Business Report
Sports Analytics

Cricket Win Prediction

Rajthilak S

1. Business Problem:

BCCI has hired an external analytics consulting firm for data analytics. The major objective of this tie-up is to extract actionable insights from the historical match data and make strategic changes to make India win. The primary objective is to create Machine Learning models that correctly predict a win for the Indian Cricket Team. Once a model is developed, you have to extract actionable insights and recommendations.

Also, below are the details of the next 10 matches India will play. You have to predict the result of the matches and if you are getting a prediction as a Loss then suggest some changes and re-run your model again until you are getting Win as a prediction. You cannot use the same strategy in the entire series, because opponents will get to know your strategy and they can come up with a counterstrategy. Hence for all the below 5 matches, you have to suggest unique strategies to make India win. The suggestions should be in-line with the variables that have been mentioned in the given data set. Do consider the feasibility of the suggestions very carefully as well.

1.1 Test match with England in England. All the matches are day matches. In England, it will be the rainy season at the time to match.

2.2 T20 match with Australia in India. All the matches are Day and Night matches. In India, it will be the winter season at the time to match.
3.2 ODI match with Sri Lanka in India. All the matches are Day and Night matches. In India, it will be the winter season at the time to match.

2. Need of the project and social opportunities:

The requirement is to create a machine learning model that predicts the results of the game which can help develop a strategy to win the games. Once the match is set with the opponent the model should predict the result and come up with actionable strategies. There are many application platforms which use win prediction mostly betting apps and websites. By building a robust model we can suggest this tool to fans for a data-driven team and strategy selection and also to

the cricket board. Since cricket is a popular sport and there is a lot of money invested in it around the world setting them up. Additionally, by organising them the BCCI ought to make money. With the BCCI the recommendations and winning tactics offered by the past games' analysed data played, can be used to train the Indian team to increase their chances of winning and tickets sold to audiences, advertising firms, and other revenue-generating sources will ultimately benefit the BCCI. merchandise promotions, parking fees, etc. The use of sports data analytics is growing quickly every year. New developments in technology, various machine learning models have been developed, and evaluation of these models have provided insight into developing sports strategies to increase winning potential

3. Exploratory Data Analysis:

	Game_number	Result	Avg_team_Age	Match_light_type	Match_format	Bowlers_in_team	Wicket_keeper_in_team	All_rounder_in_team	First_selection
0	Game_1	Loss	18.0	Day	ODI	3.0	1	3.0	Bowling
1	Game_2	Win	24.0	Day	T20	3.0	1	4.0	Batting
2	Game_3	Loss	24.0	Day and Night	T20	3.0	1	2.0	Bowling
3	Game_4	Win	24.0	NaN	ODI	2.0	1	2.0	Bowling
4	Game_5	Loss	24.0	Night	ODI	1.0	1	3.0	Bowling
...	...	...	...	...	...	...	...	...	...
2925	Game_2926	Win	30.0	Day	T20	3.0	1	4.0	Batting
2926	Game_2927	Win	30.0	Day	ODI	4.0	1	3.0	Bowling
2927	Game_2928	Win	30.0	Day and Night	ODI	4.0	1	3.0	Bowling
2928	Game_2929	Win	30.0	Day	ODI	4.0	1	3.0	Batting
2929	Game_2930	Win	30.0	Day	ODI	4.0	1	3.0	Batting

2930 rows × 23 columns

Opponent	Season	Audience_number	Offshore	Max_run_scored_1over	Max_wicket_taken_1over	Extra_bowls_bowled	Min_run_given_1over
Srilanka	Summer	9940.0	No	13.0	3	0.0	2
Zimbabwe	Summer	8400.0	No	12.0	1	0.0	0
Zimbabwe	NaN	13146.0	Yes	14.0	4	0.0	0
Kenya	Summer	7357.0	No	15.0	4	0.0	2
Srilanka	Summer	13328.0	No	12.0	4	0.0	0
...	...	...	...	...	...	...	...
South Africa	Summer	33950.0	No	15.0	3	8.0	0
Kenya	Summer	19663.0	No	14.0	4	8.0	2
Pakistan	Rainy	39823.0	Yes	14.0	4	10.0	2
Kenya	Rainy	14007.0	No	14.0	2	20.0	2
Kenya	Rainy	20839.0	No	12.0	4	4.0	5

Min_run_scored_1over	Max_run_given_1over	extra_bowls_opponent	player_highest_run	Players_scored_zero	player_highest_wicket
3.0	6.0	0	54.0	3	1
3.0	6.0	0	69.0	2	1
3.0	6.0	0	69.0	3	1
3.0	6.0	0	73.0	3	1
3.0	6.0	0	80.0	3	1
...	...	...	...	...	...
3.0	6.0	3	50.0	3	2
3.0	6.0	2	52.0	2	1
4.0	10.0	2	80.0	3	2
3.0	6.0	3	98.0	3	1
3.0	6.0	3	62.0	1	1

Fig 1: Data head

4. EDA summary:

- The data has 2930 rows and 23 columns. It has key info like an average team age, Match format etc and the variable to predict is the result.

- There are no duplicate entries

Variables	Description
Game_number	Unique ID for each match
Result	Final result of the match
Avg_team_Age	Average age of the playing 11 players for that match
Match_light_type	type of match: Day, night or day & night
Match_format	Format of the match: T20, ODI or test
Bowlers_in_team	how many full time bowlers has been player in the team
Wicket_keeper_in_team	how many full time wicket keeper has been player in the team
All_rounder_in_team	how many full time all rounder has been player in the team
First_selection	First inning of team: batting or bowling
Opponent	Opponent team in the match
Season	What is the season of the city, where match has been played
Audience_number	Total number of audience in the stadium
Offshore	Match played within country or outside of the country
Max_run_scored_1over	Maximum run scored in 1 over by team
Max_wicket_taken_1over	Maximum wicket taken in 1 over by team
Extra_bowls_bowled	Total number of extras bowled by team
Min_run_given_1over	Minimum run given by the bowler in one over
Min_run_scored_1over	Minimum run scored in 1 over by team
Max_run_given_1over	Maximum run given by the bowler in one over

extra_bowls_opponent	Total number of extras bowled by opponent
player_highest_run	Highest score in the match by one player
Players_scored_zero	Number of player out on zero run
player_highest_wicket	Highest wickets taken by single player in match

Fig 2: Variables & description

	Avg_team_Age	Bowlers_in_team	Wicket_keeper_in_team	All_rounder_in_team	Audience_number	Max_run_scored_1over	Max_wicket_taken_1over
count	2833.000000	2848.000000	2930.0	2890.000000	2.849000e+03	2902.000000	2930.000000
mean	29.242852	2.913624	1.0	2.722491	4.626796e+04	15.199862	2.713993
std	2.264230	1.023907	0.0	1.092699	4.859958e+04	3.661010	1.080623
min	12.000000	1.000000	1.0	1.000000	7.063000e+03	11.000000	1.000000
25%	30.000000	2.000000	1.0	2.000000	2.036300e+04	12.000000	2.000000
50%	30.000000	3.000000	1.0	3.000000	3.434900e+04	14.000000	3.000000
75%	30.000000	4.000000	1.0	4.000000	5.787600e+04	18.000000	4.000000
max	70.000000	5.000000	1.0	4.000000	1.399930e+06	25.000000	4.000000

(8, 15)

Extra_bowls_bowled	Min_run_given_1over	Min_run_scored_1over	Max_run_given_1over	extra_bowls_opponent	player_highest_run	Players_scored_zero
2901.000000	2930.000000	2903.000000	2896.000000	2930.000000	2902.000000	2930.000000
11.252671	1.952560	2.762659	8.669199	4.229693	65.889387	2.730034
7.780829	1.678332	0.705759	5.003525	3.626108	20.331614	0.710708
0.000000	0.000000	1.000000	6.000000	0.000000	30.000000	1.000000
6.000000	0.000000	2.000000	6.000000	2.000000	48.000000	2.000000
10.000000	2.000000	3.000000	6.000000	3.000000	66.000000	3.000000
15.000000	3.000000	3.000000	9.250000	7.000000	84.000000	3.000000
40.000000	6.000000	4.000000	40.000000	18.000000	100.000000	4.000000

(8, 15)

Fig 3: Key statistical parameters

- The key averages and the five-number summary can be inferred from the above figures which tell about the average age of squads selected so far and other key parameters.

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2930 entries, 0 to 2929
Data columns (total 23 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Game_number             2930 non-null   object
 1   Result                  2930 non-null   object
 2   Avg_team_Age            2833 non-null   float64
 3   Match_light_type        2878 non-null   object
 4   Match_format            2860 non-null   object
 5   Bowlers_in_team         2848 non-null   float64
 6   Wicket_keeper_in_team   2930 non-null   int64
 7   All_rounder_in_team     2890 non-null   float64
 8   First_selection         2871 non-null   object
 9   Opponent                2894 non-null   object
 10  Season                  2868 non-null   object
 11  Audience_number         2849 non-null   float64
 12  Offshore                2866 non-null   object
 13  Max_run_scored_1over    2902 non-null   float64
 14  Max_wicket_taken_1over  2930 non-null   int64
 15  Extra_bowls_bowled      2901 non-null   float64
 16  Min_run_given_1over     2930 non-null   int64
 17  Min_run_scored_1over    2903 non-null   float64
 18  Max_run_given_1over     2896 non-null   float64
 19  extra_bowls_opponent    2930 non-null   int64
 20  player_highest_run      2902 non-null   float64
 21  Players_scored_zero     2930 non-null   object
 22  player_highest_wicket   2930 non-null   object
dtypes: float64(9), int64(4), object(10)
memory usage: 526.6+ KB
```

Fig 4: Data types

There are 10 object variable, 13 integer & float variable.

5. Univariate Analysis:

```
unique count of Match_format
['ODI' 'T20' 'Test' '20-20' nan]


unique count of First_selection
['Bowling' 'Batting' 'Bat' nan]


unique count of Players_scored_zero
[3 2 1 4 'Three']

unique count of player_highest_wicket
[1 2 3 4 'Three' 5]
```

Fig 5: Unique count

The data entry is not uniform it has the same data type with different names “T20 and 20-20” are in the same format so that is corrected and maintained uniformly. Similarly “Bat & Batting” and also few integers are mentioned in object form which was corrected.

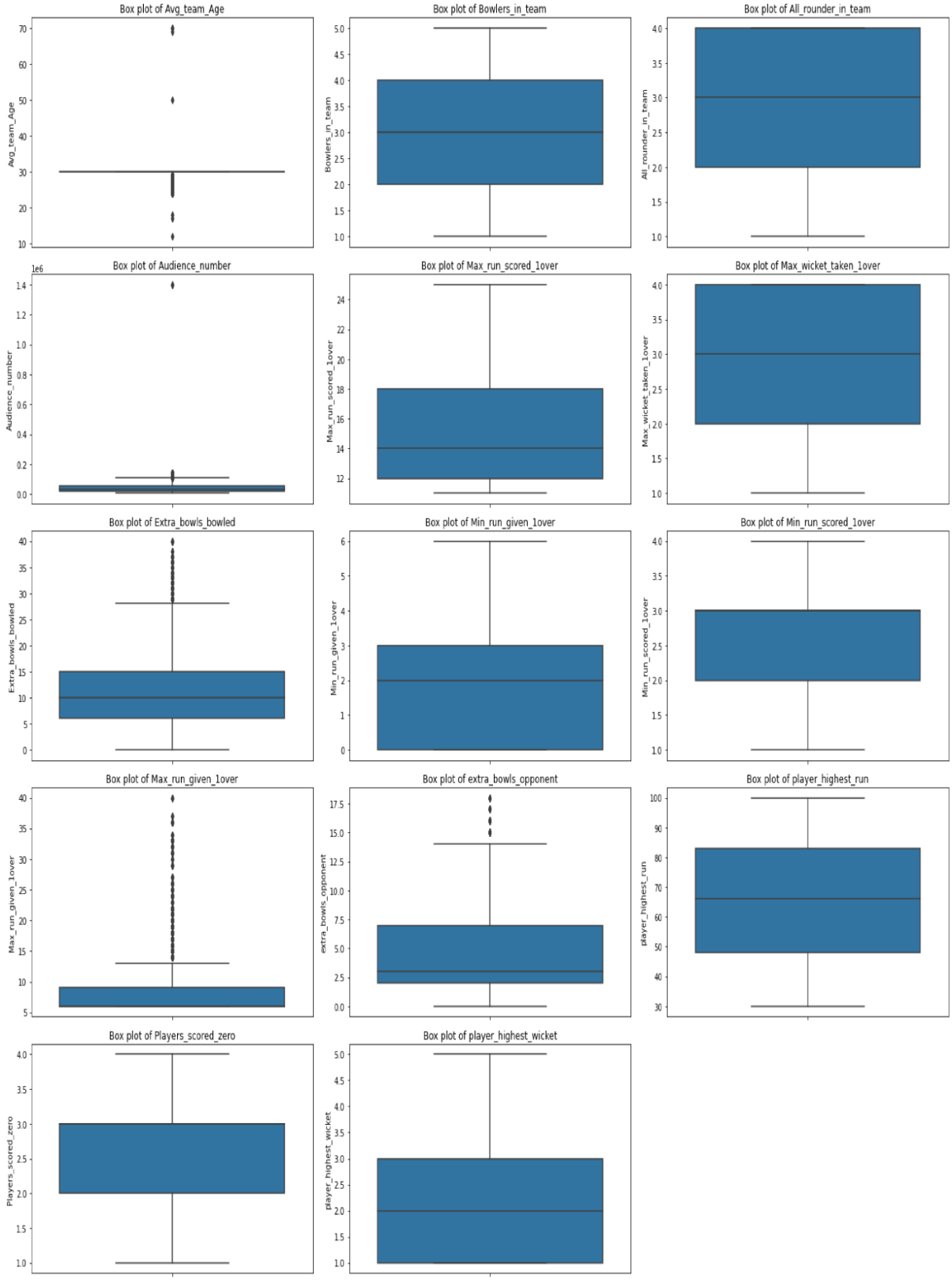


Fig 6: Box plot analysis

Key Inferences:

- Although it has outliers, the variable **avg_team_age** has a mean and median that are near to those of a normal distribution.

- The variable **Bowlers_in_team** has a normal distribution because the mean and median are almost equal, and there are no outliers.

- Variable **All_rounder_in_team** is somewhat left-skewed since the mean and median are different, the 75th percentile and the maximum value are same, and there are no outliers.

- Due to the presence of outliers, the variable **audience_number** is right-skewed and the mean is affected. There are no outliers.

- Variable **Max_run_scored_1over** variable is somewhat right-skewed.

- Outliers are present, and the variable **Extra_bowls_bowled** is right skewed since the mean is higher than the median.

- Outliers are present and the **extra_bowls_opponent** variable is right-skewed. **Player_Highest_Run** has a regularly distributed distribution; there are no outliers.

- **Player_highest_wicket** is a normally distributed variable with equal skewness at the minimum value and 25 percentile.

- Variable **Max_wickets_taken_1over** has the mean is lower than the median and both the 75th percentile and the maximum value are the same.

- Variable **Min_run_given_1over** There are no outliers because is close to the mean and the minimum value and 25 percentile are equal.

- In Variable **Min_run_scored_ 1over** there are no outliers, the 50th and 75th percentiles are equal and has a little left-skewed distribution.

- Variable **Max_run_ given_1_over** is right-skewed, the minimum value, the 25th and 50th percentiles have the same values, and outliers are visible. The

50th and 75th percentiles of the variable Players scored zero are equal, and there are no outliers.

```
Avg_team_Age              5.068403
Bowlers_in_team          -0.296492
All_rounder_in_team      -0.335012
Audience_number          15.782867
Max_run_scored_1over      0.838907
Max_wicket_taken_1over   -0.305597
Extra_bowls_bowled        1.132432
Min_run_given_1over       0.433859
Min_run_scored_1over     -0.568821
Max_run_given_1over       2.692147
extra_bowls_opponent      0.916295
player_highest_run       -0.031472
Players_scored_zero      -0.505491
player_highest_wicket     1.026090
dtype: float64
```

Fig 7: Skewness

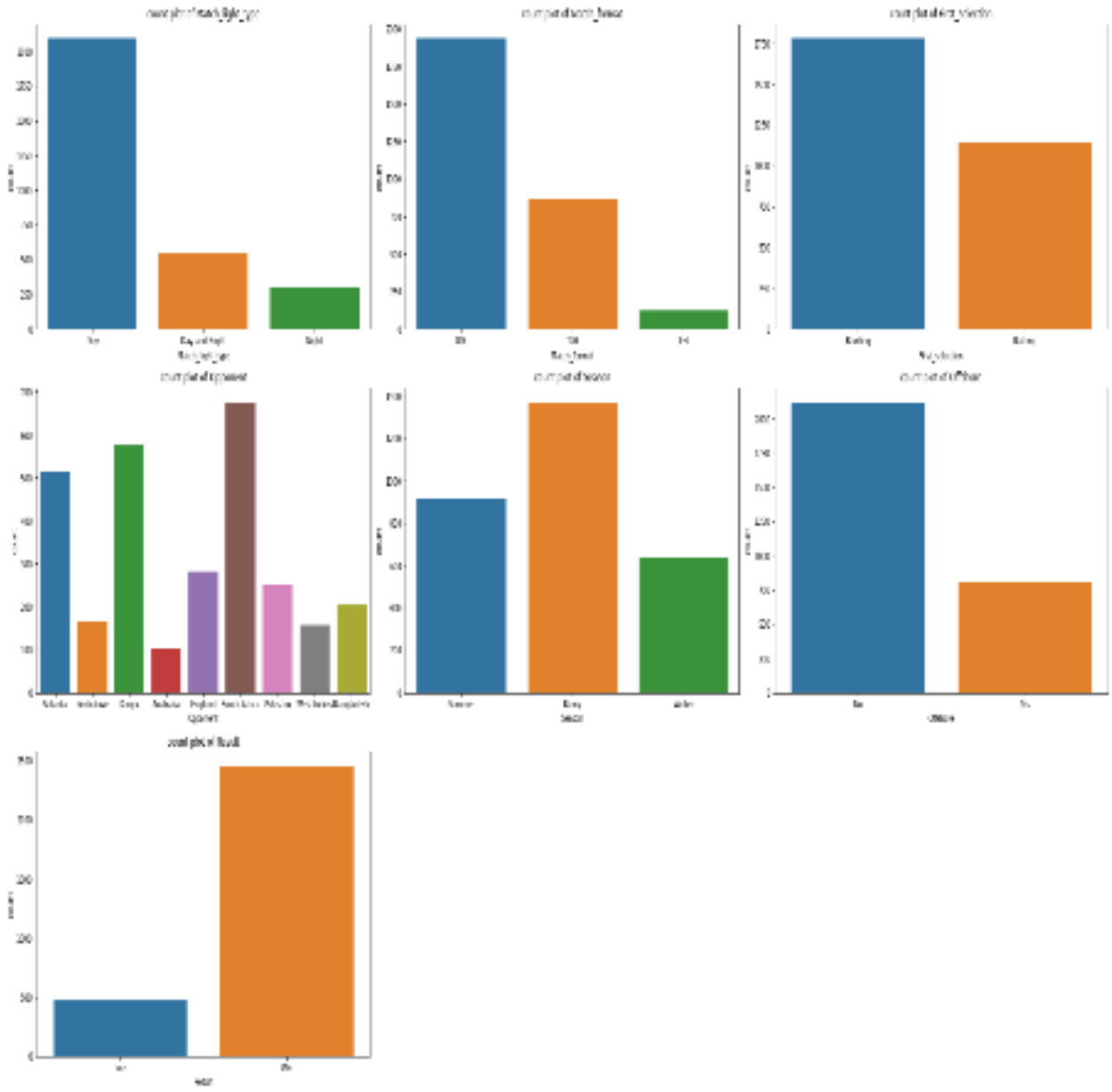


Fig 8: Count Plot for categorical values

Key Inferences:

Match light type: Night - time games have the fewest and most matches played during the day, respectively.

Match format: ODI matches are played the most, while test matches are played the fewest.

First selection: The majority of games were played with the bowling first, and the least number with the batting first.

Opponent: The most matches are played against South Africa, and the least number of matches are played against Australia.

Season: The rainy season sees the most matches played, while the winter months see the fewest.

Offshore: The majority of games are played on the home field, and fewer games are played offshore.

Results: Consequently, out of all the games, the majority of wins outweigh the losses.

6. Bivariate Analysis:

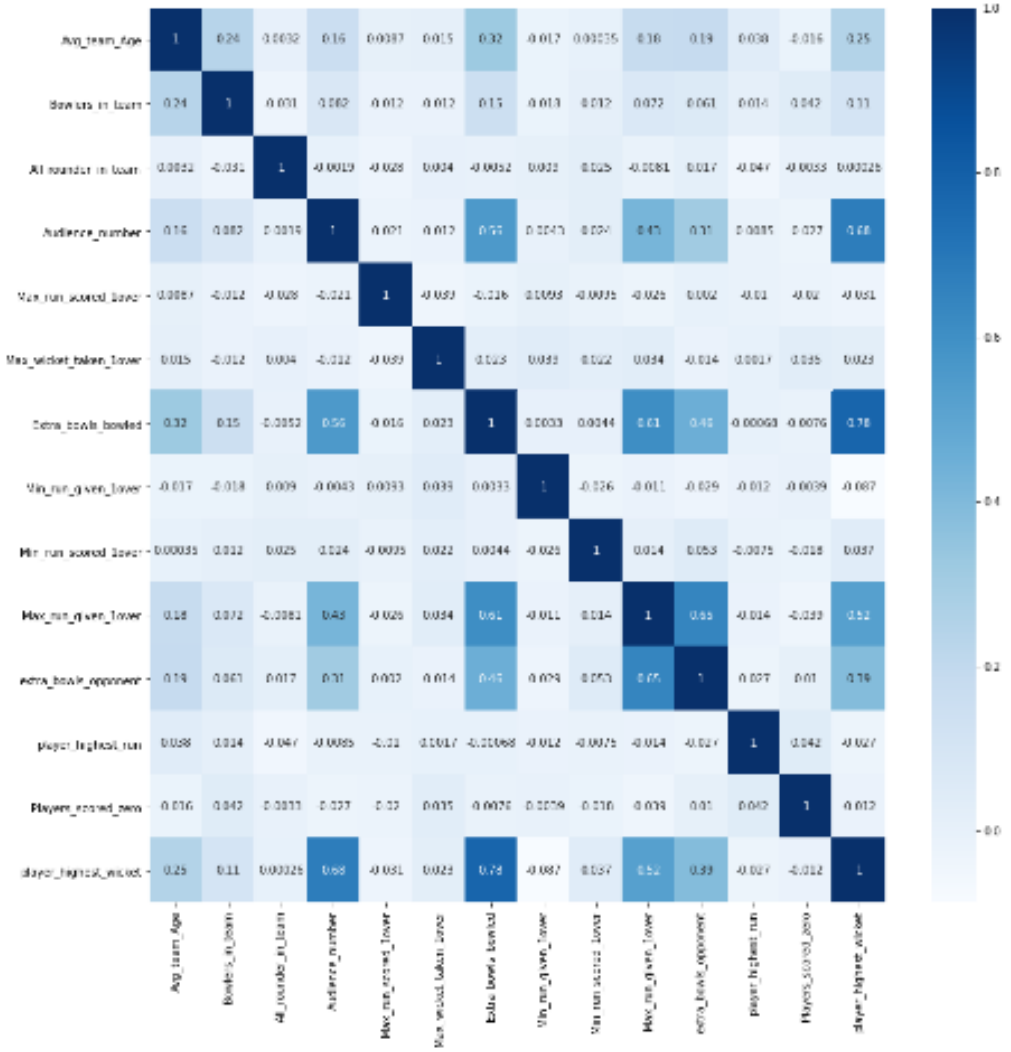


Fig 9: Correlation Plot

- Variables extra bowls bowled and Players_highest_wicket has the highest correlation- 0.78.

- Variables Audience number and Players_highest_wicket has the second highest correlation- 0.68.

- Variables Maximum runs given in one over and extra bowls opponents has correlation of 0.65

- Variables Maximum runs given in one over and extra bowls bowled has correlation of 0.61

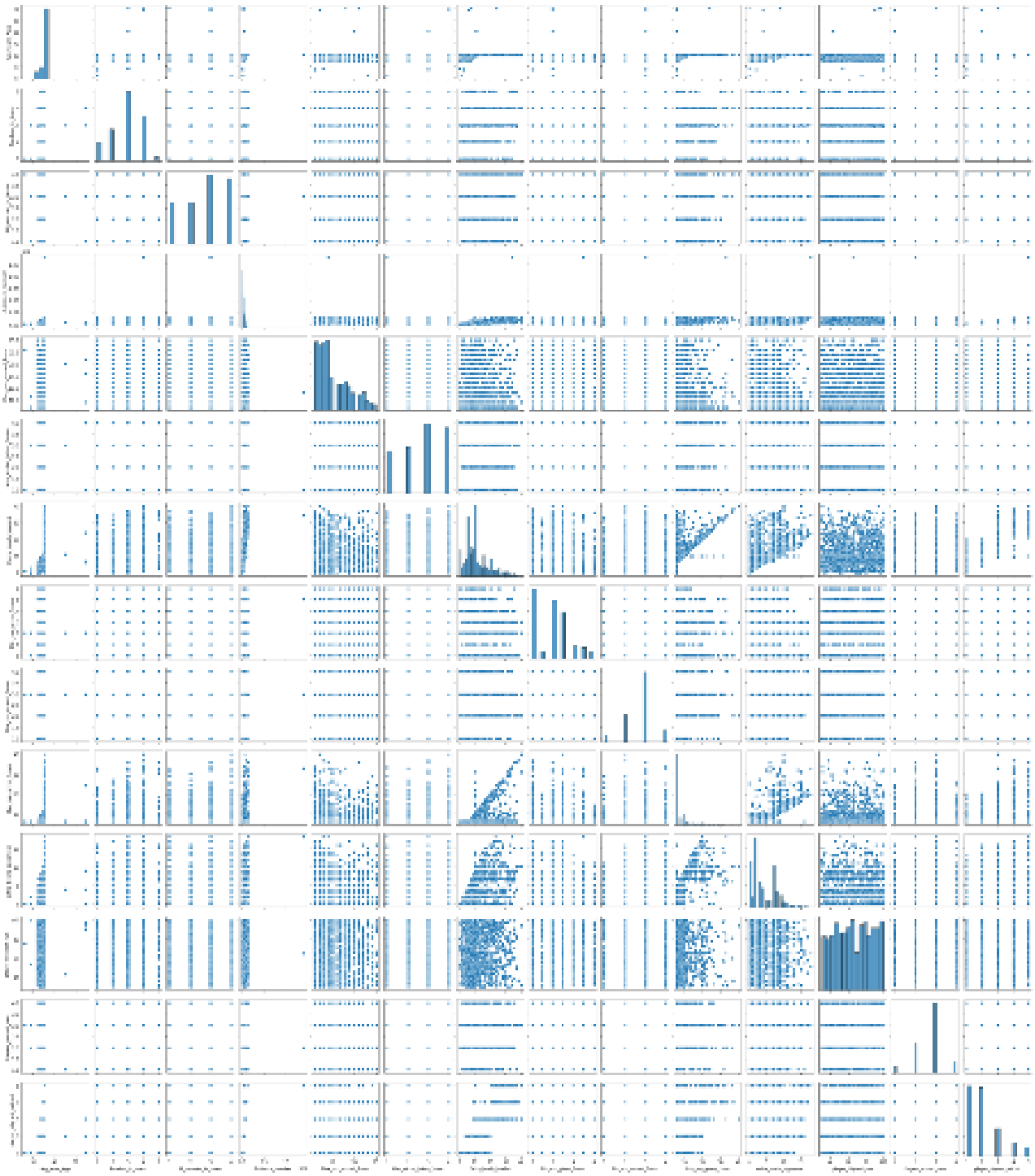


Fig 10: Pair plot

Pair plot gives pairwise bivariate distribution.

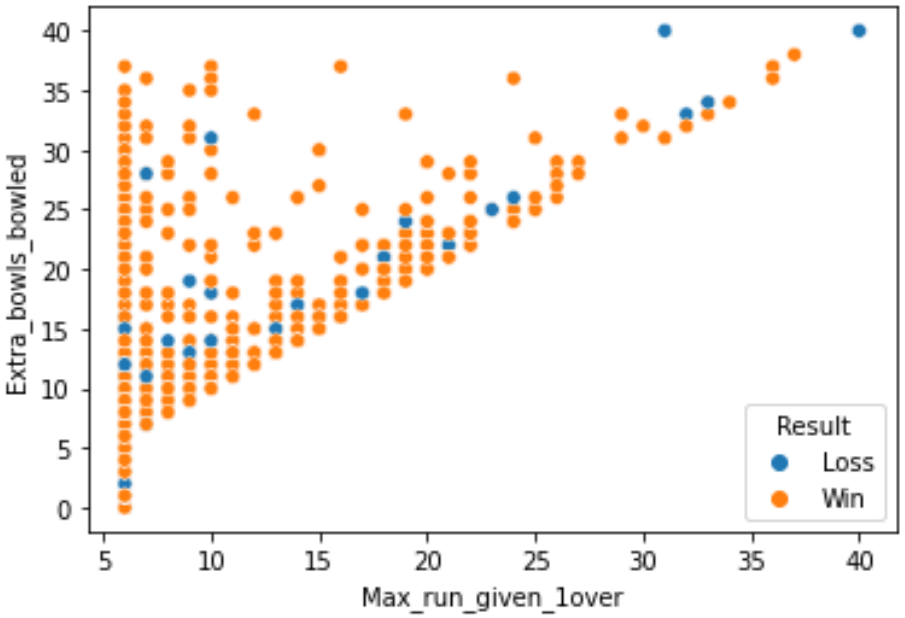


Fig 11: Scatterplot Extra bowls bowled vs Max run given 1over

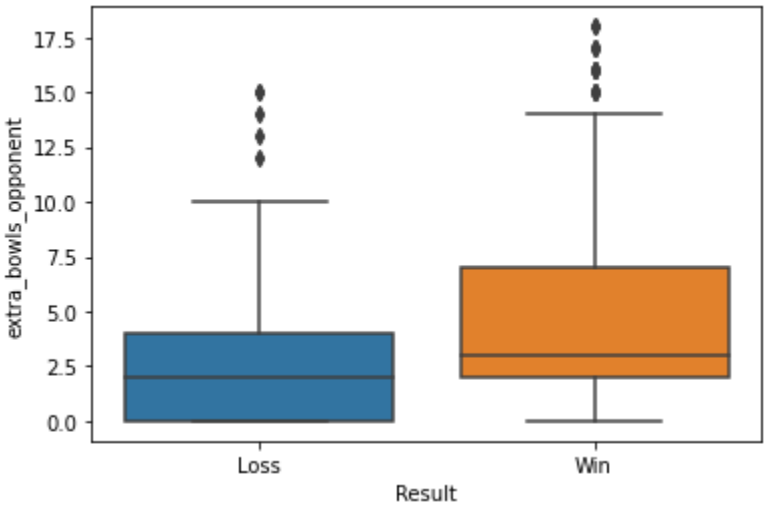


Fig 12: Box plot extra bowls opponent

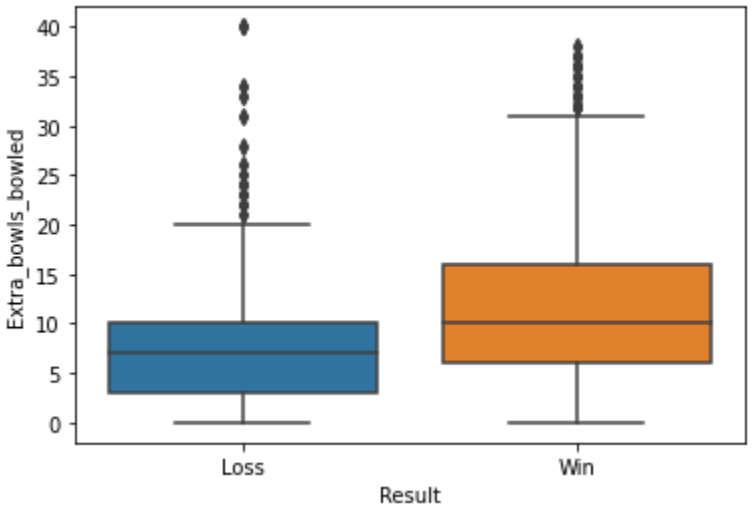
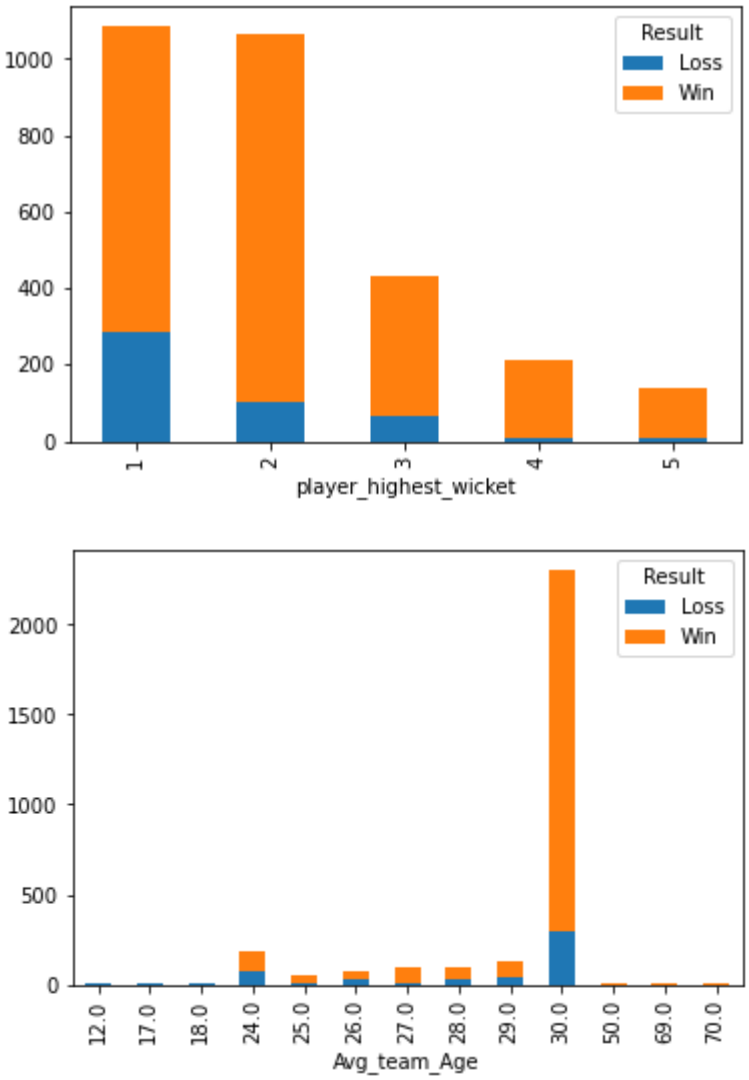
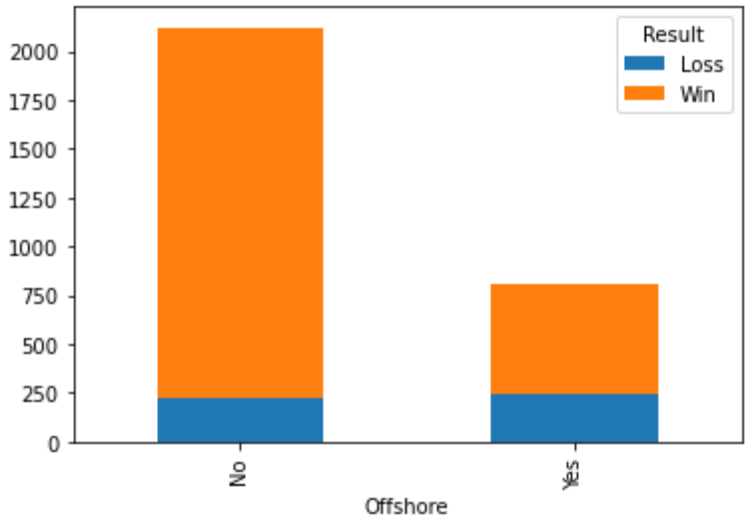
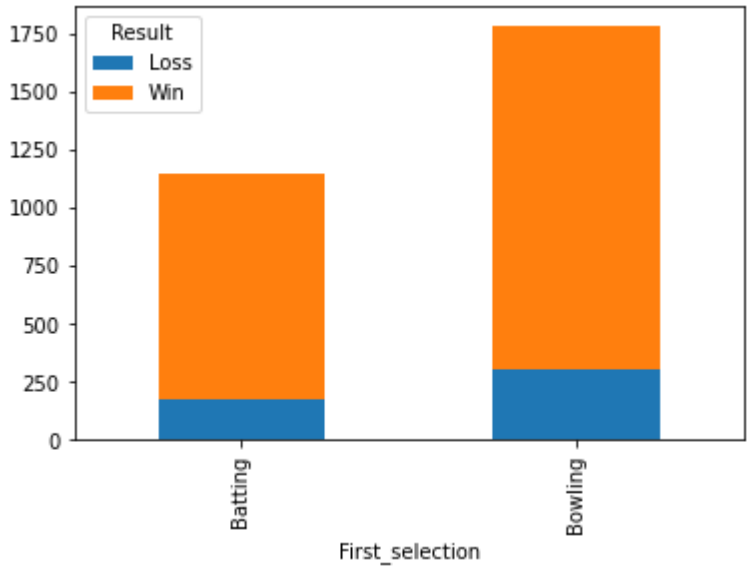
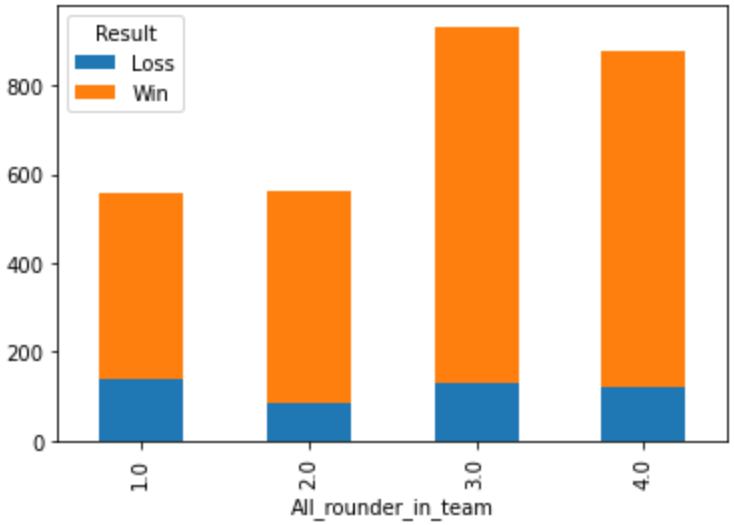


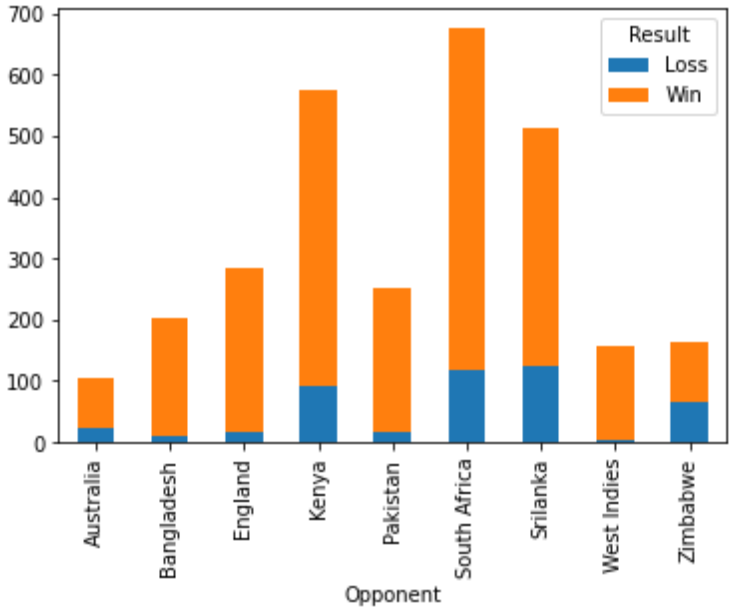
Fig 13: Box plot extra bowls bowled

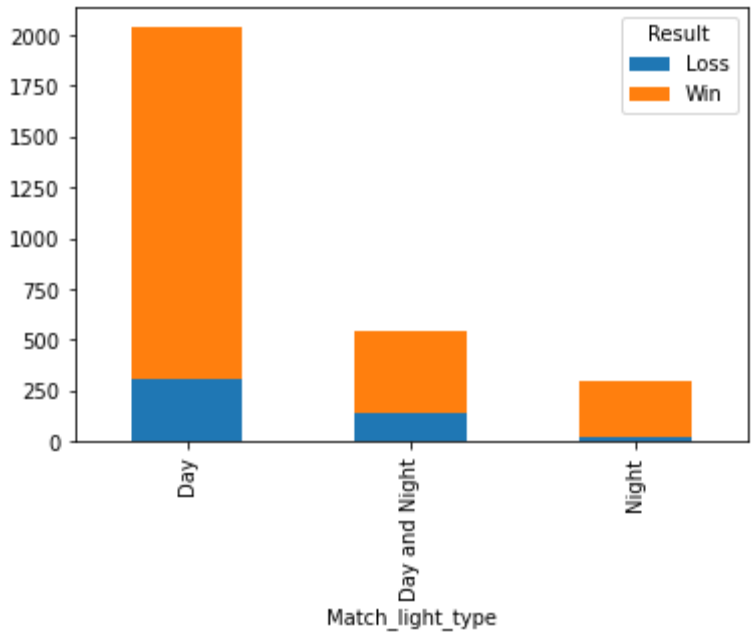



Result
Loss
Win
2000
1750
1500
1250
1000
750
500
250
0
No
Yes
Offshore


Result
Loss
Win
1750
1500
1250
1000
750
500
250
0
Batting
Bowling
First_selection


Result
Loss
Win
800
600
400
200
0
1.0
2.0
3.0
4.0
All_rounder_in_team


Result
Loss
Win
700
600
500
400
300
200
100
0
Australia
Bangladesh
England
Kenya
Pakistan
South Africa
Srilanka
West Indies
Zimbabwe
Opponent


Result
Loss
Win
2000
1750
1500
1250
1000
750
500
250
0
Day
Day and Night
Night
Match_light_type

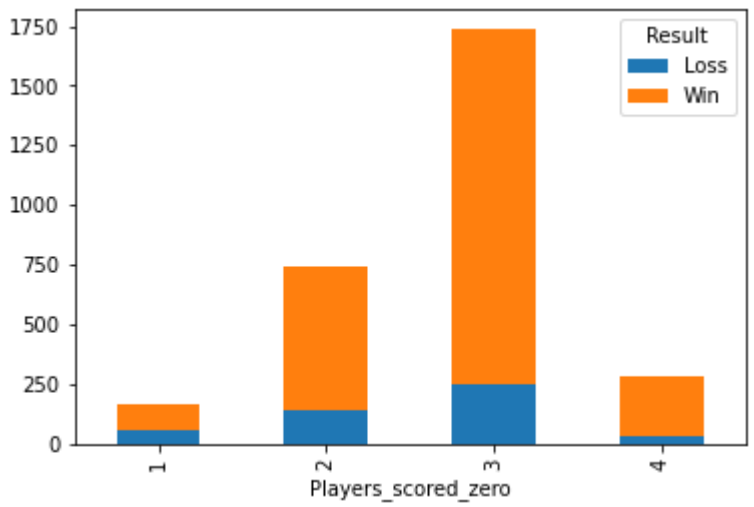


Fig 14 : Bar plots of key variables

Key Inferences:

- Maximum runs scored in an over and additional bowls bowled are correlated linearly. Loss results from the highest value of either variable.
- According to the data set, if the extra bowls of opponents are greater than 16, India will win the game. The median of extra bowls opponents is higher for winning.
- The odds of winning the match increase if the opponents' extra bowls total is higher than 10.
- According to data, India will undoubtedly lose the game if you they bowl 40 extra balls.
- When a single player takes two wickets, there is a good chance of winning the game.
- With a team age of 30 on average, India has the highest win rate.
- When playing at home, India's team exhibits strong performance.
- The majority of games are won when the first bowler is chosen.
- When teams consisting of three to four all-around players play matches, the winning percentage is higher.

- With a high winning percentage, the Indian team is doing well against the West Indies, Bangladesh, England, and Pakistan.

- India's team has a lower winning percentage when playing South Africa, Sri Lanka, Zimbabwe, and Australia.

- Compared to both formats, the Indian team performs well in the one-day international format.

- The winning percentage is higher in the ODI format and lower in the T20 and test formats.

- The Indian team has the highest winning percentage when three players have zero points, and the lowest when one player has zero points.

Business Insights:

- Maximum runs scored in an over and additional bowls bowled have a strong correlation with the outcome of the game.

- The likelihood of losing increases as more runs are scored in an over and as more bowls are bowled.

- The opponent's variable extra bowls can improve the prediction. The likelihood of winning increases as the opponent bowls more.

- Offshore variables also foretell success. If there are more home games played, there are higher winning odds.

- The outcome is also affected by the first selection variable.

- The likelihood of winning is high if bowling is the first choice.

- The performance of each all-around player on the team matters. Three to four all-around players on the team could lead to victory.

7. Data cleaning and pre-processing:

The method used to find missing values is the is **null condition.**

```
Game_number               0
Result                    0
Avg_team_Age             97
Match_light_type         52
Match_format             70
Bowlers_in_team          82
Wicket_keeper_in_team     0
All_rounder_in_team      40
First_selection          59
Opponent                 36
Season                   62
Audience_number          81
Offshore                 64
Max_run_scored_1over     28
Max_wicket_taken_1over    0
Extra_bowls_bowled       29
Min_run_given_1over       0
Min_run_scored_1over     27
Max_run_given_1over      34
extra_bowls_opponent      0
player_highest_run       28
Players_scored_zero       0
player_highest_wicket     0
dtype: int64
```

Fig 15 : Null Values

The figure above depicts the number of null values present in each variable. It is necessary to fill in the null values with a suitable null value treatment.

For numerical variable

Variable Avg_team_Age has 97 missing values and is replaced by the median value as the variable is normally distributed mean and median are same

Variable Bowlers_in_team has 82 missing value and is replaced by the mean value as the variable is slightly left skewed

Variable All_rounder_in_team has 40 missing value and is replaced by the median value as the variable is slightly left skewed

Variable Audience_number has 81 missing value and is replaced by the median value as the variable is right skewed

Variable Max_run_scored_1over has 28 missing values and is replaced by the median value Variable Extra_bowls_bowled has 29 missing value and is replaced by the median value

Variable Min_run_scored1over has 27 missing value and is replaced by the median value

Variable Max_run_given_1over has 34 missing values and is replaced by the median value Variable player_highest_run has 28 missing values and is replaced by the median value

For categorical variable:

Variable Match_light_type has 52 missing values and it is replaced by the mode value the most occurring value.

Variable Match_format has 70 missing values and it is replaced by the mode

Variable First_selection has 59 missing values and it is replaced by the mode

Variable Opponent has 36 missing values and it is replaced by the mode

Variable Season has 62 missing values and it is replaced by the mode

Variable Offshore has 64 missing values and it is replaced by the mode

8. Outlier Treatment:

Outliers increase the variability in your data, which decreases statistical power. Consequently, excluding outliers can cause your results to become statistically significant.

Variables avg_team_age, audience number, extra bowls bowled, maximum run given in one over, extra bowls opponent have outliers

Inter quartile range (IQR) method is used to treat the outliers IQR = Q3 – Q1

Q1 is the first quantile which is 25 percentile

Q3 is the third quantile which is 75 percentile

Lower limit = Q1 – 1.5*IQR

Upper limit = Q3 + 1.5*IQR

Outliers are capped to the upper and lower limit

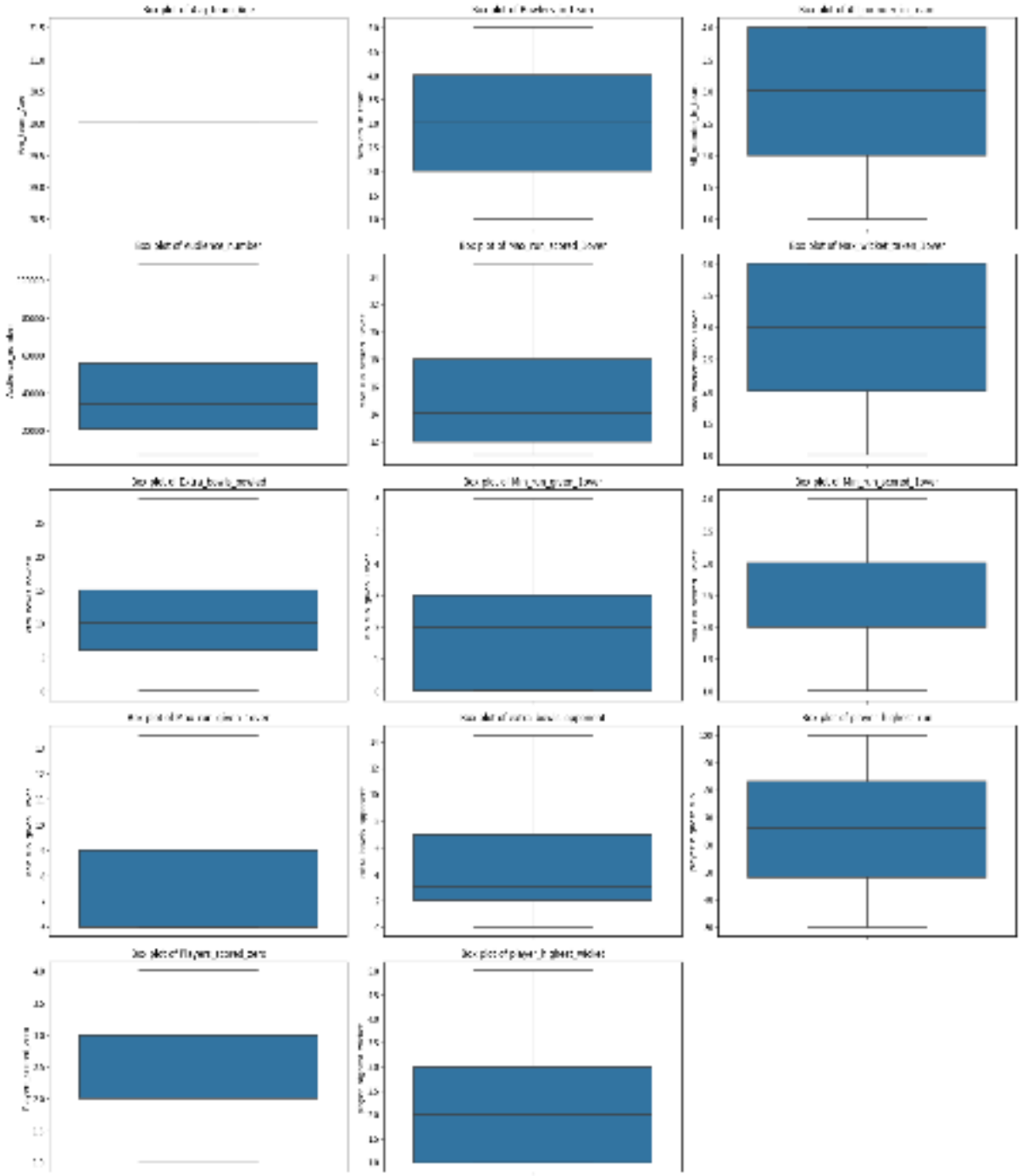


Fig 16: After Outlier treatment Boxplot

9. Variable transformation:

The variable player scored zero and player highest wicket was an object data type it is converted into integer data type.

10. Model building

Data using one hot encoding

	Avg_team_Age	Bowlers_in_team	All_rounder_in_team	Audience_number	Max_run_scored_1over	Max_wicket_taken_1over	Extra_bowls_bowled
0	30.0	3.0	3.0	9940.0	13.0	3.0	0.0
1	30.0	3.0	4.0	8400.0	12.0	1.0	0.0
2	30.0	3.0	2.0	13146.0	14.0	4.0	0.0
3	30.0	2.0	2.0	7357.0	15.0	4.0	0.0
4	30.0	1.0	3.0	13328.0	12.0	4.0	0.0

Min_run_given_1over	Min_run_scored_1over	Max_run_given_1over	extra_bowls_opponent	player_highest_run	Players_scored_zero	player_highest_wicket
2.0	3.0	6.0	0.0	54.0	3.0	1.0
0.0	3.0	6.0	0.0	69.0	2.0	1.0
0.0	3.0	6.0	0.0	69.0	3.0	1.0
2.0	3.0	6.0	0.0	73.0	3.0	1.0
0.0	3.0	6.0	0.0	80.0	3.0	1.0

Result	Match_light_type_Day	Match_light_type_Day and Night	Match_light_type_Night	Match_format_ODI	Match_format_T20	Match_format_Test
0	1	0	0	1	0	0
1	1	0	0	0	1	0
0	0	1	0	0	1	0
1	1	0	0	1	0	0
0	0	0	1	1	0	0

First_selection_Batting	First_selection_Bowling	Opponent_Australia	Opponent_Bangladesh	Opponent_England	Opponent_Kenya	Opponent_Pakistan
0	1	0	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	1	0	0	0	1	0
0	1	0	0	0	0	0

Opponent_South Africa	Opponent_Srilanka	Opponent_West Indies	Opponent_Zimbabwe	Season_Rainy	Season_Summer	Season_Winter	Offshore_No	Offshore_Yes
0	1	0	0	0	1	0	1	0
0	0	0	1	0	1	0	1	0
0	0	0	1	1	0	0	0	1
0	0	0	0	0	1	0	1	0
0	1	0	0	0	1	0	1	0

shape of the data (2930,37)

Data using label encoding

Avg_team_Age	Bowlers_in_team	All_rounder_in_team	Audience_number	Max_run_scored_1over	Max_wicket_taken_1over	Extra_bowls_bowled
30.0	3.0	3.0	9940.0	13.0	3.0	0.0
30.0	3.0	4.0	8400.0	12.0	1.0	0.0
30.0	3.0	2.0	13146.0	14.0	4.0	0.0
30.0	2.0	2.0	7357.0	15.0	4.0	0.0
30.0	1.0	3.0	13328.0	12.0	4.0	0.0

Min_run_given_1over	Min_run_scored_1over	Max_run_given_1over	extra_bowls_opponent	player_highest_run	Players_scored_zero	player_highest_wicket
2.0	3.0	6.0	0.0	54.0	3.0	1.0
0.0	3.0	6.0	0.0	69.0	2.0	1.0
0.0	3.0	6.0	0.0	69.0	3.0	1.0
2.0	3.0	6.0	0.0	73.0	3.0	1.0
0.0	3.0	6.0	0.0	80.0	3.0	1.0

Match_light_type	Match_format	First_selection	Opponent	Season	Offshore
0	0	1	6	1	0
0	1	0	8	1	0
1	1	1	8	0	1
0	0	1	3	1	0
2	0	1	6	1	0

Shape of the data (2930,21)

We split the result with all independent variables

We then split the data into 70 and 30. 70 for training and 30 for testing using train test split

Building various model:

1 .logistic regression using stats model

For logistics regression one hot encoding is done

Logistic regression model internally uses linear equation to find the intercept and coefficient and then it is converted to the classes using activation function. It uses sigmoid curve to calculate the probability depending on the defined threshold. Any value greater than threshold will be considered as 1 and the value less than threshold will be considered as 0. Threshold value is usually 0.5 and it can be adjusted accordingly. It uses log of odds to convert into the probability. Log of odds is the linear equation having intercept and coefficient.

Logit Regression Results

Dep. Variable:	Result	No. Observations:	2930
Model:	Logit	Df Residuals:	2900
Method:	MLE	Df Model:	29
Date:	Tue, 31 May 2022	Pseudo R-squ.:	0.2501
Time:	12:59:23	Log-Likelihood:	-971.21
converged:	True	LL-Null:	-1295.2
Covariance Type:	nonrobust	LLR p-value:	7.077e-118

	coef	std err	z	P>|z|	[0.025	0.975]
Avg_team_Age	-0.1074	0.048	-2.234	0.025	-0.202	-0.013
Bowlers_in_team	-0.0322	0.058	-0.555	0.579	-0.146	0.081
All_rounder_in_team	0.3381	0.054	6.253	0.000	0.232	0.444
Audience_number	2.67e-06	6.77e-06	0.394	0.693	-1.06e-05	1.59e-05
Max_run_scored_1over	0.0241	0.016	1.467	0.142	-0.008	0.056
Max_wicket_taken_1over	0.1737	0.054	3.231	0.001	0.068	0.279
Extra_bowls_bowled	0.0567	0.016	3.560	0.000	0.025	0.088
Min_run_given_1over	0.2330	0.060	3.854	0.000	0.114	0.351
Min_run_scored_1over	0.2621	0.083	3.174	0.002	0.100	0.424
Max_run_given_1over	-0.1418	0.042	-3.416	0.001	-0.223	-0.060
extra_bowls_opponent	0.1444	0.028	5.111	0.000	0.089	0.200
player_highest_run	-0.0007	0.003	-0.254	0.800	-0.006	0.005
Players_scored_zero	0.5206	0.080	6.474	0.000	0.363	0.678
player_highest_wicket	-0.1148	0.185	-0.621	0.535	-0.477	0.247
Match_light_type_Day and Night	-0.6757	0.137	-4.927	0.000	-0.945	-0.407
Match_light_type_Night	0.7951	0.244	3.255	0.001	0.316	1.274
Match_format_T20	0.5067	0.405	1.250	0.211	-0.288	1.301
Match_format_Test	1.3228	1.326	0.997	0.319	-1.277	3.922
First_selection_Bowling	-0.2514	0.122	-2.059	0.040	-0.491	-0.012
Opponent_Bangladesh	2.3718	1.378	1.722	0.085	-0.328	5.072
Opponent_England	2.7566	1.364	2.020	0.043	0.082	5.431
Opponent_Kenya	2.1283	1.338	1.590	0.112	-0.495	4.751
Opponent_Pakistan	2.6804	1.365	1.963	0.050	0.005	5.356
Opponent_South Africa	1.8050	1.364	1.324	0.186	-0.867	4.478
Opponent_Srilanka	1.3367	1.337	1.000	0.317	-1.283	3.956
Opponent_West Indies	3.6085	1.481	2.436	0.015	0.705	6.512
Opponent_Zimbabwe	0.9704	1.367	0.710	0.478	-1.709	3.650
Season_Summer	-0.9185	0.129	-7.129	0.000	-1.171	-0.666
Season_Winter	0.2839	0.172	1.653	0.098	-0.053	0.621
Offshore_Yes	-1.6736	0.124	-13.543	0.000	-1.916	-1.431

Significant variables are whose p value is less than alpha which is 0.05
Avg_team_Age
All_rounder_in_team
Max_wicket_taken_1over
Extra_bowls_bowled
Min_run_given_1over
Min_run_scored_1over
Max_run_given_1over
Extra_bowls_opponent
Players_scored_zero
Match_light_type_Day and Night
Match_light_type_Night
Season_Summer
Offshore_yes

2 Decision tree classifier (CART)

For decision tree we use label encoding

Parameters used for building model

Criterion = ‘gini’

Max_depth = ‘none’

Min_sample_leaf = ‘1’

Min_sample_split = ‘2’

Max_features = None

3 Random forest classifier

Making random forest model using random forest classifier with parameters estimator which is number of trees, max_features which is the number of variables, min_sample_leaf is the minimum sample of the terminal node, minimum_sample_split is the minimum split of the parent node and fitting the data in the model.

Parameters used for model building

n_estimators = 100

max_features=7

random_state =0

4 Artificial neural network

To build artificial neural networks first we need to scale both training and testing data
By using MLP classifier we pass the parameters
Hidden_layer_sizes: it consists of number of perceptron’s and each perceptron are connected to the inputs.
max_iter: weights are adjusted at every iteration and the losses are reduced.
Solver: solver gradient method is used for calculation of weights.
Tolerance: tolerance of losses at every iteration.

Parameters used for model building

hidden_layer_sizes=100,

max_iter=2500,

solver='sgd',

verbose=True,

random_state=0,

tol=0.01

Efforts to improve the model performance

Logistic regression using stats model

Taking threshold as 0.5

If the value is greater than 0.5 it is will be 1 and less than 0.5 it will 0

To increase the precision value, we need to decrease the false positive cases we can do by shifting the threshold point to the right

In this case precision value should be high, so we reduce the false positive rate by shifting the threshold value from 0.5 to 0.6

Taking threshold as 0.6

If the value is greater than 0.6 it is will be 1 and less than 0.6 it will 0

We can further increase the precision value we shifting the threshold from 0.6 to 0.7

Taking threshold as 0.7

We can consider threshold point as 0.7 where we get the maximum precision value which is 0.91 and lower false positive cases

We can use this threshold point for predictions

Ensemble modeling

Random forest model uses ensemble technique

Random forest using grid search. Grid search cross validation is a technique to find the best combination of parameters

Getting the best parameters using grid search

```
{'max_depth': 7,
 'max_features': 7,
 'min_samples_leaf': 30,
 'min_samples_split': 90,
 'n_estimators': 100}
```

Decision tree model (CART) using regularisation

Parameters used in model building

criterion='gini'

max_depth=10

min_samples_leaf=30

min_samples_split =300

Feature importance

	Imp
player_highest_wicket	0.320525
Offshore	0.311881
Extra_bowls_bowled	0.165018
Min_run_given_1over	0.074466
Min_run_scored_1over	0.052626
All_rounder_in_team	0.030320
Audience_number	0.026602
Max_run_scored_1over	0.011541
player_highest_run	0.007021
Match_light_type	0.000000
Season	0.000000
Opponent	0.000000
First_selection	0.000000
Match_format	0.000000
Avg_team_Age	0.000000
Players_scored_zero	0.000000
Bowlers_in_team	0.000000
Max_run_given_1over	0.000000
Max_wicket_taken_1over	0.000000
extra_bowls_opponent	0.000000

Artificial neural network using grid search

After using grid search cross validation, we get best parameters

{'hidden_layer_sizes': 50, 'max_iter': 2500, 'solver': 'sgd', 'tol': 0.01}

11. Model validation

Model validation is done on the test set by checking the performance metrics of each models

As the data is imbalance we cannot select the accuracy we need to select precision as false positive cases are not accepted

Logistic regression using stats model

Confusion metrics

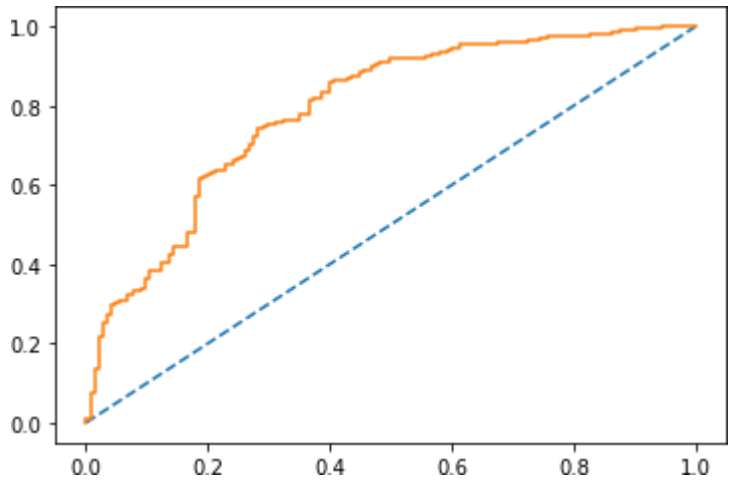
```
[[ 82  63]
 [ 77 657]]
```

Classification report

	precision	recall	f1-score	support
0	0.52	0.57	0.54	145
1	0.91	0.90	0.90	734
accuracy			0.84	879
macro avg	0.71	0.73	0.72	879
weighted avg	0.85	0.84	0.84	879

Area under curve

figure 17: roc auc curve of logistic regression using grid search for test



AUC: 0.80

Random forest

Confusion metrics after grid search for test set

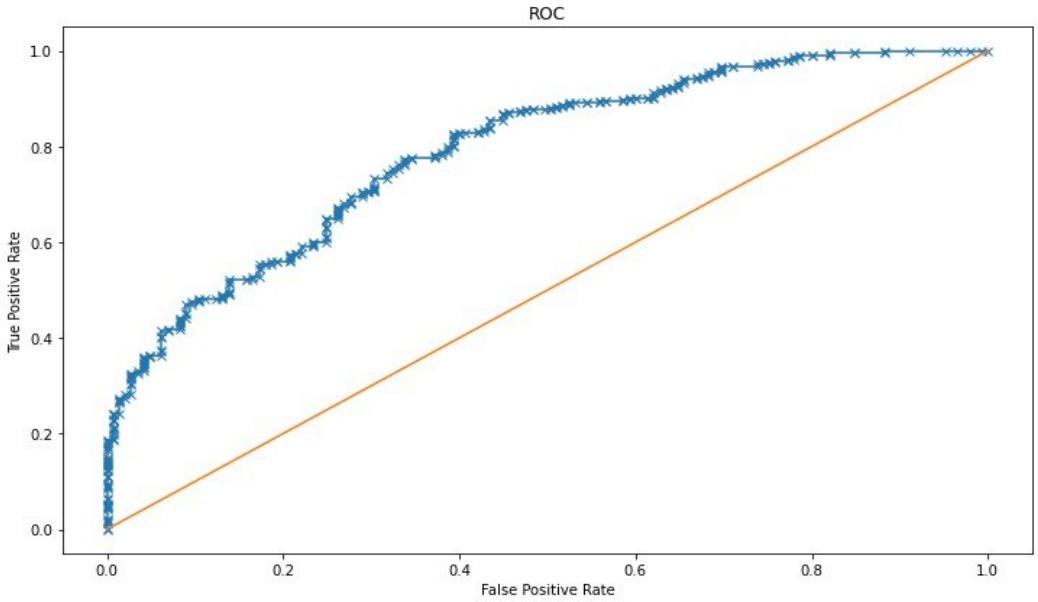
```
[ 28, 117]
[  7, 727]
```

Classification report for test set

	precision	recall	f1-score	support
0	0.80	0.19	0.31	145
1	0.86	0.99	0.92	734
accuracy			0.86	879
macro avg	0.83	0.59	0.62	879
weighted avg	0.85	0.86	0.82	879

ROC AUC curve

figure 18: roc auc curve of RF model using grid search




```
Area under Curve is 0.7920980926430516
```

Decision tree model (CART) using regularisation

Confusion metrics for test set

```
[ 43, 102]
[ 45, 689]
```

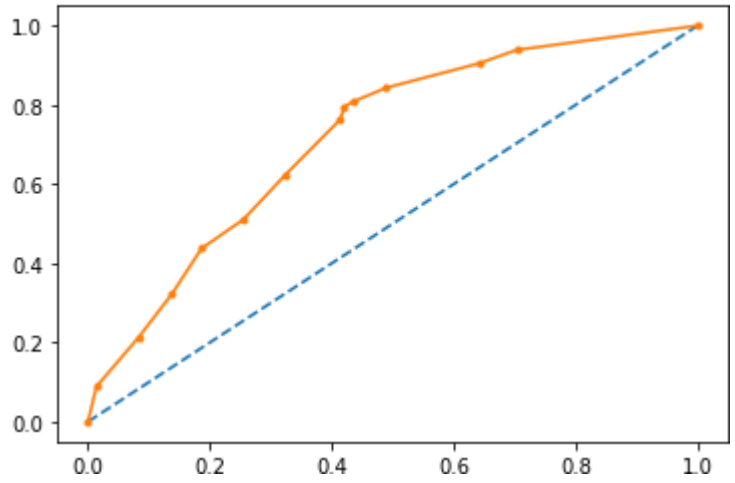
Classification report for test set

	precision	recall	f1-score	support
0	0.49	0.30	0.37	145
1	0.87	0.94	0.90	734
accuracy			0.83	879
macro avg	0.68	0.62	0.64	879
weighted avg	0.81	0.83	0.82	879

AUC ROC curve for test set

figure 19: roc auc of DT model for test set

AUC: 0.717



Artificial neural network

Confusion metrics for test set

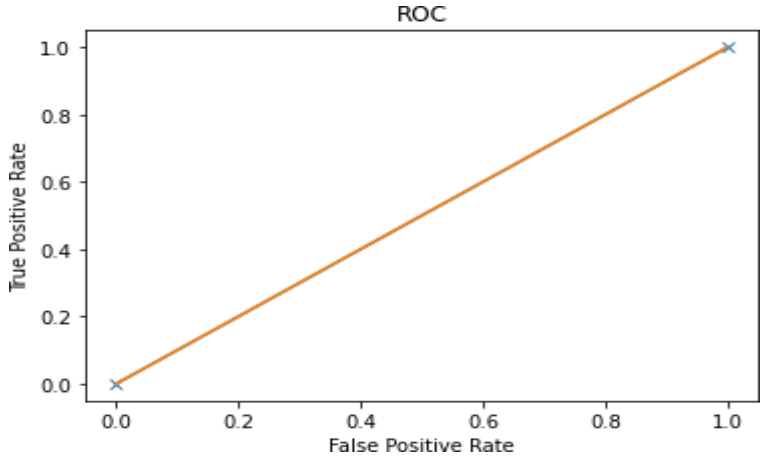
```
[  0, 145]
[  0, 734]
```

Classification report for test set

	precision	recall	f1-score	support
0	0.00	0.00	0.00	145
1	0.84	1.00	0.91	734
accuracy			0.84	879
macro avg	0.42	0.50	0.46	879
weighted avg	0.70	0.84	0.76	879

AUC ROC curve

figure 20: roc auc of ANN model for test set



Interpretation of the models

Table 1: interpretations of all the models

	logistic Train(sm)	logistic Test(sm)	CART train	CART test
Accuracy	0.87	0.84	0.85	0.83
AUC	0.85	0.80	0.82	0.72
Precision	0.93	0.91	0.88	0.87
Recall	0.92	0.90	0.94	0.94
F1 score	0.92	0.90	0.91	0.90

	RANDOM FOREST train	RANDOM FOREST test	NEURAL NETWORK train
Accuracy	0.86	0.86	0.84
AUC	0.87	0.79	0.50
Precision	0.87	0.86	0.84
Recall	0.99	0.99	1.00
F1 score	0.92	0.92	0.91

	NEURAL NETWORK test
Accuracy	0.84
AUC	0.50
Precision	0.84
Recall	1.00
F1 score	0.91

Logistic regression using stats model

Accuracy is 0.87 and 0.84 for train and test set

As false positive cases are not acceptable. Hence precision is important. It has precision 0.93 and 0.91 for train and test set. It is right fit model.

Area under curve for train and test is 0.85 and 0.80

CART model

Accuracy is 0.85 and 0.83 for train and test set

As false positive cases are not acceptable. Hence precision is important. It has precision 0.88 and 0.87 for train and test set. It is right fit model.

Area under curve for train and test is 0.82 and 0.72

RANDOM FOREST

Accuracy is 0.86 and 0.86 for train and test set

As false positive cases are not acceptable. Hence precision is important. It has precision 0.87 and 0.86 for train and test set. It is right fit model.

Area under curve for train and test is 0.87 and 0.79

Artificial neural network

Accuracy is 0.84 and 0.84 for train and test set

As false positive is not acceptable. Hence precision is important. It has precision 0.84 and 0.84 for train and test set. It is right fit model.

Area under curve for train and test is 0.5 and 0.5

From above all the models we select logistic regression using stats model. It has highest accuracy and precision value. Logistic regression using stats model gives us approach to make the strategy by making changes to the values of the variables with respect to the coefficient

12. Final recommendations given to the BCCI

1 Test match with England in England. All the match are day matches. In England, it will be rainy season at the time to match.

Strategy to be followed

Average team age: Team average age should not be above 34. above age 34 we may lose the match
All-rounder's in team: There should be at least 3 all-rounders' in team
First selection: The first selection should be bowling
Bowlers in team: There should be at least one bowler in the team
Players scored zero: There should be no player scored zero

2 T20 match with Australia in India. All the match are Day and Night matches. In India, it will be winter season at the time to match.

1st Strategy to be followed

Average team age*:* Team average age should be 31. If it is greater 31 then we may lose the match
All-rounder's in team*:* There should be at least 3 all-rounders' in team, less than 3 all-rounders may lose the match
First selection*:* The first selection should be bowling
Bowlers in team*:* There should be 3 bowlers in team
Extra bowls opponents: It should be greater than 14. if it is 14 we may lose the match

Maximum runs given in one over: It should be less than 9 runs. If it 9 or greater then we may lose the match
Player scored zero: There should be at least 2 players scored zero

2nd Strategy to be followed
Average team age*:* Team average age should be 32. If it is greater than 32 we may lose the match.
All rounder's in team: There should be at least one all-rounder's in team. Playing with no all rounders can lose the match
First selection: The first selection should be batting
Bowlers in team: There should be 2 bowlers in team
Extra bowls opponents: It should be greater than 14. If it is 14 we may lose the match
Maximum runs given in one over: It should not be greater than 4. If it is greater than 4 then we may lose the match
Player scored zero: There should be at least 3 players scored zero

2 ODI match with Sri Lanka in India. All the match are Day and Night matches. In India, it will be winter season at the time to match.

1st strategy to be followed
Average team age*:* Team average age should be less than 36. if it is 36 we may lose the match
All-rounder's in team: There should be at least 2 all-rounder's in team.
First selection: The first selection should be bowling
Bowlers in team: There should be 2 bowlers in team
Maximum runs given in one over: It should be less than 13. If it is 13 or greater than that we may lose the match
Extra bowls opponents: It should be greater than 4. If it is 5 we may lose the match
Player scored zero: We should be having at least two player scored zero. With one players scored zero we may lose the match

2nd strategy to be followed
Average team age*:* Team average age should be 34. If it is greater than 34 we may lose the match
All-rounder's in team: There should be at least 3 all rounder's in team.
First selection: The first selection should be batting
Bowlers in team: There should be 3 bowlers in team
Maximum runs given in one over: It should be 23. more than 23 runs will result into lost
Extra bowls opponents: It should be greater than 19. If it is 19 we may lose the match
Player scored zero: We should be having at least one player scored zero. With no players scored zero we may lose the match