Football IV

Produced by Dr. Mario | UNC STOR 390

Football Decision Making

- 5 Key Decisions in Football
  - Fourth and 4 on Opponent's 30 Yard Line. Field Goal or Punt?
  - Fourth and 4 on Own 30 Yard Line. Attempt or Punt?
  - Gained 7 Yards on First Down From Own 30 Yard Line and Defense Was Offsides. Accept the Penalty?
  - Opponent Gained 0 Yards on Run on First Down. They were Offside. Accept the Penalty?
  - Optimal Run/Pass Mixture on First Down? → Look at Later
- Decision Based on States of Football
- Best Decision Maximizes the Expected Margin

$$Expected\ Points = V(Down, Yards\ For\ 1st\ Down, Yard\ Line)$$

Football Decision Making

- Examples of Expected Margin Based on States
  - $V(1,10,50) = 1.875$
  - $V(3,3,80) = 3.851$
  - $V(2,9,5) = -1.647$

- Works of Konstantinos Pelechrinis
  - University of Pittsburgh in School of Computing and Information
  - Excellent Sports Analytics Course
  - Recent Research on American Football
  - Analyzes Decision Making Based on Expected Points
  - Problem He Discusses: All Analysis is From View of Offense
  - Builds Predictive Model for NFL Games

Football Decision Making

- Fourth and 4 on Opponent's 30 Yard Line
  - Evaluate Expected Margin if Team Attempts to Get 1st Down

$$E[Margin|Go\ For\ It] = P(Success)E[Margin|Success] + P(Failure)E[Margin|Failure]$$
$$= P(Success) \times V(1,10,75) - P(Failure) \times V(1,10,28)$$

What Assumptions are Being Made Here?

  - Evaluate Expected Margin if Team Attempts Field Goal

$$E[Margin|Field\ Goal] = P(Success)E[Margin|Success] + P(Failure)E[Margin|Failure]$$
$$= P(Success) \times (3 - V(1,10,27)) - P(Failure) \times V(1,10,37)$$

What Assumptions are Being Made Here?

Football Decision Making

- Fourth and 4 on Opponent's 30 Yard Line
  - Modeling Probability of Making Field Goal
    - Let p Represent the Probability of Making a Field Goal
    - Assumption: Distance Effects p
    - Let d Represent the Distance of the Field Goal
    - Consider the Linear Regression

$$p = \beta_0 + \beta_1 \times d + \epsilon$$ ← What is the Problem Here?

    - Consider the Logistic Regression

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 \times d$$

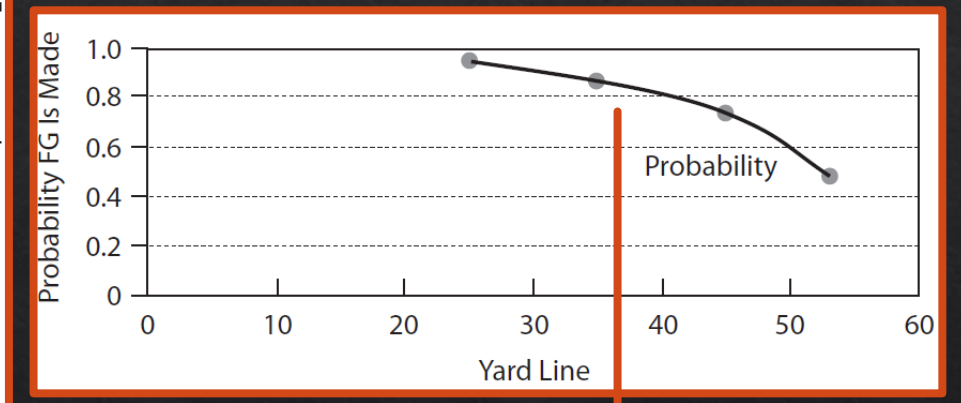
    - What Other Considerations Should Be Made?

Football Decision Making

- Fourth and 4 on Opponent's 30 Yard Line
  - Modeling Probability of Making Field Goal
    - Raw Aggregated Data From 2006

Field Goal Accuracy as a Function of Distance, 2006

Length of Field Goal	Made	Attempted	Percentage Made
20–29 yards	252	264	95.1
30–39 yards	232	268	86.9
40–49 yards	211	283	74.5
> 50 yards	39	81	48.1



Logistic Regression Smooths This Relationship?

Football Decision Making

- Fourth and 4 on Opponent's 30 Yard Line
  - Modeling Probability of Making Field Goal
    - Results from Logistic Regression

$$\log\left(\frac{p}{1-p}\right) = 7.05 - 0.134 \times d$$

- Expected Margin for States of Interest

$$V(1,10,75) = 3.884$$
$$V(1,10,28) = 0.336$$
$$V(1,10,27) = 0.266$$
$$V(1,10,37) = 0.979$$

- Expected Margin Under Field Goal

$$0.676 \times (3 - 0.266) - 0.324 \times 0.978 = 1.531$$

Estimated Probabilities of Field Goal Success

Yard Line	Prob FG good	Yard Line	Prob FG good
18	0.990343545	38	0.874819179
19	0.988970783	39	0.859355781
20	0.987405351	40	0.842326493
21	0.985620959	41	0.823658399
22	0.98358796	42	0.803296202
23	0.981272984	43	0.781207347
24	0.978638563	44	0.757387178
25	0.975642746	45	0.7318638
26	0.9722387	46	0.704702208
27	0.968374343	47	0.676007244
28	0.963991992	48	0.645924914
29	0.959028075	49	0.614641689
30	0.953412923	50	0.582381532
31	0.947070692	51	0.549400598
32	0.939919458	52	0.515979754
33	0.931871532	53	0.482415361
34	0.922834072	54	0.4490089
35	0.912710062	55	0.41605622
36	0.901399719	56	0.383837206
37	0.888802418	57	0.352606624

Football Decision Making

- Fourth and 4 on Opponent's 30 Yard Line
  - Modeling Probability of Making Field Goal
    - When to Go for First Down

$$P(Success) \times 3.884 - (1 - P(Success)) \times 0.336 \geq 1.531$$

$$P(Success) \times 3.884 - 0.336 + 0.336 \times P(Success) \geq 1.531$$

$$4.22 \times P(Success) \geq 1.867$$

$$P(Success) \geq 0.442$$

- According to Football Reference

Yards to Go	Probability Third- or Fourth-Down Play Makes the First Down
1	.67
2	.52
3	.53
4	.48
5	.41

Football Decision Making

- **Fourth and 4 on Our 30 Yard Line**
  - **Evaluate Expected Margin If We Punt**

$$E[Margin|Punt] = -V(1,10,30) = -0.48$$

$$E[Margin|Punt] = -P(5\ YD) \times V(1,10,65) - P(10\ YD) \times V(1,10,55) - \cdots - P(65\ YD) \times V(1,10,5)$$

Consideration of All Possible Punt Scenarios
Assuming the Punt is Not Blocked

  - **Evaluate Expected Margin If We Go For It**

$$E[Margin|Go\ For\ It] = P(Success) \times V(1,10,35) - P(Failure) \times V(1,10,68)$$

  - **Need 67.8% Probability to Justify Going for First Down**

Football Decision Making

- Simpler Scenarios
  - Gained 7 Yards on 1st Down from 30 Yard Line and Defense Offsides

$V(2,3,37) = 0.956$ → Don't Accept Penalty

$V(1,5,35) = 0.983$ → Accept Penalty

  - Opponent Ran for 0 Yards on 1st Down on 30 Yard Line and Offense Offsides

$V(2,10,30) = 0.115$ → Don't Accept Penalty

$V(1,15,25) = -0.057$ → Accept Penalty

  - Do You See Any Problems With Using This to Make Decisions?

Final Inspiration

This is no democracy.
It is a dictatorship.
I am the law.

- Coach Herman Boone