

Using CBA Technology to Analyze Sports Data

**Brown Bag Seminar
TERC**

Tools for the Day

In this seminar, we will use the following tools:

- R
 - Free, open-source analysis tool
- RStudio
 - Interface to work with code
 - Visualization tool
- SQL
 - Retrieve data
- SQLectron
 - Great interface to SQL and databases

Data for the Day

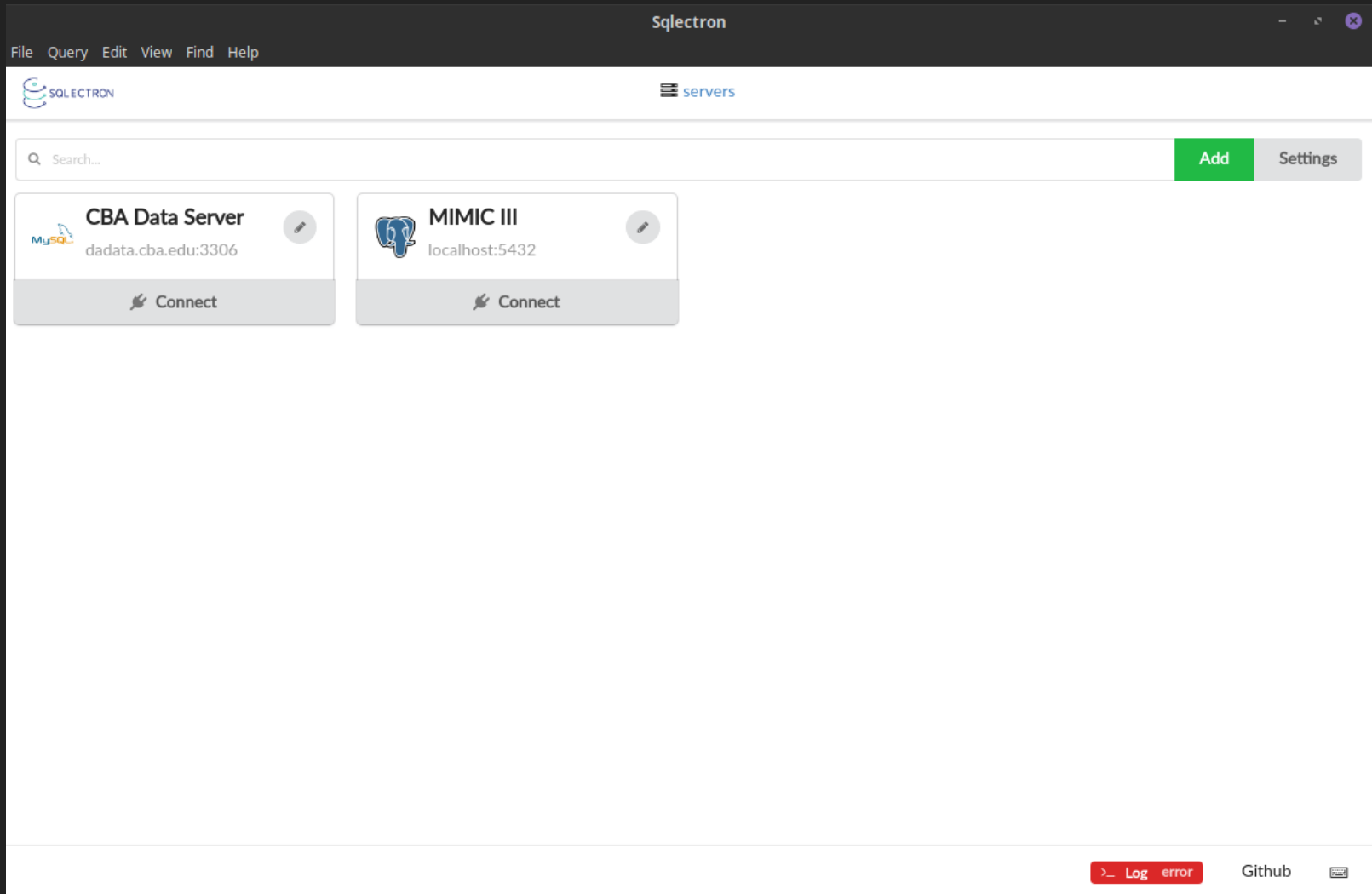
Our available NFL Data is a great tool for learning how to work with data.

- Has many tables
- Play-by-play data from 2000-2015
- Actually gets audiences interested! 😊

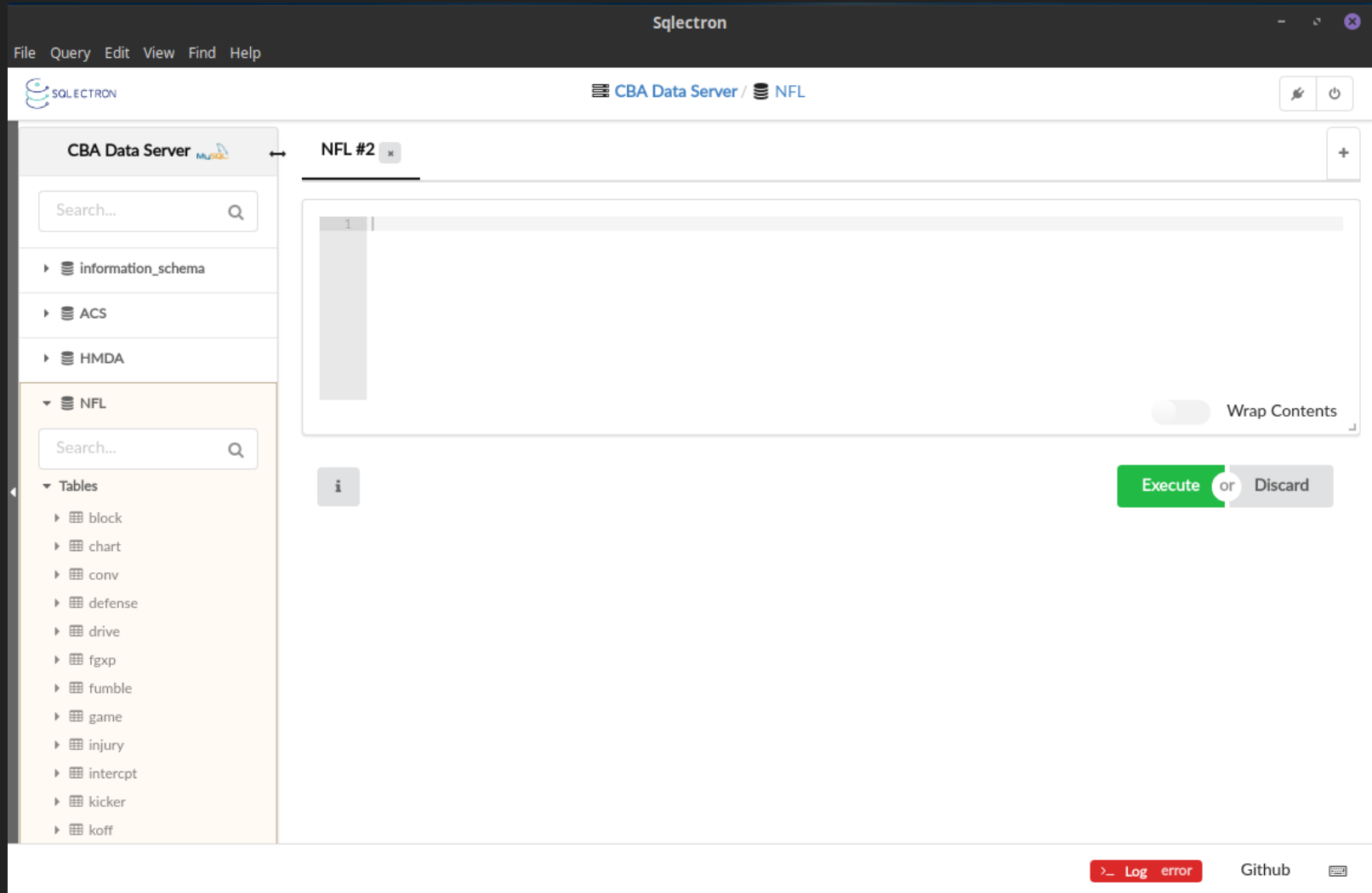
A simple question, really...

What are the relationships between offensive and defensive statistics, points scored, and wins in the NFL?

Get the Data from SQLectron



Get the Data from SQLectron



An Important Aside...

There is lots of other data available! We are using sports data for fun, but we have plenty of other great information on the server!

Retrieve Data Using SQL

```
SELECT
  team.tname AS team,
  game.seas AS season,
  game.wk AS week,
  game.sprv AS spreadAway,
  game.ou AS overUnder,
  CASE
    WHEN game.h=team.tname
      THEN game.ptsh
    ELSE game.ptsv
  END
  AS pointsFor,
  CASE
    WHEN game.h=team.tname
      THEN game.ptsv
    ELSE game.ptsh
  END
  AS pointsAgainst,
  CASE
    WHEN game.h=team.tname AND game.ptsh>game.ptsv
      THEN 1
    WHEN game.v=team.tname AND game.ptsh<game.ptsv
      THEN 1
    WHEN game.ptsv=game.ptsh
      THEN 0.5
    ELSE 0
  END
  AS win,
  CASE
    WHEN game.h=team.tname
      THEN game.v
    ELSE game.h
  END
  AS opponent,
  CASE
    WHEN team.tname=game.h
      THEN 1
    ELSE 0
  END
  AS homeTeam,
  team.ry AS rushYards,
  team.ra AS rushAttempts,
  team.py AS passYards,
  team.pc AS passCompletions,
  team.sk AS sacksAgainst,
  team.top AS timeOfPoss,
  team.pen AS penYardsAgainst,
  team.tdr AS rushTD,
  team.tdp AS passTD
FROM
  game, team
WHERE
  game.gid = team.gid
  AND ((game.v = team.tname) OR (game.h = team.tname))
```


Open RStudio!

The screenshot displays the RStudio IDE interface. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The top toolbar contains icons for file operations and a 'Go to file/function' search bar. The main source editor on the left shows a file named 'Untitled1' with a single line of code: '1'. The right-hand pane is divided into two sections. The top section, titled 'Environment', shows 'Global Environment' and a message 'Environment is empty'. The bottom section, titled 'Packages', shows a list of installed and available packages. The console at the bottom displays the R startup message and version information.

Environment

Global Environment

Environment is empty

Packages

Name	Description	Version
User Library		
assertthat	Easy Pre and Post Assertions	0.2.0
backports	Reimplementations of Functions Introduced Since R-3.0.0	1.1.1
base64enc	Tools for base64 encoding	0.1-3
BH	Boost C++ Header Files	1.65.0-1
bindr	Parametrized Active Bindings	0.1
bindrcpp	An 'Rcpp' Interface to Active Bindings	0.2
bit	A class for vectors of 1-bit booleans	1.1-12
bit64	A S3 Class for Vectors of 64bit Integers	0.9-7
blob	A Simple S3 Class for Representing Vectors of Binary Data ('BLOBs')	1.1.0
broom	Convert Statistical Analysis Objects into Tidy Data Frames	0.4.3
checkmate	Fast and Versatile Argument Checks	1.8.4
chron	Chronological Objects which can Handle Dates and Times	2.3-52
colorspace	Color Space Manipulation	1.3-2
CVST	Fast Cross-Validation via Sequential Testing	0.2-1
DBI	R Database Interface	0.8
ddalpha	Depth-Based Classification and Calculation of Data Depth	1.3.1
DEoptimR	Differential Evolution Optimization in Pure R	1.0-8
dichromat	Color Schemes for Dichromats	2.0-0
digest	Create Compact Hash Digests of R Objects	0.6.12
dimRed	A Framework for Dimensionality Reduction	0.1.0
dplyr	A Grammar of Data Manipulation	0.7.4
DRR	Dimensionality Reduction via Regression	0.0.2
evaluate	Parsing and Evaluation Tools that Provide More Details than the Default	0.10.1
foreach	Provides Foreach Looping Construct for R	1.4.3

Console

```
R version 3.4.4 (2018-03-15) -- "Someone to Lean On"
Copyright (C) 2018 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> |
```

Getting Started in R

Four Panels:

1. The script editor (top-left)
2. Environment panel (top-right)
3. Console (bottom-left)
4. Package Manager/Viewer (bottom-right)

Getting Started in R

We import our data using a nice, clean, built-in function:

```
data <- read.csv("/home/dusty/BrownBag - TERC/footballData.csv")
```

Here, we tell **R** to store the data from our query in a variable named **data** (I am a sucker for overly simple names)

Getting Started in R

Let's sure that our data was imported correctly. Use the following command to view the first rows of the imported data:

```
head(data)
```

Summary statistics

We can create summary statistics tables in R, as well!

```
summary(data)
```

Tabulating Information

We can cross-tabulate variables to check for basic or obvious relationships

```
table(data$win, data$homeTeam)
```

In this case, we use the `$` to denote a column within a data frame. So, we are tabulating the number of wins (`data$win`) based on status as the home team (`data$homeTeam`) in a given matchup.

Plotting 101

We first need to import the plotting library that we will use:

```
library(ggplot2)
```

`ggplot2` follows a grammar-of-graphics, which makes plotting fairly organic once you get the hang of it

Plotting 101

Let's begin investigating the relationship between points and simple offensive metrics by building our plotting space

```
ggplot(data, aes(x=rushYards, y=pointsAgainst))
```


Plotting 101

Now we can add points to our plot in order to make it a scatter plot

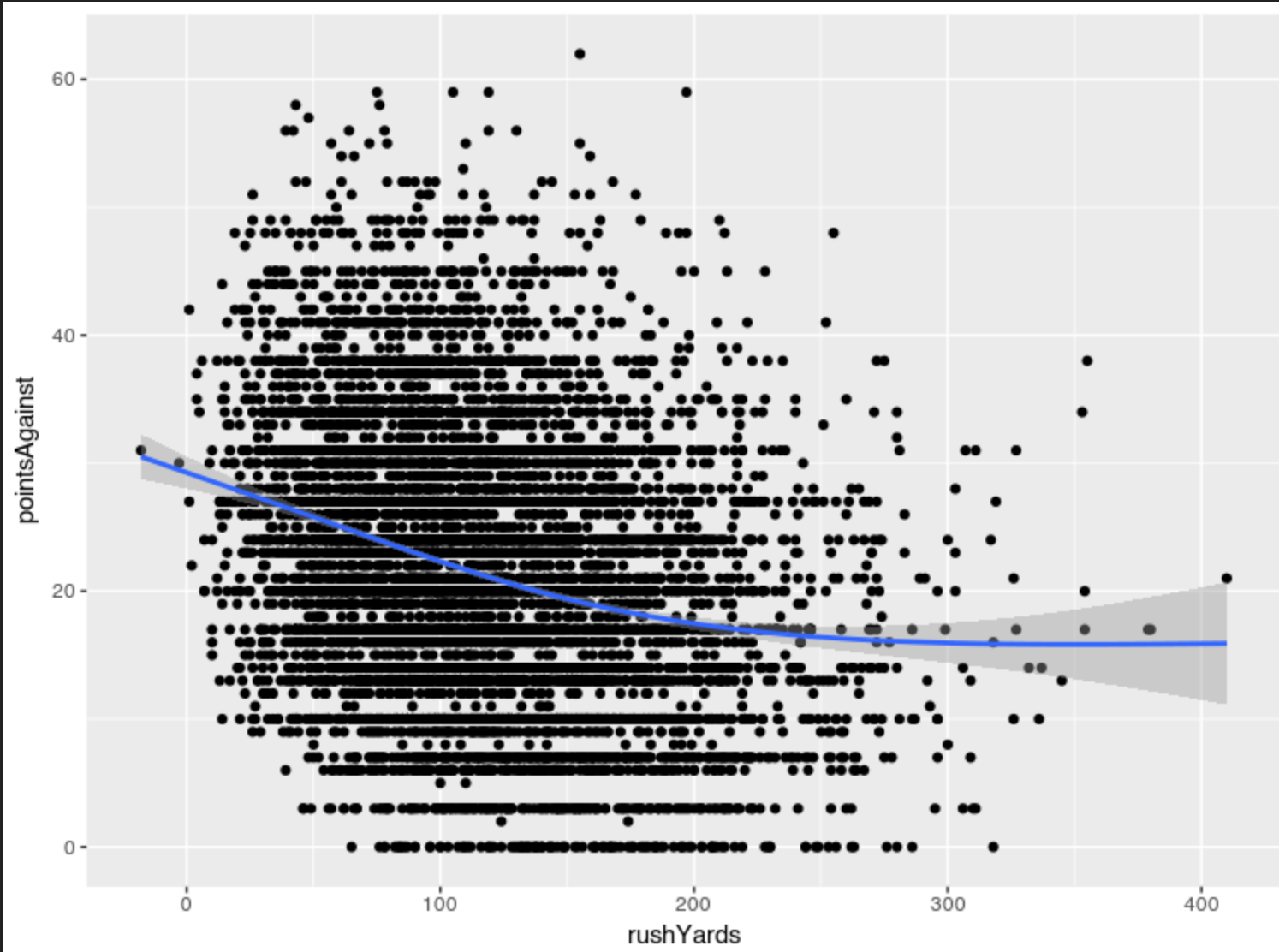
```
ggplot(data, aes(x=rushYards, y=pointsAgainst))  
  + geom_point()
```

Plotting 101

And then add a trend line!

```
ggplot(data, aes(x=rushYards, y=pointsAgainst))  
  + geom_point()  
  + geom_smooth()
```

Pretty easy! RStudio even allows us to quickly save the visual as a static image file.



More plots

Passing yards vs points by opposing team

```
ggplot(data, aes(x=passYards, y=pointsAgainst))  
  + geom_point()  
  + geom_smooth()
```

More plots

Rushing yards vs probability of winning

```
ggplot(data, aes(x=rushYards, y=win))  
  + geom_smooth()
```

More plots

Passing yards vs probability of winning

```
ggplot(data, aes(x=passYards, y=win))  
  + geom_smooth()
```

Plotting averages

We will incorporate a new library to create a "summarized" data set

```
library(dplyr)

means <- data %>%
  group_by(season) %>%
  summarise(rushYards = mean(rushYards),
            passYards = mean(passYards),
            pointsFor = mean(pointsFor))
```

We use this code to measure the mean of three columns broken out by season, and store the data in a data frame called `means`

Plotting averages

Now we can plot the data using almost identical syntax to what was used above! First, rush yards by season:

```
ggplot(means, aes(x=season, y=rushYards))  
  + geom_smooth()  
  + geom_point(size=3)
```


Plotting averages

Pass yards by season

```
ggplot(means, aes(x=season, y=passYards))  
  + geom_smooth()  
  + geom_point(size=3)
```

Plotting averages

Points scored by season

```
ggplot(means, aes(x=season, y=pointsFor))  
  + geom_smooth()  
  + geom_point(size=3)
```

Regression analysis

It's hard to determine what the relationship between winning and offensive statistics are without controlling for other variables that may change between games.

Regression saves the day, and allows us to explore the relationships between statistics and the probability of winning.

Linear Regression - Linear Probability Model

```
model <- lm(  
  win ~ rushYards + passYards + opponent + team  
  + penYardsAgainst + passTD + rushTD + sacksAgainst  
  + timeOfPoss,  
  
  data=dataWin)
```

Regression results

We can print out a regression table by using the `summary` function. This will work with nearly any regression model in R.

```
summary(model)
```

Logistic Regression

First, we need to ignore ties (we will just eliminate them from our data for now)

```
dataWin <- subset(data, data$win!=0.5)
```

Logistic Regression

Now, we can use our model to determine the effects of the variables we collected:

```
model <- glm(  
  win ~ rushYards + passYards + opponent + team  
  + penYardsAgainst + passTD + rushTD + sacksAgainst  
  + timeOfPoss,  
  
  data=dataWin,  
  family="binomial")
```

Logistic Regression

Dependent variable	Effect	Dependent variable	Effect
rushYards	0.003***	rushTD	0.859***
passYards	-0.008***	sacksAgainst	-0.351***
penYardsAgainst	-0.007***	timeOfPoss	0.230***
passTD	0.899***	Constant	-5.960***

After controlling for the teams playing

Questions?