows ethical guidelines.
* Societal: Understanding cognitive biases in bluffing could have broader applications in negotiation and strategic decision-making beyond poker.