

NFL Home & Away Performance Analysis

DSAN-5100 Group 17 Final Project

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Introduction

- In the National Football League (NFL), each team plays 17 regular season games, a mixture of home and away games
- Teams are theorized/supposed to have an advantage when playing at home compared to playing away
- Even oddsmakers think the same way...

Image attribution:

<https://www.sharpfootballanalysis.com/wp-content/uploads/2023/05/NFL-schedule-grid-2023.jpg>

TEAM	SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER				JANUARY	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
ARI @WAS	NYG	DAL	@SF	CIN	@LAR	@SEA	BAL	@CLE	ATL	@HOU	LAR	@PIT	SF	@CHI	@PHI	SEA		
CAR GB	@DET	@JAX	IND	@SF	DET	MIN	SEA	CLE	IND	CHI	SEA	@NOVY	TB	@CAR	IND	@CHI	@NO	
BAL HOU @CHI	IND	@SF	DET	MIN	@DET	MIN	SEA	DET	IND	CHI	SEA	@NOVY	@PHI	@KC	DAL	@LAC	MIA PIT	
BUF @TB	NE	@SEA	MIA	JAX	NYG	@NE	TB	DET	IND	CHI	SEA	@NOVY	@PHI	@KC	DAL	@LAC	NE @MIA	
CAR GB	@TB	@KC	DEN	@WAS	MIN	LV	@LAC	@NO	CAR	DET	@NOVY	@PIT	DET	@CLE	ARI	ATL	@GB	
CIN @CLE	BAL	LAR	@TEN	@ARI	SEA	@SF	BUF	HOU	@SEA	ARI	@BAL	PIT	@TEN	IND	MIN	@PIT	@KC CLE	
CLE CHI @PIT	TEN	BAL	SF	@IND	SEA	@SF	BUF	HOU	@SEA	ARI	@BAL	PIT	@DEN	ALAR	JAX	CHI	@PHO NYJ @CN	
DAL @NYG	NYJ	@ARI	NE	@SF	@LAC	DET	SEA	LAR	@PIT	NYG	@CAR	WAS	SEA	PHI	@BUF	@PIT	MAI @DET	
DEN @WAS	WAS	SEA	@CHI	NYT	@KC	GB	NE	@KC	DET	IND	CHI	SEA	@NOVY	@KC	DET	@PIT	@LAC MIN	
DET @KC	ARI	DET	DET	CAR	@TB	@BAL	DET	SEA	@DET	IND	CHI	SEA	@NOVY	@KC	DEN	@PIT	@KC MIA	
GB @CHI	@ATL	NO	DET	DET	@DEN	MIN	LAR	@PIT	LAC	@DET	KC	IND	TB	@CAR	@MIA	CHI		
HOU @BAL	IND	@JAX	PIT	@DET	NO	DET	SEA	@CAR	TB	@CIN	ARI	JAX	DET	@NOVY	@TEN	CLE	TEN @IND	
IND JAX @HOU	@BAL	LAR	TEN	@JAX	CLE	NO	@CAR	NE	SEA	ARI	JAX	DET	@TEN	@CIN	PIT	@ATL	LV HOU	
JAX @IND	KC	HOU	ATL	@DET	IND	@NOVY	@PIT	DET	SE	TEN	@HOU	CIN	@CLE	BAL	@TB	CAR	@TEN	
KC @DET	@JAX	CHI	@NOVY	@MIN	DEN	LAC	DET	IND	MIN	DET	IND	SEA	PHI	@LV	@GB	BUF	RHS LV CIN @LAC	
LV @DET	@DET	PIT	@LAC	GB	NE	@CHI	DET	IND	NYG	NYJ	@MIN	DET	IND	DET	IND	LAC	@KC DEN	
LAC @KC	DET	DET	DET	IND	PHI	ARI	PIT	@DET	IND	SEA	@MIN	DET	IND	DET	IND	DET	@KC DEN	
MIA @TEN	@MIN	LV	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
MIA @LAC	@NE	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
MIN TB	@PHI	LAC	@CAR	KC	@CHI	SE	@GB	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
NE PHI	MIA	@NOVY	@DAL	NO	LV	BUF	@MIA	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
NO TEN	@CAR	@GB	TB	@NOVY	@HOU	JAX	@IND	CHI	@MIN	@ATL	DET	CAR	DET	DET	DET	DET	DET	
NYG DAL	@ARI	@SF	SEA	SEA	@PIT	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
NYJ @DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
NYV @SEA	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
PHI @NE	MIN	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
PIT SF	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
SEA LAR	@DET	CAR	@NYO	@LAR	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
TB @MIN	CHI	PHI	@NOVY	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
TEN @NOVY	LAC	@CLE	CIN	@IND	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	
WAS ARI	@DEN	BUF	@PHI	CHI	@ATL	@NOVY	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	DET	

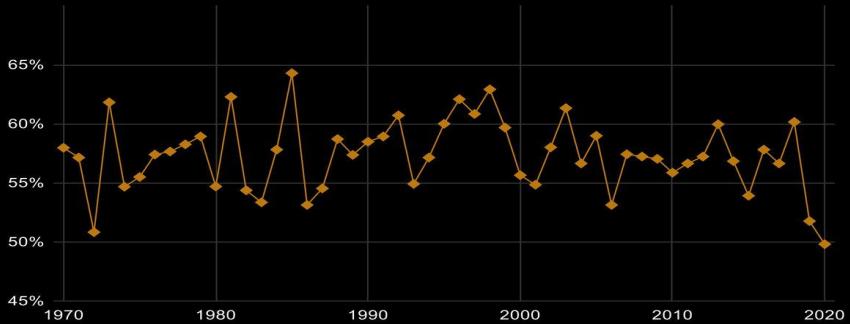
Legend:

HOME	ROAD	BYE	SUN Night	MON Night	THU Night	FRI	SAT	Thanks Giving	Christmas	London	Germany
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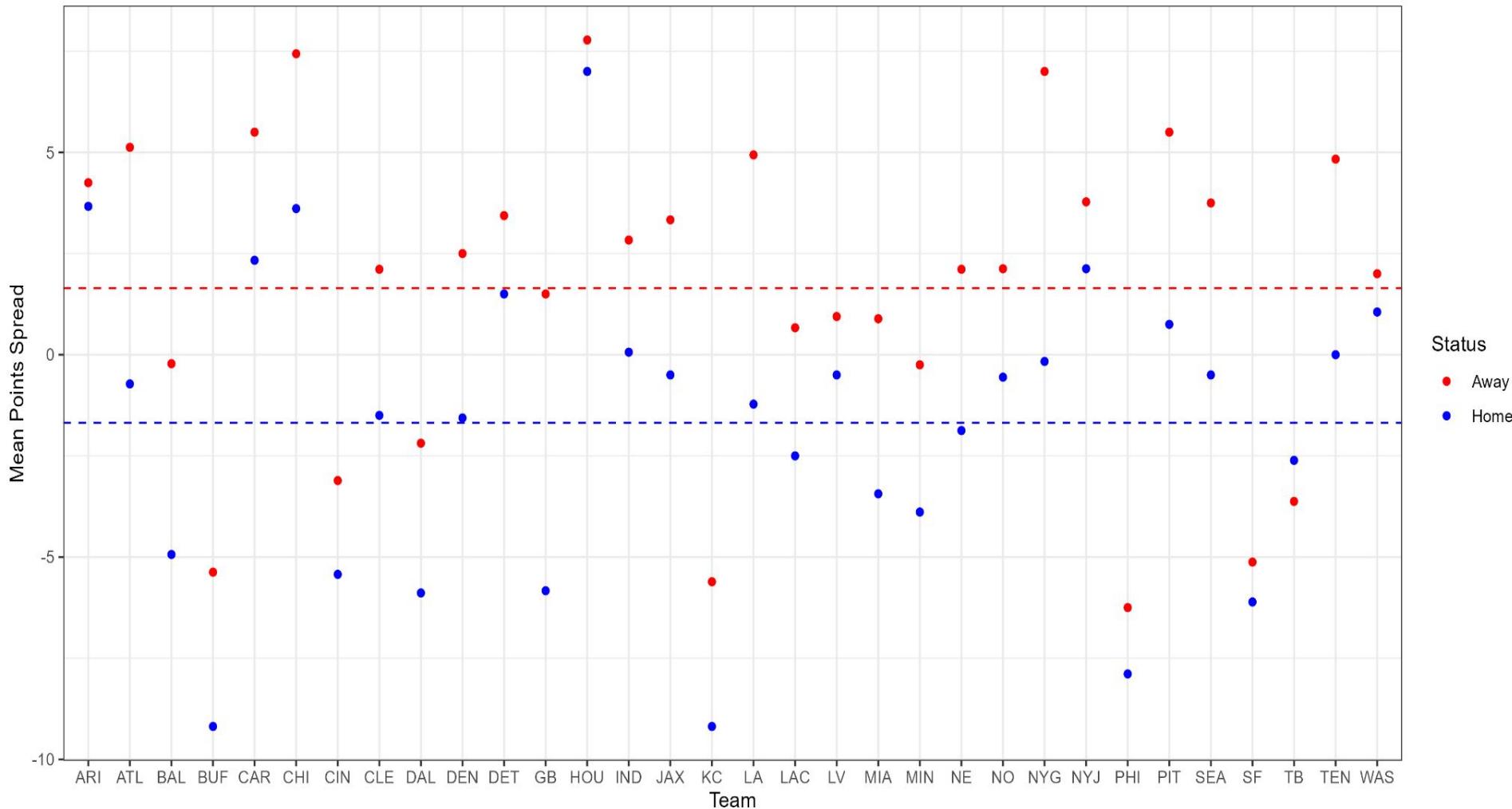
Note: Teams who are underlined/italicized play home games at 4pm ET by design

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Home win percentage over time



Average Points Favored by for Each Team by Home and Away Status (2022)



About the Data

nflreadr

nflreadr is a minimal package for downloading data from nflverse repositories. It includes caching, optional progress updates, and data dictionaries.

Please note that nflverse data repositories have been reorganized and pushed towards the [nflverse-data](#) repo, and v1.2.0+ is the minimum version that supports this change. We encourage all users to upgrade to this version immediately.

For Python access to nflverse data, please check out [nfl-data-py](#) – maintained by Cooper Adams.



Is there any performance difference
between home teams and away teams?

Does home field advantage exist?

Hypothesis Test

- Null Hypothesis (H_0): There is no difference in performance for teams in home and away games
- Alternative Hypothesis (H_1): There is difference in performance for teams in home and away games.

Team Analysis

- Score (Home vs. Away)
- Expected Points Added (EPA)
- Win Probability (WP)

What is EPA?

Expected Points(EP)

- At any moment in a football game, based on factors, there's an average number of points that a team is expected to score on their current drive.

Expected Points Added

- EPA is the change in EP as a result of a play. If a play results in a positive EPA, it means the play has improved the team's scoring chances. Conversely, a negative EPA means the play has reduced the team's scoring chances.

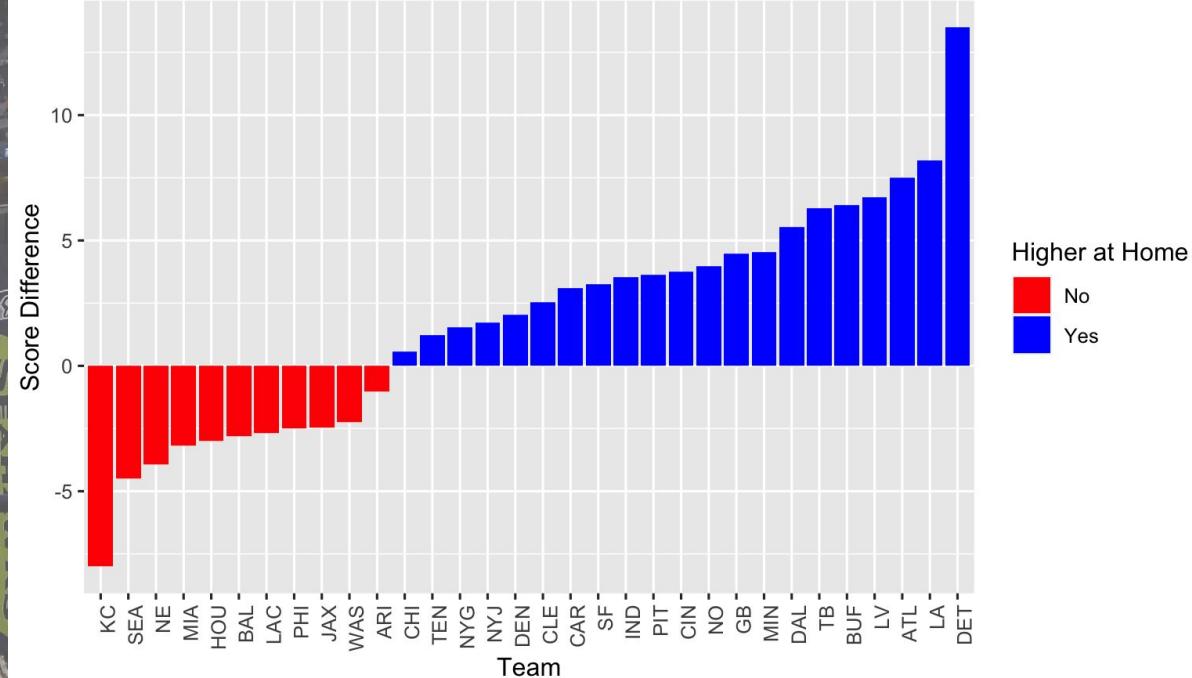
What is WP?

- Win Probability (WP) is a statistical measure that represents a team's likelihood of winning a game at any given point during the game. It is expressed as a percentage, with 0% indicating no chance of winning and 100% indicating a certain win.

Team Score Difference

- The amount of teams that score higher at home is larger than the number of teams score higher at away.

Difference in Average Scores (Home vs. Away)



Score T-test and Bootstrap

```
data: play_stats$total_home_score and play_stats$total_away_score  
t = 18.578, df = 95460, p-value < 2.2e-16  
alternative hypothesis: true difference in means is not equal to 0  
95 percent confidence interval:  
 1.015249 1.254729  
sample estimates:  
mean of x mean of y  
 11.69589 10.56090
```

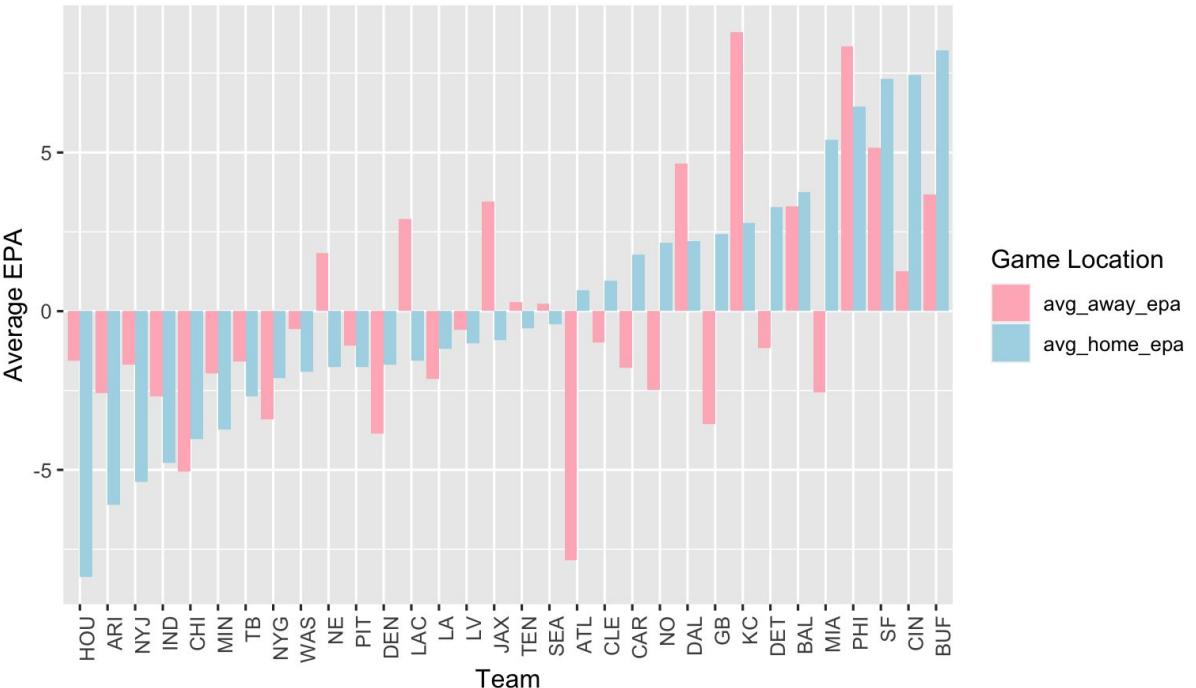
Bootstrap 95% Confidence Interval

2.5%	97.5%
1.013919	1.253325

Conclusion: There are differences between home and away games!

Team EPA Difference

Average EPA at Home vs. Away for Each Team (Ordered by Home EPA)



There are some teams that favor home games than away games.

Team EPA T-test and Bootstrap

T- test output

```
data: play_stats$total_home_epa and play_stats$total_away_epa
t = 2.8247, df = 95680, p-value = 0.004734
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0636702 0.3523169
sample estimates:
 mean of x  mean of y
 0.1039968 -0.1039968
```

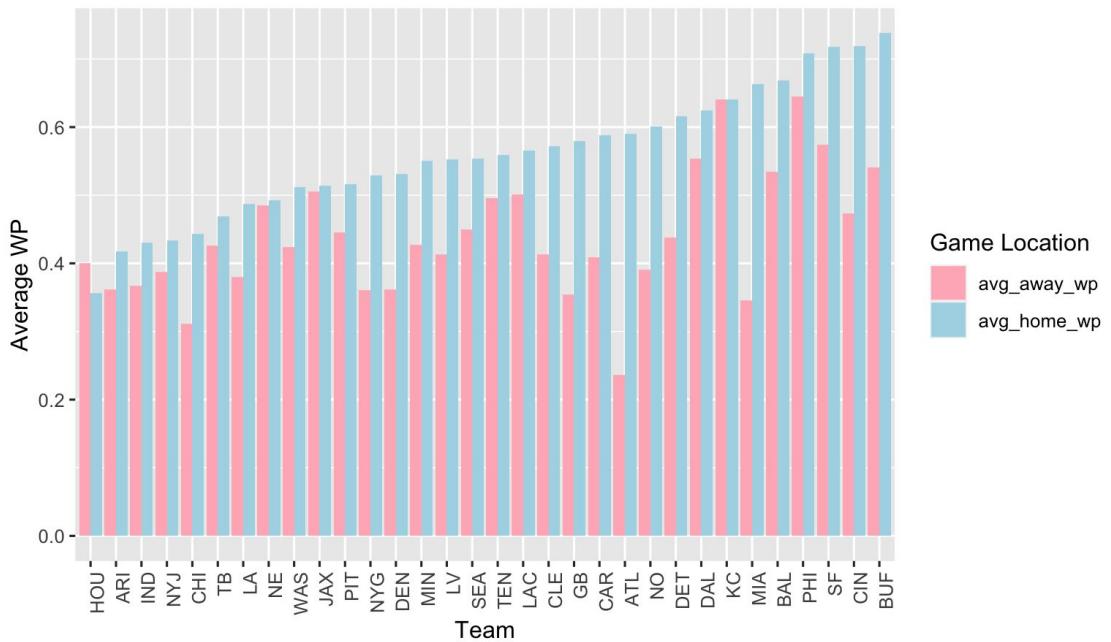
Bootstrap output

	2.5%	97.5%
0.06328148	0.35373450	

These results suggest a home field advantage in terms of EPA

Team WP Difference

Average WP at Home vs. Away for Each Team (Ordered by Home WP)



Clear to see that the win probability at home is higher than at away. Let's find out using solid numbers

Team WP T-test and Bootstrap

T- test output

```
data: play_stats$home_wp and play_stats$away_wp
t = 65.912, df = 95680, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
0.1157433 0.1228379
sample estimates:
mean of x mean of y
0.5596453 0.4403547
```

Bootstrap output

2.5%	97.5%
0.1157628	0.1229125

Both analyses confirm that there is a statistically significant difference in win probabilities, with home teams generally having a higher win probability than away teams.

Analysis of Home Field Advantage on the Quarterback

QB Analysis

- The most important position in football is the quarterback (QB)
 - They are considered “faces of the franchise”
 - Almost 70% of the NFL’s most valuable player awards (MVP) have gone to QBs



Image attribution:

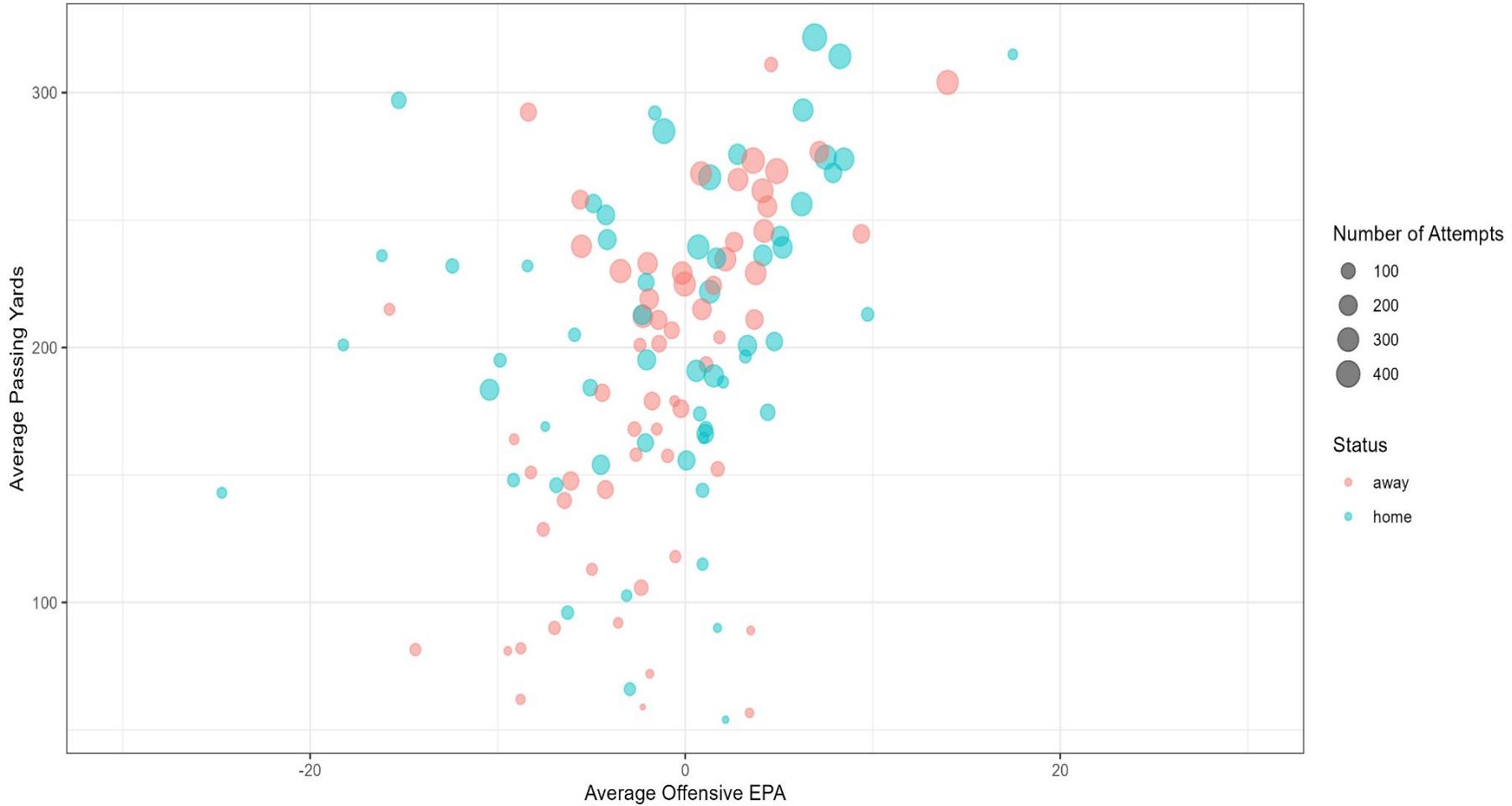
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<https://tdalabamamag.com/wp-content/uploads/2021/02/Tom-Brady-Super-Bowl-Alabama-Audible.jpg>

Why Home and Away Games May Effect QBs

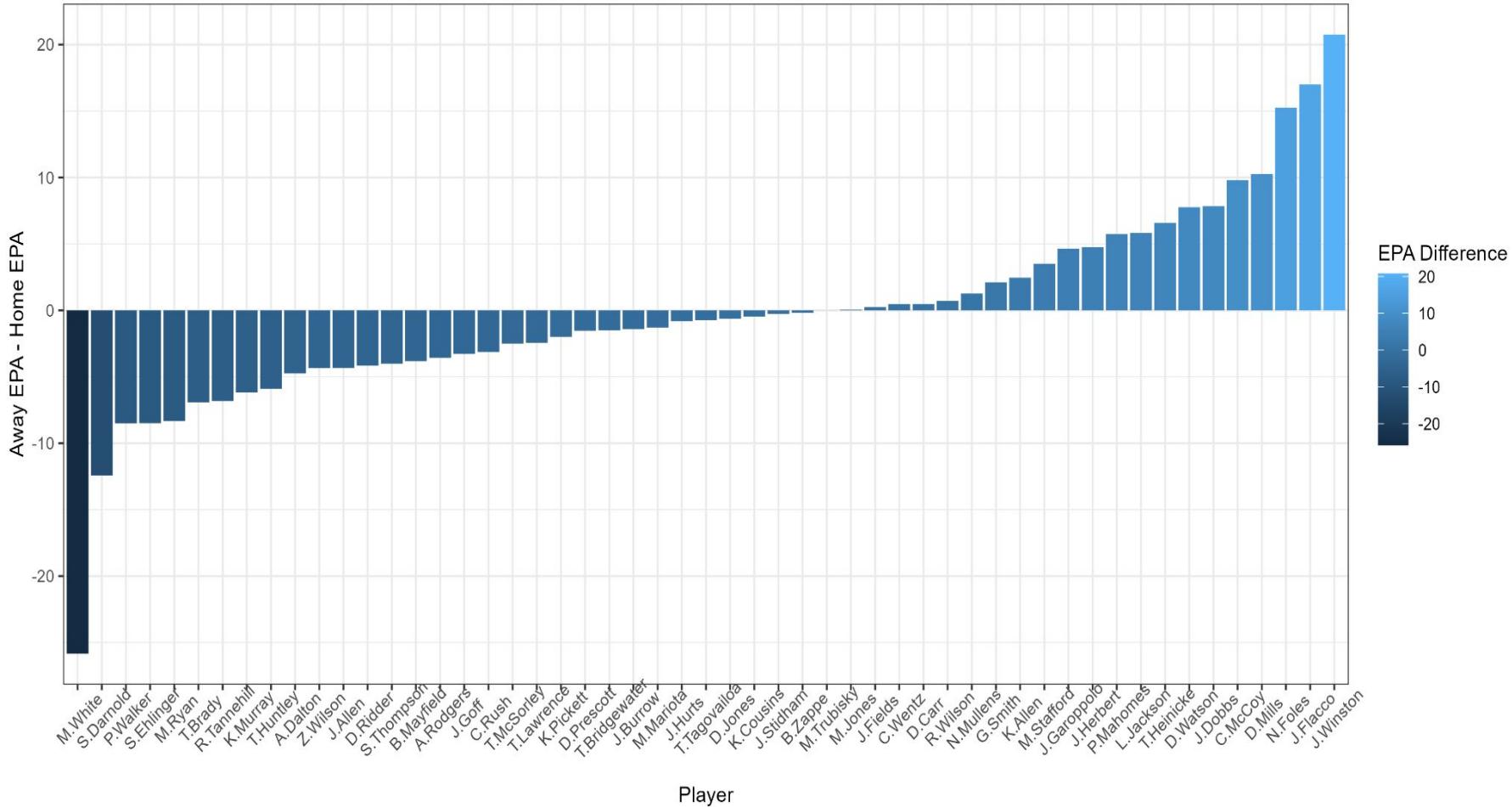
- Crowd noise
 - QBs need to communicate to their teammates, but away crowds tend to be loud
 - The Guinness World Record for Loudest Stadium Roar was set at Kansas City's Arrowhead Stadium ([Source](#))
- Unfamiliarity
 - When QBs play away from their home stadium, they may not be used to the opposition's field



QB Passing Performance by Home/Away Status

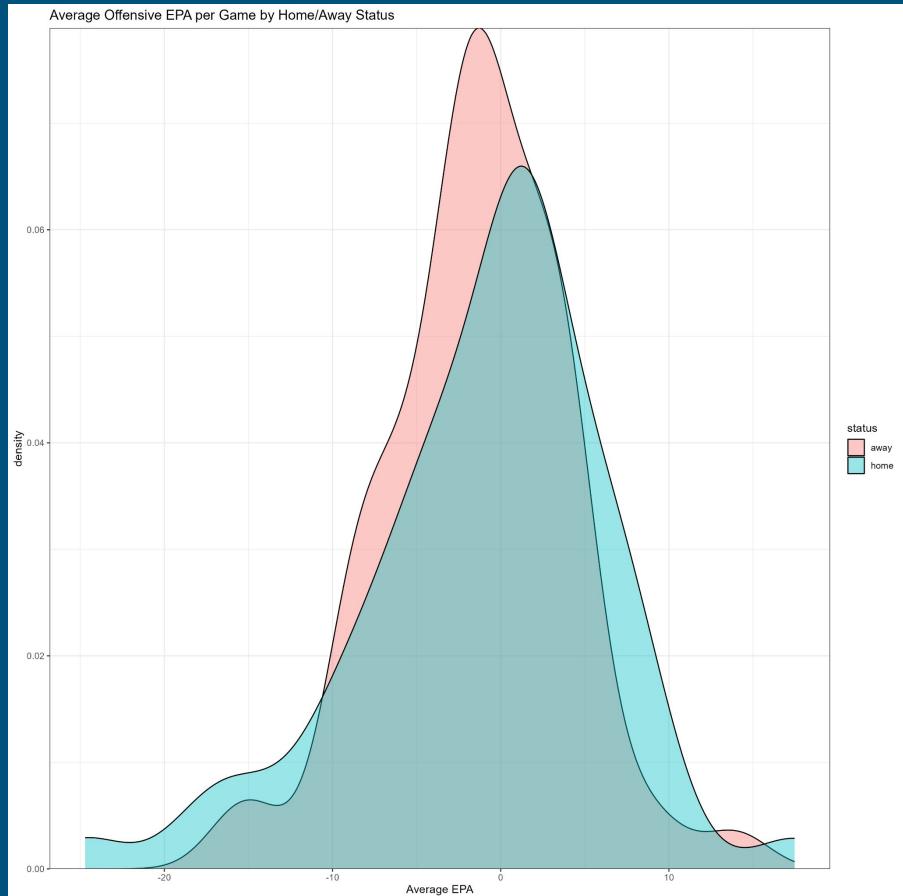


Offensive EPA Difference of QBs Home vs. Away



Hypothesis Testing (Student's T)

- Null Hypothesis: No Difference in QB EPA between Home and Away games
- Alternative Hypothesis: QB EPA is greater in home games than away games
- Results:
 - P-value: 0.4236 at 95% confidence level
 - Fail to reject Null



Regression Analysis and Elo Rating

Background

- We decided to take a more “comprehensive” look at NFL teams by looking Elo rating data from the sports and politics analytics titan FiveThirtyEight
- FiveThirtyEight's NFL Elo ratings are a statistical system designed to estimate the relative strength of NFL teams.
- Elo ratings were originally developed for chess and have been adapted for various sports, including the NFL.

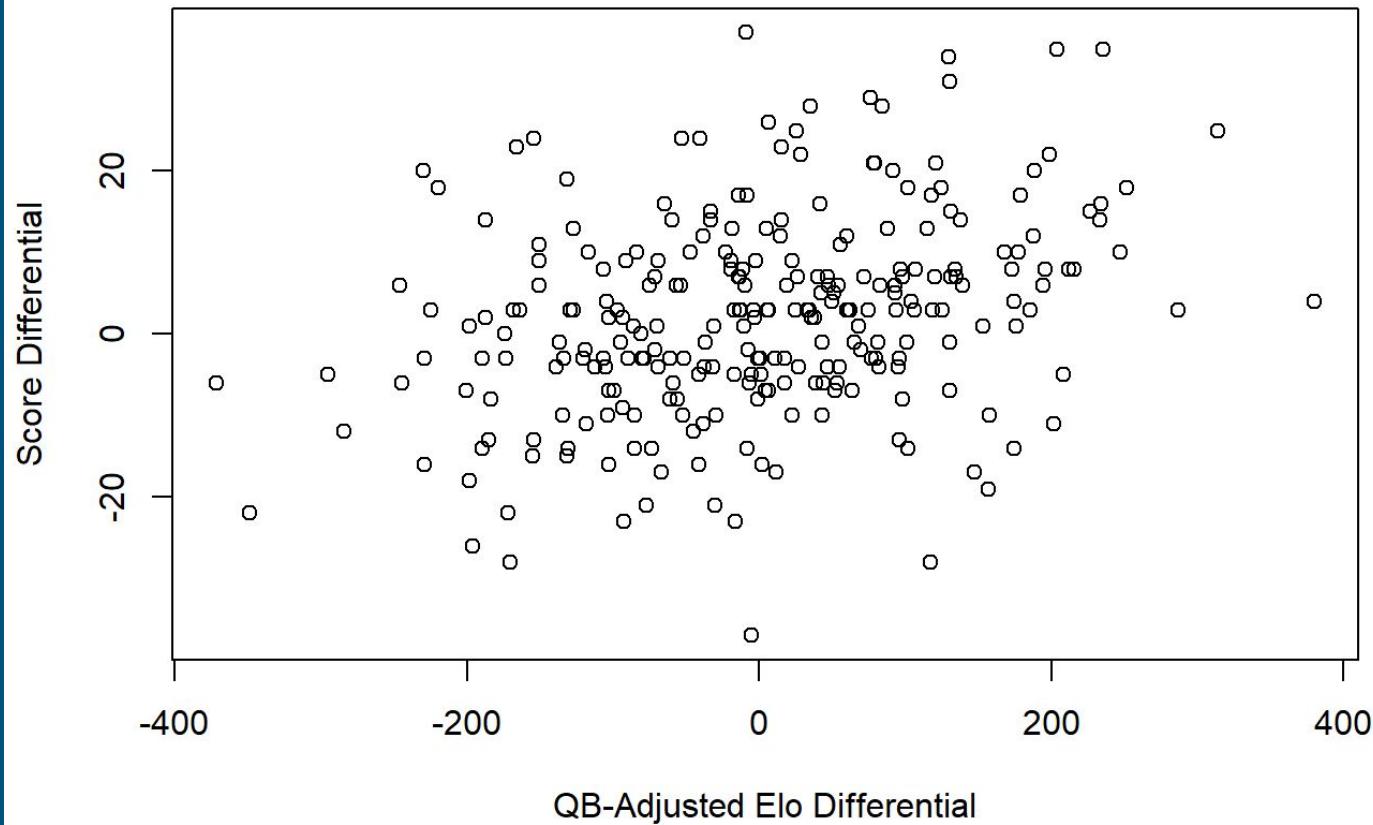
Background cont.

FiveThirtyEight's "nfl_elo.csv" file contains the Elo ratings of team's from EVERY game going back to 1920 (over 17,000 observations)

If QB Adjusted Elo ratings are held constant between two teams, does the home or away team have a quantifiable advantage?

date	season	neutral	playoff	team1	team2	elo1_pre	elo2_pre	elo_prob1	elo_prob2	elo1_post	elo2_post
9/26/1920	1920	0		RII	STP	1503.947	1300	0.824651	0.175349	1516.108	1287.838
10/3/1920	1920	0		AKR	WHE	1503.42	1300	0.824212	0.175788	1515.278	1288.142
10/3/1920	1920	0		BFF	WBU	1478.004	1300	0.802	0.198	1489.757	1288.247
10/3/1920	1920	0		DAY	COL	1493.002	1504.908	0.575819	0.424181	1515.434	1482.475
10/3/1920	1920	0		RII	MUN	1516.108	1478.004	0.644171	0.355829	1542.135	1451.977
10/3/1920	1920	0		RCH	ABU	1503.42	1300	0.824212	0.175788	1510.934	1292.486
10/3/1920	1920	0		CHI	MUT	1368.333	1300	0.682986	0.317014	1386.533	1281.8
10/3/1920	1920	0		CBD	PTQ	1504.688	1300	0.825267	0.174733	1516.803	1287.885

Home and Away Team Elo Rating Differential vs. Score Differential

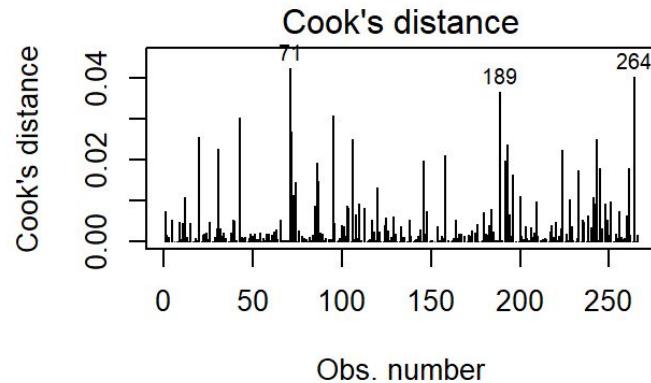
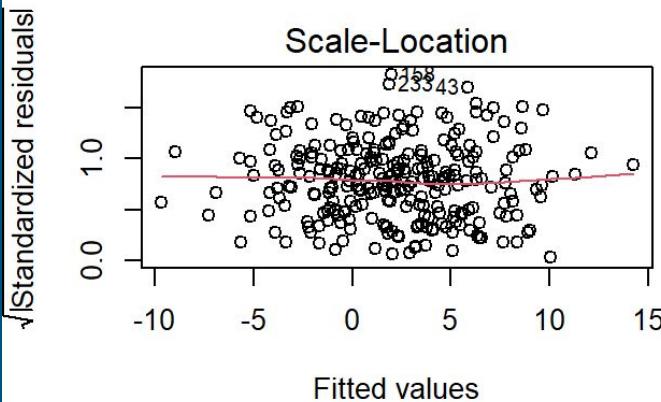
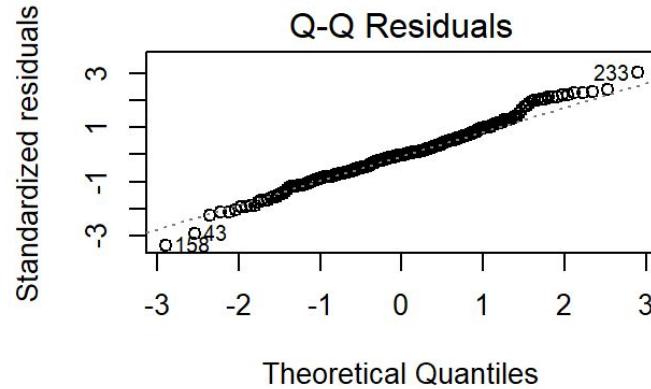
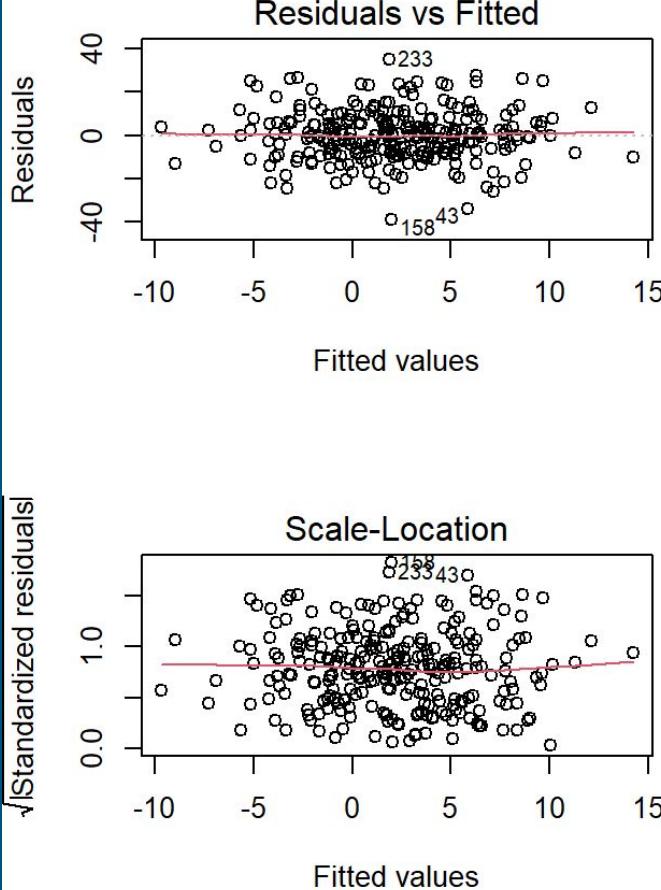


Fitting the Model

$$\text{Score Differential} = \beta_0 + \beta_1(\text{QB-Adjusted Elo Rating}) + \epsilon$$

where: - β_0 is the intercept, - β_1 is the coefficient for the QB-Adjusted Elo Rating, - ϵ represents the error term.

```
model <- lm(score.diff ~ elo.adj.diff, data = nfl.clean)
```



```
##  
## Call:  
## lm(formula = score.diff ~ elo.adj.diff, data = nfl.clean)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -38.971  -7.617  -0.172   6.460  35.138  
##  
## Coefficients:  
##                 Estimate Std. Error t value Pr(>|t|)  
## (Intercept)  2.141523  0.715992  2.991  0.00304 **  
## elo.adj.diff 0.031821  0.005774  5.511 8.48e-08 ***  
## ---  
## Signif. codes:  0 '****' 0.001 '***' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 11.68 on 264 degrees of freedom  
## Multiple R-squared:  0.1032, Adjusted R-squared:  0.09977  
## F-statistic: 30.37 on 1 and 264 DF,  p-value: 8.481e-08
```

Main Takeaways

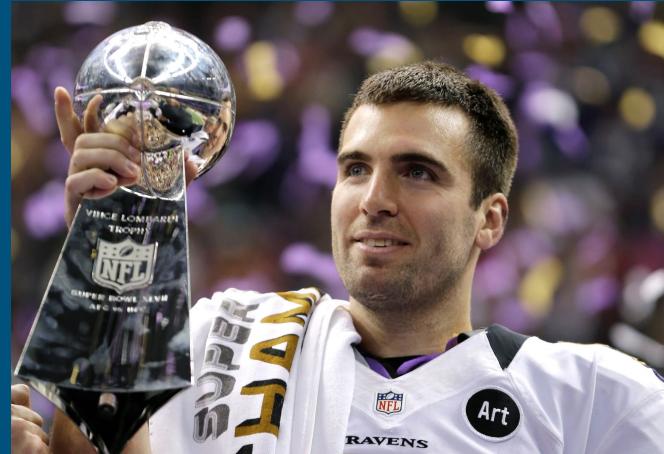
- If our home and away team both have the exact same Elo rating, then our model (specifically our intercept coefficient) tells us that the home team will still score 2.141 more points than the away team.
- Looking at a 95% confidence interval....

```
##              2.5 %    97.5 %
## (Intercept) 0.7317418 3.551304
```

Conclusion

Conclusion

- Home field advantage very much so exists and is quantifiable
- Home and Away Quarterback performance is not statistically different
- Home Teams score an estimated 2.14 more points than an Away Team they play of the same caliber



References

<https://nflreadr.nflyverse.com/>

<https://fivethirtyeight.com/methodology/how-our-nfl-predictions-work/>

[https://www.thelines.com/betting/nfl/epa/#:~:text=Expected%20Points%20Added%20\(EPA\)%2C,juxtaposed%20to%20the%20end%20result.](https://www.thelines.com/betting/nfl/epa/#:~:text=Expected%20Points%20Added%20(EPA)%2C,juxtaposed%20to%20the%20end%20result.)