FB_Models

May 25, 2019

Social network Graph Link Prediction - Facebook Challenge

```
In [1]: #Importing Libraries
        # please do go through this python notebook:
        import warnings
        warnings.filterwarnings("ignore")

        import csv
        import pandas as pd#pandas to create small dataframes
        import datetime #Convert to unix time
        import time #Convert to unix time
        # if numpy is not installed already : pip3 install numpy
        import numpy as np#Do aritmetic operations on arrays
        # matplotlib: used to plot graphs
        import matplotlib
        import matplotlib.pylab as plt
        import seaborn as sns#Plots
        from matplotlib import rcParams#Size of plots
        from sklearn.cluster import MiniBatchKMeans, KMeans#Clustering
        import math
        import pickle
        import os
        # to install xgboost: pip3 install xgboost
        import xgboost as xgb

        import warnings
        import networkx as nx
        import pdb
        import pickle
        from pandas import HDFStore,DataFrame
        from pandas import read_hdf
        from scipy.sparse.linalg import svds, eigs
        import gc
        from tqdm import tqdm
        from sklearn.ensemble import RandomForestClassifier
        from sklearn.metrics import f1_score
```

```
In [2]: #reading
        from pandas import read_hdf
        df_final_train = read_hdf('data/fea_sample/storage_sample_stage4.h5', 'train_df',mode=
        df_final_test = read_hdf('data/fea_sample/storage_sample_stage4.h5', 'test_df',mode='r
```

```
In [3]: df_final_train.columns
```

```
Out[3]: Index(['source_node', 'destination_node', 'indicator_link',
               'jaccard_followers', 'jaccard_followees', 'cosine_followers',
               'cosine_followees', 'num_followers_s', 'num_followees_s',
               'num_followees_d', 'inter_followers', 'inter_followees', 'adar_index',
               'follows_back', 'same_comp', 'shortest_path', 'weight_in', 'weight_out',
               'weight_f1', 'weight_f2', 'weight_f3', 'weight_f4', 'page_rank_s',
               'page_rank_d', 'katz_s', 'katz_d', 'hubs_s', 'hubs_d', 'authorities_s',
               'authorities_d', 'svd_u_s_1', 'svd_u_s_2', 'svd_u_s_3', 'svd_u_s_4',
               'svd_u_s_5', 'svd_u_s_6', 'svd_u_d_1', 'svd_u_d_2', 'svd_u_d_3',
               'svd_u_d_4', 'svd_u_d_5', 'svd_u_d_6', 'svd_v_s_1', 'svd_v_s_2',
               'svd_v_s_3', 'svd_v_s_4', 'svd_v_s_5', 'svd_v_s_6', 'svd_v_d_1',
               'svd_v_d_2', 'svd_v_d_3', 'svd_v_d_4', 'svd_v_d_5', 'svd_v_d_6'],
              dtype='object')
```

```
In [5]: df_final_train.head()
```

```
Out[5]:    source_node  destination_node  indicator_link  jaccard_followers  \
        0       273084           1505602               1                  0
        1       832016           1543415               1                  0
        2      1325247            760242               1                  0
        3      1368400           1006992               1                  0
        4       140165           1708748               1                  0

           jaccard_followees  cosine_followers  cosine_followees  num_followers_s  \
        0           0.000000          0.000000          0.000000                6
        1           0.187135          0.028382          0.343828               94
        2           0.369565          0.156957          0.566038               28
        3           0.000000          0.000000          0.000000               11
        4           0.000000          0.000000          0.000000                1

           num_followees_s  num_followees_d  ...      svd_v_s_3     svd_v_s_4  \
        0               15                8  ...   1.983691e-06  1.545075e-13
        1               61              142  ...  -6.236048e-11  1.345726e-02
        2               41               22  ...  -2.380564e-19 -7.021227e-19
        3                5                7  ...   6.058498e-11  1.514614e-11
        4               11                3  ...   1.197283e-07  1.999809e-14

              svd_v_s_5     svd_v_s_6     svd_v_d_1     svd_v_d_2     svd_v_d_3  \
        0  8.108434e-13  1.719702e-14 -1.355368e-12  4.675307e-13  1.128591e-06
        1  3.703479e-12  2.251737e-10  1.245101e-12 -1.636948e-10 -3.112650e-10
        2  1.940403e-19 -3.365389e-19 -1.238370e-18  1.438175e-19 -1.852863e-19
        3  1.513483e-12  4.498061e-13 -9.818087e-10  3.454672e-11  5.213635e-08
        4  3.360247e-13  1.407670e-14  0.000000e+00  0.000000e+00  0.000000e+00
```

```
      svd_v_d_4     svd_v_d_5     svd_v_d_6
0  6.616550e-14  9.771077e-13  4.159752e-14
1  6.738902e-02  2.607801e-11  2.372904e-09
2 -5.901864e-19  1.629341e-19 -2.572452e-19
3  9.595823e-13  3.047045e-10  1.246592e-13
4  0.000000e+00  0.000000e+00  0.000000e+00

[5 rows x 54 columns]
```

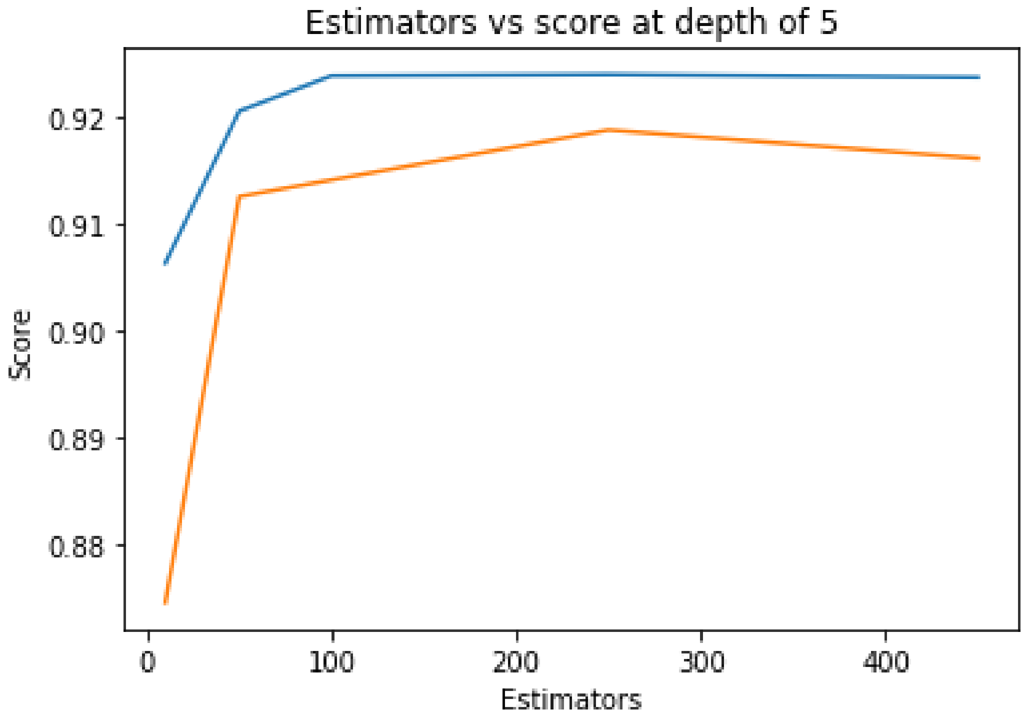
```
In [6]: y_train = df_final_train.indicator_link
        y_test = df_final_test.indicator_link
```

```
In [7]: df_final_train.drop(['source_node', 'destination_node','indicator_link'],axis=1,inplace
        df_final_test.drop(['source_node', 'destination_node','indicator_link'],axis=1,inplace=
```

```
In [8]: estimators = [10,50,100,250,450]
        train_scores = []
        test_scores = []
        for i in estimators:
            clf = RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
                    max_depth=5, max_features='auto', max_leaf_nodes=None,
                    min_impurity_decrease=0.0, min_impurity_split=None,
                    min_samples_leaf=52, min_samples_split=120,
                    min_weight_fraction_leaf=0.0, n_estimators=i, n_jobs=-1,random_state=25,ve
            clf.fit(df_final_train,y_train)
            train_sc = f1_score(y_train,clf.predict(df_final_train))
            test_sc = f1_score(y_test,clf.predict(df_final_test))
            test_scores.append(test_sc)
            train_scores.append(train_sc)
            print('Estimators = ',i,'Train Score',train_sc,'test Score',test_sc)
        plt.plot(estimators,train_scores,label='Train Score')
        plt.plot(estimators,test_scores,label='Test Score')
        plt.xlabel('Estimators')
        plt.ylabel('Score')
        plt.title('Estimators vs score at depth of 5')
```

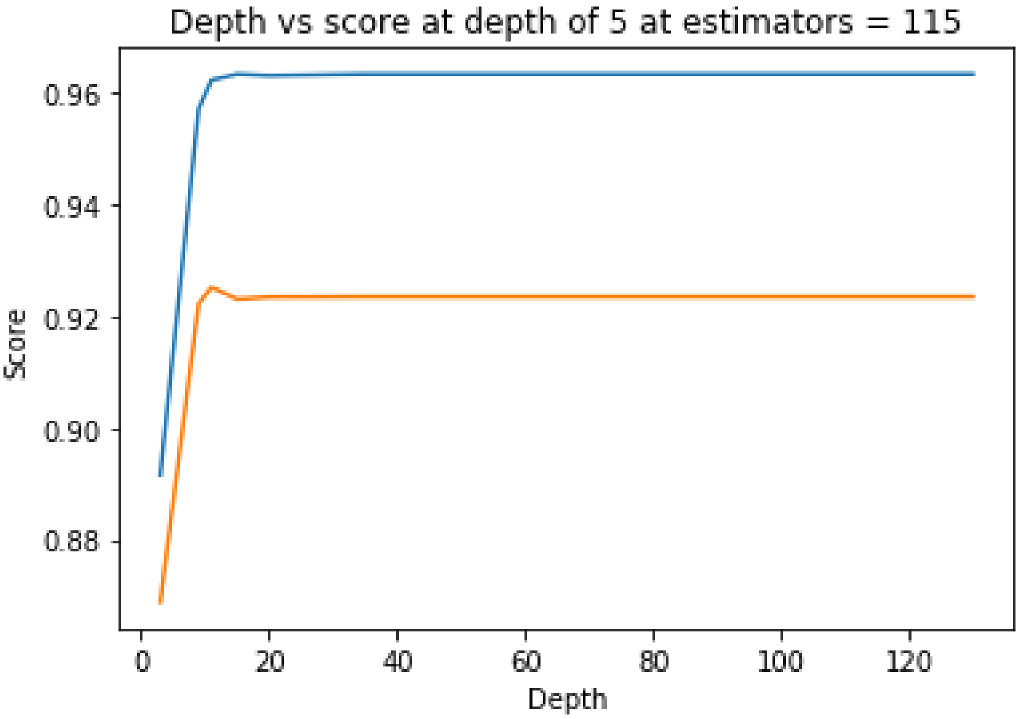
```
Estimators =  10 Train Score 0.9063252121775113 test Score 0.8745605278006858
Estimators =  50 Train Score 0.9205725512208812 test Score 0.9125653355634538
Estimators =  100 Train Score 0.9238690848446947 test Score 0.9141199714153599
Estimators =  250 Train Score 0.9239789348046863 test Score 0.9188007232664732
Estimators =  450 Train Score 0.9237190618658074 test Score 0.9161507685828595
```

```
Out[8]: Text(0.5, 1.0, 'Estimators vs score at depth of 5')
```



```
In [9]: depths = [3,9,11,15,20,35,50,70,130]
        train_scores = []
        test_scores = []
        for i in depths:
            clf = RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
                    max_depth=i, max_features='auto', max_leaf_nodes=None,
                    min_impurity_decrease=0.0, min_impurity_split=None,
                    min_samples_leaf=52, min_samples_split=120,
                    min_weight_fraction_leaf=0.0, n_estimators=115, n_jobs=-1,random_state=25,
            clf.fit(df_final_train,y_train)
            train_sc = f1_score(y_train,clf.predict(df_final_train))
            test_sc = f1_score(y_test,clf.predict(df_final_test))
            test_scores.append(test_sc)
            train_scores.append(train_sc)
            print('depth = ',i,'Train Score',train_sc,'test Score',test_sc)
        plt.plot(depths,train_scores,label='Train Score')
        plt.plot(depths,test_scores,label='Test Score')
        plt.xlabel('Depth')
        plt.ylabel('Score')
        plt.title('Depth vs score at depth of 5 at estimators = 115')
        plt.show()
```

```
depth =  3 Train Score 0.8916120853581238 test Score 0.8687934859875491
depth =  9 Train Score 0.9572226298198419 test Score 0.9222953031452904
depth =  11 Train Score 0.9623451340902863 test Score 0.9252318758281279
depth =  15 Train Score 0.9634267621927706 test Score 0.9231288356496615
depth =  20 Train Score 0.9631629153051491 test Score 0.9235051024711141
depth =  35 Train Score 0.9634333127085721 test Score 0.9235601652753184
depth =  50 Train Score 0.9634333127085721 test Score 0.9235601652753184
depth =  70 Train Score 0.9634333127085721 test Score 0.9235601652753184
depth =  130 Train Score 0.9634333127085721 test Score 0.9235601652753184
```



```
In [10]: from sklearn.metrics import f1_score
         from sklearn.ensemble import RandomForestClassifier
         from sklearn.metrics import f1_score
         from sklearn.model_selection import RandomizedSearchCV
         from scipy.stats import randint as sp_randint
         from scipy.stats import uniform

         param_dist = {"n_estimators":sp_randint(105,125),
                       "max_depth": sp_randint(10,15),
                       "min_samples_split": sp_randint(110,190),
                       "min_samples_leaf": sp_randint(25,65)}

         clf = RandomForestClassifier(random_state=25,n_jobs=-1)

         rf_random = RandomizedSearchCV(clf, param_distributions=param_dist,
                                                n_iter=5,cv=10,scoring='f1',random_state=25)

         rf_random.fit(df_final_train,y_train)
         print('mean test scores',rf_random.cv_results_['mean_test_score'])
         print('mean train scores',rf_random.cv_results_['mean_train_score'])
```

```
mean test scores [0.96225043 0.96215493 0.96057081 0.96194015 0.96330005]
mean train scores [0.96294922 0.96266735 0.96115674 0.96263457 0.96430539]
```

```
In [11]: print(rf_random.best_estimator_)
```

```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=14, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=28, min_samples_split=111,
            min_weight_fraction_leaf=0.0, n_estimators=121, n_jobs=-1,
            oob_score=False, random_state=25, verbose=0, warm_start=False)
```

```
In [12]: clf = RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
                     max_depth=14, max_features='auto', max_leaf_nodes=None,
                     min_impurity_decrease=0.0, min_impurity_split=None,
                     min_samples_leaf=28, min_samples_split=111,
                     min_weight_fraction_leaf=0.0, n_estimators=121, n_jobs=-1,
                     oob_score=False, random_state=25, verbose=0, warm_start=False)
```

```
In [13]: clf.fit(df_final_train,y_train)
         y_train_pred = clf.predict(df_final_train)
         y_test_pred = clf.predict(df_final_test)
```

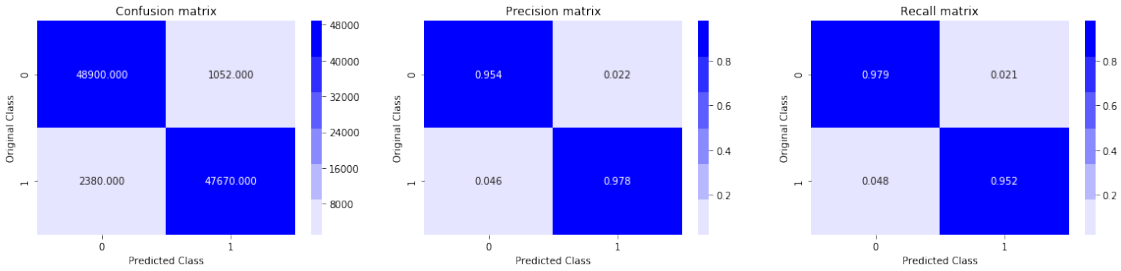
```
In [14]: from sklearn.metrics import f1_score
         print('Train f1 score',f1_score(y_train,y_train_pred))
         print('Test f1 score',f1_score(y_test,y_test_pred))
```

```
Train f1 score 0.9652533106548414
Test f1 score 0.9241678239279553
```

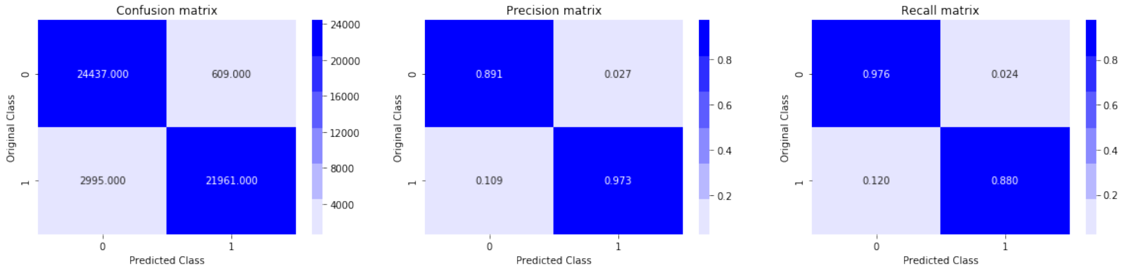
```
In [0]: from sklearn.metrics import confusion_matrix
        def plot_confusion_matrix(test_y, predict_y):
            C = confusion_matrix(test_y, predict_y)

            A =(((C.T)/(C.sum(axis=1))).T)

            B =(C/C.sum(axis=0))
            plt.figure(figsize=(20,4))

            labels = [0,1]
            # representing A in heatmap format
            cmap=sns.light_palette("blue")
            plt.subplot(1, 3, 1)
            sns.heatmap(C, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=la
            plt.xlabel('Predicted Class')
            plt.ylabel('Original Class')
            plt.title("Confusion matrix")

            plt.subplot(1, 3, 2)
            sns.heatmap(B, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=la
            plt.xlabel('Predicted Class')
            plt.ylabel('Original Class')
            plt.title("Precision matrix")

            plt.subplot(1, 3, 3)
            # representing B in heatmap format
            sns.heatmap(A, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=la
            plt.xlabel('Predicted Class')
            plt.ylabel('Original Class')
            plt.title("Recall matrix")

            plt.show()
```

```
In [0]: print('Train confusion_matrix')
        plot_confusion_matrix(y_train,y_train_pred)
        print('Test confusion_matrix')
        plot_confusion_matrix(y_test,y_test_pred)
```

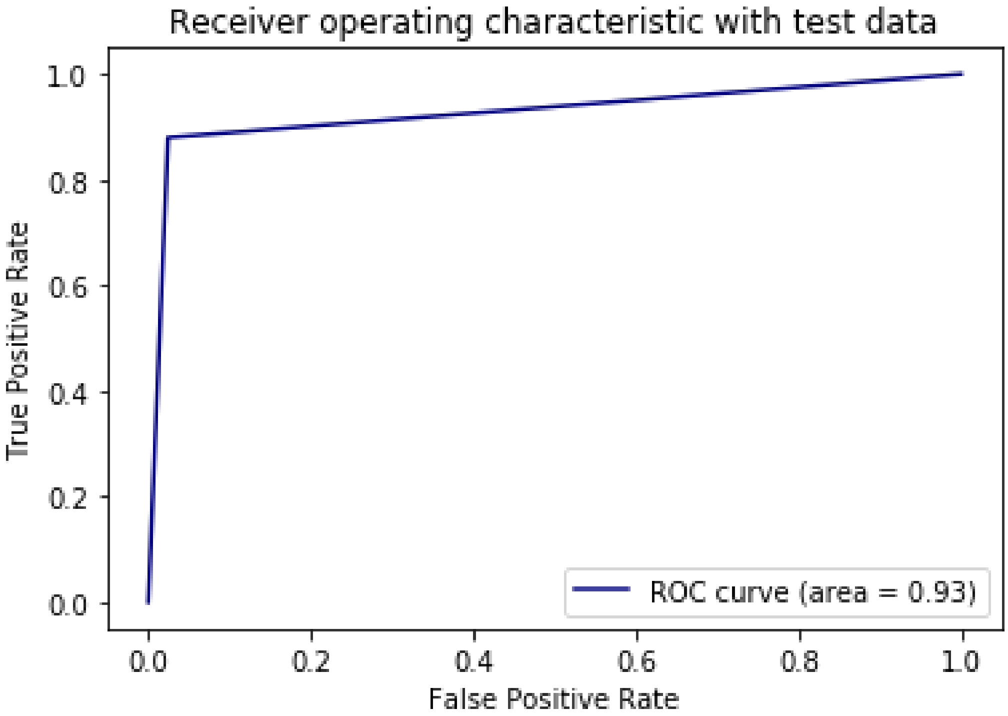
```
Train confusion_matrix
```



```
Test confusion_matrix
```

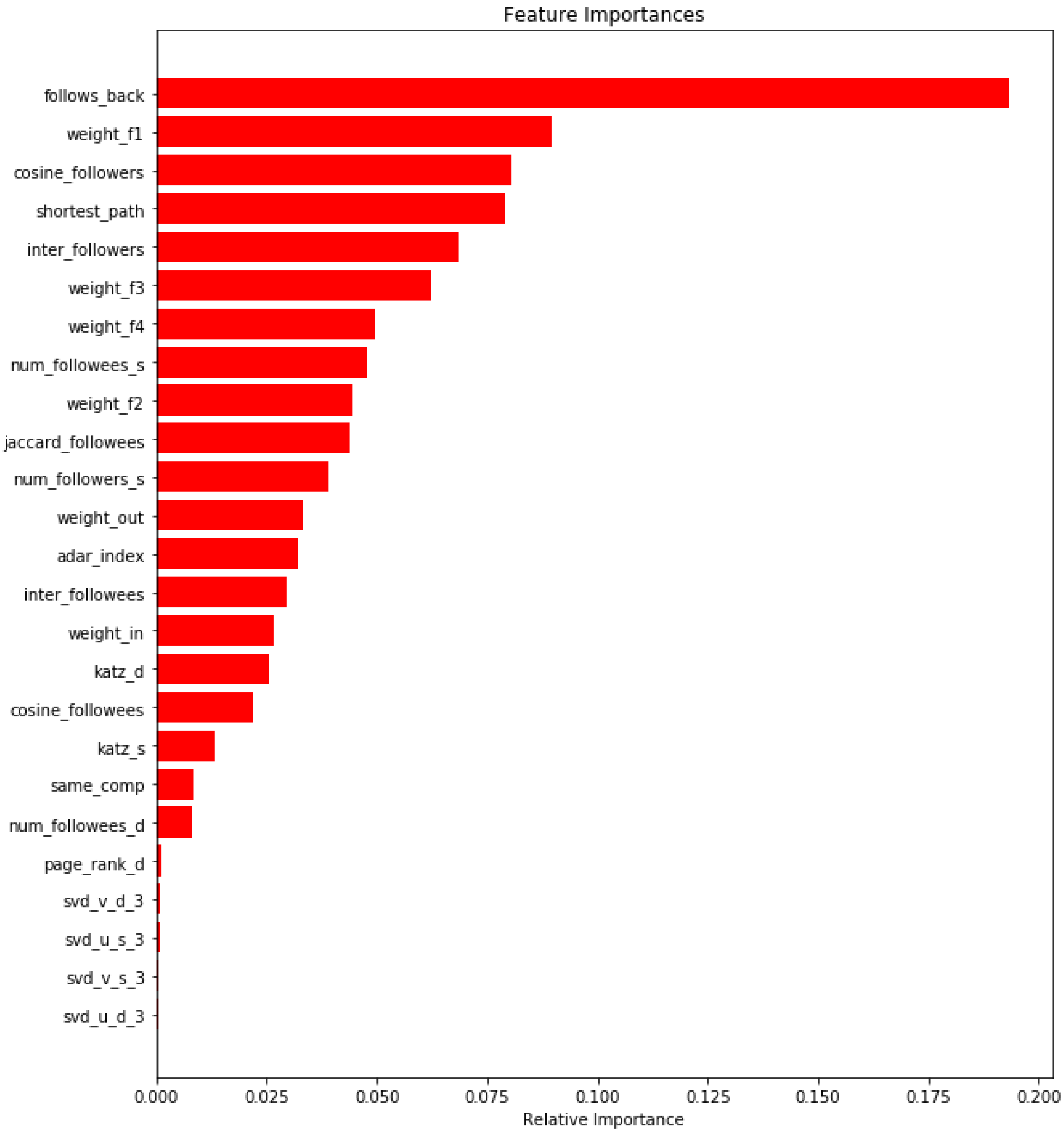


```
In [0]: from sklearn.metrics import roc_curve, auc
        fpr,tpr,ths = roc_curve(y_test,y_test_pred)
        auc_sc = auc(fpr, tpr)
        plt.plot(fpr, tpr, color='navy',label='ROC curve (area = %0.2f)' % auc_sc)
        plt.xlabel('False Positive Rate')
        plt.ylabel('True Positive Rate')
        plt.title('Receiver operating characteristic with test data')
        plt.legend()
        plt.show()
```



```
In [0]: features = df_final_train.columns
        importances = clf.feature_importances_
```

```
indices = (np.argsort(importances))[-25:]
plt.figure(figsize=(10,12))
plt.title('Feature Importances')
plt.barh(range(len(indices)), importances[indices], color='r', align='center')
plt.yticks(range(len(indices)), [features[i] for i in indices])
plt.xlabel('Relative Importance')
plt.show()
```



```
In [ ]:
```