EXAMPLE SPORTS PREDICTIFIER FORECAST

Forecasting Super Bowl LII from the Last Four Weeks of the 2017 NFL Regular Season

Super Bowl LII was played on February 4, 2018 in Minneapolis, Minnesota with the Philadelphia Eagles defeating the New England Patriots 41 points to 33. This report will demonstrate the process of developing a forecast from the final four weeks of the regular season that year.

1. Data Inputs

Data inputs are stored using comma-separated value (csv) files, a common data storage method that can be easily edited using Microsoft Excel. The primary data inputs used are tables containing the results of each game a team has played, or score tables. The first field is the round or week number, which exists solely as an index for the table. The second is the opponent played, and the third is the venue, which is a code that references another table describing each game venue, including the latitude and longitude coordinates. After that, there are fields that give the number of scores for and against the team in that game. These fields change depending on the sport. For example, there are many more ways to score in American football than in rugby union, so score tables for American football games contain more fields.

The score table for the final four weeks of the Eagles' season looks like this:

WEEK	OPP	VENUE	TDF	FGF	SFF	PAT1FS	PAT1FA	PAT2FS	PAT2FA	D2CF	TDA	FGA	SFA	PAT1AS	PAT1AA	PAT2AS	PAT2AA	D2CA
14	LAR	LAR	5	3	0	4	4	0	1	0	5	0	0	5	5	0	0	0
15	NYG	NYG	4	2	0	4	4	0	0	0	4	1	0	2	3	0	1	0
16	OAK	PHI	2	2	0	1	1	0	1	0	1	1	0	1	1	0	0	0
17	DAL	PHI	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

The score fields are as follows:

- **TDF:** Touchdowns for
- **FGF:** Field goals for
- **SFF:** Safeties for
- **PAT1FS:** Successful 1-point conversions for
- **PAT1FA:** Attempted 1-point conversions for
- **PAT2FS:** Successful 2-point conversions for
- **PAT2FA:** Attempted 2-point conversions for
- **D2CF:** Defensive 2-point conversions for
- **TDA:** Touchdowns against
- **FGA:** Field goals against
- **SFA:** Safeties against
- **PAT1AS:** Successful 1-point conversions against
- **PAT1AA:** Attempted 1-point conversions against
- **PAT2AS:** Successful 2-point conversions against
- **PAT2AA:** Attempted 2-point conversions against
- **D2CA:** Defensive 2-point conversions against

2. Geographic Weights

In order to account for the effect of travel, statistics are averaged using geographic weights based on a team's results when traveling a similar distance to what they have before. If a team had played in the same location that they are playing in the game of interest, then that past result is given the full weight. If a team had played a game on the exact other side of the world (which won't happen, but would get pretty close if the league schedules an international game in Perth), then those game's statistics wouldn't count towards the average. The formula is as follows:

$$\text{Weight} = 1 - |\text{Distance} - \text{Reference Distance}| / \text{Half of Earth's Circumference}$$

To give an example, Super Bowl LII was played in Minneapolis, which is 986 miles from the Eagles' home in Philadelphia and 1,119 miles from the Patriots' home in Foxborough, Massachusetts. The weights for each of their games are shown in the table below.

Week	Opponent	Venue	Distance from Home	Distance Differential	Proportion of Half of Earth's Circumference	Weight
14	Rams	Los Angeles	2,397 miles	1,411 miles	0.113	0.887
15	Giants	New York	85 miles	901 miles	0.072	0.928
16	Raiders	Philadelphia	0 miles	986 miles	0.079	0.921
17	Cowboys	Philadelphia	0 miles	986 miles	0.079	0.921
Hypothetical		London[1]	3,546 miles	2,560 miles	0.206	0.794
Hypothetical		Perth[2]	11,612 miles	10,626 miles	0.853	0.147

[1] Wembley Stadium
[2] nib Stadium

Week	Opponent	Venue	Distance from Home	Distance Differential	Proportion of Half of Earth's Circumference	Weight
14	Dolphins	Miami	1,124 miles	105 miles	0.008	0.992
15	Steelers	Pittsburgh	469 miles	650 miles	0.052	0.948
16	Bills	Foxborough	0 miles	1,119 miles	0.090	0.910
17	Jets	Foxborough	0 miles	1,119 miles	0.090	0.910
Hypothetical		London	3,292 miles	2,173 miles	0.175	0.825
Hypothetical		Perth	11,631 miles	10,512 miles	0.844	0.156

3. Calculating Opponent and Residual Statistics

The forecasts from the predictifier models are not driven by how teams have done overall, but how they have done relative to their opponents' average scores (the residual scores), so those must be calculated. This is done for each opponent in the team's score table, using geographic weights that were discussed in the previous section.

The Eagle's Week 14 opponent was the Los Angeles Rams, who averaged 3.7 touchdowns for and 3.1 touchdowns against in their final four games of the regular season. While playing them in Week 14, the Eagles scored 5 touchdowns and gave up 5, meaning that their residual touchdowns for in that game would be 5 – 3.1 = 1.9 and their residual touchdowns against would be 5 – 3.7 = 1.3. A table showing the calculation of the Eagles' residual touchdowns for and against is shown below.

Week	Opponent	TD For	Opponent's Average TD Against	Residual TD For	TD Against	Opponent's Average TD For	Residual TD Against
14	Rams	5	3.1	1.9	5	3.7	1.3
15	Giants	4	2.7	1.3	4	1.8	2.2
16	Raiders	2	2.0	0.0	1	1.5	-0.5
17	Cowboys	0	1.5	-1.5	1	1.5	-0.5

The average residual statistics are then calculated using the weights derived in the table in Section 2:

$$\text{Avg. Residual TD For} = \frac{0.887 \times 1.9 + 0.928 \times 1.3 + 0.921 \times 0.0 + 0.921 \times -1.5}{0.887 + 0.928 + 0.921 + 0.921} = \frac{1.51}{3.657} = 0.4$$

$$\text{Avg. Residual TD Against} = \frac{0.887 \times 1.3 + 0.928 \times 2.2 + 0.921 \times -0.5 + 0.921 \times -0.5}{0.887 + 0.928 + 0.921 + 0.921} = \frac{2.27}{3.657} = 0.6$$

Here is the same table showing the same calculation for the Patriots:

Week	Opponent	TD For	Opponent's Average TD Against	Residual TD For	TD Against	Opponent's Average TD For	Residual TD Against
14	Dolphins	2	2.2	-0.2	3	1.8	1.2
15	Steelers	3	1.2	1.8	3	3.7	-0.7
16	Bills	4	2.0	2.0	1	1.8	-0.8
17	Jets	3	2.7	0.3	0	0.7	-0.7

The Patriots' average residual touchdowns for and against would then be:

$$\text{Avg. Residual TD For} = \frac{0.992 \times -0.2 + 0.948 \times 1.8 + 0.910 \times 2.0 + 0.910 \times 0.3}{0.992 + 0.948 + 0.910 + 0.910} = \frac{3.601}{3.760} = 1.0$$

$$\text{Avg. Residual TD Against} = \frac{0.992 \times 1.2 + 0.948 \times -0.7 + 0.910 \times -0.8 + 0.910 \times -0.7}{0.992 + 0.948 + 0.910 + 0.910} = -\frac{0.838}{3.760}$$

$$= -0.2$$

4. Calculating Expected Scores

The average residual statistics are then added to the opponent's complementary average statistics (using the geographic weights) to get the expected number of scores. Over the last four weeks of the regular season, the Eagles averaged 2.7 touchdowns for and 2.7 against, whereas the Patriots averaged 3.0 touchdowns for and 1.8 against. In order to get the expected number of touchdowns that the Eagles would score in the Super Bowl, their average residual touchdowns for (0.4) are added to the Patriots' average touchdowns against (1.8). This is then averaged with the sum of the Patriots' average residual touchdowns against (-0.2) and the Eagles' average touchdowns for (2.7), allowing for contribution of the residual performances of both the Eagles' offense and the Patriots' defense. Therefore, the expected number of touchdowns the Eagles would score would be:

$$\frac{0.4 + 1.8 - 0.2 + 2.7}{2} = \frac{2.2 + 2.5}{2} = \frac{4.7}{2} = 2.35$$

Similarly, the number of touchdowns the Patriots would be expected to score would be:

$$\frac{1.0 + 2.7 + 0.6 + 3.0}{2} = \frac{3.7 + 3.6}{2} = \frac{7.3}{2} = 3.65$$

When games are simulated, these values are input into pseudorandom number generators following a Poisson distribution. A table of the chance of each team scoring a given number of touchdowns given these expected values is shown below.

Team	0	1	2	3	4	5	6	7+
Eagles	10%	22%	26%	21%	12%	6%	2%	1%
Patriots	3%	9%	17%	21%	19%	14%	9%	8%

A similar calculation is done for the number of field goals and safeties in American football and tries, penalty goals, and drop goals in rugby union. A similar calculation is done for conversions, but with the success rates and not the number of conversions themselves.

5. Simulation

Once the expected number of each type of score is calculated, simulation can begin. Within each simulation of an American football game, the number of touchdowns, field goals, and safeties are simulated using a pseudorandom number generator following a Poisson distribution. The numbers of tries, penalty goals, and drop goals in a rugby union match are simulated in the same way. In American football, for each touchdown scored it is determined whether or not a team will choose to go for a 1-point or a 2-point conversion pseudorandomly based on the percentage of times a team has done so. Then, using the expected success rate, it is pseudorandomly determined whether or not the conversion is successful. The same is done in rugby, but without the choice of how many points to go for as all conversions in rugby union are worth 2 points.

Each game is simulated 5 million times. From these simulations, the percentage of each team winning, as well as characteristics of their distribution of scores are output. The following are the results for Super Bowl LII:

Team	Chance of Winning	Expected Score	5th-Percentile Score	25th-Percentile Score	50th-Percentile Score	75th-Percentile Score	95th-Percentile Score
Eagles	40%	23	6	14	21	30	43
Patriots	60%	27	7	17	26	35	51

In the actual game itself, the Eagles scored 41 points and the Patriots scored 33. Both were higher in their score distributions, with the Eagles' score being just under the 95th percentile and the Patriots' score being at the 70th percentile.

6. Concluding Remarks

Even though the model had the Patriots as favorites, it only gave them a 60% chance of winning, which is pretty close to a coin flip. The proper way to interpret the results is not that the favorite will win, but that if this game were played a hundred times, the Patriots would win about forty. The underdog winning the game does not invalidate the model on its own. Because the model forecasts distributions for scores, one would have to look at the results for many games in order to check if the model is creating valid score distributions. It is important to note that this particular example is based on a small sample size—only a quarter of a season's worth of games.

When one sees the results of a forecast heavily favor an outcome they don't want, they might hope that the forecast is wrong. Fortunately for them, it is wrong, but not for the reasons that they would hope. There's a famous quote about statistical modeling by statistician George Box: "All models are wrong but some are useful." Statistical models attempt to explain reality using a few

predictors, when reality itself is a lot more complicated than that. For example, the only data inputs to this model are past scores and locations of game even though it is common knowledge that a lot more factors affect results. For example, this model in its current form does not contain any information on injuries even though an American football team's starting quarterback going down can be absolutely devastating. There are some things this model does well—an analysis of the last few weeks of the 2018 Super Rugby season found that the expected scores were not significantly biased in predicting the actual scores. However, about half of actual scores fell in the second quartile of their forecast distributions, when only about a quarter should have. Future efforts will be made towards improving the model, but it will never predict outcomes with absolute certainty.