Weather and the NFL

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Intro

- How much chance did the Seattle Seahawks have chance of winning the 2016 Wildcard Playoff game in frigid weather in Minnesota?

- Will the Rams' relocation from St. Louis to Los Angeles give them more success?

Intro

- How does rain affect rush defense?
- Do pass heavy teams struggle in the wind?
- Is pass defense more effective in cold or warm temperatures?
- How does snow affect teams with high-powered offenses

Research Question

How does weather affect different NFL teams according to their strengths and weaknesses?

The Data

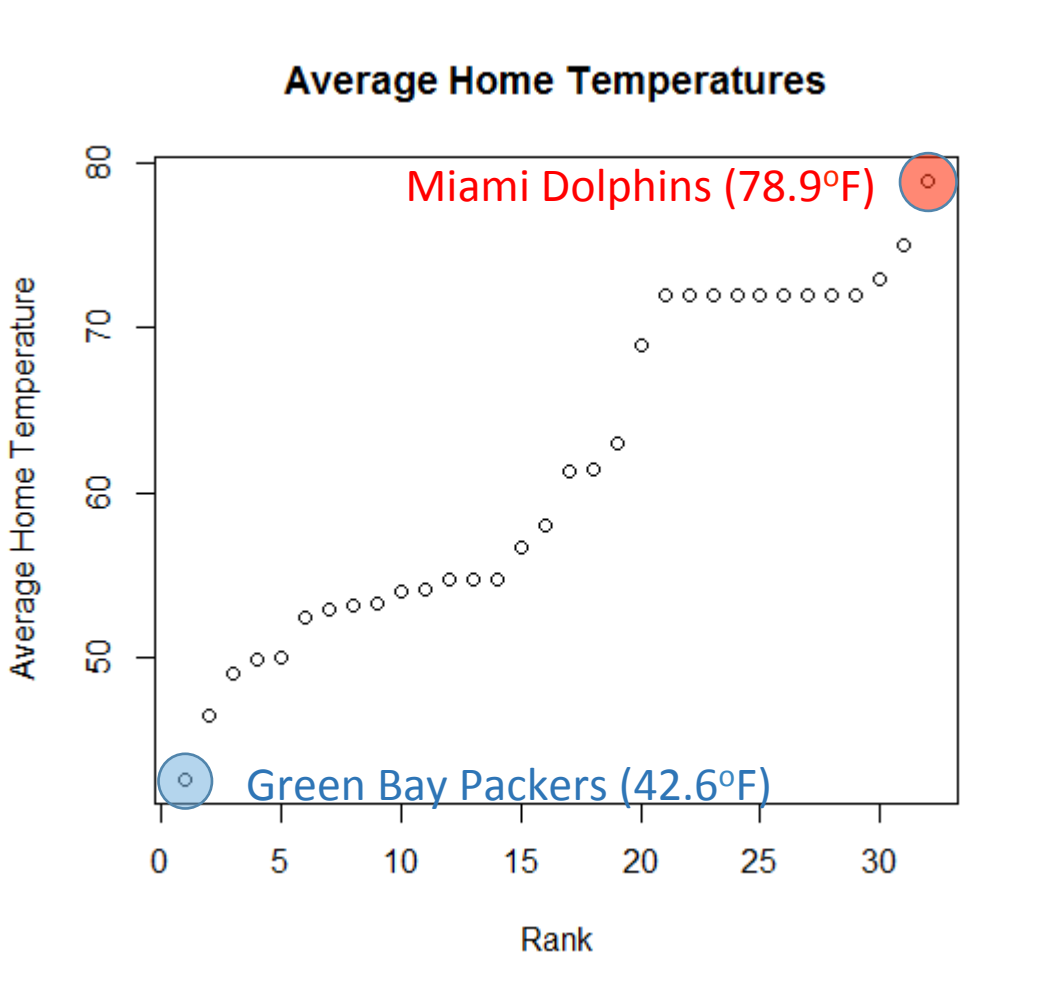
- Game-by-game score and weather data for the 2009-2013 seasons
  - Temperature
  - Wind Speed
  - Conditions

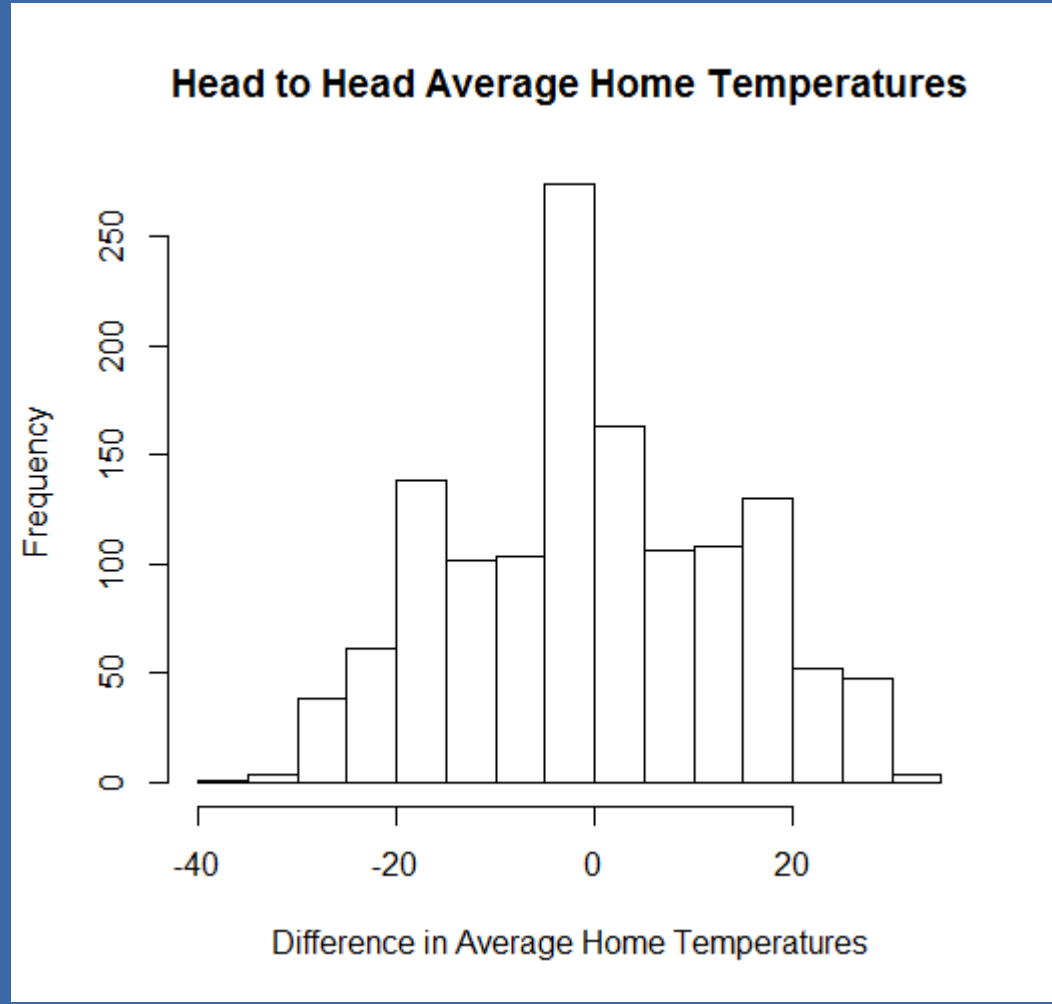
- Expected points contributed by offense and defense from pro-football-reference.com

The Data

- Coldest Game: 2014 NFC Wild Card Playoff 49ers at Packers (4°F)
- Hottest Game: 2010 regular season week 1 Broncos at Jaguars (91°F)
- Windiest Game: 2009 regular season week 4 Rams at 49ers (27mph)

The Data


Average Home Temperatures
Miami Dolphins (78.9°F)
Green Bay Packers (42.6°F)
Average Home Temperature
50
60
70
80
0
5
10
15
20
25
30
Rank


Head to Head Average Home Temperatures
Frequency
0
50
100
150
200
250
-40
-20
0
20
Difference in Average Home Temperatures

Preliminary Analysis

Weather Effects on Points per Game

Weather Aspect	**Estimate**	**P-value**
Temperature	0.011	0.65
Wind Speed	**-0.26**	**0.0009**
Rain	-1.71	0.28
Snow	5.61	0.15
Fair Weather	**2.69**	**0.0008**
Indoors	**3.27**	**0.0001**
Turf	**2.44**	**0.0014**

Preliminary Analysis

Weather Effects on Point Difference between Home and Away Teams

Weather Aspect	Estimate	P-value
Temperature	**-0.068**	**0.012**
Wind Speed	0.01	0.91
Rain	**3.72**	**0.03**
Snow	-4.20	0.32
Fair Weather	**-1.51**	**0.08**
Indoors	0.81	0.38
Turf	**3.49**	**0.00003**

Preliminary Analysis

Weather Effects on Home Score and Away Score

Weather Aspect	Home Team Estimate	P-value	Away Team Estimate	P-value
Temperature	-0.03	0.13	**0.04**	**0.03**
Wind Speed	**-0.13**	**0.03**	**-0.14**	**0.02**
Rain	1.01	0.40	**-2.72**	**0.02**
Snow	0.70	0.81	4.91	0.08
Fair Weather	**-2.10**	**0.0005**	-0.59	0.31
Indoors	**2.04**	**0.001**	**1.23**	**0.05**
Turf	**2.97**	**0.0000003**	-0.53	0.35

Preliminary Regression Model

Weather Effect	Dependent Variable	Estimate	P-value
Temperature	Points per Game	0.092	0.04
	Home Score	-0.087	0.009
Wind Speed	Away Score	-0.12	0.08
Rain	**Point Differential**	**3.25**	**0.03**
	Away Score	0.031	0.08
Indoors	**Point Differential**	**2.23**	**0.06**
	Home Score	**1.77**	**0.04**
Difference from Average Temperature for Away Team	Points per Game	0.082	0.03
	Home Score	0.058	0.03
	Away Score	0.030	0.03

Preliminary **Findings**

- Good weather conditions help both teams score more points
- Bad weather conditions increase the point difference of the Home team over the Away team
- Stadiums with Turf over Grass help both teams score more points
- Indoor stadiums come up with conflicting results, but they appear to primarily help the home team

Our Model

- Characteristics of a game's home & away teams:
  - Pass Offense EXP (expected points contributed by passing offense)
  - Rush Offense EXP
  - Pass Defense EXP
  - Rush Defense EXP
  - Average Temperature when playing at Home
- Weather data:
  - Type of Weather = { Fair, Rain, Snow, Indoor }
  - Playing Surface = { Grass, Turf }
  - Temperature
  - Wind Speed

Our Model

- Training Set: 2009-2012 seasons
- Test Set: on 2013 season
- Model:
  - Extended version of regularized Bradley-Terry Model
    - Features: { PassO, RushO, PassD, RushD, AvgTemp }
      + { PassO, RushO, PassD, RushD } X { Temperature, WindSpd, Fair, Rain, Snow, Indoor, Grass, Turf}
  - Lasso Regression

$$\sum_{i=1}^{n}\left(y_i-\beta_0-\sum_{j=1}^{p}\beta_j x_{ij}\right)^2+\lambda\sum_{j=1}^{p}|\beta_j| = \mathrm{RSS}+\lambda\sum_{j=1}^{p}|\beta_j|. \qquad (6.7)$$

Our Findings

- For home teams, we could predict the number of points scored with a mean-squared error (MSE) of 9.3 points.
- For away teams, we could predict the number of points scored with MSE of 8.4 points.
- For score differentials, we could predict with an accuracy of MSE = 11.3 points.

Home Team Weather Effects

Helps home team score more points:

- Rain (Passing)
- Turf playing surface (Passing)
- Warmer Temperatures (Rushing)

Makes home team score fewer points:

- Warmer temperatures (passing)
- Playing indoors (passing)

Away Team Weather Effects

Helps away team score more points:

- Warmer Temperatures (both)
- Fair Weather (passing)
- Turf playing surface (rushing)

Makes away team score fewer points:

- Facing a good pass defense in fair conditions

Weather Effects on Score Differential

Helps home team score gain more score differential:

- Warmer temperatures help rush defense
- Home team's pass offense in rainy weather
- Home team's pass defense in snowy weather

Makes home team score lose score differential:

- Away team's pass offense in fair weather

Limitations

- Detailed data can be hard to obtain (many NAs)
- Hard to account for variation in home field advantage
- EXPs can be negative, so can be difficult to interpret interactions
- Possible multicollinearities
- Model doesn’t account for interactions between weather conditions

Suggestions for further research

- How weather choice affects play selection
- How well different teams adapt their playing style to the weather
- How time zone changes affect team performance
- Whether teams who have to travel more in the regular season have more or less flexible game plans

References

- pro-football-reference.com
- NFLsavant.com
- NFLweather.com

Questions?