AA 228 Final Report: Outline

I. Abstract

II. Introduction

    1) Introduce the current scenario/situation in the National Football League (NFL)

- Extra-Points have been relatively easy to make in the history of the NFL, and because of this, the Rules Committee recently revised to extend the yardage for kicking extra points, from the 2 yard line to 15 yard line (2015, Rules Committee). Therefore, this revision makes it more challenging to kick an extra point

    2) Transition into how the rule change has affected coaching decision-making

- Thus, teams have started going for more 2-point conversions since the rule change (2pt conversions still play on the 2 yard line). But are two point conversions easier to make than extra points just because they are closer to the goal line?
- Other factors are at play, including weather (wind speed effecting kicker extra points) kicker availability/performance, as well as opponent defensive 2-point stops and offensive capabilities

    3) Discuss current coaching decision-making and necessity of rational algorithms

- Sometimes coaches don't always make the right choice (coaches have been known to be risk-averse earlier in game, but become greedier as the game progresses)
  - compare coaches' percentages of deciding to go for 2pt and 2pt conversion completion percentage)
  - provide real example of poor coaching decision making

    4) Introduce Problem Statement/Objectives

- This project aims at framing this problem as a Markov Decision Process (MDP) to determine the optimal policy in either kicking an extra point or a going for a 2-point conversion after scoring a touchdown at a given point in the game (1st,2nd,3rd,4th Quarter) based on point spread

III. Problem Setup/MDP Definition

    1) State Space

- Represents the point-spread between the team and opponents score at any point in the game (example s^0= "Tie game", s^1= "Team up by 1", s^{-1}= "Team down by 1", etc.)

    2) Action Space

- Represents the ability to either go for an extra point (a^1) or a two-point conversion (a^2)
- There is no option to call a timeout, or not perform a play (do nothing, let the clock roll out until the game ends)

    3) Transition Model

- Use Maximum Likelihood Estimation
- going for an extra point (a^0) will be based the number of kicks made/total number of attempted field goals (example, $T(s^7 | s^6, a^1)$=probability of being up by 7 given we just scored a touchdown, and we go for the field goal
- going for a two-point conversion (a^1) will be based on a number of factors (offensive percentage, defensive stop percentage, qb passing percentage, rb passing percentage)

    4) Reward Function
- Independent of state: 1 for going for 1 point, 2 for going for 2 points

IV.   Data Acquisition

    1) Brief Description about API: Sports Radar US
- About Sports Radar US
- What part of the API was pulled ("Game-Day Statistics," "Play-by-Play")?

    2) Data Cleaning Process
- How was the data process from "raw state" to (s,a,r,s')?
  How was data split/sorted by quarter?

V.   Policy Formulation

    1) Comparative Approaches:
- Exact Method: Value Iteration (Using $T(s'|s,a)$ and $R(s,a)$ functions approximated Section 2.3, 2.4
- Approximate Method: Q-Learning (Or another Approximate Value Function, method, still up in the air)

VI.   Results

- Plot Optimal Utility v. State, show comparison between exact and approximate method (mark each point with the optimal action)
- Create 4 plots, one for each quarter
- Compare learning time between Exact and Approximate Methods

VII.   Discussion

    1) Analyze the optimal polices for each quarter:
- Answer the problem statement:
  - Is it better to go for 2 points or not?
  - Is it better to go for 2 (or stay with an extra point) earlier or later in the game?
- It is also needs to be said that picking the optimal policy DOES NOT guarantee in winning the game
  - For example, the $\pi(s^{-21})$ (i.e. "optimal policy when the team is down 21 points") could be going for 2, but if it is the 4th quarter, it could be unlikely that the team will win

VIII.   Conclusion

IX.   Contribution of Each Team Member

X.   References

    (NOTE: Currently, needed references are highlighted in yellow in this outline)