Team 34: Partially Observed MDP (POMDP) of NFL Extra Points v. Two-Point Conversions

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1. Current Status of Project

1.1 Changes to Problem Statement

Upon receiving feedback on the Project Proposal, the main comment for improvement was that the original Problem Statement ("Structural Learning in Collegiate Football Elements" did not include some form of Decision Making. While the original intention was to determine (based on team performance metrics) who was going to win a football game, our group reflected and saw that determining who win a football game did not constitute as a "choice or action" but rather as "outcome" which is a Project Proposal Requirement.

The team revised a new problem statement (Section 1.1) that provided a scenario with more decision-making elements while maintaining elements from the original project proposal like team and player statistics. While the sport the project is centered on has not changed, it was decided to use data from to the National Football League (NFL) rather than college football since in the NFL, teams that are in the same division play each other twice in a season. This could provide more consistent data on how a team might preform against regular opponents.

1.1.1 Revised Problem Statement

A major challenge in any football game is to determine whether to go for two points(a slightly risky move) after scoring a touchdown, or play it safe and kick an extra point.This project aims at using a Partially Observed Markov Decision Process (POMDP) to determine the best policy in either kicking an extra point or take a risk by going for 2 point conversion after scoring a touchdown based on team and opponent metrics.

1.2 Additional Progress

1.2.1 Basic Problem Setup

The first approach will have five state parameters: kicker extra point percentage, offensive 2-point conversion percentage, defensive 2-point conversion percentage, quarterback passing percentage, and leading running back percentage. A continuous 5D state-space will be used to represent possible team states. From each state, there are two actions: attempt kick (a^1, go for 1 point) and attempt 2 point conversion (a^2, go for 2). a^1 from any state results in a transition to terminal states T^1 (successful kick) or T^0 (missed kick). a^2 from any state S results in a transition to terminal state T^2 (successful 2 points) or T^0 (unsuccessful).

We find that the difficulty arises in estimating the transition function across the state space. a^1 is simple: from expert knowledge, the kicker extra point percentage is a reasonable estimation of the transition probability for a^1 at any point in the state space. While, a^2 is influenced by the other factors and thus we must estimate it. We plan to discretize the state-space and use all of the 2-point conversion attempts from a season to place sample points across the state space. If the resolution is low enough, a maximum likelihood model may be used–however, 2-point conversion data is rather sparse, so we will also attempt Kernel Smoothing as a means of generating a less disjoint transition model.

Once estimated, this transition model will be used to generate the action-value function and thus optimal policy across the state space. Post-touchdown point attempts from another NFL season will be compiled and run with the model, allowing us to test our model against team's real-time actions and evaluate its accuracy. Upon achieving results, we will likely attempt the addition of new parameters and updated transition model estimation approaches to improve results.

1.2.2 Using External API to Extract Team/Player Data

Sports Radar US provides an API with a plethora of present and past player and team data, as well as play by play data concerning extra point attempts and 2-pt attempts. All five of our proposed state parameters can be found via the API. Moreover, additional/alternate parameters we discussed as a group are available via the API which will minimize refactor costs should we decide to experiment with changing parameters or adding additional parameters to the state space. This API is free to use for students, which was unique as many other APIs with NFL data required a paid subscription. This API can be found at https://developer.sportradar.com/.

2. Looking Ahead

2.1 Project Timeline

Items to be completed by assigned date:

- End of Next Week (November 19): Create an Outline for Paper, Complete Code (Version Alpha); continue adding additional parameters (from team/player data)
- Beginning of Week 10 (November 29): Complete Rough Draft of Paper, wrap up final adjustments in Code (Version Beta)
- December 3: Submit Paper