In [1]:
```
import pandas as pd
from sklearn.tree import DecisionTreeRegressor
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from math import sqrt
import sqlite3
import matplotlib.pyplot as plt
import numpy as np
from sklearn.svm import SVR
from xgboost import XGBRegressor
from sklearn.ensemble import RandomForestRegressor
from statsmodels.stats.outliers_influence import variance_inflation_factor
import seaborn as sns
import statsmodels.formula.api as smf
from sklearn.preprocessing import StandardScaler
```

In [2]:
```
cnx = sqlite3.connect('database.sqlite')
df = pd.read_sql_query("SELECT * FROM Player_Attributes", cnx)
```

In [3]:
```
df.head()
```

Out[3]:

	id	player_fifa_api_id	player_api_id	date	overall_rating	potential	preferred_foot	attackin
0	1	218353	505942	2016-02-18 00:00:00	67.0	71.0	right	
1	2	218353	505942	2015-11-19 00:00:00	67.0	71.0	right	
2	3	218353	505942	2015-09-21 00:00:00	62.0	66.0	right	
3	4	218353	505942	2015-03-20 00:00:00	61.0	65.0	right	
4	5	218353	505942	2007-02-22 00:00:00	61.0	65.0	right	

5 rows × 42 columns

In [4]:
```
df.shape
```

Out[4]:
```
(183978, 42)
```

In [5]:
```
df.columns
```

Out[5]:
```
Index(['id', 'player_fifa_api_id', 'player_api_id', 'date', 'overall_rating',
       'potential', 'preferred_foot', 'attacking_work_rate',
       'defensive_work_rate', 'crossing', 'finishing', 'heading_accuracy',
       'short_passing', 'volleys', 'dribbling', 'curve', 'free_kick_accurac
y',
       'long_passing', 'ball_control', 'acceleration', 'sprint_speed',
       'agility', 'reactions', 'balance', 'shot_power', 'jumping', 'stamina',
       'strength', 'long_shots', 'aggression', 'interceptions', 'positionin
g',
       'vision', 'penalties', 'marking', 'standing_tackle', 'sliding_tackle',
       'gk_diving', 'gk_handling', 'gk_kicking', 'gk_positioning',
       'gk_reflexes'],
      dtype='object')
```

In [6]:
```
df.describe().T
```

Out[6]:

	count	mean	std	min	25%	50%	7
id	183978.0	91989.500000	53110.018250	1.0	45995.25	91989.5	137983
player_fifa_api_id	183978.0	165671.524291	53851.094769	2.0	155798.00	183488.0	199848
player_api_id	183978.0	135900.617324	136927.840510	2625.0	34763.00	77741.0	191080
overall_rating	183142.0	68.600015	7.041139	33.0	64.00	69.0	73
potential	183142.0	73.460353	6.592271	39.0	69.00	74.0	78
crossing	183142.0	55.086883	17.242135	1.0	45.00	59.0	68
finishing	183142.0	49.921078	19.038705	1.0	34.00	53.0	65
heading_accuracy	183142.0	57.266023	16.488905	1.0	49.00	60.0	68
short_passing	183142.0	62.429672	14.194068	3.0	57.00	65.0	72
volleys	181265.0	49.468436	18.256618	1.0	35.00	52.0	64
dribbling	183142.0	59.175154	17.744688	1.0	52.00	64.0	72
curve	181265.0	52.965675	18.255788	2.0	41.00	56.0	67
free_kick_accuracy	183142.0	49.380950	17.831746	1.0	36.00	50.0	63
long_passing	183142.0	57.069880	14.394464	3.0	49.00	59.0	67
ball_control	183142.0	63.388879	15.196671	5.0	58.00	67.0	73
acceleration	183142.0	67.659357	12.983326	10.0	61.00	69.0	77
sprint_speed	183142.0	68.051244	12.569721	12.0	62.00	69.0	77
agility	181265.0	65.970910	12.954585	11.0	58.00	68.0	75
reactions	183142.0	66.103706	9.155408	17.0	61.00	67.0	72
balance	181265.0	65.189496	13.063188	12.0	58.00	67.0	74
shot_power	183142.0	61.808427	16.135143	2.0	54.00	65.0	73
jumping	181265.0	66.969045	11.006734	14.0	60.00	68.0	74
stamina	183142.0	67.038544	13.165262	10.0	61.00	69.0	76
strength	183142.0	67.424529	12.072280	10.0	60.00	69.0	76
long_shots	183142.0	53.339431	18.367025	1.0	41.00	58.0	67
aggression	183142.0	60.948046	16.089521	6.0	51.00	64.0	73
interceptions	183142.0	52.009271	19.450133	1.0	34.00	57.0	68
positioning	183142.0	55.786504	18.448292	2.0	45.00	60.0	69
vision	181265.0	57.873550	15.144086	1.0	49.00	60.0	69
penalties	183142.0	55.003986	15.546519	2.0	45.00	57.0	67
marking	183142.0	46.772242	21.227667	1.0	25.00	50.0	66
standing_tackle	183142.0	50.351257	21.483706	1.0	29.00	56.0	69
sliding_tackle	181265.0	48.001462	21.598778	2.0	25.00	53.0	67
gk_diving	183142.0	14.704393	16.865467	1.0	7.00	10.0	13
gk_handling	183142.0	16.063612	15.867382	1.0	8.00	11.0	15

	count	mean	std	min	25%	50%	7
gk_kicking	183142.0	20.998362	21.452980	1.0	8.00	12.0	15
gk_positioning	183142.0	16.132154	16.099175	1.0	8.00	11.0	15
gk_reflexes	183142.0	16.441439	17.198155	1.0	8.00	11.0	15

In [7]:
```
# Checking missing values
df.isnull().sum()
```

Out[7]:
```
id                        0
player_fifa_api_id        0
player_api_id             0
date                      0
overall_rating          836
potential               836
preferred_foot          836
attacking_work_rate    3230
defensive_work_rate     836
crossing                836
finishing               836
heading_accuracy        836
short_passing           836
volleys                2713
dribbling               836
curve                  2713
free_kick_accuracy      836
long_passing            836
ball_control            836
acceleration            836
sprint_speed            836
agility                2713
reactions               836
balance                2713
shot_power              836
jumping                2713
stamina                 836
strength                836
long_shots              836
aggression              836
interceptions           836
positioning             836
vision                 2713
penalties               836
marking                 836
standing_tackle         836
sliding_tackle         2713
gk_diving               836
gk_handling             836
gk_kicking              836
gk_positioning          836
gk_reflexes             836
dtype: int64
```

In [8]:
```
# Calculating % of missing values:
row = df.shape[0]
for i in df.columns:
    print('{}: {}'.format(i, (df[i].isnull().sum() / row)))
```

```
id: 0.0
player_fifa_api_id: 0.0
player_api_id: 0.0
date: 0.0
overall_rating: 0.004544021567796149
potential: 0.004544021567796149
preferred_foot: 0.004544021567796149
attacking_work_rate: 0.017556446966485124
defensive_work_rate: 0.004544021567796149
crossing: 0.004544021567796149
finishing: 0.004544021567796149
heading_accuracy: 0.004544021567796149
short_passing: 0.004544021567796149
volleys: 0.01474632836534803
dribbling: 0.004544021567796149
curve: 0.01474632836534803
free_kick_accuracy: 0.004544021567796149
long_passing: 0.004544021567796149
ball_control: 0.004544021567796149
acceleration: 0.004544021567796149
sprint_speed: 0.004544021567796149
agility: 0.01474632836534803
reactions: 0.004544021567796149
balance: 0.01474632836534803
shot_power: 0.004544021567796149
jumping: 0.01474632836534803
stamina: 0.004544021567796149
strength: 0.004544021567796149
long_shots: 0.004544021567796149
aggression: 0.004544021567796149
interceptions: 0.004544021567796149
positioning: 0.004544021567796149
vision: 0.01474632836534803
penalties: 0.004544021567796149
marking: 0.004544021567796149
standing_tackle: 0.004544021567796149
sliding_tackle: 0.01474632836534803
gk_diving: 0.004544021567796149
gk_handling: 0.004544021567796149
gk_kicking: 0.004544021567796149
gk_positioning: 0.004544021567796149
gk_reflexes: 0.004544021567796149
```

As the % of missing values is quite less, we can drop missing values

In [9]:
```
df = df.dropna()
```

Now if we check the null values and number of rows, we will see that there are no null values and number of rows decreased accordingly.

In [10]:
```
print(row)
df.isnull().any().any(), df.shape
```

```
183978
```

Out[10]:
```
(False, (180354, 42))
```

To find exactly how many lines we removed, we need to subtract the current number of rows in our data frame from the original number of rows.

In [11]:
```
row - df.shape[0]
```

Out[11]:
```
3624
```

In [12]:
```
df.isnull().sum()
```

Out[12]:
```
id                     0
player_fifa_api_id     0
player_api_id          0
date                   0
overall_rating         0
potential              0
preferred_foot         0
attacking_work_rate    0
defensive_work_rate    0
crossing               0
finishing              0
heading_accuracy       0
short_passing          0
volleys                0
dribbling              0
curve                  0
free_kick_accuracy     0
long_passing           0
ball_control           0
acceleration           0
sprint_speed           0
agility                0
reactions              0
balance                0
shot_power             0
jumping                0
stamina                0
strength               0
long_shots             0
aggression             0
interceptions          0
positioning            0
vision                 0
penalties              0
marking                0
standing_tackle        0
sliding_tackle         0
gk_diving              0
gk_handling            0
gk_kicking             0
gk_positioning         0
gk_reflexes            0
dtype: int64
```

In [13]:
```
df[:10][['penalties', 'overall_rating']]
```

Out[13]:

	penalties	overall_rating
0	48.0	67.0
1	48.0	67.0
2	48.0	62.0
3	47.0	61.0
4	47.0	61.0
5	59.0	74.0
6	59.0	74.0
7	59.0	73.0
8	59.0	73.0
9	59.0	73.0

Next, we will check if 'penalties' is correlated to 'overall_rating'. We are using within the correlation function.

In [14]:
```
df['overall_rating'].corr(df['penalties'])
```

Out[14]:
```
0.39271510791118647
```

We see that Pearson's Correlation Coefficient for these two columns is 0.39.

Pearson goes from -1 to +1. A value of 0 would have told there is no correlation, so we shouldn't bother looking at that attribute. A value of 0. shows some correlation, although it could be stronger.

In [15]:
```
# Create a list of potential Features that you want to measure correlation wit
h
potentialFeatures  = ['acceleration', 'curve', 'free_kick_accuracy', 'ball_con
trol', 'shot_power', 'stamina']
```

In [16]:
```
for fc in potentialFeatures:
    related = df['overall_rating'].corr(df[fc])
    print("%s: %f" % (fc,related))
```

```
acceleration: 0.243998
curve: 0.357566
free_kick_accuracy: 0.349800
ball_control: 0.443991
shot_power: 0.428053
stamina: 0.325606
```

Looking at the values printed by the previous cell, we notice that the to two are "ball_control" (0.44) and "shot_power" (0.43). So these two features seem to have higher correlation with "overall_rating".

Data Visualization:

- Next we will start plotting the correlation coefficients of each feature with "overall_rating". We start by selecting the columns and creating a list with correlation coefficients, called "correlations".

In [17]:
```python
correlation_matrix  = df.corr()
correlation_matrix["overall_rating"].sort_values(ascending=False)
```

Out[17]:
```
overall_rating        1.000000
reactions             0.771856
potential             0.765435
short_passing         0.458243
ball_control          0.443991
long_passing          0.434525
vision                0.431493
shot_power            0.428053
penalties             0.392715
long_shots            0.392668
positioning           0.368978
volleys               0.361739
curve                 0.357566
crossing              0.357320
dribbling             0.354191
free_kick_accuracy    0.349800
finishing             0.330079
stamina               0.325606
aggression            0.322782
strength              0.315684
heading_accuracy      0.313324
jumping               0.258978
sprint_speed          0.253048
interceptions         0.249094
acceleration          0.243998
agility               0.239963
standing_tackle       0.163986
balance               0.160211
marking               0.132185
sliding_tackle        0.128054
gk_kicking            0.028799
gk_diving             0.027675
gk_positioning        0.008029
gk_reflexes           0.007804
gk_handling           0.006717
id                   -0.003738
player_fifa_api_id   -0.278703
player_api_id        -0.328315
Name: overall_rating, dtype: float64
```

In [18]:
```
columns = ['potential',  'crossing', 'finishing', 'heading_accuracy', 'short_passing', 'volleys', 'dribbling', 'curve',
           'free_kick_accuracy', 'long_passing', 'ball_control', 'acceleration', 'sprint_speed', 'agility', 'reactions',
           'balance', 'shot_power', 'jumping', 'stamina', 'strength', 'long_shots', 'aggression', 'interceptions',
           'positioning', 'vision', 'penalties', 'marking', 'standing_tackle', 'sliding_tackle', 'gk_diving', 'gk_handling',
           'gk_kicking', 'gk_positioning', 'gk_reflexes']
```

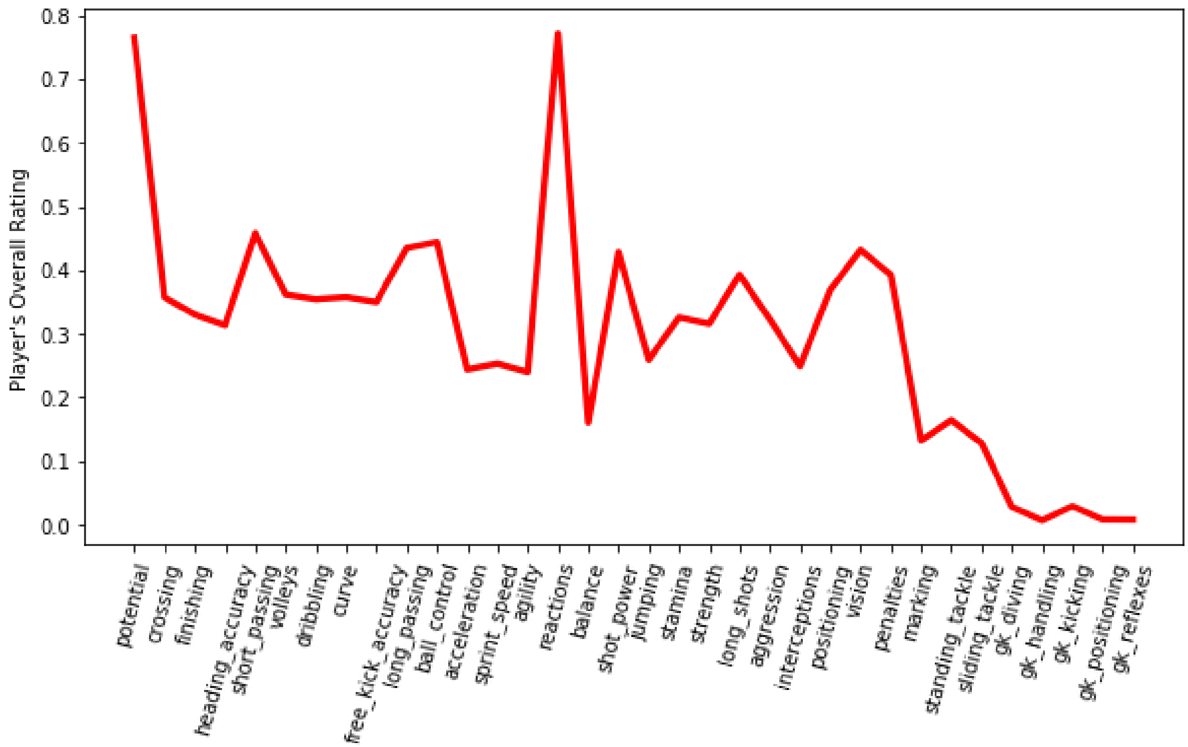
In [19]:
```
correlations = [ df['overall_rating'].corr(df[f]) for f in columns ]
```

Graph or Ploting

In [20]:
```
def plot_dataframe(df, y_label):
    color='red'
    fig = plt.gcf()
    fig.set_size_inches(10, 5)
    plt.ylabel(y_label)

    ax = df.correlation.plot(linewidth=3.3, color=color)
    ax.set_xticks(df.index)
    ax.set_xticklabels(df.attributes, rotation=75);
    plt.show()
```

In [21]:
```
df1 = pd.DataFrame({'attributes': columns, 'correlation': correlations})
plot_dataframe(df1, 'Player\'s Overall Rating')
plt.xkcd()
```



Out[21]:
```
<matplotlib.rc_context at 0x24e53d53f88>
```

Preprocessing

In [22]:
```
def onehot_encode(df, column):
    df = df.copy()
    dummies = pd.get_dummies(df[column], prefix=column)
    df = pd.concat([df, dummies], axis=1)
    df = df.drop(column, axis=1)
    return df
```

In [23]:
```
df.columns
```

Out[23]:
```
Index(['id', 'player_fifa_api_id', 'player_api_id', 'date', 'overall_rating',
       'potential', 'preferred_foot', 'attacking_work_rate',
       'defensive_work_rate', 'crossing', 'finishing', 'heading_accuracy',
       'short_passing', 'volleys', 'dribbling', 'curve', 'free_kick_accurac
y',
       'long_passing', 'ball_control', 'acceleration', 'sprint_speed',
       'agility', 'reactions', 'balance', 'shot_power', 'jumping', 'stamina',
       'strength', 'long_shots', 'aggression', 'interceptions', 'positionin
g',
       'vision', 'penalties', 'marking', 'standing_tackle', 'sliding_tackle',
       'gk_diving', 'gk_handling', 'gk_kicking', 'gk_positioning',
       'gk_reflexes'],
      dtype='object')
```

In [24]:
```
def preprocess_inputs(df):
    df1 = df.copy()

    # Drop unused columns
    df1 = df1.drop(columns=['id', 'player_fifa_api_id', 'date'])

    # Get categorical data
    categoricals = df1.groupby(by = 'player_api_id', as_index = False)[[
        'player_api_id', 'preferred_foot', 'attacking_work_rate', 'defensive_w
ork_rate']].head(1)

    # Clean categorical columns
    for columns in ['attacking_work_rate', 'defensive_work_rate']:
        categoricals[columns] = categoricals[columns].apply(lambda x: np.NaN i
f x not in ['low', 'medium', 'high'] else x)
        categoricals[columns] = categoricals[columns].fillna(categoricals[colu
mns].mode()[0])

    # Take the average numeric stats within groups and merge with categorical
 columns
    df1 = df1.groupby(by='player_api_id').mean()
    df1 = df1.merge(categoricals, on='player_api_id')

    # Binary encoding:
    df1['preferred_foot'] = df1['preferred_foot'].replace({'left': 0, 'right':
1})

    # One-hot encoding
    for column in ['attacking_work_rate', 'defensive_work_rate']:
        df1 = onehot_encode(df1, column=column)

    return df1
```

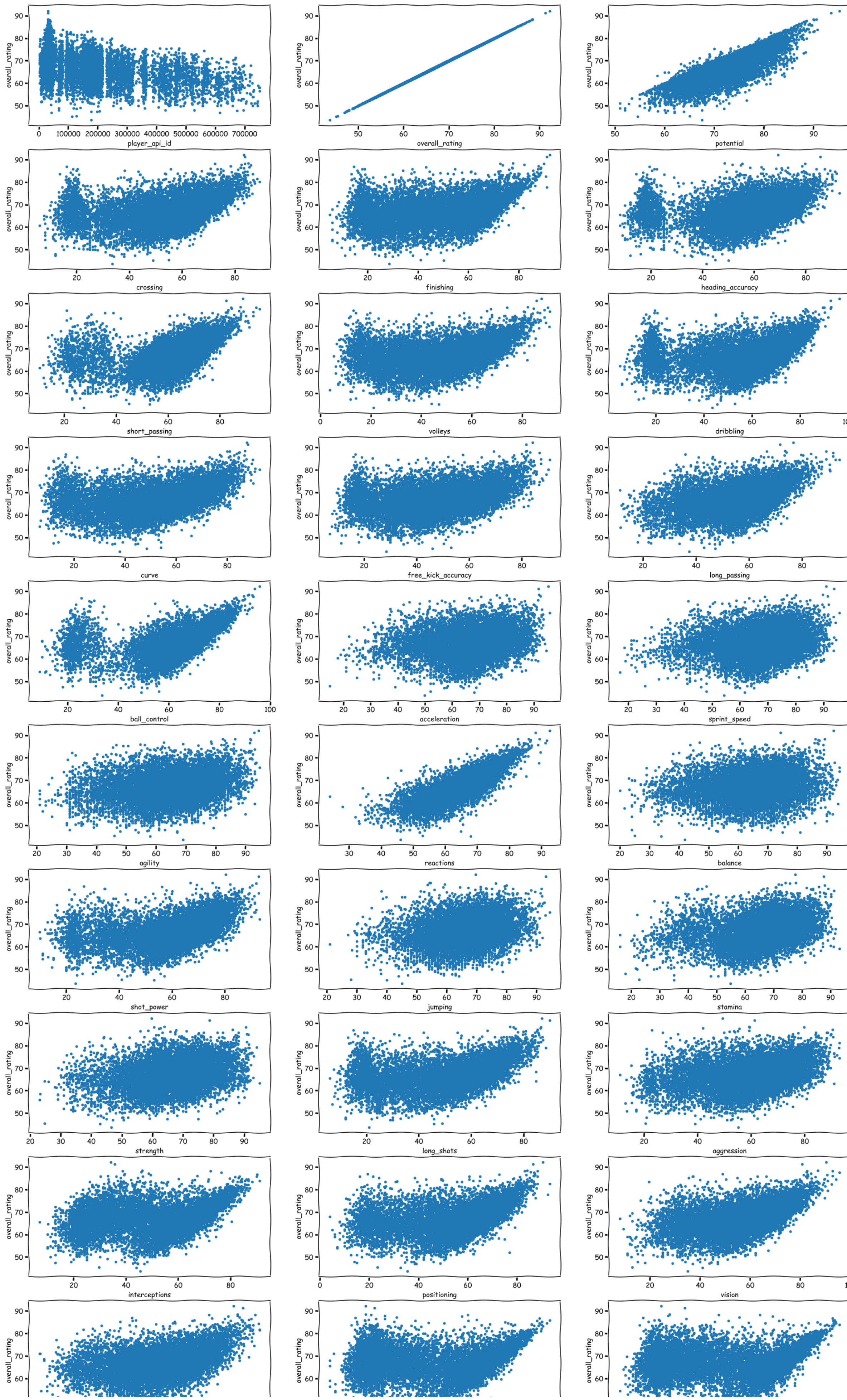
In [25]:
```
processed_data = preprocess_inputs(df)
```

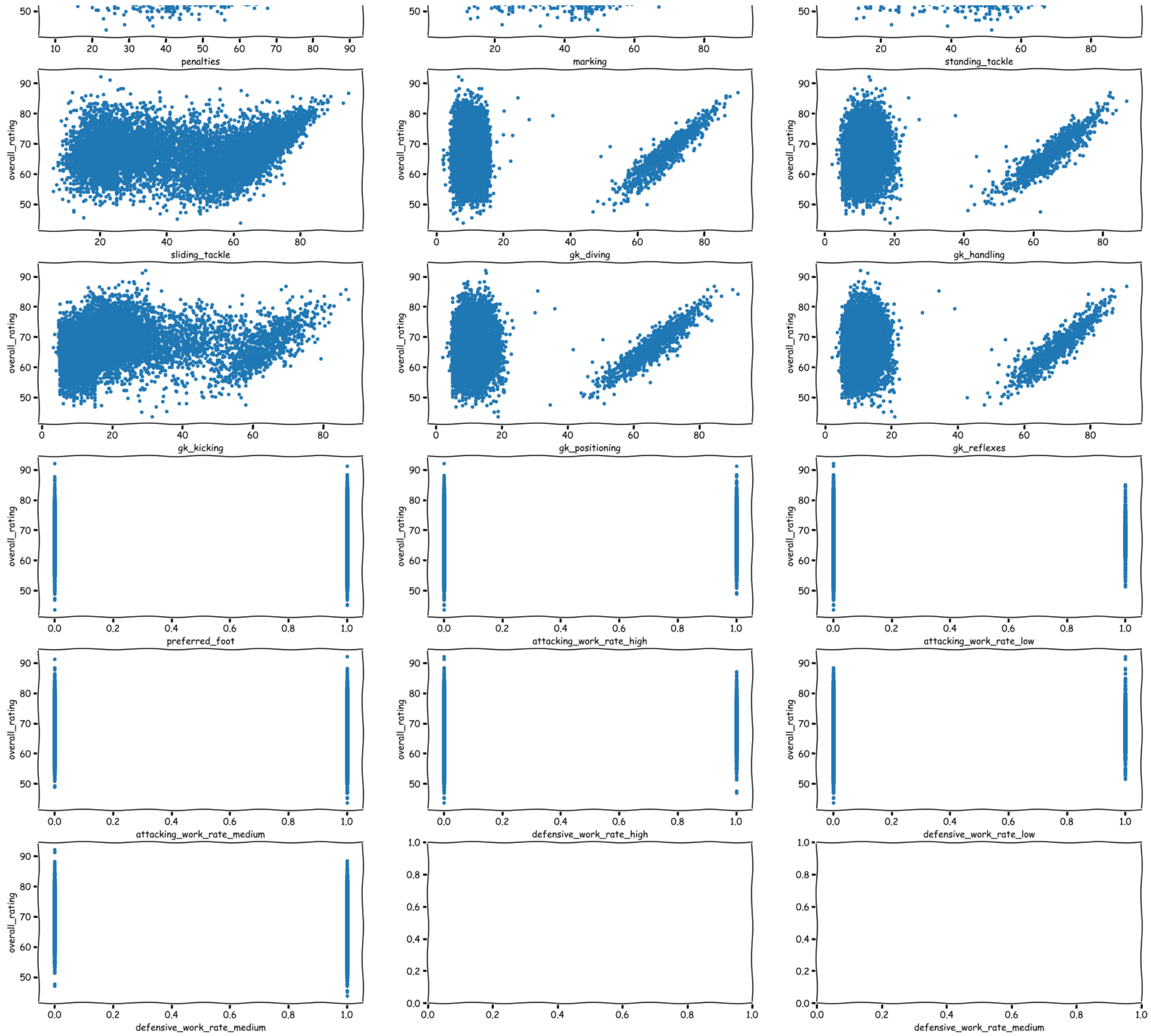
In [26]:
```
# Split df into X and y
y = processed_data['overall_rating']
X = processed_data.drop('overall_rating', axis=1)
```

In [27]:
```
# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.7, shuf
fle=True, random_state=1)
```

Linear Regression Model

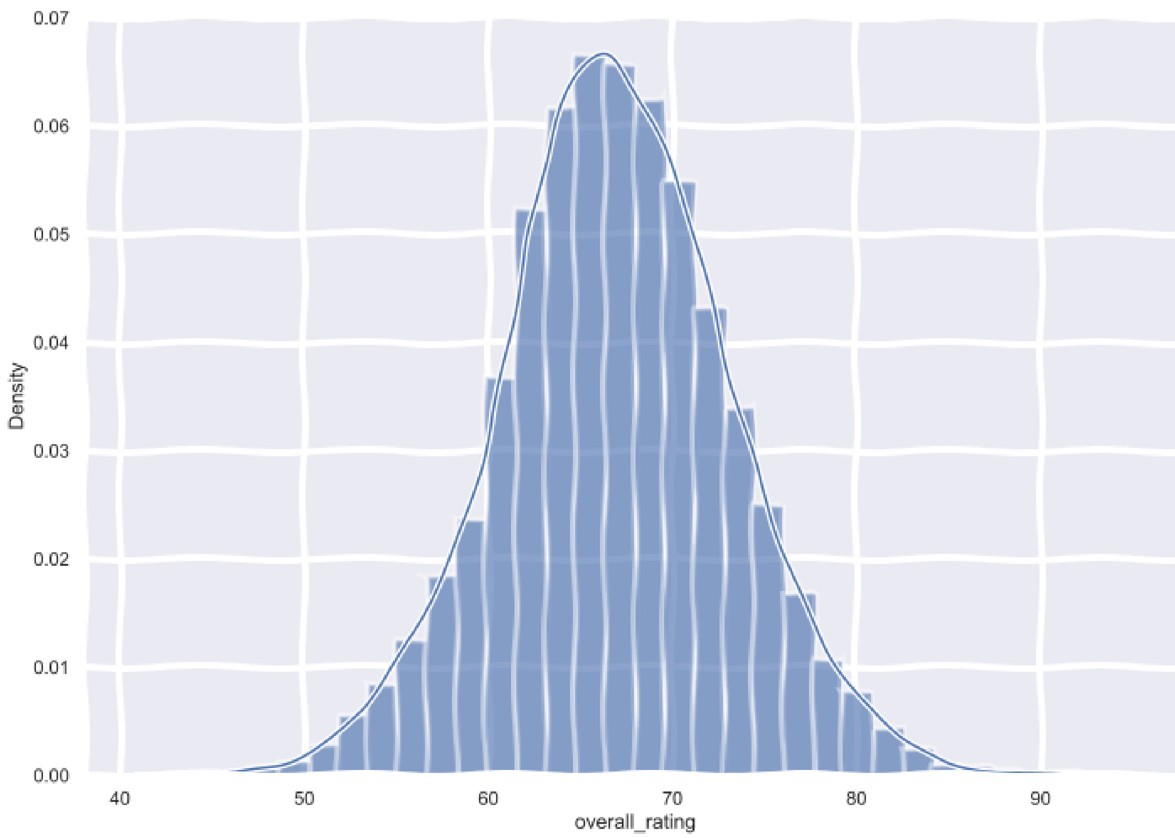
In [28]:
```
# visualize the relationship between the features and the response using scatt
erplots
fig, axs = plt.subplots(15, 3, figsize=(30, 80))
# unpack all the axes subplots
axe = axs.ravel()
for i in range(len(processed_data.columns)):
    processed_data.plot(kind='scatter', x=processed_data.columns[i], y='overal
l_rating', ax=axe[i])
    plt.xlabel(processed_data.columns[i])
```


overall_rating
player_api_id
overall_rating
potential
crossing
finishing
heading_accuracy
short_passing
volleys
dribbling
curve
free_kick_accuracy
long_passing
ball_control
acceleration
sprint_speed
agility
reactions
balance
shot_power
jumping
stamina
strength
long_shots
aggression
interceptions
positioning
vision


penalties
marking
standing_tackle
overall_rating
sliding_tackle
gk_diving
gk_handling
gk_kicking
gk_positioning
gk_reflexes
preferred_foot
attacking_work_rate_high
attacking_work_rate_low
attacking_work_rate_medium
defensive_work_rate_high
defensive_work_rate_low
defensive_work_rate_medium
defensive_work_rate_medium

In [29]:
```
sns.set(rc={'figure.figsize':(11.7,8.27)})
sns.distplot(processed_data['overall_rating'], bins=30)
plt.show()
```

```
C:\Users\Urvi\AppData\Roaming\Python\Python37\site-packages\seaborn\distribut
ions.py:2551: FutureWarning: `distplot` is a deprecated function and will be
removed in a future version. Please adapt your code to use either `displot`
(a figure-level function with similar flexibility) or `histplot` (an axes-lev
el function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [30]:
```
correlation_matrix = processed_data.corr().round(2)
# annot = True to print the values inside the square
print(correlation_matrix)
```

```
                           player_api_id  overall_rating  potential  \
player_api_id                       1.00           -0.43      -0.03   
overall_rating                     -0.43            1.00       0.80   
potential                          -0.03            0.80       1.00   
crossing                           -0.15            0.34       0.29   
finishing                          -0.08            0.32       0.29   
heading_accuracy                   -0.14            0.30       0.21   
short_passing                      -0.13            0.42       0.39   
volleys                            -0.15            0.38       0.32   
dribbling                          -0.00            0.31       0.34   
curve                              -0.13            0.37       0.33   
free_kick_accuracy                 -0.20            0.37       0.30   
long_passing                       -0.20            0.44       0.37   
ball_control                       -0.09            0.42       0.41   
acceleration                        0.09            0.20       0.31   
sprint_speed                        0.08            0.22       0.31   
agility                            -0.01            0.24       0.30   
reactions                          -0.41            0.80       0.63   
balance                             0.02            0.17       0.21   
shot_power                         -0.16            0.42       0.35   
jumping                            -0.17            0.28       0.20   
stamina                            -0.18            0.31       0.23   
strength                           -0.27            0.30       0.12   
long_shots                         -0.16            0.39       0.33   
aggression                         -0.25            0.33       0.18   
interceptions                      -0.23            0.27       0.15   
positioning                        -0.15            0.38       0.33   
vision                             -0.25            0.48       0.40   
penalties                          -0.19            0.43       0.34   
marking                            -0.10            0.11       0.04   
standing_tackle                    -0.09            0.13       0.07   
sliding_tackle                     -0.07            0.11       0.05   
gk_diving                          -0.07            0.02      -0.02   
gk_handling                        -0.14            0.05      -0.00   
gk_kicking                         -0.35            0.18       0.06   
gk_positioning                     -0.14            0.05      -0.01   
gk_reflexes                        -0.14            0.05      -0.01   
preferred_foot                     -0.01            0.01      -0.00   
attacking_work_rate_high            0.04            0.12       0.14   
attacking_work_rate_low            -0.08            0.04      -0.02   
attacking_work_rate_medium          0.01           -0.13      -0.12   
defensive_work_rate_high           -0.06            0.11       0.07   
defensive_work_rate_low            -0.06            0.10       0.08   
defensive_work_rate_medium          0.09           -0.16      -0.12   

                           crossing  finishing  heading_accuracy  \
player_api_id                 -0.15      -0.08             -0.14   
overall_rating                 0.34       0.32              0.30   
potential                      0.29       0.29              0.21   
crossing                       1.00       0.58              0.39   
finishing                      0.58       1.00              0.39   
heading_accuracy               0.39       0.39              1.00   
short_passing                  0.81       0.59              0.57   
volleys                        0.65       0.88              0.42   
dribbling                      0.82       0.80              0.42   
curve                          0.81       0.71              0.35   
free_kick_accuracy             0.75       0.66              0.35   
```

```
long_passing                  0.72        0.35               0.38
ball_control                  0.83        0.74               0.58
acceleration                  0.66        0.57               0.24
sprint_speed                  0.64        0.56               0.31
agility                       0.64        0.58               0.10
reactions                     0.40        0.36               0.30
balance                       0.59        0.44               0.13
shot_power                    0.67        0.77               0.57
jumping                       0.01       -0.01               0.30
stamina                       0.62        0.36               0.54
strength                     -0.11       -0.08               0.49
long_shots                    0.72        0.83               0.43
aggression                    0.35        0.03               0.60
interceptions                 0.35       -0.18               0.48
positioning                   0.73        0.85               0.46
vision                        0.74        0.69               0.39
penalties                     0.61        0.79               0.49
marking                       0.26       -0.31               0.47
standing_tackle               0.30       -0.27               0.48
sliding_tackle                0.29       -0.29               0.45
gk_diving                    -0.64       -0.50              -0.71
gk_handling                  -0.62       -0.48              -0.69
gk_kicking                   -0.41       -0.36              -0.51
gk_positioning               -0.62       -0.48              -0.69
gk_reflexes                  -0.62       -0.49              -0.69
preferred_foot               -0.17        0.02               0.00
attacking_work_rate_high      0.28        0.28               0.07
attacking_work_rate_low      -0.07       -0.13               0.15
attacking_work_rate_medium   -0.22       -0.20              -0.14
defensive_work_rate_high      0.06       -0.04               0.18
defensive_work_rate_low       0.12        0.32               0.07
defensive_work_rate_medium   -0.14       -0.19              -0.19

                            short_passing  volleys  dribbling  curve  ...  \
player_api_id                       -0.13    -0.15      -0.00  -0.13  ...
overall_rating                       0.42     0.38       0.31   0.37  ...
potential                            0.39     0.32       0.34   0.33  ...
crossing                             0.81     0.65       0.82   0.81  ...
finishing                            0.59     0.88       0.80   0.71  ...
heading_accuracy                     0.57     0.42       0.42   0.35  ...
short_passing                        1.00     0.66       0.80   0.76  ...
volleys                              0.66     1.00       0.81   0.76  ...
dribbling                            0.80     0.81       1.00   0.83  ...
curve                                0.76     0.76       0.83   1.00  ...
free_kick_accuracy                   0.74     0.71       0.74   0.83  ...
long_passing                         0.85     0.45       0.60   0.64  ...
ball_control                         0.91     0.77       0.91   0.82  ...
acceleration                         0.55     0.56       0.75   0.61  ...
sprint_speed                         0.55     0.55       0.73   0.58  ...
agility                              0.55     0.59       0.74   0.65  ...
reactions                            0.46     0.42       0.37   0.43  ...
balance                              0.54     0.46       0.62   0.55  ...
shot_power                           0.75     0.79       0.77   0.72  ...
jumping                              0.06     0.01      -0.01  -0.02  ...
stamina                              0.67     0.42       0.56   0.51  ...
strength                             0.06    -0.05      -0.16  -0.13  ...
long_shots                           0.75     0.85       0.82   0.80  ...
```

```
aggression                     0.49     0.13       0.21   0.23  ...
interceptions                  0.47    -0.04       0.10   0.17  ...
positioning                    0.73     0.83       0.85   0.78  ...
vision                         0.82     0.73       0.77   0.77  ...
penalties                      0.67     0.78       0.72   0.71  ...
marking                        0.37    -0.18      -0.00   0.05  ...
standing_tackle                0.42    -0.13       0.05   0.10  ...
sliding_tackle                 0.40    -0.15       0.04   0.08  ...
gk_diving                     -0.73    -0.52      -0.69  -0.57  ...
gk_handling                   -0.71    -0.50      -0.68  -0.56  ...
gk_kicking                    -0.49    -0.34      -0.53  -0.38  ...
gk_positioning                -0.71    -0.50      -0.68  -0.56  ...
gk_reflexes                   -0.71    -0.51      -0.68  -0.56  ...
preferred_foot                -0.06    -0.01      -0.08  -0.12  ...
attacking_work_rate_high       0.19     0.25       0.31   0.26  ...
attacking_work_rate_low        0.00    -0.10      -0.12  -0.09  ...
attacking_work_rate_medium    -0.18    -0.19      -0.23  -0.20  ...
defensive_work_rate_high       0.15    -0.01       0.02   0.01  ...
defensive_work_rate_low        0.10     0.28       0.24   0.20  ...
defensive_work_rate_medium    -0.19    -0.19      -0.18  -0.15  ...

                           gk_kicking  gk_positioning  gk_reflexes  \
player_api_id                   -0.35           -0.14        -0.14   
overall_rating                   0.18            0.05         0.05   
potential                        0.06           -0.01        -0.01   
crossing                        -0.41           -0.62        -0.62   
finishing                       -0.36           -0.48        -0.49   
heading_accuracy                -0.51           -0.69        -0.69   
short_passing                   -0.49           -0.71        -0.71   
volleys                         -0.34           -0.50        -0.51   
dribbling                       -0.53           -0.68        -0.68   
curve                           -0.38           -0.56        -0.56   
free_kick_accuracy              -0.31           -0.51        -0.51   
long_passing                    -0.27           -0.48        -0.49   
ball_control                    -0.56           -0.76        -0.76   
acceleration                    -0.47           -0.55        -0.55   
sprint_speed                    -0.49           -0.57        -0.57   
agility                         -0.35           -0.42        -0.42   
reactions                        0.07           -0.06        -0.06   
balance                         -0.33           -0.44        -0.44   
shot_power                      -0.43           -0.60        -0.60   
jumping                         -0.02           -0.05        -0.05   
stamina                         -0.45           -0.61        -0.62   
strength                         0.02           -0.06        -0.06   
long_shots                      -0.37           -0.55        -0.55   
aggression                      -0.27           -0.45        -0.45   
interceptions                   -0.17           -0.38        -0.38   
positioning                     -0.38           -0.57        -0.57   
vision                          -0.26           -0.49        -0.50   
penalties                       -0.30           -0.50        -0.51   
marking                         -0.25           -0.40        -0.40   
standing_tackle                 -0.28           -0.44        -0.44   
sliding_tackle                  -0.27           -0.42        -0.42   
gk_diving                        0.78            0.96         0.97   
gk_handling                      0.85            0.97         0.97   
gk_kicking                       1.00            0.85         0.84   
gk_positioning                   0.85            1.00         0.97   
```

```
gk_reflexes                   0.84          0.97          1.00
preferred_foot                0.06          0.07          0.07
attacking_work_rate_high     -0.20         -0.18         -0.18
attacking_work_rate_low      -0.04         -0.07         -0.07
attacking_work_rate_medium    0.21          0.20          0.20
defensive_work_rate_high     -0.11         -0.13         -0.13
defensive_work_rate_low      -0.08         -0.10         -0.10
defensive_work_rate_medium    0.15          0.17          0.17

                            preferred_foot  attacking_work_rate_high  \
player_api_id                        -0.01                      0.04
overall_rating                        0.01                      0.12
potential                            -0.00                      0.14
crossing                             -0.17                      0.28
finishing                             0.02                      0.28
heading_accuracy                      0.00                      0.07
short_passing                        -0.06                      0.19
volleys                              -0.01                      0.25
dribbling                            -0.08                      0.31
curve                                -0.12                      0.26
free_kick_accuracy                   -0.12                      0.19
long_passing                         -0.09                      0.11
ball_control                         -0.07                      0.26
acceleration                         -0.08                      0.35
sprint_speed                         -0.08                      0.36
agility                              -0.06                      0.32
reactions                             0.01                      0.15
balance                              -0.06                      0.23
shot_power                           -0.05                      0.24
jumping                               0.04                      0.04
stamina                              -0.07                      0.25
strength                              0.05                     -0.09
long_shots                           -0.05                      0.25
aggression                           -0.04                      0.04
interceptions                        -0.08                     -0.05
positioning                          -0.03                      0.30
vision                               -0.04                      0.20
penalties                            -0.01                      0.20
marking                              -0.10                     -0.06
standing_tackle                      -0.09                     -0.05
sliding_tackle                       -0.10                     -0.04
gk_diving                             0.07                     -0.16
gk_handling                           0.07                     -0.17
gk_kicking                            0.06                     -0.20
gk_positioning                        0.07                     -0.18
gk_reflexes                           0.07                     -0.18
preferred_foot                        1.00                     -0.04
attacking_work_rate_high             -0.04                      1.00
attacking_work_rate_low               0.04                     -0.13
attacking_work_rate_medium            0.02                     -0.87
defensive_work_rate_high              0.04                      0.05
defensive_work_rate_low               0.00                      0.05
defensive_work_rate_medium           -0.04                     -0.08

                            attacking_work_rate_low  \
player_api_id                                 -0.08
overall_rating                                 0.04
```

```
potential                                   -0.02
crossing                                    -0.07
finishing                                   -0.13
heading_accuracy                             0.15
short_passing                                0.00
volleys                                     -0.10
dribbling                                   -0.12
curve                                       -0.09
free_kick_accuracy                          -0.05
long_passing                                 0.02
ball_control                                -0.04
acceleration                                -0.14
sprint_speed                                -0.13
agility                                     -0.16
reactions                                   -0.00
balance                                     -0.08
shot_power                                  -0.03
jumping                                      0.05
stamina                                      0.00
strength                                     0.17
long_shots                                  -0.08
aggression                                   0.16
interceptions                                0.19
positioning                                 -0.12
vision                                      -0.05
penalties                                   -0.04
marking                                      0.20
standing_tackle                              0.20
sliding_tackle                               0.18
gk_diving                                   -0.07
gk_handling                                 -0.07
gk_kicking                                  -0.04
gk_positioning                              -0.07
gk_reflexes                                 -0.07
preferred_foot                               0.04
attacking_work_rate_high                    -0.13
attacking_work_rate_low                      1.00
attacking_work_rate_medium                  -0.38
defensive_work_rate_high                     0.14
defensive_work_rate_low                     -0.01
defensive_work_rate_medium                  -0.11

                            attacking_work_rate_medium  \
player_api_id                                     0.01
overall_rating                                   -0.13
potential                                        -0.12
crossing                                         -0.22
finishing                                        -0.20
heading_accuracy                                 -0.14
short_passing                                    -0.18
volleys                                          -0.19
dribbling                                        -0.23
curve                                            -0.20
free_kick_accuracy                               -0.16
long_passing                                     -0.12
ball_control                                     -0.22
acceleration                                     -0.26
```

```
sprint_speed                                  -0.27
agility                                       -0.22
reactions                                     -0.14
balance                                       -0.18
shot_power                                    -0.20
jumping                                       -0.06
stamina                                       -0.24
strength                                      -0.00
long_shots                                    -0.20
aggression                                    -0.12
interceptions                                 -0.05
positioning                                   -0.22
vision                                        -0.16
penalties                                     -0.16
marking                                       -0.04
standing_tackle                               -0.05
sliding_tackle                                -0.05
gk_diving                                      0.19
gk_handling                                    0.20
gk_kicking                                     0.21
gk_positioning                                 0.20
gk_reflexes                                    0.20
preferred_foot                                 0.02
attacking_work_rate_high                      -0.87
attacking_work_rate_low                       -0.38
attacking_work_rate_medium                     1.00
defensive_work_rate_high                      -0.12
defensive_work_rate_low                       -0.04
defensive_work_rate_medium                     0.13

                            defensive_work_rate_high  defensive_work_rate_low
\
player_api_id                                  -0.06                    -0.06
overall_rating                                  0.11                     0.10
potential                                       0.07                     0.08
crossing                                        0.06                     0.12
finishing                                      -0.04                     0.32
heading_accuracy                                0.18                     0.07
short_passing                                   0.15                     0.10
volleys                                        -0.01                     0.28
dribbling                                       0.02                     0.24
curve                                           0.01                     0.20
free_kick_accuracy                              0.03                     0.18
long_passing                                    0.17                    -0.00
ball_control                                    0.09                     0.19
acceleration                                   -0.00                     0.17
sprint_speed                                    0.01                     0.16
agility                                        -0.02                     0.18
reactions                                       0.11                     0.09
balance                                         0.03                     0.09
shot_power                                      0.08                     0.20
jumping                                         0.14                    -0.04
stamina                                         0.25                    -0.03
strength                                        0.18                    -0.05
long_shots                                      0.04                     0.23
aggression                                      0.29                    -0.12
interceptions                                   0.28                    -0.22
```

```
positioning                    0.00                 0.25
vision                         0.07                 0.16
penalties                      0.00                 0.24
marking                        0.28                -0.27
standing_tackle                0.29                -0.26
sliding_tackle                 0.28                -0.27
gk_diving                     -0.12                -0.10
gk_handling                   -0.13                -0.10
gk_kicking                    -0.11                -0.08
gk_positioning                -0.13                -0.10
gk_reflexes                   -0.13                -0.10
preferred_foot                 0.04                 0.00
attacking_work_rate_high       0.05                 0.05
attacking_work_rate_low        0.14                -0.01
attacking_work_rate_medium    -0.12                -0.04
defensive_work_rate_high       1.00                -0.14
defensive_work_rate_low       -0.14                 1.00
defensive_work_rate_medium    -0.73                -0.58

                            defensive_work_rate_medium
player_api_id                                     0.09
overall_rating                                   -0.16
potential                                        -0.12
crossing                                         -0.14
finishing                                        -0.19
heading_accuracy                                 -0.19
short_passing                                    -0.19
volleys                                          -0.19
dribbling                                        -0.18
curve                                            -0.15
free_kick_accuracy                               -0.14
long_passing                                     -0.14
ball_control                                     -0.21
acceleration                                     -0.12
sprint_speed                                     -0.12
agility                                          -0.11
reactions                                        -0.15
balance                                          -0.09
shot_power                                       -0.20
jumping                                          -0.09
stamina                                          -0.19
strength                                         -0.12
long_shots                                       -0.19
aggression                                       -0.15
interceptions                                    -0.08
positioning                                      -0.18
vision                                           -0.17
penalties                                        -0.17
marking                                          -0.04
standing_tackle                                  -0.06
sliding_tackle                                   -0.04
gk_diving                                         0.17
gk_handling                                       0.18
gk_kicking                                        0.15
gk_positioning                                    0.17
gk_reflexes                                       0.17
preferred_foot                                   -0.04
```

```
attacking_work_rate_high                              -0.08
attacking_work_rate_low                               -0.11
attacking_work_rate_medium                             0.13
defensive_work_rate_high                              -0.73
defensive_work_rate_low                               -0.58
defensive_work_rate_medium                             1.00

[43 rows x 43 columns]
```

In [31]:

```
## Checking vif
vif = pd.DataFrame()
vif["VIF"] = [variance_inflation_factor(X.values, i) for i in range(X.shape[1
])]
vif["Features"] = X.columns
```

```
C:\ProgramData\Anaconda3\lib\site-packages\statsmodels\stats\outliers_influen
ce.py:193: RuntimeWarning: divide by zero encountered in double_scalars
  vif = 1. / (1. - r_squared_i)
```

In [32]:
```
vif
```

Out[32]:

	VIF	Features
0	2.161221	player_api_id
1	2.859756	potential
2	5.976104	crossing
3	9.890948	finishing
4	5.471613	heading_accuracy
5	12.519310	short_passing
6	6.247624	volleys
7	12.943865	dribbling
8	5.585140	curve
9	4.648278	free_kick_accuracy
10	5.981093	long_passing
11	19.527219	ball_control
12	10.039718	acceleration
13	8.305203	sprint_speed
14	4.837762	agility
15	2.947213	reactions
16	2.844208	balance
17	5.534573	shot_power
18	1.566554	jumping
19	3.336308	stamina
20	2.827420	strength
21	8.003257	long_shots
22	3.472525	aggression
23	7.708101	interceptions
24	7.367449	positioning
25	5.797475	vision
26	4.130926	penalties
27	19.076590	marking
28	28.479438	standing_tackle
29	21.278013	sliding_tackle
30	23.392608	gk_diving
31	25.795223	gk_handling
32	6.266171	gk_kicking
33	26.318344	gk_positioning
34	29.497448	gk_reflexes

	VIF	Features
35	1.091762	preferred_foot
36	inf	attacking_work_rate_high
37	inf	attacking_work_rate_low
38	inf	attacking_work_rate_medium
39	inf	defensive_work_rate_high
40	inf	defensive_work_rate_low
41	inf	defensive_work_rate_medium

Observations in VIF:

short_passing, dribbling, ball_control, marking, standing_tackle, sliding_tackle, gk_diving, gk_handling, gk_positioning, gk_reflexes have vif > 10

In [33]:
```
col=['ball_control', 'overall_rating', 'short_passing', 'dribbling', 'marking'
, 'standing_tackle', 'sliding_tackle',
     'gk_diving', 'gk_handling', 'gk_positioning', 'gk_reflexes']
X_linear = processed_data.drop(columns=col)
```

In [34]:
```
## Checking vif
vif = pd.DataFrame()
vif["VIF"] = [variance_inflation_factor(X_linear.values, i) for i in range(X_l
inear.shape[1])]
vif["Features"] = X_linear.columns
```

```
C:\ProgramData\Anaconda3\lib\site-packages\statsmodels\stats\outliers_influen
ce.py:193: RuntimeWarning: divide by zero encountered in double_scalars
  vif = 1. / (1. - r_squared_i)
```

In [35]:
```
vif
```

Out[35]:

	VIF	Features
0	2.019377	player_api_id
1	2.267004	potential
2	5.295644	crossing
3	8.997160	finishing
4	3.890618	heading_accuracy
5	6.100403	volleys
6	5.476876	curve
7	4.599292	free_kick_accuracy
8	4.177982	long_passing
9	9.827023	acceleration
10	8.224285	sprint_speed
11	4.685641	agility
12	2.696345	reactions
13	2.801016	balance
14	5.489681	shot_power
15	1.495031	jumping
16	3.292730	stamina
17	2.798039	strength
18	7.957654	long_shots
19	3.388399	aggression
20	4.438341	interceptions
21	6.981542	positioning
22	5.432903	vision
23	4.091354	penalties
24	3.017452	gk_kicking
25	1.084372	preferred_foot
26	inf	attacking_work_rate_high
27	inf	attacking_work_rate_low
28	inf	attacking_work_rate_medium
29	inf	defensive_work_rate_high
30	inf	defensive_work_rate_low
31	inf	defensive_work_rate_medium

In [36]:
```
# Train-test split
X_train1, X_test1, y_train1, y_test1 = train_test_split(X_linear, y, train_siz
e=0.7, shuffle=True, random_state=1)
```

In [37]:
```
lm = LinearRegression()
lm.fit(X_train1, y_train1)
```

Out[37]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=Fals
e)
```

In [38]:
```
lm.score(X_train1, y_train1)
```

Out[38]:
```
0.8721909899356671
```

In [39]:
```
lm.score(X_test1, y_test1)
```

Out[39]:
```
0.8631139900357162
```

In [40]:
```
lm = smf.ols(formula='overall_rating ~ '+' + '.join(X_linear.columns), data=pr
ocessed_data).fit()
lm.conf_int()
```

Out[40]:

	0	1
Intercept	2.107873	2.993115
player_api_id	-0.000009	-0.000008
potential	0.603831	0.626334
crossing	0.010757	0.022916
finishing	0.006786	0.020935
heading_accuracy	-0.005333	0.005477
volleys	-0.002494	0.009707
curve	0.005660	0.017250
free_kick_accuracy	-0.013445	-0.002196
long_passing	0.021343	0.034756
acceleration	-0.025657	-0.002739
sprint_speed	-0.016764	0.004968
agility	-0.016043	-0.000851
reactions	0.194040	0.211530
balance	-0.002592	0.010107
shot_power	0.005028	0.018180
jumping	0.016507	0.027439
stamina	-0.021938	-0.008262
strength	0.043302	0.056311
long_shots	-0.024373	-0.010413
aggression	0.004692	0.015250
interceptions	-0.012987	-0.002703
positioning	-0.018525	-0.004978
vision	-0.004766	0.009418
penalties	0.015055	0.027574
gk_kicking	0.026104	0.035315
preferred_foot	-0.105540	0.101824
attacking_work_rate_high	0.668842	1.034441
attacking_work_rate_low	0.917089	1.322470
attacking_work_rate_medium	0.420611	0.737534
defensive_work_rate_high	0.677974	1.045253
defensive_work_rate_low	0.823667	1.194627
defensive_work_rate_medium	0.525641	0.833826

In [41]:
```
lm.summary()
```

Out[41]:

OLS Regression Results

Dep. Variable:	overall_rating	**R-squared:**	0.870
Model:	OLS	**Adj. R-squared:**	0.869
Method:	Least Squares	**F-statistic:**	2311.
Date:	Wed, 17 Mar 2021	**Prob (F-statistic):**	0.00
Time:	09:59:52	**Log-Likelihood:**	-23093.
No. Observations:	10410	**AIC:**	4.625e+04
Df Residuals:	10379	**BIC:**	4.647e+04
Df Model:	30		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
Intercept	2.5505	0.226	11.295	0.000	2.108	2.993
player_api_id	-8.28e-06	1.9e-07	-43.516	0.000	-8.65e-06	-7.91e-06
potential	0.6151	0.006	107.157	0.000	0.604	0.626
crossing	0.0168	0.003	5.429	0.000	0.011	0.023
finishing	0.0139	0.004	3.840	0.000	0.007	0.021
heading_accuracy	7.195e-05	0.003	0.026	0.979	-0.005	0.005
volleys	0.0036	0.003	1.159	0.247	-0.002	0.010
curve	0.0115	0.003	3.875	0.000	0.006	0.017
free_kick_accuracy	-0.0078	0.003	-2.725	0.006	-0.013	-0.002
long_passing	0.0280	0.003	8.198	0.000	0.021	0.035
acceleration	-0.0142	0.006	-2.429	0.015	-0.026	-0.003
sprint_speed	-0.0059	0.006	-1.064	0.287	-0.017	0.005
agility	-0.0084	0.004	-2.180	0.029	-0.016	-0.001
reactions	0.2028	0.004	45.454	0.000	0.194	0.212
balance	0.0038	0.003	1.160	0.246	-0.003	0.010
shot_power	0.0116	0.003	3.459	0.001	0.005	0.018
jumping	0.0220	0.003	7.880	0.000	0.017	0.027
stamina	-0.0151	0.003	-4.329	0.000	-0.022	-0.008
strength	0.0498	0.003	15.010	0.000	0.043	0.056
long_shots	-0.0174	0.004	-4.885	0.000	-0.024	-0.010
aggression	0.0100	0.003	3.702	0.000	0.005	0.015
interceptions	-0.0078	0.003	-2.991	0.003	-0.013	-0.003
positioning	-0.0118	0.003	-3.401	0.001	-0.019	-0.005
vision	0.0023	0.004	0.643	0.520	-0.005	0.009
penalties	0.0213	0.003	6.675	0.000	0.015	0.028

gk_kicking	0.0307	0.002	13.070	0.000	0.026	0.035
preferred_foot	-0.0019	0.053	-0.035	0.972	-0.106	0.102
attacking_work_rate_high	0.8516	0.093	9.132	0.000	0.669	1.034
attacking_work_rate_low	1.1198	0.103	10.829	0.000	0.917	1.322
attacking_work_rate_medium	0.5791	0.081	7.163	0.000	0.421	0.738
defensive_work_rate_high	0.8616	0.094	9.197	0.000	0.678	1.045
defensive_work_rate_low	1.0091	0.095	10.665	0.000	0.824	1.195
defensive_work_rate_medium	0.6797	0.079	8.647	0.000	0.526	0.834

Omnibus:	787.714	**Durbin-Watson:**	1.799
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	1891.006
Skew:	-0.463	**Prob(JB):**	0.00
Kurtosis:	4.871	**Cond. No.**	1.42e+16

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 2.76e-18. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

As p values for heading_accuracy, volleys, sprint_speed, balance, vision and preferred_foot > 0.05, we fail to reject null hypothesis. Hence, there is no correlation between these variables and overall_rating. So, we drop them

In [42]:
```
X_linear = X_linear.drop(columns=['heading_accuracy', 'volleys', 'sprint_speed', 'balance', 'vision', 'preferred_foot'])
lm = smf.ols(formula='overall_rating ~ '+' + '.join(X_linear.columns), data=processed_data).fit()
lm.summary()
```

Out[42]:

OLS Regression Results

Dep. Variable:	overall_rating	**R-squared:**	0.870
Model:	OLS	**Adj. R-squared:**	0.869
Method:	Least Squares	**F-statistic:**	2888.
Date:	Wed, 17 Mar 2021	**Prob (F-statistic):**	0.00
Time:	09:59:52	**Log-Likelihood:**	-23096.
No. Observations:	10410	**AIC:**	4.624e+04
Df Residuals:	10385	**BIC:**	4.642e+04
Df Model:	24		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	2.6170	0.215	12.187	0.000	2.196	3.038
player_api_id	-8.296e-06	1.88e-07	-44.121	0.000	-8.66e-06	-7.93e-06
potential	0.6148	0.006	108.496	0.000	0.604	0.626
crossing	0.0167	0.003	5.482	0.000	0.011	0.023
finishing	0.0152	0.003	4.573	0.000	0.009	0.022
curve	0.0120	0.003	4.126	0.000	0.006	0.018
free_kick_accuracy	-0.0074	0.003	-2.594	0.010	-0.013	-0.002
long_passing	0.0291	0.003	9.136	0.000	0.023	0.035
acceleration	-0.0184	0.004	-4.824	0.000	-0.026	-0.011
agility	-0.0073	0.004	-1.962	0.050	-0.015	-7.66e-06
reactions	0.2031	0.004	45.774	0.000	0.194	0.212
shot_power	0.0116	0.003	3.528	0.000	0.005	0.018
jumping	0.0224	0.003	8.385	0.000	0.017	0.028
stamina	-0.0155	0.003	-4.487	0.000	-0.022	-0.009
strength	0.0481	0.003	15.697	0.000	0.042	0.054
long_shots	-0.0165	0.004	-4.693	0.000	-0.023	-0.010
aggression	0.0103	0.003	3.854	0.000	0.005	0.015
interceptions	-0.0076	0.002	-3.062	0.002	-0.013	-0.003
positioning	-0.0104	0.003	-3.173	0.002	-0.017	-0.004
penalties	0.0221	0.003	7.132	0.000	0.016	0.028
gk_kicking	0.0310	0.002	14.614	0.000	0.027	0.035
attacking_work_rate_high	0.8656	0.091	9.547	0.000	0.688	1.043
attacking_work_rate_low	1.1502	0.100	11.550	0.000	0.955	1.345
attacking_work_rate_medium	0.6012	0.078	7.724	0.000	0.449	0.754
defensive_work_rate_high	0.8874	0.090	9.835	0.000	0.711	1.064

defensive_work_rate_low	1.0297	0.092	11.185	0.000	0.849	1.210
defensive_work_rate_medium	0.6998	0.075	9.318	0.000	0.553	0.847

Omnibus:	795.685	**Durbin-Watson:**	1.797
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	1927.802
Skew:	-0.465	**Prob(JB):**	0.00
Kurtosis:	4.892	**Cond. No.**	1.42e+16

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 2.76e-18. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

In [43]:
```
# Train-test split
X_train1, X_test1, y_train1, y_test1 = train_test_split(X_linear, y, train_siz
e=0.7, shuffle=True, random_state=1)
```

In [44]:
```
regression = LinearRegression()
regression.fit(X_train1, y_train1)
linear_score = regression.score(X_test1, y_test1)
linear_score
```

Out[44]:
```
0.863511040006284
```

Decision Tree Regressor Model

In [45]:
```
dtr = DecisionTreeRegressor()
dtr.fit(X_train, y_train)
```

Out[45]:
```
DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse', max_depth=None,
                      max_features=None, max_leaf_nodes=None,
                      min_impurity_decrease=0.0, min_impurity_split=None,
                      min_samples_leaf=1, min_samples_split=2,
                      min_weight_fraction_leaf=0.0, presort='deprecated',
                      random_state=None, splitter='best')
```

In [46]:
```
dtr.score(X_train, y_train)
```

Out[46]:
```
1.0
```

In [47]:
```
dtr_score = dtr.score(X_test, y_test)
dtr_score
```

Out[47]:
```
0.8589730610292061
```

Random Forest Regressor Model

In [48]:
```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

In [49]:
```
x_train2, x_test2, y_train2, y_test2 = train_test_split(X_scaled, y, test_size
=0.3, random_state=7)
```

In [50]:
```
rf = RandomForestRegressor()
rf.fit(x_train2, y_train2)
```

Out[50]:
```
RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
                      max_depth=None, max_features='auto', max_leaf_nodes=Non
e,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=1,
                      min_samples_split=2, min_weight_fraction_leaf=0.0,
                      n_estimators=100, n_jobs=None, oob_score=False,
                      random_state=None, verbose=0, warm_start=False)
```

In [51]:
```
rf.score(x_train2, y_train2)
```

Out[51]:
```
0.9924013303203617
```

In [52]:
```
rf_score = rf.score(x_test2, y_test2)
rf_score
```

Out[52]:
```
0.9420321201993997
```

Support Vector Regressor Model

In [53]:
```
svr = SVR()
svr.fit(x_train2, y_train2)
```

Out[53]:
```
SVR(C=1.0, cache_size=200, coef0=0.0, degree=3, epsilon=0.1, gamma='scale',
    kernel='rbf', max_iter=-1, shrinking=True, tol=0.001, verbose=False)
```

In [54]:
```
svr.score(x_train2, y_train2)
```

Out[54]:
```
0.9712385183998505
```

In [55]:
```
svr_score = svr.score(x_test2, y_test2)
svr_score
```

Out[55]:
```
0.9639709904060725
```

XG - Boost Regressor Model

In [56]:
```
xgbr = XGBRegressor()
xgbr.fit(x_train2, y_train2)
```

Out[56]:
```
XGBRegressor(base_score=0.5, booster='gbtree', colsample_bylevel=1,
             colsample_bynode=1, colsample_bytree=1, gamma=0, gpu_id=-1,
             importance_type='gain', interaction_constraints='',
             learning_rate=0.300000012, max_delta_step=0, max_depth=6,
             min_child_weight=1, missing=nan, monotone_constraints='()',
             n_estimators=100, n_jobs=0, num_parallel_tree=1,
             objective='reg:squarederror', random_state=0, reg_alpha=0,
             reg_lambda=1, scale_pos_weight=1, subsample=1, tree_method='exac
t',
             validate_parameters=1, verbosity=None)
```

In [57]:
```
xgbr.score(x_train2, y_train2)
```

Out[57]:
```
0.9960869805278653
```

In [58]:
```
xgbr_score = xgbr.score(x_test2, y_test2)
xgbr_score
```

Out[58]:
```
0.9602613658002433
```

Final Scores of all Models

In [59]:
```
print('Linear Regression Model Score: ', linear_score)
print('Decision Tree Regressor Model Score: ', dtr_score)
print('Random Forest Regressor Model Score: ', rf_score)
print('Support Vector Machine Regressor Model Score: ', svr_score)
print('XGBoost Regressor Model Score: ', xgbr_score)
```

```
Linear Regression Model Score:  0.863511040006284
Decision Tree Regressor Model Score:  0.8589730610292061
Random Forest Regressor Model Score:  0.9420321201993997
Support Vector Machine Regressor Model Score:  0.9639709904060725
XGBoost Regressor Model Score:  0.9602613658002433
```

As seen, support vector machine regressor is giving the best score

In [ ]:
```

```