14D006 Stochastic Models and Optimization

Play Selection in American Football

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1 Motivation

In the following sections we assume some basic understanding of the American football rules.

2 The Football Model

In our American football model we consider the score of one offense drive and add to it the expected points gained by the opposing team from our final field position. More concretely, we want to maximize the expected difference between our drive-score and the opposing team's responding drive-score (which is simply a function of our final field position).

The state of the system $i \in S$ is described by a vector of 3 quantities: $i = [x, y, d]$:

- x = the number of yards to the goal (discrete value between 1 and 100)
- y = the number of yards to go until the next first down (discrete value between 1 and 100)
- d = down number ($\in \{1, 2, 3, 4\}$)

At each state, the team can choose from one of 4 play options (actions) $u \in U$ with $U = \{R, P, U, K\}$:

- (R)un: moves $D_p - 2$ yards forward with $D_p \sim \text{Poisson}(6)$
- (P)ass: moves $D_p - 2$ yards forward with $D_p \sim \text{Poisson}(12)$
- P(u)nt: moves $6D_p + 6$ yards forward with $D_p \sim \text{Poisson}(10)$
- (K)ick: successful with probability $\max(0, .95 - .95x/60)$

The set of state-action pairs determine the stationary policy μ. The reward of the drive is determined by the final state transition:

- Touchdown: 6.8 points (from run or pass)
- Opponent's touchdown: -6.8 points (from run or pass)
- Safety: -2.0 points (from pass or run)
- Field goal: 3.0 points (from kick)
- No score due to fumble (from run), interception (from pass), missed 4th down (from pass or run), missed field-goal (from kick) or punt

Fixed probabilities are assigned to the outcome of each action.