data_analysis

January 5, 2020

[62]:
```
import time, ast, json, requests
import xgboost
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
import statsmodels.api as sm
import datetime
from pprint import pprint
from sklearn.linear_model import LogisticRegression
from sklearn.feature_selection import RFE
from sklearn.model_selection import train_test_split, RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier, RandomForestRegressor
from sklearn.metrics import accuracy_score, confusion_matrix,␣
 ↪classification_report
from sklearn import svm, tree
# from sklearn.grid_search import GridSearchCV

from scipy import stats

sns.set(color_codes=True)
```

[2]:
```
import warnings
warnings.filterwarnings('ignore')
```

1 Load TFT Game Data

[3]:
```
game_data = pd.read_csv('./tft_csv/complete_match_data.csv')
match_ids = pd.read_csv('./tft_csv/match_ids.csv')
player_data = pd.read_csv('./tft_csv/player_data.csv')
```

[4]:
```
game_data.drop('Unnamed: 0', axis=1, inplace=True)
match_ids.drop('Unnamed: 0', axis=1, inplace=True)
player_data.drop('Unnamed: 0', axis=1, inplace=True)
```

2 Load Extra TFT Data

[5]:
```
tft_items = None
tft_traits = None
tft_champs = None
with open('./tft_extra_data/items.json') as json_file:
    tft_items = json.load(json_file)

with open('./tft_extra_data/traits.json') as json_file:
    tft_traits = json.load(json_file)

with open('./tft_extra_data/champions.json') as json_file:
    tft_champs = json.load(json_file)

temp_items = {}
for item in tft_items:
    temp_items[item['id']] = {'name': item['name'],
                              'tier': item['tier']
                             }
tft_items = temp_items

temp_traits = {}
for trait in tft_traits:
    temp_traits[trait['name']] = {'tier': trait['tier']}

tft_traits = temp_traits
tft_traits['Set2_Glacial'] = {'tier': 'B'}
tft_traits['Set2_Assassin'] = {'tier': 'A'}
tft_traits['Set2_Blademaster'] = {'tier': 'S'}
tft_traits['Set2_Ranger'] = {'tier': 'A'}
tft_traits['Metal'] = {'tier': 'A'}
tft_traits['Wind'] = {'tier': 'B'}
tft_traits['Soulbound'] = {'tier': 'A'}
```

3 Manipulate Data Columns into Features

[6]:
```
# Group Top/Bottom 4 Placements
game_data['game_won'] = [1 if p <= 4 else 0 for p in game_data['placement']]
```

3.0.1 Champ + Tier Evaluation Attempt: #1

[100]:
```
# Champion Evaluation
unit_powers = []
for u in game_data['units']:
    unit_lst = ast.literal_eval(u)
```

```
    unit_power = 0
    for unit in unit_lst:
        name = unit[0]
        rarity = unit[1]
        char_tier = unit[2]
        items = unit[3]

        item_power = 0
        for item in items:
            if item not in tft_items:
                continue
            item_data = tft_items[item]
            # print(item_data['name'], item_data['tier'])

            if item_data['tier'] == 'S':
                item_power += 3
            elif item_data['tier'] == 'A':
                item_power += 2
            elif item_data['tier'] == 'B':
                item_power += 1
            elif item_data['tier'] == 'S-':
                item_power += 2.5
            elif item_data['tier'] == 'A-':
                item_power += 1.5
            elif item_data['tier'] == 'B-':
                item_power += 0.5
        # print(unit)

        unit_power += (1 + rarity) * char_tier + item_power
    unit_powers.append(unit_power)

game_data['team_unit_power'] = unit_powers
```

[101]:
```
# Class Evaluation
class_powers = []
for t in game_data['traits']:
    traits_lst = ast.literal_eval(t)
    class_bonus = 0

    for trait in traits_lst:
        #print(trait)
        trait_name = trait[0]
        trait_active_tier = trait[1]
        trait_power = 0

        if tft_traits[trait_name]['tier'] == 'S':
            trait_power += 3
```

```
        elif tft_traits[trait_name]['tier'] == 'A':
            trait_power += 2
        elif tft_traits[trait_name]['tier'] == 'B':
            trait_power += 1
        elif tft_traits[trait_name]['tier'] == 'C':
            trait_power += 0.5

        if trait_active_tier == 1:
            active_tier_multiplier = 0.4
        else:
            active_tier_multiplier = trait_active_tier/10

        class_bonus += trait_power * (1 + active_tier_multiplier)

    class_powers.append(class_bonus)
game_data['class_powers'] = class_powers
```

4 Split Data for Test/Train

[9]:
```
game_data.head(8)
```

[9]:

	puuid	match_id	game_length	gold_left	last_round	level	placement	players_eliminated	time_eliminated	total_damage_to_players
0	HbYsPpRS3X2RaQ8n5Sm9n2gKU80f927PzBk_krw4kdyRG6...	NA1_3249805878	1959.947266	5	31	8	4	0	1714.102783	95
1	OkaQSLZuy-FUjgfc_a770gWAvOtn5WLYcBN7toyVLJsc1d...	NA1_3249805878	1959.947266	0	35	9	2	3	1951.685059	146
2	HGeDGOQrklxGiScizUCLq_BVn5gTYBy-DldOuy38XcaKap...	NA1_3249805878	1959.947266	0	31	7	5	0	1711.923218	72
3	VyCpwiJ3MifHEREwjj0cSAXHQIjFGd7UtWMBG9ZvCdlGso...	NA1_3249805878	1959.947266	30	26	7	7	0	1445.723633	55
4	UsiShYgxH3X5_pNeJjE-EpBhbR4vevorLcs83aI8ZSQFaZ...	NA1_3249805878	1959.947266	4	33	8	3	0		
5	BXPswgAxjGfAfQHvaF-m7CtUdbBvZQhcviLqZwZDyDZbDn...	NA1_3249805878	1959.947266	50	28	8	6	0		
6	zqelCdkKSSNGoCJA9msW7sP-wmzIW0HPG8b8ElUMwLCIMl...	NA1_3249805878	1959.947266	8	24	7	8	0		
7	BXZMHIfauv8M3BuaqO6wZnxQXrN2flWKj1GhJ6nNQeP3DD...	NA1_3249805878	1959.947266	1	35	9	1	4		

```
4      1819.271362                       129
5      1567.998779                        80
6      1324.369019                        31
7      1951.685059                       176

                                                traits  \
0  [('Berserker', 2), ('Desert', 0), ('Electric',...
1  [('Avatar', 1), ('Electric', 3), ('Inferno', 1...
2  [('Berserker', 0), ('Desert', 2), ('Inferno', ...
3  [('Inferno', 1), ('Light', 0), ('Mountain', 0)...
4  [('Avatar', 1), ('Desert', 1), ('Inferno', 0),...
5  [('Inferno', 1), ('Light', 0), ('Mage', 0), ('...
6  [('Desert', 1), ('Inferno', 0), ('Light', 0), ...
7  [('Avatar', 1), ('Crystal', 0), ('Electric', 0...

                                                units  game_won  \
0  [('Renekton', 0, 2, []), ('DrMundo', 2, 2, [])...         1
1  [('Annie', 3, 2, []), ('Zed', 4, 2, [24, 66, 1...         1
2  [('Nocturne', 2, 2, [19, 19, 23]), ('Sivir', 2...         0
3  [('Kindred', 2, 2, [44, 22, 39]), ('Malzahar',...         0
4  [('Yasuo', 1, 2, []), ('Sivir', 2, 2, [25, 46,...         1
5  [('Nami', 4, 1, [25, 57]), ('Thresh', 1, 2, [6...         0
6  [('Aatrox', 2, 2, []), ('Nocturne', 2, 2, [19,...         0
7  [('Malphite', 3, 2, []), ('Lux', 5, 1, []), ('...         1

   team_unit_power  class_powers
0               52          16.6
1               91          26.0
2               52          14.8
3               57          20.8
4               73          23.0
5               61          22.4
6               48          13.6
7               89          31.4
```

[102]:
```
# feature_columns = ['gold_left', 'level','players_eliminated',␣
 ↪'total_damage_to_players']
feature_columns = ['team_unit_power',
                   'class_powers',
                   'players_eliminated',
                   'total_damage_to_players',
#                    'gold_left',
#                    'level'
                  ]
X = game_data[feature_columns]
y = game_data['game_won']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
↪shuffle=True)
```

4.0.1 Logistic Regression

[103]:
```
# Feature Elimination
logreg = LogisticRegression()
rfe = RFE(logreg, 20)
rfe = rfe.fit(X_train, y_train)
print(rfe.support_)
print(rfe.ranking_)
```

```
[ True  True  True  True]
[1 1 1 1]
```

[104]:
```
logit_model=sm.Logit(y,X)
result=logit_model.fit()
print(result.summary2())
```

```
Optimization terminated successfully.
         Current function value: 0.325575
         Iterations 8
                          Results: Logit
==========================================================================
Model:                 Logit              Pseudo R-squared:   0.530
Dependent Variable:    game_won           AIC:                10509.7574
Date:                  2020-01-04 13:26   BIC:                10540.5106
No. Observations:      16128              Log-Likelihood:     -5250.9
Df Model:              3                  LL-Null:            -11179.
Df Residuals:          16124              LLR p-value:        0.0000
Converged:             1.0000             Scale:              1.0000
No. Iterations:        8.0000
--------------------------------------------------------------------------
                         Coef.  Std.Err.    z     P>|z|   [0.025  0.975]
--------------------------------------------------------------------------
team_unit_power         -0.0838   0.0031 -27.1395 0.0000 -0.0899 -0.0778
class_powers            -0.0964   0.0064 -15.1346 0.0000 -0.1089 -0.0839
players_eliminated       1.0487   0.0438  23.9573 0.0000  0.9629  1.1344
total_damage_to_players  0.0715   0.0014  50.9089 0.0000  0.0688  0.0743
==========================================================================
```

[105]:
```
logreg = LogisticRegression()
logreg.fit(X_train, y_train)
y_pred = logreg.predict(X_test)
```

```
print('Accuracy of logistic regression classifier on test set: {:.2f}'.
 ↪format(logreg.score(X_test, y_test)))
```

```
Accuracy of logistic regression classifier on test set: 0.89
```

[106]:
```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.88      0.91      0.89      2374
           1       0.91      0.88      0.90      2465

    accuracy                           0.89      4839
   macro avg       0.89      0.90      0.89      4839
weighted avg       0.90      0.89      0.89      4839
```

4.0.2 Decision Tree

[107]:
```
model_dt = tree.DecisionTreeClassifier()
model_dt.fit(X_train, y_train)
y_pred= model_dt.predict(X_test)

acc = accuracy_score(y_test, y_pred)
print("Accuracy of %s is %s"%(model_dt, acc))
```

```
Accuracy of DecisionTreeClassifier(class_weight=None, criterion='gini',
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=False,
                       random_state=None, splitter='best') is 0.9266377350692292
```

[108]:
```
pd.Series(model_dt.feature_importances_,index=feature_columns).
 ↪sort_values(ascending=False)
```

[108]:
```
total_damage_to_players    0.755999
class_powers               0.131397
team_unit_power            0.093343
players_eliminated         0.019261
dtype: float64
```

4.0.3 Random Forest

[109]:
```
model_rfc = RandomForestClassifier(n_estimators=200)
model_rfc.fit(X_train, y_train)
y_pred= model_rfc.predict(X_test)

acc = accuracy_score(y_test, y_pred)
print("Accuracy of %s is %s"%(model_rfc, acc))
```

```
Accuracy of RandomForestClassifier(bootstrap=True, class_weight=None,
criterion='gini',
                       max_depth=None, max_features='auto', 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, n_estimators=200,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False) is 0.943170076462079
```

[110]:
```
rf_feature_importance = pd.Series(model_rfc.
 ↪feature_importances_,index=feature_columns).sort_values(ascending=False)
rf_feature_importance
```

[110]:
```
total_damage_to_players    0.556631
team_unit_power            0.208219
class_powers               0.128198
players_eliminated         0.106952
dtype: float64
```

Random Forest Paramter Tuning

[61]:
```
rf = RandomForestRegressor(random_state=420)
print('Parameters currently in use:\n')
pprint(rf.get_params())
```

```
Parameters currently in use:

{'bootstrap': True,
 'criterion': 'mse',
 'max_depth': None,
 'max_features': 'auto',
 '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,
 'n_estimators': 'warn',
 'n_jobs': None,
```

```
 'oob_score': False,
 'random_state': 420,
 'verbose': 0,
 'warm_start': False}
```

[63]:
```
# Number of trees in random forest
n_estimators = [int(x) for x in np.linspace(start = 200, stop = 2000, num = 10)]

# Number of features to consider at every split
max_features = ['auto', 'sqrt']

# Maximum number of levels in tree
max_depth = [int(x) for x in np.linspace(10, 110, num = 11)]
max_depth.append(None)

# Minimum number of samples required to split a node
min_samples_split = [2, 5, 10]

# Minimum number of samples required at each leaf node
min_samples_leaf = [1, 2, 4]

# Method of selecting samples for training each tree
bootstrap = [True, False]

# Create the random grid
random_grid = {'n_estimators': n_estimators,
               'max_features': max_features,
               'max_depth': max_depth,
               'min_samples_split': min_samples_split,
               'min_samples_leaf': min_samples_leaf,
               'bootstrap': bootstrap
              }
pprint(random_grid)
```

```
{'bootstrap': [True, False],
 'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, None],
 'max_features': ['auto', 'sqrt'],
 'min_samples_leaf': [1, 2, 4],
 'min_samples_split': [2, 5, 10],
 'n_estimators': [200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000]}
```

[65]:
```
rf = RandomForestRegressor()
rf_random = RandomizedSearchCV(estimator=rf,
                               param_distributions=random_grid,
                               n_iter=100,
                               cv=3,
                               verbose=2,
```

```
                               random_state=420,
                               n_jobs=-1)
rf_random.fit(X_train, y_train)
```

```
Fitting 3 folds for each of 100 candidates, totalling 300 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 4 concurrent workers.
[Parallel(n_jobs=-1)]: Done  33 tasks      | elapsed:  1.4min
[Parallel(n_jobs=-1)]: Done 154 tasks      | elapsed:  6.0min
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed: 11.0min finished
```

[65]:
```
RandomizedSearchCV(cv=3, error_score='raise-deprecating',
                   estimator=RandomForestRegressor(bootstrap=True,
                                                   criterion='mse',
                                                   max_depth=None,
                                                   max_features='auto',
                                                   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,
                                                   n_estimators='warn',
                                                   n_jobs=None, oob_score=False,
                                                   random_sta...
                   param_distributions={'bootstrap': [True, False],
                                        'max_depth': [10, 20, 30, 40, 50, 60,
                                                      70, 80, 90, 100, 110,
                                                      None],
                                        'max_features': ['auto', 'sqrt'],
                                        'min_samples_leaf': [1, 2, 4],
                                        'min_samples_split': [2, 5, 10],
                                        'n_estimators': [200, 400, 600, 800,
                                                         1000, 1200, 1400, 1600,
                                                         1800, 2000]},
                   pre_dispatch='2*n_jobs', random_state=420, refit=True,
                   return_train_score=False, scoring=None, verbose=2)
```

[66]:
```
pprint(rf_random.best_params_)
```

```
{'bootstrap': True,
 'max_depth': 90,
 'max_features': 'sqrt',
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'n_estimators': 1800}
```

[111]:
```
model_rfc_tuned = RandomForestClassifier(n_estimators=1800,
                                         bootstrap=True,
                                         max_depth=90,
                                         max_features='sqrt',
                                         min_samples_leaf=1,
                                         min_samples_split=2
                                        )
model_rfc_tuned.fit(X_train, y_train)
y_pred= model_rfc_tuned.predict(X_test)

acc = accuracy_score(y_test, y_pred)
print("Accuracy of %s is %s"%(model_rfc_tuned, acc))
```

```
Accuracy of RandomForestClassifier(bootstrap=True, class_weight=None,
criterion='gini',
                       max_depth=90, max_features='sqrt', 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, n_estimators=1800,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False) is 0.9433767307294896
```

[112]:
```
rf_tuned_feature_importance = pd.Series(model_rfc_tuned.
 ↪feature_importances_,index=feature_columns).sort_values(ascending=False)
rf_tuned_feature_importance
```

[112]:
```
total_damage_to_players    0.527788
team_unit_power            0.242971
class_powers               0.128201
players_eliminated         0.101040
dtype: float64
```

[99]:
```
cm = confusion_matrix(y_test, y_pred)
print("Confusion Matrix of %s is \n%s"%(model_rfc_tuned, cm))
```

```
Confusion Matrix of RandomForestClassifier(bootstrap=True, class_weight=None,
criterion='gini',
                       max_depth=90, max_features='sqrt', 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, n_estimators=1800,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False) is
[[2274  134]
 [ 168 2263]]
```

4.0.4 SVM

[113]:
```
# SVM
model_svm = svm.SVC(kernel='linear') # linear, rbf, sigmoid, polynomial
model_svm.fit(X_train, y_train)
y_pred = model_svm.predict(X_test)
acc = accuracy_score(y_test, y_pred)
print("Accuracy of %s is %s"%(model_svm, acc))
```

```
Accuracy of SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
    decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
    kernel='linear', max_iter=-1, probability=False, random_state=None,
    shrinking=True, tol=0.001, verbose=False) is 0.8941930150857615
```

[114]:
```
model_svm.coef_, feature_columns
```

[114]:
```
(array([[ 0.0466912 , -0.00845251,  0.52245431,  0.05154237]]),
 ['team_unit_power',
  'class_powers',
  'players_eliminated',
  'total_damage_to_players'])
```

5 XGBoost

[115]:
```
# Extreme Gradient Boost
model_xg = xgboost.XGBClassifier()
model_xg.fit(X_train, y_train)
y_pred = model_xg.predict(X_test)
acc = accuracy_score(y_test, y_pred)
print("Accuracy of %s is %s" % (model_xg, acc))
```

```
Accuracy of XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=1, gamma=0,
              learning_rate=0.1, max_delta_step=0, max_depth=3,
              min_child_weight=1, missing=None, n_estimators=100, n_jobs=1,
              nthread=None, objective='binary:logistic', random_state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
              silent=None, subsample=1, verbosity=1) is 0.8946063236205828
```

[52]:
```
sum(model_xg.feature_importances_.tolist())
```

[52]:
```
1.0000000223517418
```

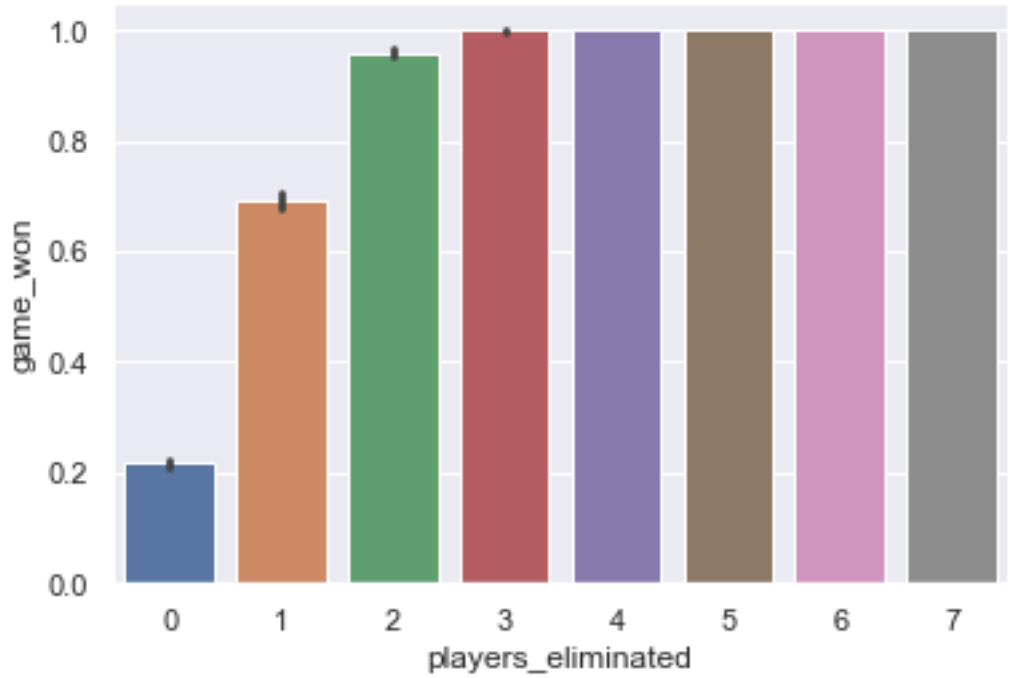
[116]:
```
model_xg.feature_importances_, feature_columns
```

[116]:
```
(array([0.06017964, 0.01340315, 0.06486427, 0.86155295], dtype=float32),
 ['team_unit_power',
  'class_powers',
```

```
        'players_eliminated',
        'total_damage_to_players'])
```

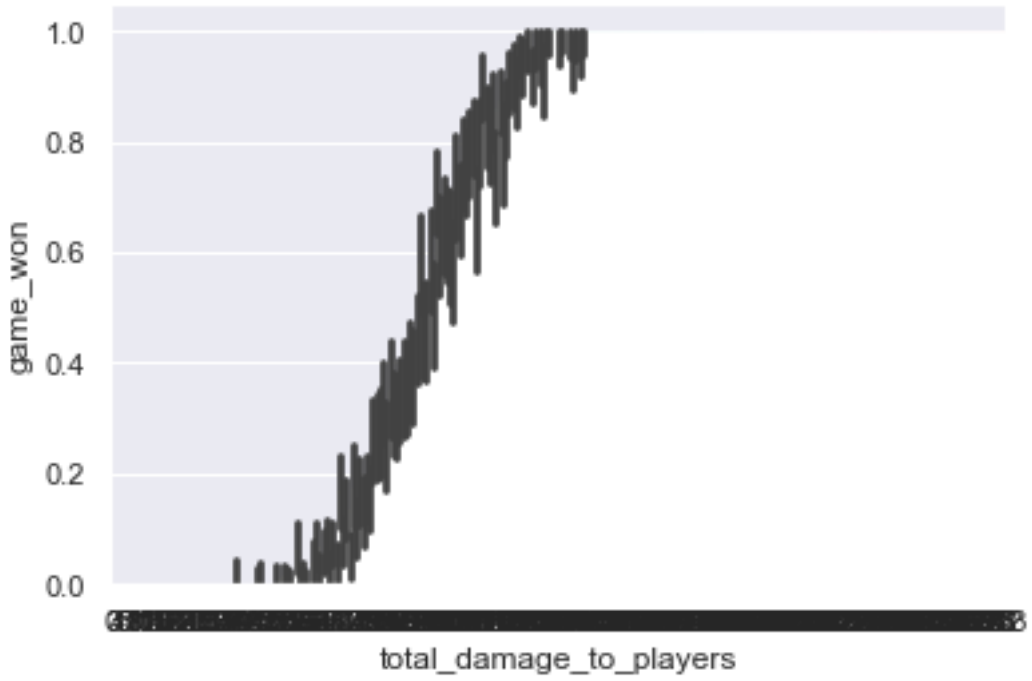
[117]:
```
sns.barplot(x='players_eliminated', y='game_won', data=game_data)
```

[117]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c3d26b080>
```



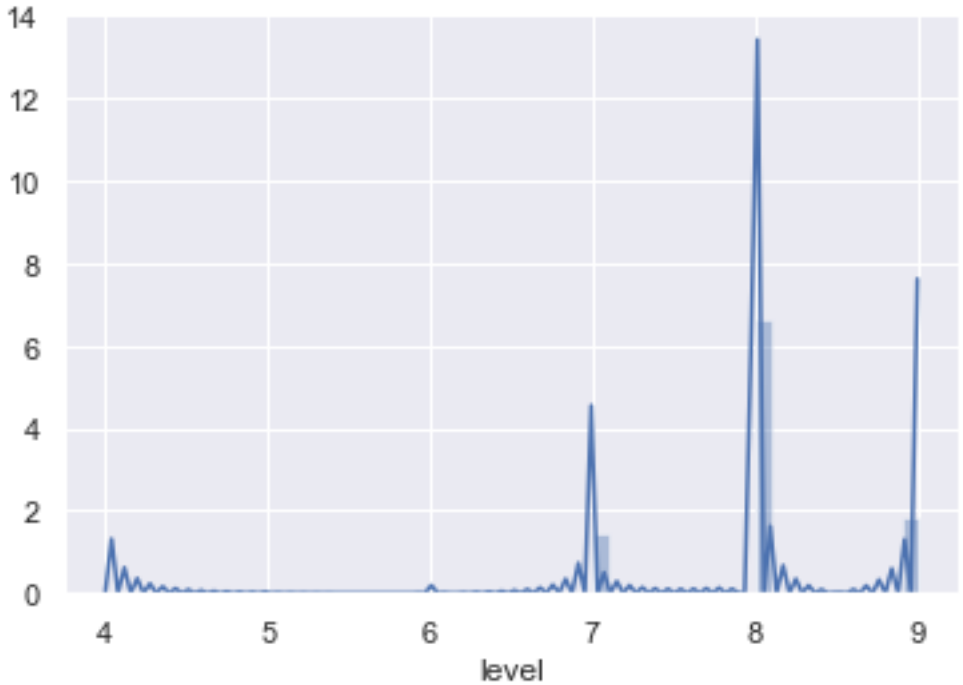
[118]:
```
sns.barplot(x='total_damage_to_players', y='game_won', data=game_data)
```

[118]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c2803ac88>
```



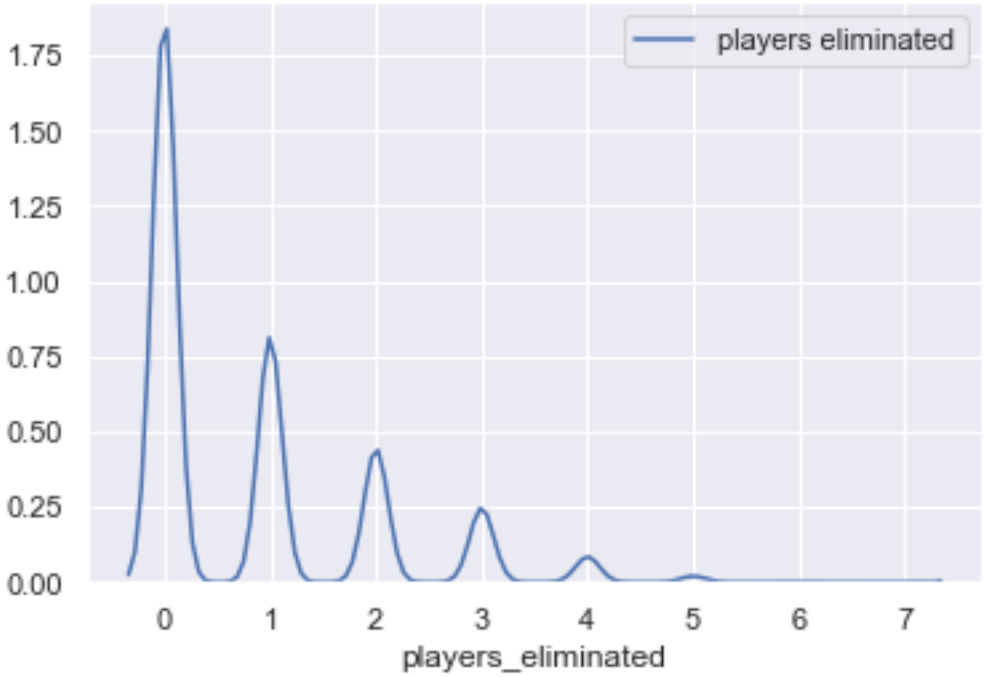
[119]:
```
sns.distplot(game_data['level'], hist=True, kde=True, label = 'Level')
```

[119]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c2ad2c0f0>
```



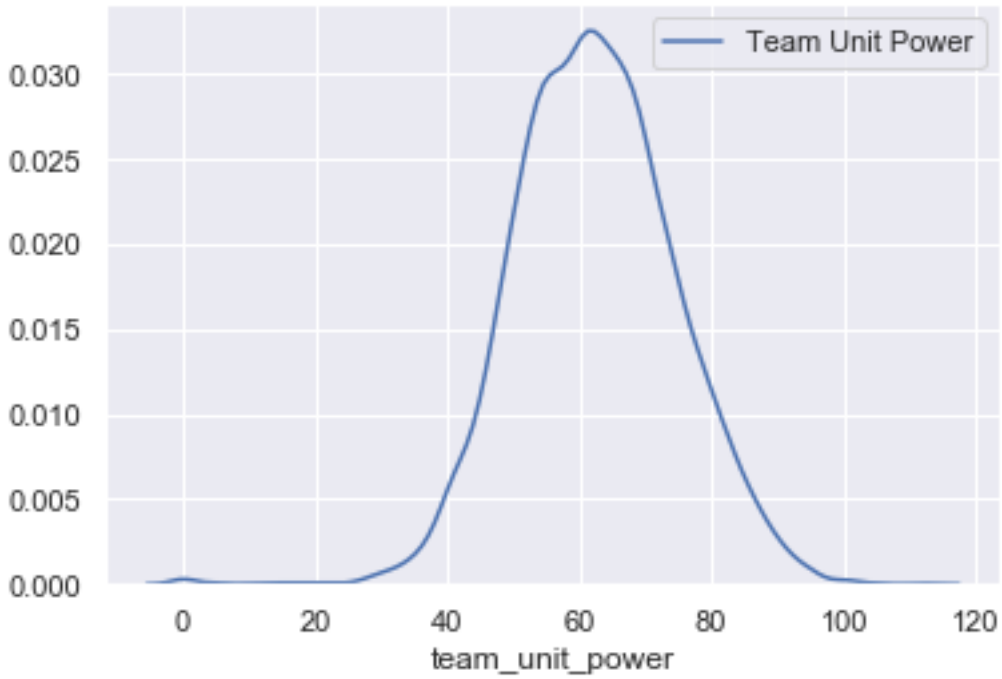
[120]:
```
sns.distplot(game_data['players_eliminated'], hist=False, kde=True, label =␣
↪'players eliminated')
```

[120]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c2af13ac8>
```



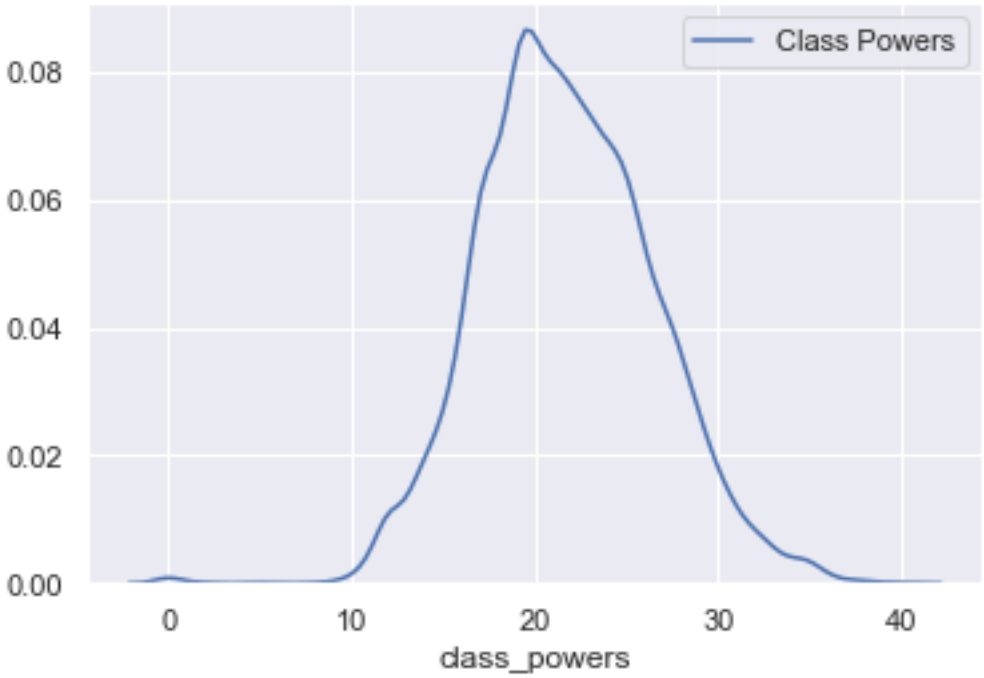
[124]:
```
sns.distplot(game_data['team_unit_power'], hist=False, kde=True, label = 'Team␣
↪Unit Power')
```

[124]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c2b2edc88>
```



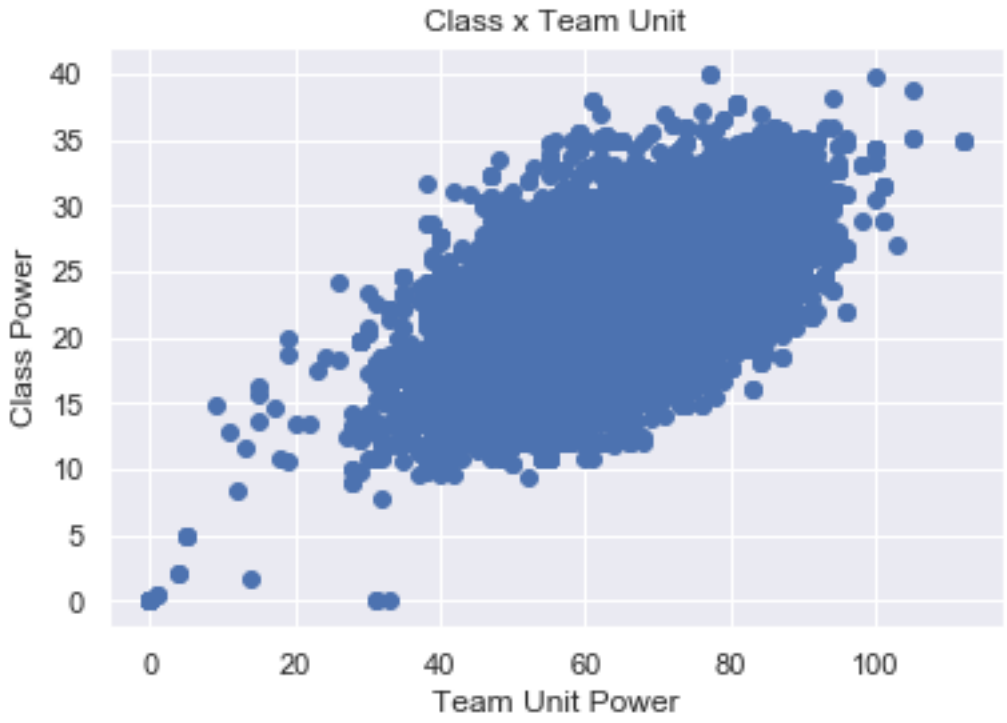
[125]:
```
sns.distplot(game_data['class_powers'], hist=False, kde=True, label = 'Class␣
↪Powers')
```

[125]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c2b3fe6d8>
```



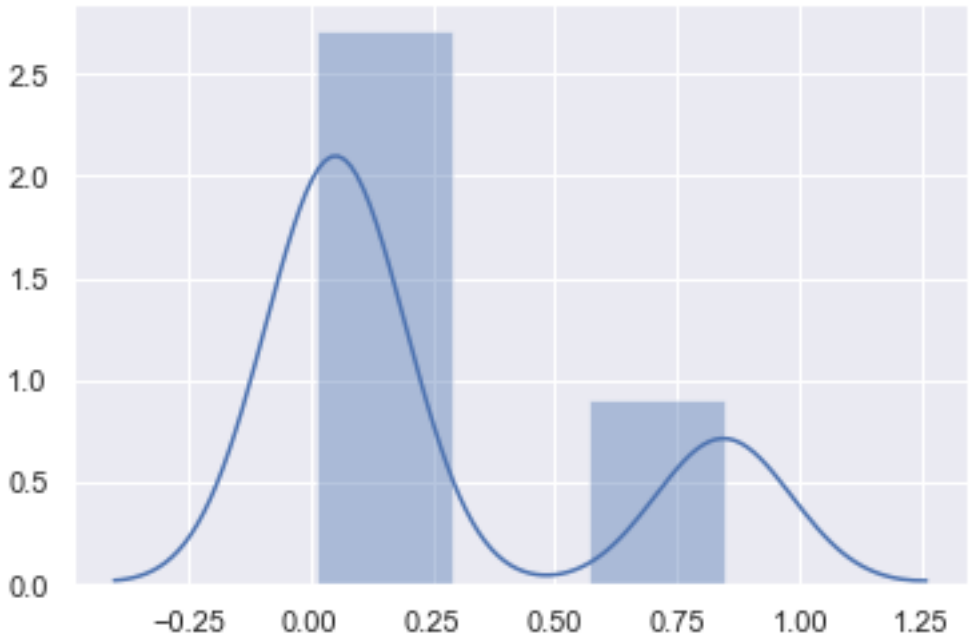
[123]:
```
plt.scatter(x=game_data['team_unit_power'], y=game_data['class_powers'])
plt.xlabel("Team Unit Power")
plt.ylabel("Class Power")
plt.title("Class x Team Unit")
```

[123]:
```
Text(0.5, 1.0, 'Class x Team Unit')
```



[54]:
```
sns.distplot(model_xg.feature_importances_)
```

[54]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c28033a58>
```


2.5
2.0
1.5
1.0
0.5
0.0
−0.25
0.00
0.25
0.50
0.75
1.00
1.25

[ ]: