

FINAL PROJECT: MONTE CARLO SIMULATION

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SEASON OVERVIEW (2017-18 NFL SEASON)

- The 2017 NFL season saw an incredibly entertaining season, with many unique events occurring in both the regular season and playoffs. Being from the Philadelphia area and wholehearted Eagles fan, it intrigues me to analyze the insanity that occurred in 2018. From Wentz having a remarkable year and tearing his ACL vs. the Rams to Foles and Pederson creating magic in the playoffs, the Eagles performed at an elite level during the 2017 NFL season. Comparing a simulation to reality can show just how unique this Super Bowl win really was.

SEASON OVERVIEW (2017-18 NFL SEASON)

Major events during the season:

- 4 Teams went 13-3: Patriots, Steelers, Eagles, and Vikings.
- Cleveland Browns record winless season
- 3 Teams from the same division (NFC South) make the playoffs
- Tom Brady wins MVP award along with being the NFL's leading passer with 4,577 yards
- Tom Brady's Patriots faced off against Nick Foles' Eagles in historic Super Bowl, with a record set for most combined total yards 1,151
 - 1 total punt in the game
 - Most total points by losing team in Super Bowl
 - "Philly Philly" Trick play

NFL SEASON FORMAT

- Regular season
 - 32 Teams
 - 2 conferences (NFC, AFC)
 - 4 divisions per conference (North, South, East & West)
 - 4 teams per division
 - Each team plays 16 regular season games
 - (although in 2021 a 17th game was added)
- Playoffs
 - Wild card round → Divisional Round → Conference Championships → Super Bowl
 - 6 teams per conference make the playoffs, with the divisional winners automatically making the playoffs and the best 2 remaining teams from each conference clinching wild card berths
 - The top 2 seeded teams in each conference get a bye to the divisional round
 - The #1 seed in each conference will play the lowest remaining seed in the divisional round, and the #2 seed will then play the highest remaining seed in the divisional round



PRESEASON ELO RATINGS

- Maximum Elo rating: Patriots with 1685
- Minimum Elo Rating: Browns with 1330
 - Predicted Division Winners based on Elo ratings:
 - AFC East: New England Patriots
 - AFC North: Pittsburgh Steelers
 - AFC South: Indianapolis Colts
 - AFC West: Kansas City Chiefs
 - NFC East: Dallas Cowboys
 - NFC North: Green Bay Packers
 - NFC South: Atlanta Falcons
 - NFC West: Seattle Seahawks

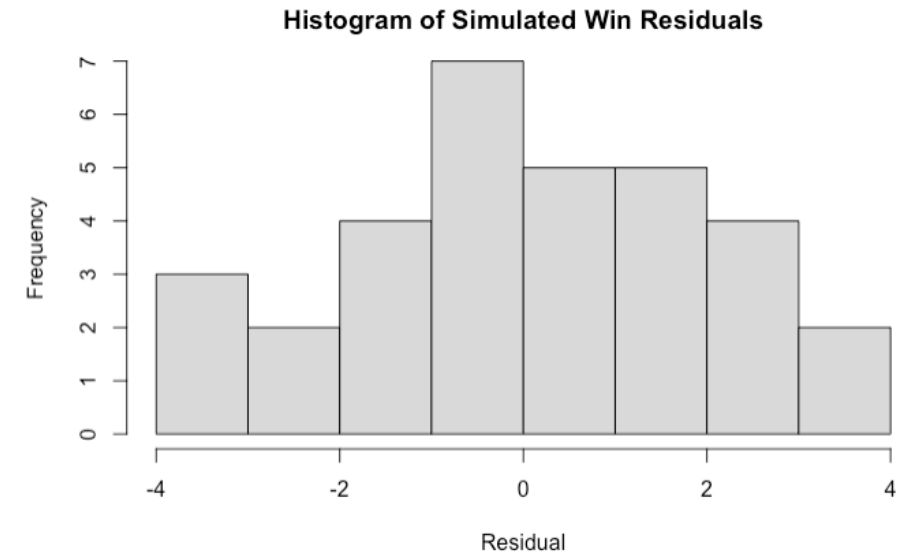
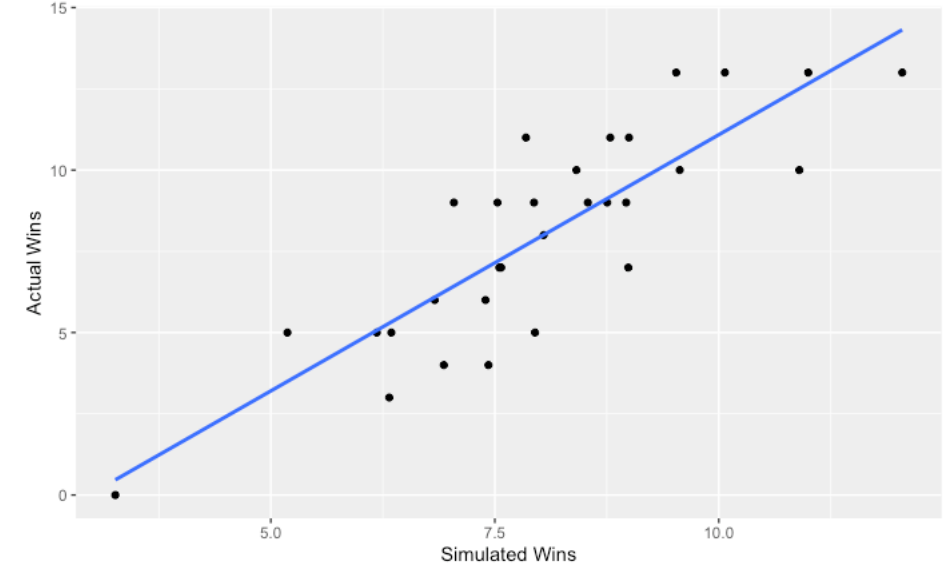
Team	Division	Elo Rating
Buffalo Bills	afc_east	1482.761
Miami Dolphins	afc_east	1498.630
New England Patriots	afc_east	1685.768
New York Jets	afc_east	1448.316
Cincinnati Bengals	afc_north	1516.988
Cleveland Browns	afc_north	1330.259
Pittsburgh Steelers	afc_north	1594.022
Baltimore Ravens	afc_north	1487.549
Houston Texans	afc_south	1495.312
Indianapolis Colts	afc_south	1505.759
Jacksonville Jaguars	afc_south	1371.330
Tennessee Titans	afc_south	1445.601
Denver Broncos	afc_west	1558.180
Kansas City Chiefs	afc_west	1610.841
Los Angeles Chargers	afc_west	1432.787
Las Vegas Raiders	afc_west	1519.583
Dallas Cowboys	nfc_east	1564.689
New York Giants	nfc_east	1520.832
Philadelphia Eagles	nfc_east	1505.394
Washington Redskins	nfc_east	1499.356
Chicago Bears	nfc_north	1378.708
Detroit Lions	nfc_north	1493.625
Green Bay Packers	nfc_north	1580.044
Minnesota Vikings	nfc_north	1501.185
Atlanta Falcons	nfc_south	1607.779
Carolina Panthers	nfc_south	1527.206
New Orleans Saints	nfc_south	1489.225
Tampa Bay Buccaneers	nfc_south	1489.389
Arizona Cardinals	nfc_west	1536.522
Los Angeles Rams	nfc_west	1396.282
San Francisco 49ers	nfc_west	1351.964
Seattle Seahawks	nfc_west	1574.041

SIMULATED REGULAR SEASON RESULTS

Team	Average Wins in Simulation	Actual Wins	Residual
Buffalo Bills	7.5291	9	1.4709
Miami Dolphins	6.8284	6	-0.8284
New England Patriots	12.0467	13	0.9533
New York Jets	6.1833	5	-1.1833
Cincinnati Bengals	7.5710	7	-0.5710
Cleveland Browns	3.2644	0	-3.2644
Pittsburgh Steelers	10.9981	13	2.0019
Baltimore Ravens	8.9662	9	0.0338
Houston Texans	7.4290	4	-3.4290
Indianapolis Colts	6.9312	4	-2.9312
Jacksonville Jaguars	8.4105	10	1.5895
Tennessee Titans	7.9377	9	1.0623
Denver Broncos	7.9484	5	-2.9484
Kansas City Chiefs	10.8984	10	-0.8984
Los Angeles Chargers	7.0436	9	1.9564
Las Vegas Raiders	7.3960	6	-1.3960
Dallas Cowboys	8.7540	9	0.2460
New York Giants	6.3217	3	-3.3217
Philadelphia Eagles	10.0674	13	2.9326
Washington Redskins	7.5497	7	-0.5497
Chicago Bears	5.1855	5	-0.1855
Detroit Lions	8.5377	9	0.4623
Green Bay Packers	8.9895	7	-1.9895
Minnesota Vikings	9.5244	13	3.4756
Atlanta Falcons	9.5638	10	0.4362
Carolina Panthers	8.7884	11	2.2116
New Orleans Saints	8.9970	11	2.0030
Tampa Bay Buccaneers	6.3450	5	-1.3450
Arizona Cardinals	8.0455	8	-0.0455
Los Angeles Rams	7.8474	11	3.1526
San Francisco 49ers	4.2305	6	1.7695
Seattle Seahawks	9.8705	9	-0.8705

COMPARISON OF SIMULATED AND ACTUAL REGULAR SEASONS

- Overall, simulated vs actual wins were highly correlated, with a correlation of about 0.8
 - Strong relationship between simulated vs actual results, therefore the simulation was accurate
- Residuals were close to being uniformly distributed



DISCUSSION OF REGULAR SEASON RESULTS

- Teams that performed very close to expectations:
 - CHI Bears (5-11) with a 0.185 residual for simulated vs actual wins
 - BAL Ravens (9-7) with a 0.033 residual
 - DAL Cowboys (9-7) with a 0.246 residual
 - ATL Falcons (10-6) with a 0.436 residual
- Teams that overperformed according to the simulation:
 - MIN Vikings (13-3) won division and clinched 1st round bye with a 3.476 residual
 - LA Rams (11-5) won division with a 3.153 residual
 - Likely the most surprising playoff appearance/division winner, had the 3rd highest preseason Elo rating in the NFC West
 - PHI Eagles (13-3) won division and clinched 1st round bye with a 2.933 residual
 - JAX Jaguars (10-6) won division with a 1.589 residual

DISCUSSION OF REGULAR SEASON RESULTS

- Teams that underperformed according to the simulation:
 - HOU Texans (4-12) with a -3.429 residual
 - GB Packers (7-9) with a -1.989 residual
 - Missed playoffs as predicted division champs
 - DAL Cowboys (9-7) with a 0.246 residual
 - Missed playoffs as predicted division champs
 - Did not underperform according to residual although
 - NY Giants (3-13) with a -3.322 residual

SIMULATED PLAYOFF RESULTS

- Playoff appearances, division titles, championship game appearances, and championships for all teams in 10,000 iterations of the simulation
 - The team with the highest Elo rating (Patriots) won the Super Bowl in over 50% of the simulations
 - Even the team with the lowest Elo rating (Browns) made the playoffs in 1.23% of the simulations

Team	Playoffs	Divisional Champs	Conference Champs	Super Bowl
Buffalo Bills	5135	483	49	9
Miami Dolphins	3685	230	3	0
New England Patriots	9921	9157	6792	5571
New York Jets	2432	130	2	0
Cincinnati Bengals	5162	720	11	0
Cleveland Browns	123	6	0	0
Pittsburgh Steelers	9710	7202	2259	1384
Baltimore Ravens	7745	2072	229	46
Houston Texans	4954	2007	0	0
Indianapolis Colts	3929	1384	1	0
Jacksonville Jaguars	6870	3767	55	6
Tennessee Titans	5956	2842	23	3
Denver Broncos	5912	1196	4	0
Kansas City Chiefs	9602	7488	1271	623
Los Angeles Chargers	4083	553	128	20
Las Vegas Raiders	4781	763	4	0
Dallas Cowboys	6942	2669	445	76
New York Giants	2246	388	1	0
Philadelphia Eagles	8831	5752	2294	713
Washington Redskins	4563	1191	38	1
Chicago Bears	856	116	0	0
Detroit Lions	6491	2431	192	15
Green Bay Packers	7393	3134	67	4
Minnesota Vikings	8091	4319	1935	644
Atlanta Falcons	8187	4140	1605	438
Carolina Panthers	7020	2586	524	78
New Orleans Saints	7402	2942	942	214
Tampa Bay Buccaneers	2271	332	2	0
Arizona Cardinals	5577	2038	55	3
Los Angeles Rams	5202	1741	184	27
San Francisco 49ers	337	66	1	0
Seattle Seahawks	8591	6155	884	125

ACTUAL PLAYOFF BRACKET

Eagles beat the Patriots 41-33 in Super Bowl LII



COMPARISON OF SIMULATED AND ACTUAL PLAYOFFS

- The Jacksonville Jaguars made a run and upset both the Buffalo Bills and Pittsburgh Steelers, but lost to the Patriots in the AFC Championship
 - Jaguars made an AFC Championship appearance in only 37.67% of the simulations
- The Pittsburgh Steelers (#2 seed in the AFC) lost in the divisional round despite winning the Super Bowl in 13.84% of the simulations (2nd highest probability)
- The Tennessee Titans made the divisional round, despite doing so in only 28.42% of the simulations
- The actual Super Bowl champions (Philadelphia Eagles) won the super bowl in merely 7.13% of the simulations

THREE TEAMS OVERVIEW

- Average Team: Baltimore Ravens
 - Actual record (9-7) vs simulated record (9-7)
 - Missed Playoffs in reality because of tiebreakers, made it 77.45% of the time in the simulated playoffs
- Overachiever: Philadelphia Eagles
 - Actual record (13-3) vs simulated record (10-6)
 - Super Bowl champions, only won the Super Bowl in 7.13% of simulations
- Underachiever: Green Bay Packers
 - Actual record (7-9) vs simulated record (9-7)
 - Missed playoffs, made it 73.93% of the time in the simulated playoffs

RELEVANT STATISTICS

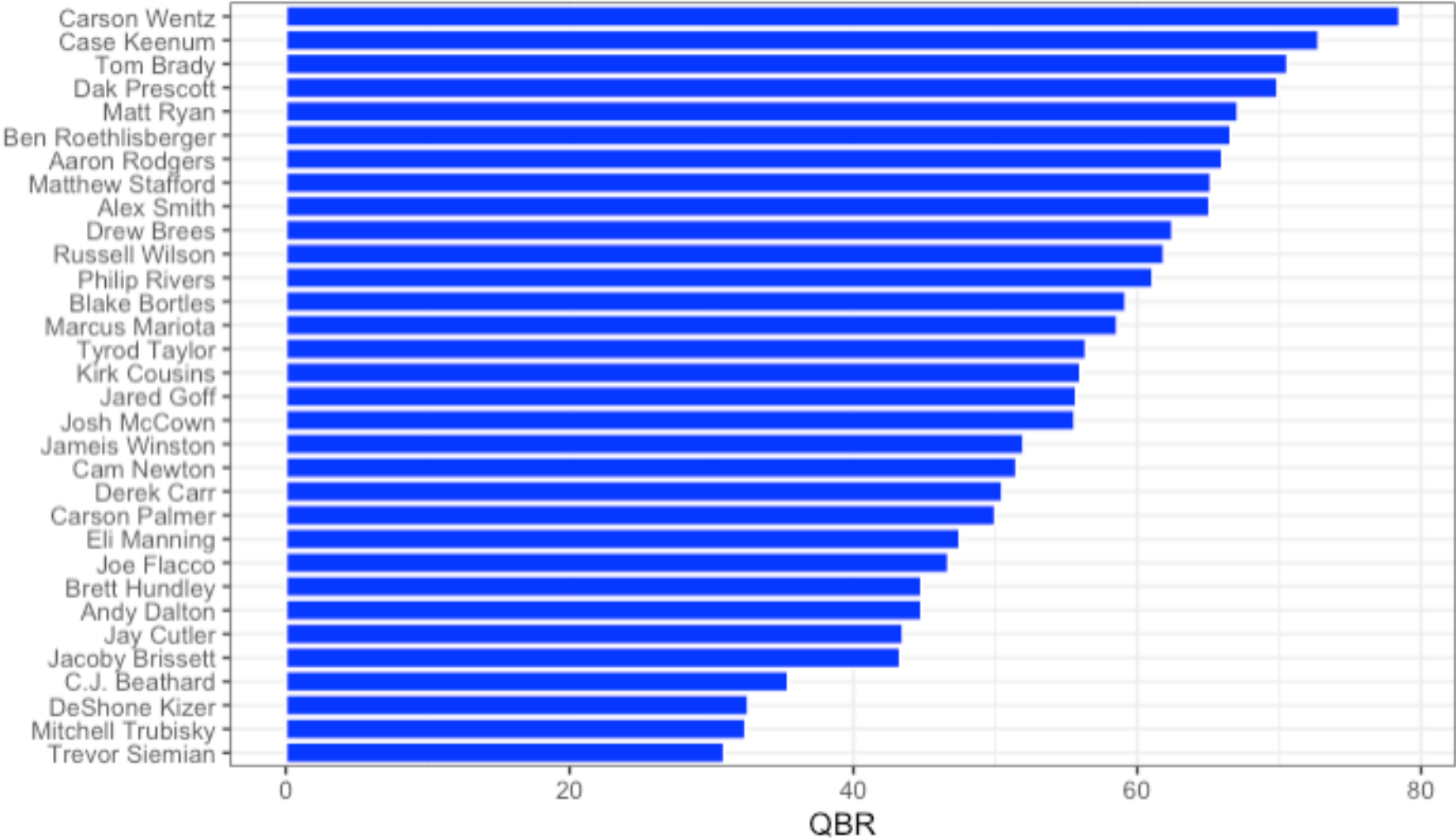
- At this age of the NFL, an elite QB is necessary in order to make any significant playoff run
- Along with QBs, a strong defense is a key factor, hence the phrase “Defense wins championships”
- The strength of these two facets together, determines much of what it takes to have a successful season in the NFL

RELEVANT STATISTICS

- QBR & Defensive Points Allowed Per Game

(Pro-football-reference.com)

2017-18 NFL Quarterback Ratings

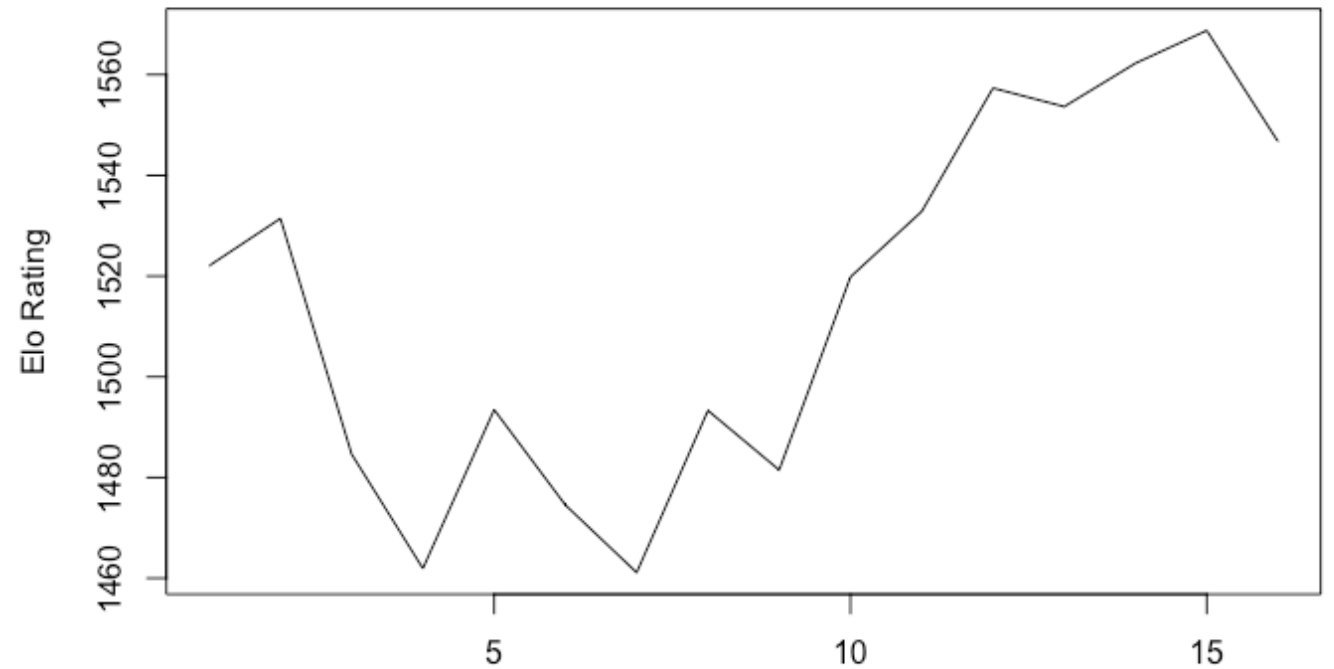


Team	PA /G
Minnesota Vikings	15.8
Jacksonville Jaguars	16.8
Los Angeles Chargers	17.0
Philadelphia Eagles	18.4
New England Patriots	18.5
Baltimore Ravens	18.9
Pittsburgh Steelers	19.3
Atlanta Falcons	19.7
Chicago Bears	20.0
New Orleans Saints	20.4
Carolina Panthers	20.4
Los Angeles Rams	20.6
Dallas Cowboys	20.8
Seattle Seahawks	20.8
Kansas City Chiefs	21.2
Avg Team	21.7
Cincinnati Bengals	21.8
Tennessee Titans	22.3
Buffalo Bills	22.4
Arizona Cardinals	22.6
Oakland Raiders	23.3
Detroit Lions	23.5
New York Jets	23.9
Denver Broncos	23.9
Tampa Bay Buccaneers	23.9
San Francisco 49ers	23.9
Green Bay Packers	24.0
New York Giants	24.3
Washington Redskins	24.3
Miami Dolphins	24.6
Indianapolis Colts	25.3
Cleveland Browns	25.6
Houston Texans	27.3

ANALYSIS OF AVERAGE TEAM: BALTIMORE RAVENS

- Hypothesis of why the Ravens performed similar to expectations

The 2017-18 Baltimore Ravens were at the end of Joe Flacco's glory days, as he posted a QBR of 46.7, 21st in the league. Although the Ravens had a good defense allowing just 18.9 points per game, it was not enough to compensate for Flacco's poor QB play. The Ravens likely showed nothing beyond or worse than their expectations, as Flacco played poorly and the competition in the AFC proved too intense.



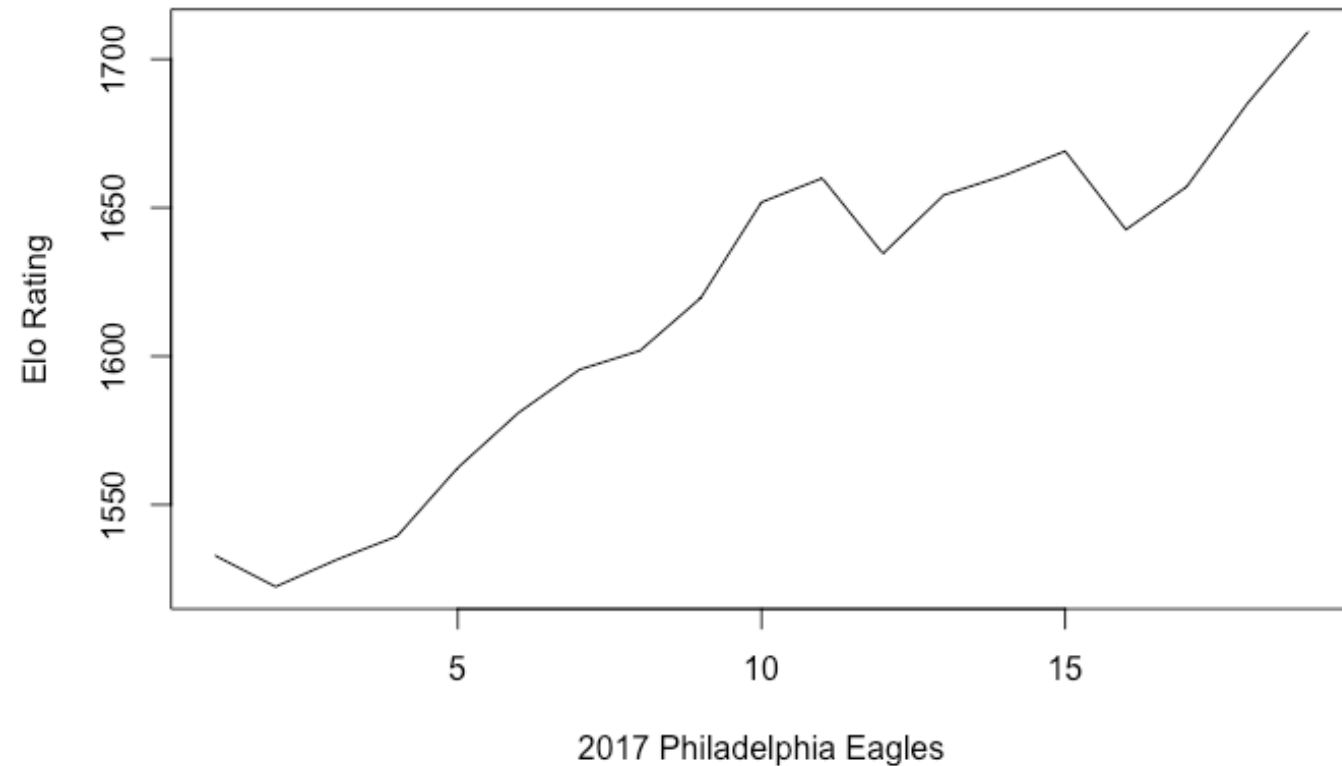
2017 Baltimore Ravens

(Plots from lecture 18 material, not included in markdown file)

ANALYSIS OF OVERACHIEVING TEAM: PHILADELPHIA EAGLES

- Hypothesis of why the Eagles performed better than expectations

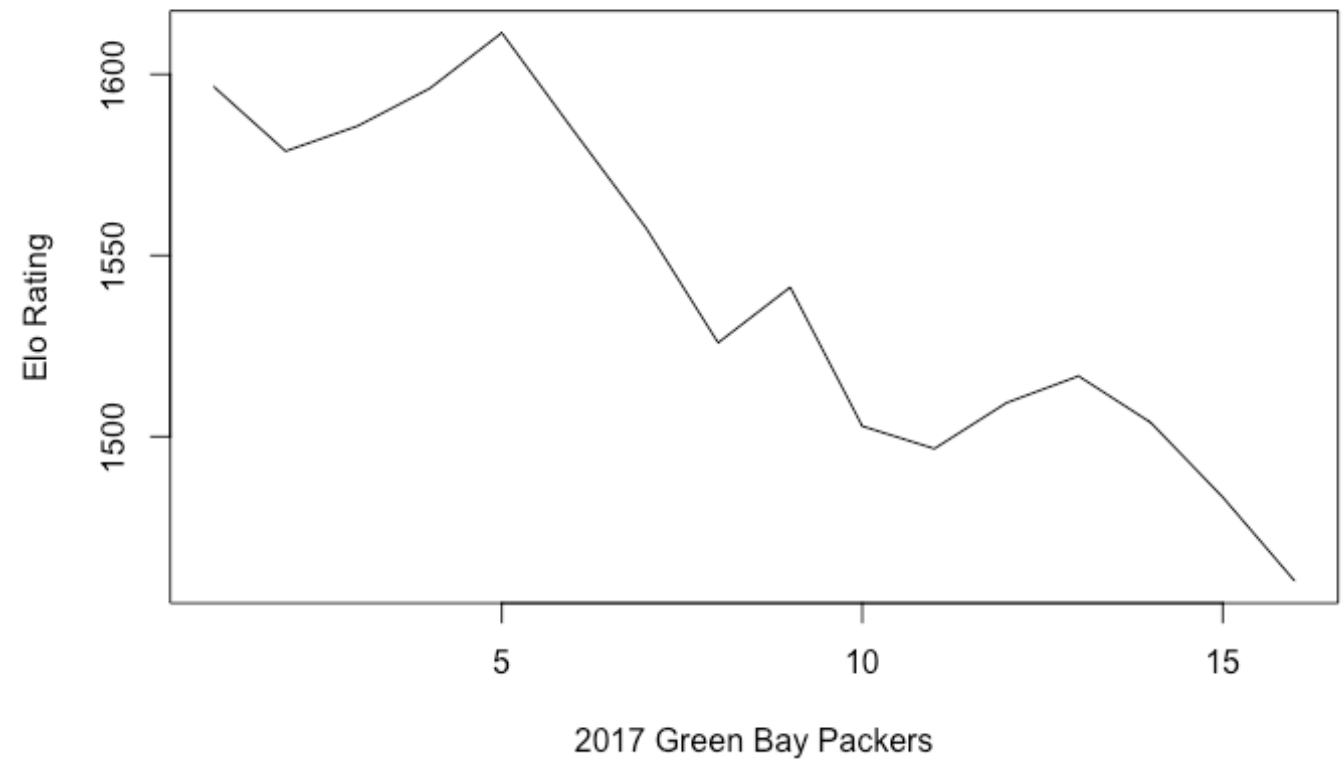
The 2017-18 Philadelphia Eagles overachieved significantly during the regular season and playoffs. Carson Wentz had a breakout year, posting a league high QBR of 78.5 (20th all time for a single-season). The Eagles defense was also top 5 for points allowed per game. These two statistics explain the great performance the team displayed, as an Elite QB and stout defense together allowed Philly to perform at the highest possible levels, above all prior expectations.



ANALYSIS OF UNDERACHIEVING TEAM: GREEN BAY PACKERS

- Hypothesis of why the Packers performed worse than expectations

The 2017-18 Green Bay packers underachieved significantly during the 2017-18 NFL season. Despite Aaron Rodgers having the 7th highest QBR during the season, the Packers fell to 7-9 and missed the playoffs after a 4-1 start to the season. The Packers' defense was what led to their downfall, allowing a 7th worst 24 points per game to opponents. The Packers lousy defense was likely not expected prior to the beginning of the season and led to their underwhelming performance.



CONCLUSIONS/TAKEAWAYS

- Philadelphia had the 3rd highest probability of winning Super Bowl LII according to simulation
 - Were not the simulated NFC East champs (3rd highest pre-season elo in NFC East)
 - Simulation could not account for Nick Foles taking over after Carson Wentz's season-ending knee injury
 - This would have likely lowered the Eagles' Super Bowl probability
- New England was the expected AFC champion (highest probability)
 - Had a ridiculously high chance to win Super Bowl
 - Simulation: 55.71%
 - For comparison, Vegas odds: +275 (per sportsoddshistory.com)
- $\frac{3}{4}$ Of AFC Teams successfully predicted division winners, while none of the NFC Teams were predicted as division winners