Final Project G15

NFL Team Statistics and Championships

Blaine McGraw, Jacob Stoffel, Justice Jones, and Blaine Stockman

1. Introduction:

At the start of the NFL season every team has one goal in mind: to win the Super Bowl. What regular-season factors are the best indicators of whether a team will actually become a champion? A team's win-loss percentage/record is obviously one indicator, but point differential, total points scored, average margin of victory, penalty yards, and turnover percentage, and average margin of victory might reveal more about which teams are truly dominant.

In this project, we will use a Kaggle[1] dataset containing regular-season performance stats for every team, including wins, losses, points scored, points allowed, and point differential. We will combine this with Super Bowl results scraped from Pro-Football-Reference[2], which provides data on each championship game, including the winning and losing teams, their scores, and the MVP. By merging these two datasets, we will be able to see how regular-season performance predicts postseason success. Specifically, we will look at whether teams with higher point differential or stronger margins of victory are more likely to have a higher win percentage, and if penalty yards and turnover percentage hurt a team's odds of winning games. Our final question we will look at regular season statistics from teams and use a logistical regression model to determine what variables best help predict a team will make the playoffs.

2. Data:

This project uses two primary sources of NFL team statistics: Super Bowl outcome data scraped from Pro-Football-Reference[1] and regular-season performance metrics from a Kaggle dataset[2]. These combined data sources allow us to evaluate how team efficiency, scoring margins, and discipline relate to postseason advancement and championship success.

2.1 Kaggle Dataset:

The first dataset we used is from Kaggle[1]. It was a dataset made by Nick Cantalupa. This dataset looked at outcomes of all teams' games during the regular season from 2003-2023 and contained statistics on those games. Some of the statistics it contained were point differential, points scored, points allowed and point differential along with other columns that we think can help determine the outcomes of postseason and Super Bowl success. These metrics give a detailed picture of each team's scoring efficiency and overall performance. Only minimal preprocessing was needed aside from renaming columns for consistency and preparing merge keys.

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/

2.2 Pro Football Reference:

For the other data we used, we scraped it from Pro-Football-Reference[2] looking at Super Bowl winners and losers along with the scores of the game and the game's MVP. With our first dataset, we will create an understanding of what variables can lead to postseason success. This data gave us tangible answers to the winners of the postseason so therefore we could look at their regular seasons to see what factors led to that success. Team names and seasons were cleaned to match the structure of the Kaggle dataset before merging.

2.3 Merged Data:

After scraping data from Pro-Football-Reference[2], we merged them using team names and seasons as key columns, creating two versions of our dataset for analysis. The intersection dataset contains only teams and seasons that appear in both sources, providing a complete and reliable picture of team performance leading to Super Bowl appearances. The union dataset included all available records from both datasets, maximizing the sample size and allowing us to explore broader patterns within regular season games, such as point differential and turnover percentage to see if that correlates to postseason success.

2.4 Core Data Analysis and Relevance:

We used a variety of data analysis techniques, such as correlation metrics with confusion matrices, logistic and linear regression, as well as scoring teams and seasons with a dominance score based on these techniques. To begin, we used all 3 techniques to analyze the last 20 years of NFL teams' data to understand baseline metrics. Then we did the same process to capture the same metrics for exclusively the teams that made the playoffs performed in those games (seperate of their regular season). Lastly, we used a dominance score and comparisons from regular season to post season to better understand what makes a football team successful.

Data Dictionary:

Column	Type	Source	Description
team_name	Text	Pro-Football-Reference	The official name of each NFL team (e.g., Kansas City Chiefs, New England Patriots). Used as a key variable for merging datasets.
season	Numeric (Year)	Pro-Football-Reference	The NFL season year (2003–2023) for which the team's statistics were recorded. Used to align regular season and Super Bowl data.
wins	Numeric	Kaggle	Total number of regular-season wins for each team.
losses	Numeric	Kaggle	Total number of regular-season losses for each team.
win_pct	Numeric (Decimal)	Kaggle	Win percentage for the team, calculated as wins divided by total games played.
points_scored	Numeric	Kaggle	Total number of points scored during the regular season.
points_allowed	Numeric	Kaggle	Total number of points allowed during the regular season.

point_differential	Numeric	Kaggle	The difference between points scored and points allowed; a measure of team dominance.
avg_margin_victory	Numeric	Kaggle	The team's average point margin in games won; an indicator of performance strength.
penalty_yards	Numeric	Kaggle	Total penalty yards accumulated during the season; used to measure discipline and efficiency.
turnover_percentage	Numeric (Decimal)	Kaggle	Percentage of offensive possessions ending in a turnover; used to measure ball control.
playoff_appearance	Text (Yes/No)	Kaggle	Indicates whether the team qualified for the postseason.
postseason_success	Numeric (0–2)	Derived	Indicator of postseason advancement. A value of **0** means the team did not make the playoffs, and **2** indicates the team reached the second round. Used to compare performance across different postseason outcomes.
super_bowl_winner	Text (Yes/No)	Pro-Football-Reference	Identifies whether the team won the Super Bowl that season.
super_bowl_opponent	Text	Pro-Football-Reference	The opposing team in the Super Bowl.
super_bowl_score_winner	Numeric	Pro-Football-Reference	Points scored by the winning team in the Super Bowl.
super_bowl_score_loser	Numeric	Pro-Football-Reference	Points scored by the losing team in the Super Bowl.
super_bowl_mvp	Text	Pro-Football-Reference	Player who received the Super Bowl Most Valuable Player award.
conference	Text	Kaggle	Indicates whether the team competes in the AFC or NFC conference.
division	Text	Kaggle	The team's division (e.g., AFC East, NFC West). Useful for grouping and comparisons.
data_source_link	Text (URL)	Kaggle & Pro-Football-Reference	Reference links to the original datasets: Kaggle NFL Team Data (2003–2023) and Pro-Football-Reference Super Bowl history.

3. Analysis:

3.1 Correlation Between Win/Loss Percentage and Postseason Success:

To evaluate whether regular-season performance correlates with postseason success, we first examined how key team metrics relate to win percentage. We computed a correlation matrix, including win percentage, point differential, average margin of victory, penalty yards, turnover percentage, points scored, and points allowed. The heatmap in Figure 1 shows that point differential and average margin of victory have the strongest positive correlations with win percentage, both above 0.90. This makes intuitive sense because both metrics measure how consistently a team outperformed its opponents over the course of the season. Points scored also showed a strong positive relationship with winning, while points allowed showed a strong negative one, reflecting the basic idea that successful teams score more and allow fewer points. Turnover percentage had a moderate negative correlation with win percentage, which aligns with the fact that giveaways reduce scoring opportunities and often lead to opponent points. Penalty yards displayed only a weak negative correlation, suggesting that while penalties matter situationally, their impact is less consistent across a full season.
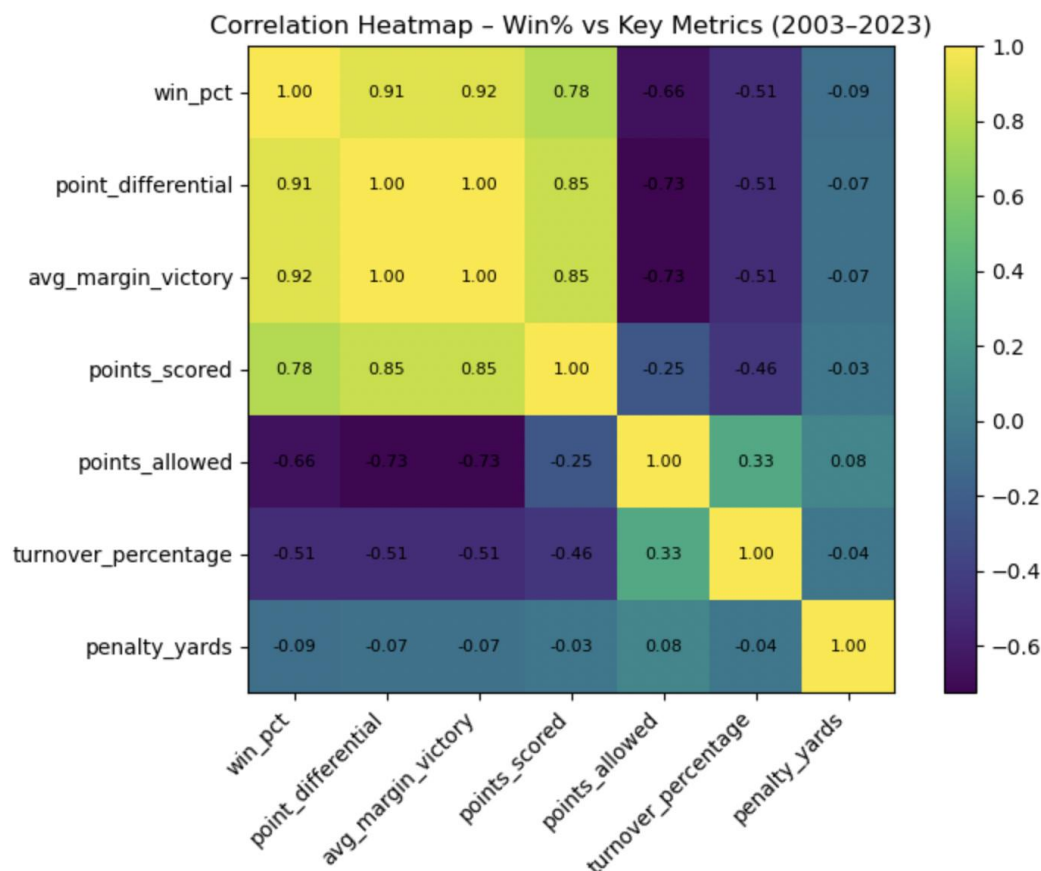
Figure 1. Correlations among key team metrics, with point differential and margin of victory most strongly tied to win percentage.

Because postseason success is often influenced by regular-season performance, we also compare average metrics between teams with different levels of playoff advancement. In our dataset, a value of 0 represents teams that did not make the playoffs, while 2 represents teams that reached the second round, as displayed in Figure 2.

Interestingly, the averages for these two groups looked more similar than expected. Some non-playoff teams even had comparable win percentages and scoring margins to second-round teams. This may seem counterintuitive, but it reflects the narrower performance gap among teams near the playoff cutoff and the fact that a single postseason game can depend heavily on matchups, injuries, or situational factors that regular-season averages cannot fully capture. Penalty yards and turnover percentage were also very close between the two groups, reinforcing the idea that teams in this range tend to have similar efficiency profiles yet can make resilient runs deep into the playoffs.

---

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/

postseason_success	win_pct	point_differential	avg_margin_victory	penalty_yards	turnover_percentage	points_scored	points_allowed
0	0.784	144.333	10.082	853.905	10.171	462.476	318.143
2	0.738	115.810	6.327	862.810	10.967	421.667	305.857

Figure 2. Average regular-season statistics for teams by postseason advancement and failure to appear.

Overall, these results show that regular-season metrics such as point differential, margin of victory, and points scored are strong indicators of how often a team wins and whether it reaches the postseason. However, they are less reliable predictors of what happens once teams get there. Playoff teams tend to have similar statistical profiles, and the competition becomes much more fierce, with far less room for error than in the regular season. As a result, individual matchups, game situations, and small mistakes often have a greater impact than season-long averages, which helps explain why stronger regular-season teams do not always advance further in the playoffs.

3.2 Linear Regression Predicting Win Percentage:

In this question, we wanted to try and quantify how much of a team's winning percentage can be explained by point differential, average margin of victory, penalty yards, and turnover percentage. The primary focus of this question we will view is the overall R^2 and see how much variance in the win percentage is explained. Along with looking at the sign and magnitude of each coefficient. Finally, look at any signs of multicollinearity between point differential and average margin of victory.

```
R² on full-league dataset: 0.841
Intercept: 0.5716388370719391
```

	feature	coefficient
1	avg_margin_victory	0.052408
2	penalty_yards	-0.000034
0	point_differential	-0.001593
3	turnover_percentage	-0.003217

Figure 3. Linear regression results

We found an R^2 of 0.841 in the whole league telling us that our model explains the variation in the target variable very well. With our intercept being 0.5716, which sets a basis for our regression line which we will take a deeper look at when analyzing Figure 4. For average margin of victory, it is the strongest positive predictor for a team's winning percentage. This makes sense as when we look at a team's winning percentage when they are blowing teams out that can show how they are winning more

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/

games. When looking at penalty yards, it has a low negative value. This is telling us that when you commit more penalties it hurts your chances of winning but not very much. With point differential, it also has a small negative impact on win percentage. This is surprising as you would think with a higher differential you would be more likely to have a better winning percentage but as seen here it is quite the opposite of that. Finally, looking at the turnover percentage, it has a clear negative effect which makes sense as more turnover prone teams don't win as many games.
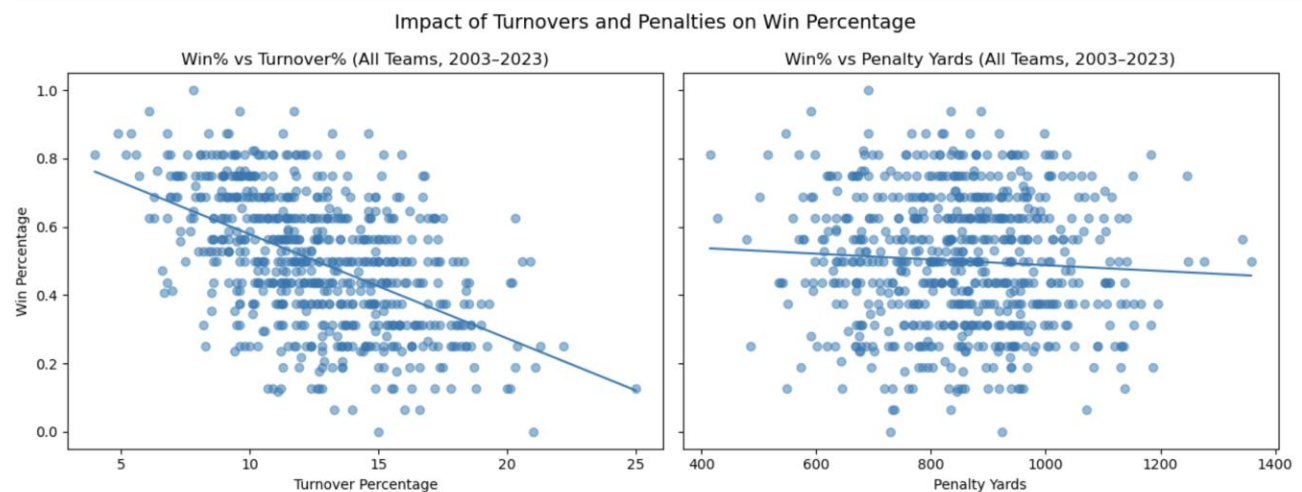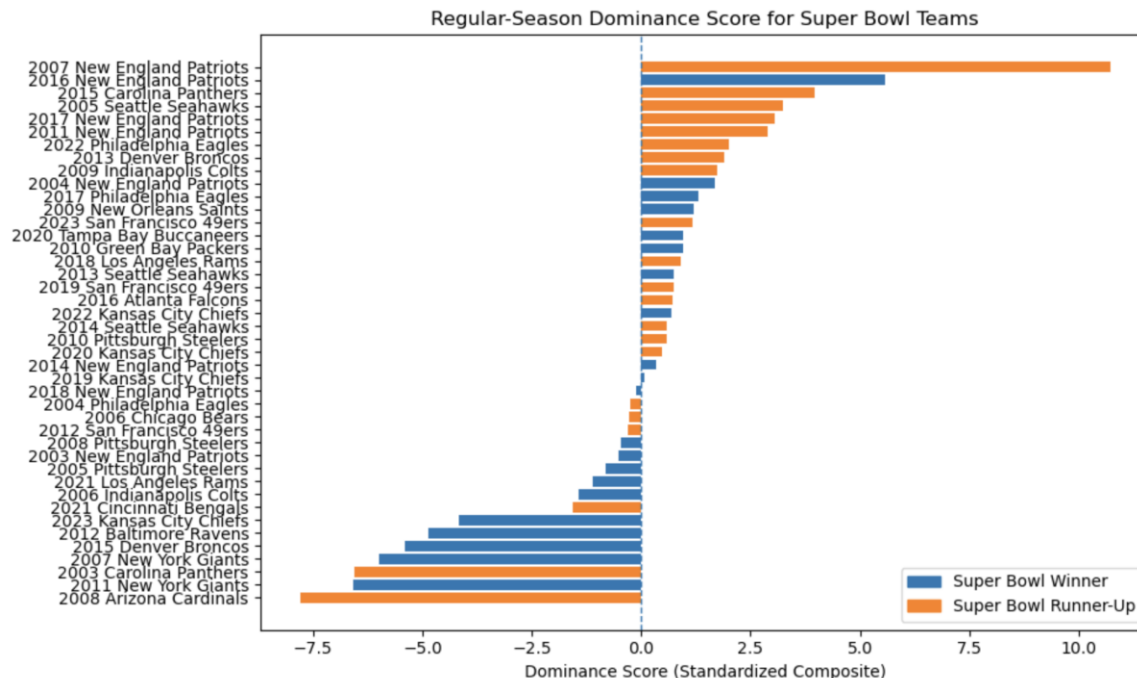

Figure 4. Scatterplot of Win% vs Turnover% and Win% vs Penalty Yards

Figure 4 looks at two separate scatterplots with comparing turnover percentage vs win percentage along with penalty yards vs win percentage. First viewing turnover percentage vs win percentage, we can see this plot reinforces what we said in Figure 3 showing a clear strong negative relationship between the two variables. Along with that it tells us what we kind of already know in the fact the more turnover prone you are, that it will result in you not winning as many games. For the penalty yards vs win percentage, it does not show any real clear pattern though it does barely show a negative relationship. It tells us that penalties are not a major contributor to the reason a team's winning percentage is high.

Figure 4.1 Bar chart of Super Bowl winners' dominance score during regular season play

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/

Regular-Season Dominance Score for Super Bowl Teams

For Figure 4.1 we wanted to compare our dominance score we calculated with Super Bowl winners and losers to if it was always the best team throughout the season winning the Super Bowl. We found that some of the best teams in their respective years did not end up winning the big game. When trying to examine and explain this result the only thing we could really come up with is that you can play great a whole season and dominate every opponent you face, but with the Super Bowl coming down to just one game it can lead to maybe the best overall team not winning the game. We thought to better determine the best team each year you would play in a series so then to crown a champion it doesn't come down to one game where a lesser team can pull off an upset and be the champion.

3.3 Logistic Regression Predicting Playoff Appearance:

We created a logistics regression model to predict whether an NFL team will make the playoffs based on the team's regular-season statistics. Those statistics include win percentage, point differential, average margin of victory, penalty yards, and turnover percentage. After running the model, we found that the model performed at a 0.943 accuracy and an ROC AUC of 0.98, as shown in Figure 6. These percentages indicate that there is significant separation between playoff teams and non-playoff teams. Our logistics regression model in Figure 5 also showed us that win percentage was the most influential feature that predicts postseason success. As a group, we expected to see win percentage be the most influential feature as teams are required to have a higher win percentage to qualify for the playoffs. We also expected to see the turnover percentage have a negative influence as it indicates you are giving the ball away to the other team.

	feature	logit_coefficient
0	win_pct	2.667157
1	point_differential	0.034657
3	penalty_yards	-0.000580
2	avg_margin_victory	-0.042662
4	turnover_percentage	-0.051647

Figure 5. Features of the logistics regression model and each feature's coefficients

```
Class counts (0 = missed, 1 = made playoffs):
made_playoffs
0    233
1    119
Name: count, dtype: int64

Accuracy: 0.943
ROC AUC: 0.980

Confusion matrix:
[[56  2]
 [ 3 27]]

Classification report:
              precision    recall  f1-score   support

           0      0.949     0.966     0.957        58
           1      0.931     0.900     0.915        30

    accuracy                          0.943        88
   macro avg      0.940     0.933     0.936        88
weighted avg      0.943     0.943     0.943        88
```

Figure 6. Confusion matrix and classification report

4. Conclusion:

In this project, we analyzed what variables can lead to NFL success which in this instance is winning the Super Bowl. Those variables included win percentage, point differential, penalty yards, average margin of victory, and turnover percentage. Given the analysis questions in our proposal, we found the following results:

> 1. **Is there a correlation between win/loss percentage and postseason success?**

We found that regular-season metrics such as point differential, average margin of victory, and points scored are unsurprisingly very strongly tied to win percentage, which makes sense because teams that outscore opponents the most almost always end up in playoff contention. However, these same metrics were far less effective at predicting postseason advancement. Once teams reach the playoffs, their statistical profiles become much more similar, and the competition becomes significantly more intense. Single-game matchups, late-season injuries, turnovers, and high-leverage moments have a greater influence than season-long averages. This helps explain why teams with dominant regular seasons do not always advance further, and why postseason success is much more difficult to predict than regular-season performance.

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/

2. **How much of a team's win percentage can be explained by point differential, scoring margins, penalties, and turnovers?**

Our linear regression results showed that regular-season statistics explain a large portion of a team's win percentage, with an R^2 of about 0.84. The average margin of victory was the strongest positive predictor, while turnover percentage also had a clear negative impact on winning. Penalty yards contributed only slightly, and the negative coefficient on point differential was likely due to multicollinearity rather than a true relationship. Overall, a small set of scoring and efficiency metrics accounts for most of the difference in win percentage across teams.

3. **What variables best help predict a team will make the playoffs and how do they interact with each other?**

Our results show that the variables that best predict whether a team will make the playoffs (modeled as having 10+ wins) are the ones that capture **season-long dominance on the scoreboard**, especially point differential and average margin of victory, with win percentage being a byproduct of those same forces. Offensive strength (points scored) and defensive strength (points allowed) are the main drivers of that dominance: playoff-caliber teams both score more and allow fewer points than the rest of the league.

Overall, the efficiency-related stats like turnover percentage and, to a lesser extent, penalty yards can act as "amplifiers" or "drag factors" rather than primary drivers. This means that more turnovers and penalties don't automatically make a bad team, but they steadily erode point differential by killing drives, extending opponent possessions, and giving up hidden yardage. Put together, offense, defense, and efficiency interact to shape a team's point differential and margin of victory, and those dominance metrics in turn strongly determine win percentage and the likelihood that a team reaches the postseason because that is when those metrics are more costly and opponents are better, more efficient with clock time and per drive efficiency.

4.1 Overall Limitations:

When it came to limitations or problems, we ran into during this project they were very minimal. One of the biggest limitations was our data size as it was only from 2003-2023. We believe that if we had a larger sample size of data, we would be able to draw even more conclusions to make our models and predictions even more accurate. There are also many other variables within an NFL season that can't be measured like a team could be 12-5 heading into the playoffs and their star quarterback gets injured and can't lead their team in the playoffs, so injuries is also a key variable that is really hard to quantify. Finally, it is hard to predict a Super Bowl winner as it comes down to one game in each round of the playoffs, there are instances in the playoffs where the better team either doesn't show up to meet the moment or the more inferior team does step up their game to pull off an upset. We can compare this to other sports who do series in their playoffs, and it feels a better team can have an off night and still come back to win the series and a championship.

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/

1 https://www.kaggle.com/
2 https://www.pro-football-reference.com/