Amazon Employee Access Challenge

In [1]:
```
import warnings
warnings.filterwarnings("ignore")
```

In [2]:
```
#importing needed modules/packages
import pandas as pd
import numpy as np
import seaborn as sb
import matplotlib.pyplot as plt
%matplotlib inline
from scipy import sparse
```

In [3]:
```
#importing the data
train=pd.read_csv('train.csv')
test=pd.read_csv('test.csv')
train.shape,test.shape
```

Out[3]:
```
((32769, 10), (58921, 10))
```

In [4]:
```
ohe_train = sparse.load_npz('data/ohe_train.npz')
ohe_test = sparse.load_npz('data/ohe_test.npz')
ohe_train.shape,ohe_test.shape
```

Out[4]:
```
((32769, 4500), (58921, 4500))
```

In [5]:
```
fc_df_train=pd.read_csv('data/fc_df_train.csv')
fc_df_test=pd.read_csv('data/fc_df_test.csv')
fc_df_train.shape,fc_df_test.shape
```

Out[5]:
```
((32769, 9), (58921, 9))
```

In [6]:
```
rc_df_train=pd.read_csv('data/rc_df_train.csv')
rc_df_test=pd.read_csv('data/rc_df_test.csv')
rc_df_train.shape,rc_df_test.shape
```

Out[6]:
```
((32769, 9), (58921, 9))
```

In [7]:
```
train_svd = pd.read_csv('data/train_svd.csv')
test_svd=pd.read_csv('data/test_svd.csv')
train_svd.shape,test_svd.shape
```

Out[7]:
```
((32769, 72), (58921, 72))
```

In [8]:
```
train_data=train.drop(columns=['ACTION'],axis=1)
train_data.shape
```

Out[8]:
```
(32769, 9)
```

In [9]:
```
y_true = train['ACTION']
y_true.shape
```

Out[9]:
```
(32769,)
```

In [10]:
```
test_data=test.drop(columns=['id'],axis=1)
test_data.shape
```

Out[10]:
```
(58921, 9)
```

Build a Model

Initially lets use linear models like KNN, Linear SVM , Logistic Regression etc... and compare these models to see which models perfroms better.

We will also use the data obtained using feature engineering techniques to see whether the model's performance is getting improved while any new featuers are added

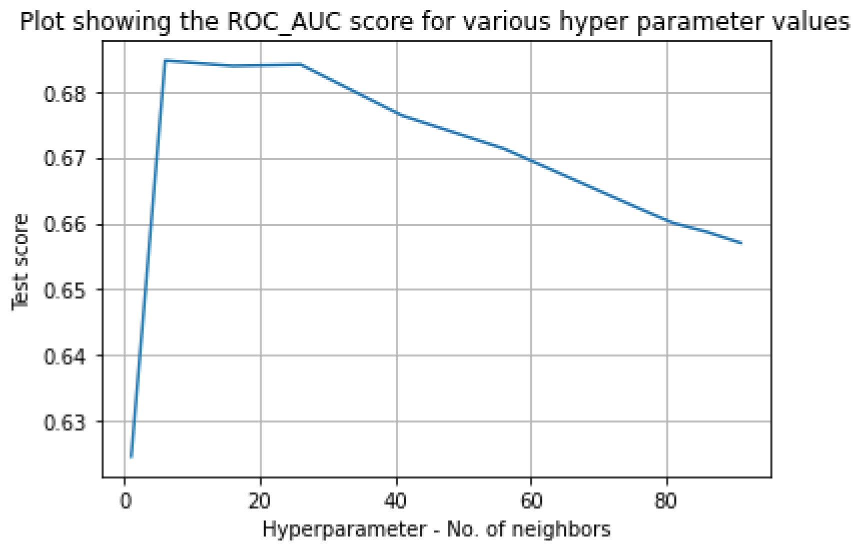
KNN classifier

In [11]:
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.neighbors import KNeighborsClassifier
n_neighbors = np.arange(1,100,5)
lr= KNeighborsClassifier(n_jobs=-1)
parameters={'n_neighbors':n_neighbors}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_data,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   13.4s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   17.6s finished
```

In [12]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
plt.plot(results['param_n_neighbors'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - No. of neighbors');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [13]:
```
best_c=best_model.best_params_['n_neighbors']
best_c
```

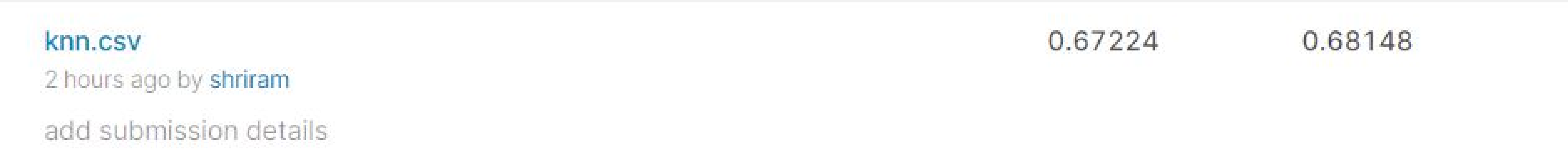
Out[13]:
```
6
```

In [14]:
```
model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
model.fit(train_data,y_true)
```

Out[14]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=-1, n_neighbors=6, p=2,
                     weights='uniform')
```

In [15]:
```
predictions = model.predict_proba(test_data)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/knn.csv", index = False)
```

```
    Kaggle Score(test AUC )                                          private score          public score
```



knn.csv 0.67224 0.68148

2 hours ago by shriram

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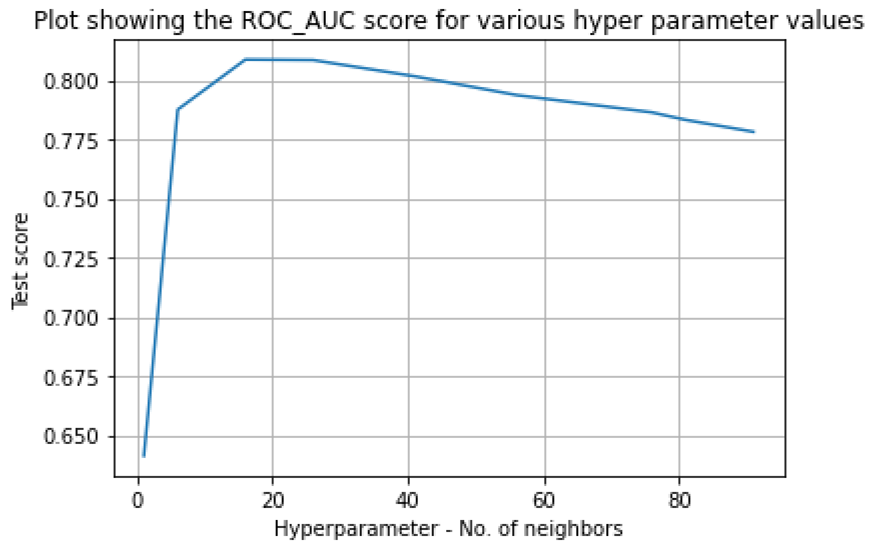
KNN classifier - OHE

In [16]:
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.neighbors import KNeighborsClassifier
n_neighbors = np.arange(1,100,5)
lr= KNeighborsClassifier(n_jobs=-1)
parameters={'n_neighbors':n_neighbors}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=2)
best_model = clf.fit(ohe_train,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=2)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=2)]: Done  37 tasks      | elapsed:  5.8min
[Parallel(n_jobs=2)]: Done  50 out of  50 | elapsed:  8.0min finished
```

In [17]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
plt.plot(results['param_n_neighbors'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - No. of neighbors');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [18]:
```
best_c=best_model.best_params_['n_neighbors']
best_c
```

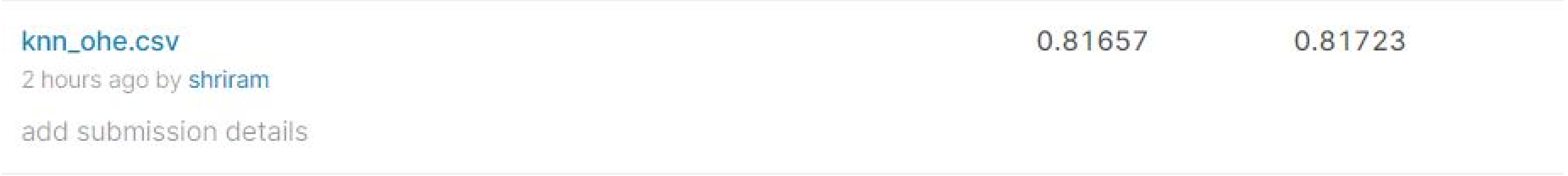
Out[18]:
```
16
```

In [19]:
```
model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
model.fit(ohe_train,y_true)
```

Out[19]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=-1, n_neighbors=16, p=2,
                     weights='uniform')
```

In [20]:
```
predictions = model.predict_proba(ohe_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/knn_ohe.csv", index = False)
```

```
    Kaggle Score(test AUC )                                          private score          public score
```



knn_ohe.csv 0.81657 0.81723

2 hours ago by shriram

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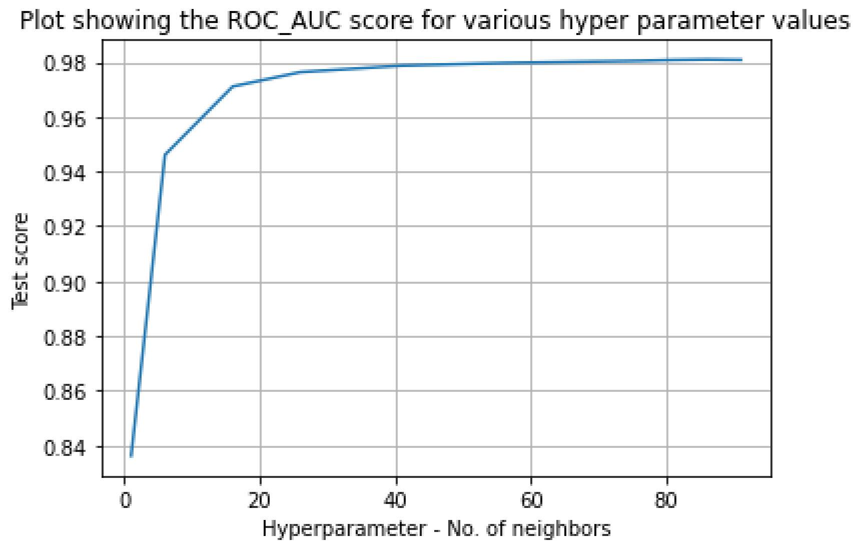
KNN classifier - Response Coding

In [21]:
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.neighbors import KNeighborsClassifier
n_neighbors = np.arange(1,100,5)
lr= KNeighborsClassifier(n_jobs=-1)
parameters={'n_neighbors':n_neighbors}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(rc_df_train,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   17.4s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   24.0s finished
```

In [22]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
plt.plot(results['param_n_neighbors'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - No. of neighbors');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [23]:
```
best_c=best_model.best_params_['n_neighbors']
best_c
```

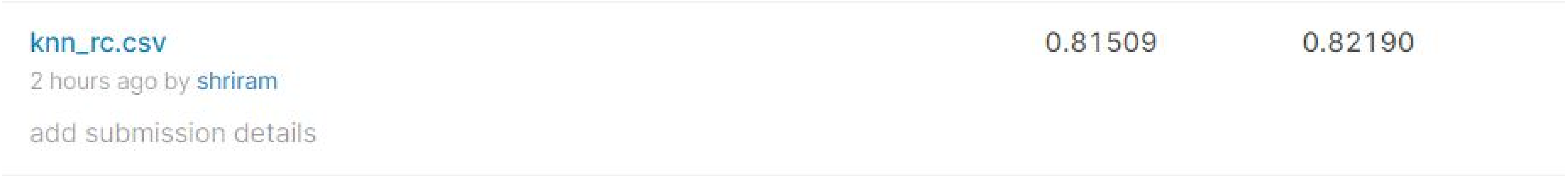
Out[23]:
```
86
```

In [24]:
```
model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
model.fit(rc_df_train,y_true)
```

Out[24]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=-1, n_neighbors=86, p=2,
                     weights='uniform')
```

In [25]:
```
predictions = model.predict_proba(rc_df_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/knn_rc.csv", index = False)
```

```
    Kaggle Score(test AUC )                                             private score          public score
```



knn_rc.csv 0.81509 0.82190

2 hours ago by shriram

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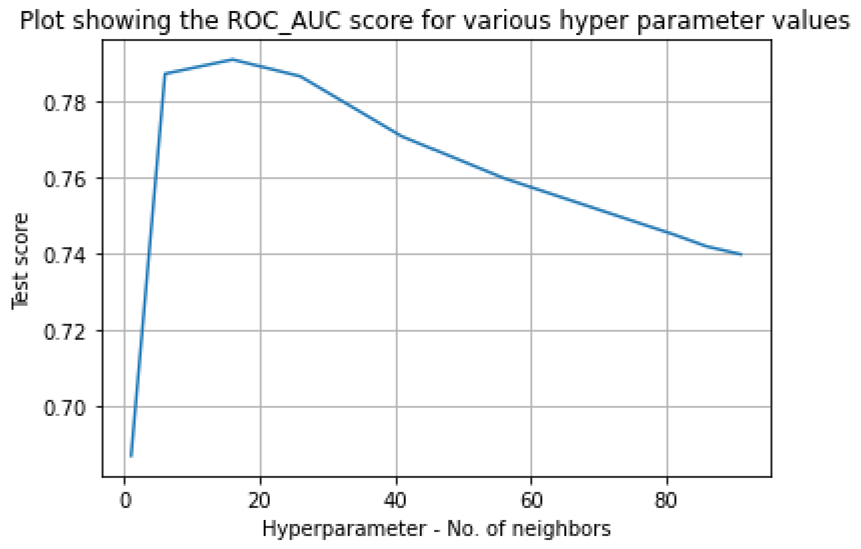
KNN classifier - Frequency Coding

In [26]:
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.neighbors import KNeighborsClassifier
n_neighbors = np.arange(1,100,5)
lr= KNeighborsClassifier(n_jobs=-1)
parameters={'n_neighbors':n_neighbors}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(fc_df_train,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=2)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=2)]: Done  37 tasks      | elapsed:   17.5s
[Parallel(n_jobs=2)]: Done  50 out of  50 | elapsed:   23.0s finished
```

In [27]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
plt.plot(results['param_n_neighbors'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - No. of neighbors');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [28]:
```
best_c=best_model.best_params_['n_neighbors']
best_c
```

Out[28]:
```
16
```

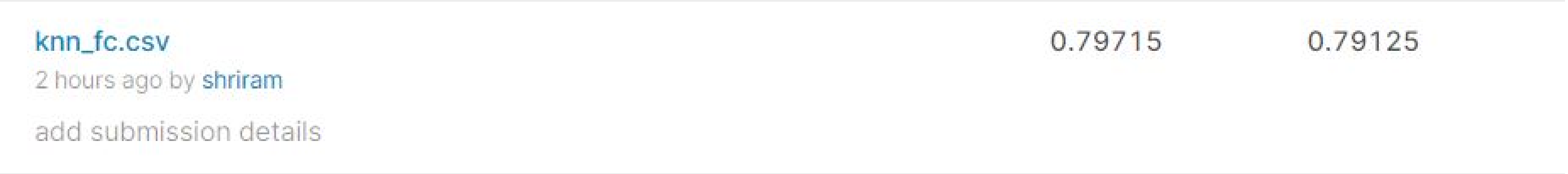
In [29]:
```
model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
model.fit(fc_df_train,y_true)
```

Out[29]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=-1, n_neighbors=16, p=2,
                     weights='uniform')
```

In [30]:

```
predictions = model.predict_proba(fc_df_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/knn_fc.csv", index = False)
```

```
    Kaggle Score(test AUC )                                             private score          public score
```



knn_fc.csv 0.79715 0.79125

2 hours ago by shriram

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KNN classifier - SVD

In [31]:

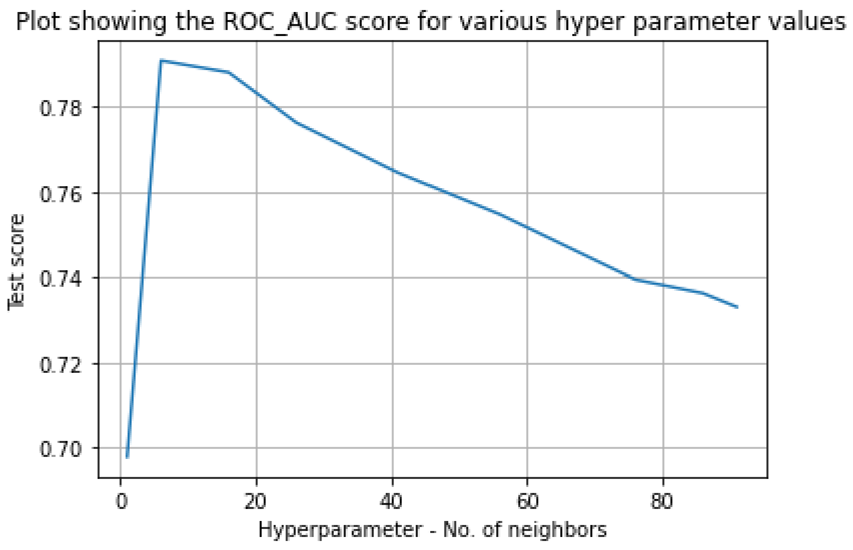
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.neighbors import KNeighborsClassifier
n_neighbors = np.arange(1,100,5)
lr= KNeighborsClassifier(n_jobs=-1)
parameters={'n_neighbors':n_neighbors}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_svd,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=2)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=2)]: Done  37 tasks      | elapsed:   35.5s
[Parallel(n_jobs=2)]: Done  50 out of  50 | elapsed:   50.0s finished
```

In [32]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
plt.plot(results['param_n_neighbors'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - No. of neighbors');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [33]:

```
best_c=best_model.best_params_['n_neighbors']
best_c
```

Out[33]: 6

In [34]:

```
model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
model.fit(train_svd,y_true)
```

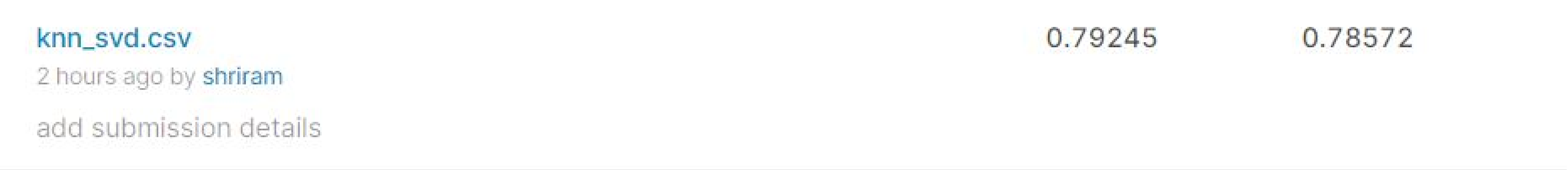
Out[34]:

```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                     metric_params=None, n_jobs=-1, n_neighbors=6, p=2,
                     weights='uniform')
```

In [35]:

```
predictions = model.predict_proba(test_svd)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/knn_svd.csv", index = False)
```

```
    Kaggle Score(test AUC )                                             private score          public score
```



knn_svd.csv 0.79245 0.78572

2 hours ago by shriram

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In [168]:

```
#https://stackoverflow.com/questions/36423259/how-to-use-pretty-table-in-python-to-print-out-data-from-multiple-lists
from prettytable import PrettyTable

x=PrettyTable(['Algorithm','Test AUC score'])
x.add_row(['KNN',0.68148])
x.add_row(['KNN (using OHE)',0.81723])
x.add_row(['KNN (Using Frequency coding)',0.79125])
x.add_row(['KNN (Using Response Coding)',0.82190])
x.add_row(['KNN (Using SVD)',0.78572])
print(x)
```

```
+------------------------------+----------------+
|          Algorithm           | Test AUC score |
+------------------------------+----------------+
|             KNN              |    0.68148     |
|       KNN (using OHE)        |    0.81723     |
| KNN (Using Frequency coding) |    0.79125     |
| KNN (Using Response Coding)  |     0.8219     |
|       KNN (Using SVD)        |    0.78572     |
+------------------------------+----------------+
```

OBSERVATIONS

Applying KNN on raw data (i.e. without any feature engineering doesn't perform well)

KNN algorithm performs well for One Hot encoded features and Response encoding features.

For SVD encoding, the model's performance doesn't seem to improve much

SVM

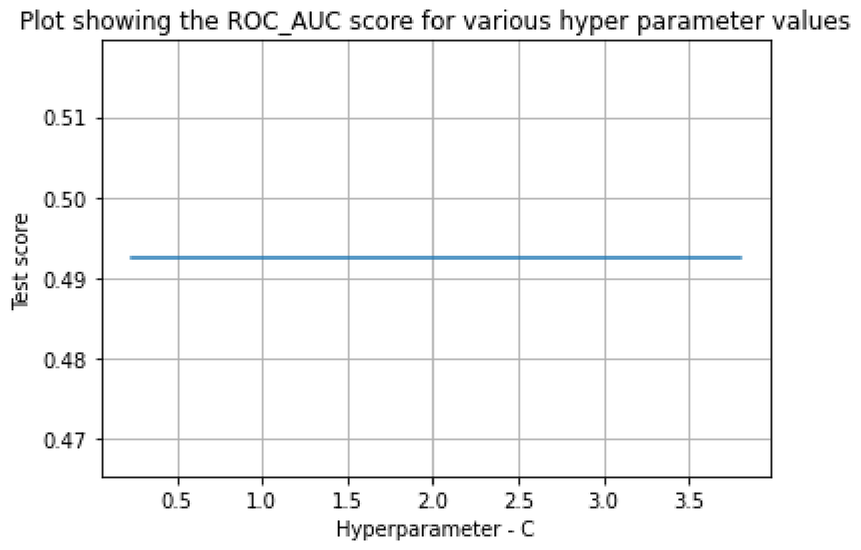
In [37]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.svm import LinearSVC
C_val = uniform(loc=0, scale=4)
lr= LinearSVC(verbose=2,random_state=42,class_weight='balanced',max_iter=2000)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_data,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:  2.2min
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:  3.5min finished

[LibLinear]

C:\Users\shri1\Anaconda3\lib\site-packages\sklearn\svm\base.py:929: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
```

In [38]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [39]:

```
best_c=best_model.best_params_['C']
best_c
```

Out[39]:

```
1.49816047538945
```

In [40]:

```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-decision-function-to-probabilities-scikit-learn-python
from sklearn.calibration import CalibratedClassifierCV
model = LinearSVC(C=best_c,verbose=1,random_state=42,class_weight='balanced',max_iter=2000)
model = CalibratedClassifierCV(model)
model.fit(train_data,y_true)
```

```
[LibLinear]

C:\Users\shri1\Anaconda3\lib\site-packages\sklearn\svm\base.py:929: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)

[LibLinear]

C:\Users\shri1\Anaconda3\lib\site-packages\sklearn\svm\base.py:929: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)

[LibLinear]

C:\Users\shri1\Anaconda3\lib\site-packages\sklearn\svm\base.py:929: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
```

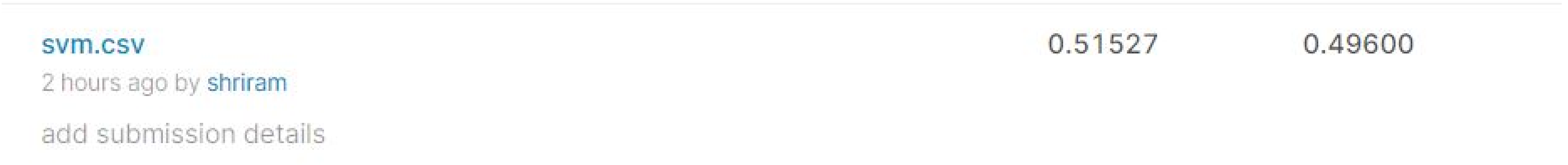
Out[40]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=1.49816047538945,
                                                class_weight='balanced',
                                                dual=True, fit_intercept=True,
                                                intercept_scaling=1,
                                                loss='squared_hinge',
                                                max_iter=2000,
                                                multi_class='ovr', penalty='l2',
                                                random_state=42, tol=0.0001,
                                                verbose=1),
                       cv='warn', method='sigmoid')
```

In [41]:

```
predictions = model.predict_proba(test_data)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/svm.csv", index = False)
```

```
     Kaggle Score(test AUC )                                            private score          public score
```



svm.csv 0.51527 0.49600

2 hours ago by shriram

add submission details

SVM - OHE

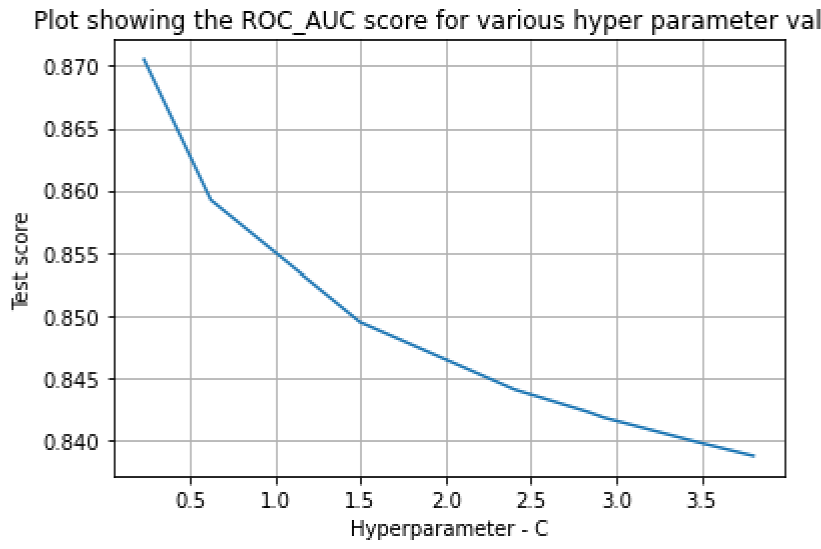
In [42]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.svm import LinearSVC
C_val = uniform(loc=0, scale=4)
lr= LinearSVC(verbose=2,random_state=42,class_weight='balanced',max_iter=1000)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=2)
best_model = clf.fit(ohe_train,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=2)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=2)]: Done  37 tasks      | elapsed:   45.9s
[Parallel(n_jobs=2)]: Done  50 out of  50 | elapsed:  1.1min finished

[LibLinear]
```

In [43]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [44]:

```
best_c=best_model.best_params_['C']
best_c
```

Out[44]:

```
0.23233444867279784
```

In [45]:

```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-decision-function-to-probabilities-scikit-learn-python
from sklearn.calibration import CalibratedClassifierCV
model = LinearSVC(C=best_c,verbose=1,random_state=42,class_weight='balanced',dual=False)
model = CalibratedClassifierCV(model)
model.fit(ohe_train,y_true)
```

```
[LibLinear][LibLinear][LibLinear]
```

Out[45]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=0.23233444867279784,
                                                class_weight='balanced',
                                                dual=False, fit_intercept=True,
                                                intercept_scaling=1,
                                                loss='squared_hinge',
                                                max_iter=1000,
                                                multi_class='ovr', penalty='l2',
                                                random_state=42, tol=0.0001,
                                                verbose=1),
                       cv='warn', method='sigmoid')
```

In [46]:

```
predictions = model.predict_proba(ohe_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/svm_ohe.csv", index = False)
```

```
Kaggle Score(test AUC )                                          private score          public score
```

svm_ohe.csv 0.87228 0.87960
2 hours ago by shriram
add submission details

SVM - Frequency Coding

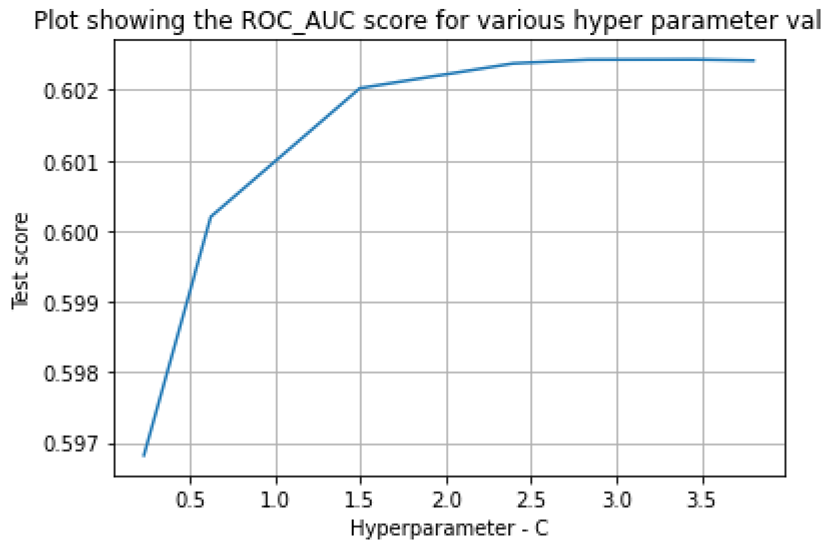
In [47]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.svm import LinearSVC
C_val = uniform(loc=0, scale=4)
lr= LinearSVC(verbose=2,random_state=42,class_weight='balanced',max_iter=1000)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(fc_df_train,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   37.0s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   59.7s finished

[LibLinear]
```

In [48]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [49]:

```
best_c=best_model.best_params_['C']
best_c
```

Out[49]:

```
3.4647045830997407
```

In [50]:

```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-decision-function-to-probabilities-scikit-learn-python
from sklearn.calibration import CalibratedClassifierCV
model = LinearSVC(C=best_c,verbose=1,random_state=42,class_weight='balanced')
model = CalibratedClassifierCV(model)
model.fit(fc_df_train,y_true)
```

```
[LibLinear][LibLinear][LibLinear]
```

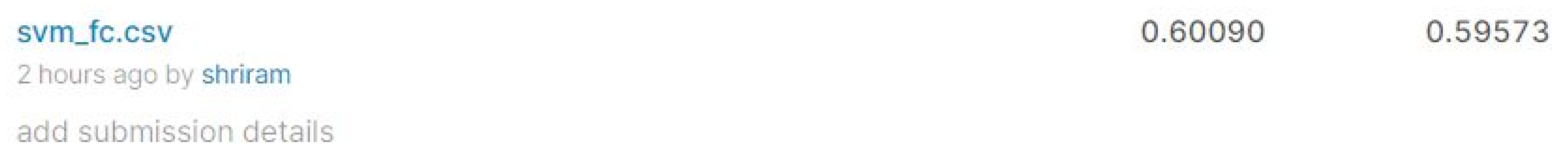
Out[50]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=3.4647045830997407,
                                                class_weight='balanced',
                                                dual=True, fit_intercept=True,
                                                intercept_scaling=1,
                                                loss='squared_hinge',
                                                max_iter=1000,
                                                multi_class='ovr', penalty='l2',
                                                random_state=42, tol=0.0001,
                                                verbose=1),
                       cv='warn', method='sigmoid')
```

In [51]:

```
predictions = model.predict_proba(fc_df_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/svm_fc.csv", index = False)
```

```
Kaggle Score(test AUC )                                                      private score          public score
```



svm_fc.csv
2 hours ago by shriram
add submission details
0.60090 0.59573

SVM - RESPONSE CODING

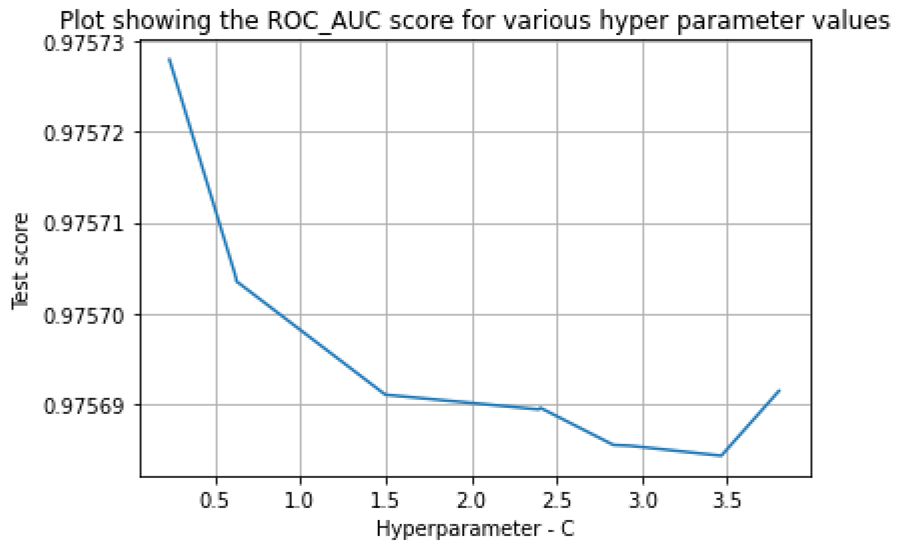
In [52]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.svm import LinearSVC
C_val = uniform(loc=0, scale=4)
lr= LinearSVC(verbose=2,random_state=42,class_weight='balanced',max_iter=1000)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(rc_df_train,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   58.8s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:  1.6min finished

[LibLinear]
```

In [53]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [54]:

```
best_c=best_model.best_params_['C']
best_c
```

Out[54]:

```
0.23233444867279784
```

In [55]:

```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-decision-function-to-probabilities-scikit-learn-python
from sklearn.calibration import CalibratedClassifierCV
model = LinearSVC(C=best_c,verbose=1,random_state=42,class_weight='balanced')
model = CalibratedClassifierCV(model)
model.fit(rc_df_train,y_true)
```

```
[LibLinear][LibLinear][LibLinear]
```

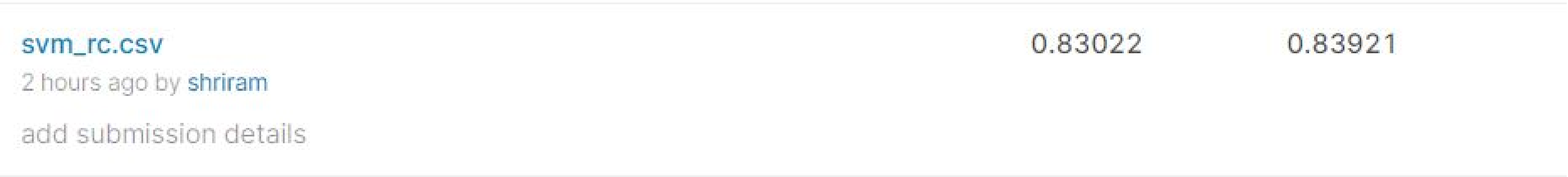
Out[55]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=0.23233444867279784,
                                                class_weight='balanced',
                                                dual=True, fit_intercept=True,
                                                intercept_scaling=1,
                                                loss='squared_hinge',
                                                max_iter=1000,
                                                multi_class='ovr', penalty='l2',
                                                random_state=42, tol=0.0001,
                                                verbose=1),
                       cv='warn', method='sigmoid')
```

In [56]:

```
predictions = model.predict_proba(rc_df_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/svm_rc.csv", index = False)
```

```
Kaggle Score(test AUC )                                                      private score          public score
```



svm_rc.csv 0.83022 0.83921

2 hours ago by shriram

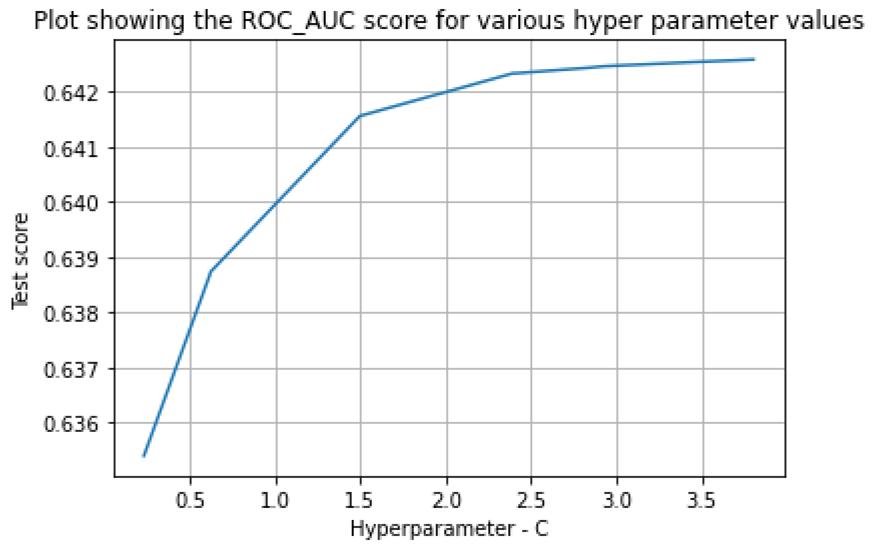
add submission details

SVM - SVD

In [57]:
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.svm import LinearSVC
C_val = uniform(loc=0, scale=4)
lr= LinearSVC(verbose=2,random_state=42,class_weight='balanced',max_iter=1500)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_svd,y_true)
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:  2.9min
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:  5.4min finished

[LibLinear]
```

In [58]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [59]:
```
best_c=best_model.best_params_['C']
best_c
```

Out[59]:
```
3.8028572256396647
```

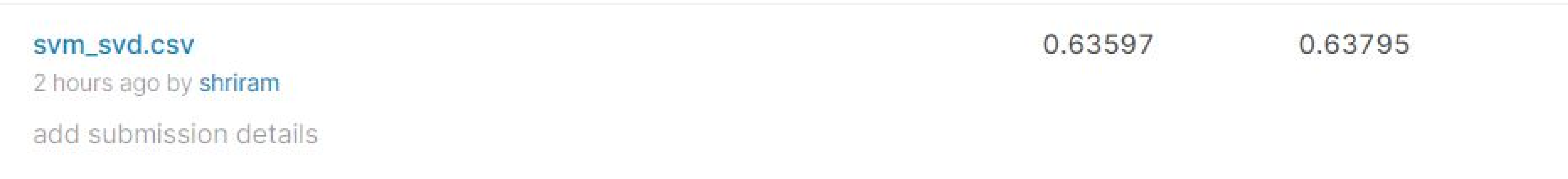
In [60]:
```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-decision-function-to-probabilities-scikit-learn-python
from sklearn.calibration import CalibratedClassifierCV
model = LinearSVC(C=best_c,verbose=1,random_state=42,class_weight='balanced',max_iter=1500)
model = CalibratedClassifierCV(model)
model.fit(train_svd,y_true)
```

```
[LibLinear][LibLinear][LibLinear]
```

Out[60]:
```
CalibratedClassifierCV(base_estimator=LinearSVC(C=3.8028572256396647,
                                                class_weight='balanced',
                                                dual=True, fit_intercept=True,
                                                intercept_scaling=1,
                                                loss='squared_hinge',
                                                max_iter=1500,
                                                multi_class='ovr', penalty='l2',
                                                random_state=42, tol=0.0001,
                                                verbose=1),
                       cv='warn', method='sigmoid')
```

In [61]:
```
predictions = model.predict_proba(test_svd)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/svm_svd.csv", index = False)
```

```
Kaggle Score(test AUC )                                             private score          public score
```



svm_svd.csv 0.63597 0.63795

2 hours ago by shriram

add submission details

In [169]:
```
#https://stackoverflow.com/questions/36423259/how-to-use-pretty-table-in-python-to-print-out-data-from-multiple-lists
from prettytable import PrettyTable

x=PrettyTable(['Algorithm','Test AUC score'])
x.add_row(['SVM',0.49600])
x.add_row(['SVM (using OHE)',0.87960])
x.add_row(['SVM (Using Frequency coding)',0.59573])
x.add_row(['SVM (Using Response Coding)',0.83921])
x.add_row(['SVM (Using SVD)',0.63795])
print(x)
```

```
+------------------------------+----------------+
|          Algorithm           | Test AUC score |
+------------------------------+----------------+
|             SVM              |     0.496      |
|       SVM (using OHE)        |     0.8796     |
| SVM (Using Frequency coding) |    0.59573     |
| SVM (Using Response Coding)  |    0.83921     |
|       SVM (Using SVD)        |    0.63795     |
+------------------------------+----------------+
```

OBSERVATIONS

Using One Hot encoded features , SVM model seems to perform much better than the KNN model built using OHE.

The response encoded features are also working well with SVM , as the test AUC score is better while using response encoded features.

Logistic Regression

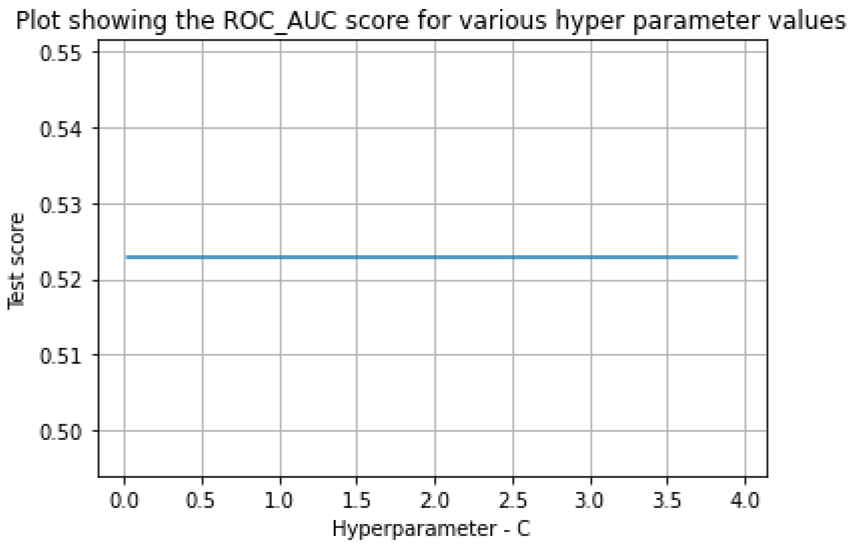
In [63]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.linear_model import LogisticRegression
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=2,random_state=42,class_weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_data,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   14.2s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:   26.8s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:   47.1s
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  1.1min finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    5.8s finished
```

In [64]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [65]:

```
best_c=best_model.best_params_['C']
best_c
```

Out[65]:

```
1.49816047538945
```

In [66]:

```
model = LogisticRegression(C=best_c,verbose=1,n_jobs=-1,random_state=42,class_weight='balanced',solver='lbfgs')
model.fit(train_data,y_true)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    6.9s finished
```

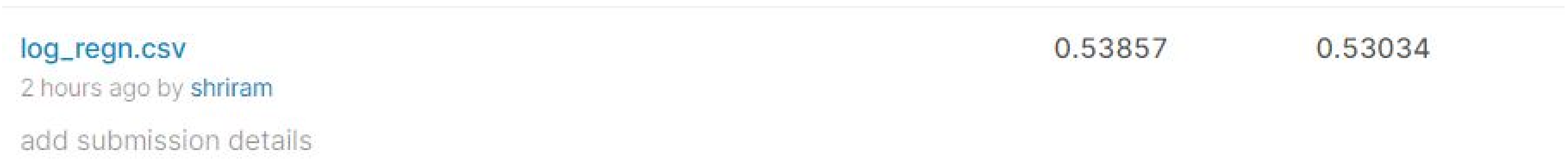
Out[66]:

```
LogisticRegression(C=1.49816047538945, class_weight='balanced', dual=False,
                   fit_intercept=True, intercept_scaling=1, l1_ratio=None,
                   max_iter=100, multi_class='warn', n_jobs=-1, penalty='l2',
                   random_state=42, solver='lbfgs', tol=0.0001, verbose=1,
                   warm_start=False)
```

In [67]:

```
predictions = model.predict_proba(test_data)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/log_regn.csv", index = False)
```

```
    Kaggle Score(test AUC )                                           private score          public score
```



log_regn.csv 0.53857 0.53034
2 hours ago by shriram
add submission details

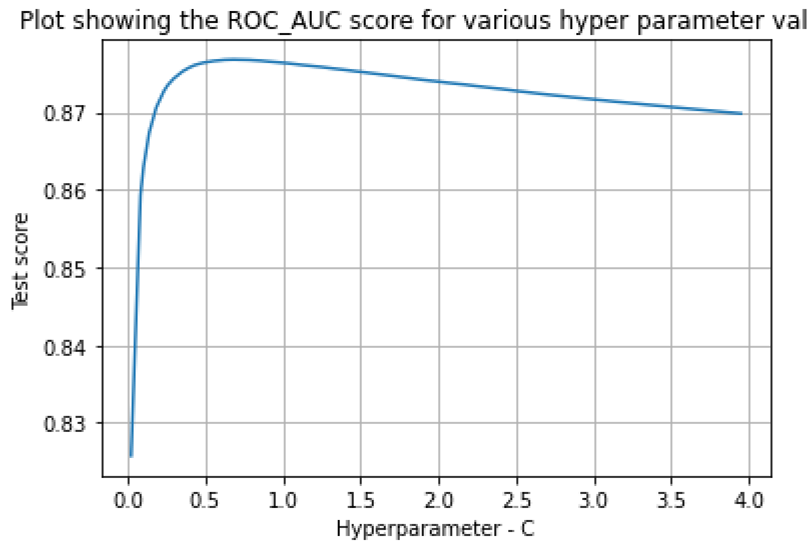
Logistic Regression (Using One Hot Encoding)

In [68]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.linear_model import LogisticRegression
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=2,random_state=42,class_weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,n_iter=100,scoring='roc_auc',n_jobs=2)
best_model = clf.fit(ohe_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=2)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=2)]: Done  37 tasks      | elapsed:   38.3s
[Parallel(n_jobs=2)]: Done 158 tasks      | elapsed:  2.5min
[Parallel(n_jobs=2)]: Done 361 tasks      | elapsed:  4.9min
[Parallel(n_jobs=2)]: Done 500 out of 500 | elapsed:  6.4min finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    6.3s finished
```

```
In [69]: results = pd.DataFrame.from_dict(best_model.cv_results_)
         results=results.sort_values('param_C')
         results
         plt.plot(results['param_C'],results['mean_test_score']);
         plt.grid();
         plt.xlabel('Hyperparameter - C');
         plt.ylabel('Test score');
         plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



```
In [70]: best_c=best_model.best_params_['C']
         best_c

Out[70]: 0.6820964947491661
```

```
In [71]: model = LogisticRegression(C=best_c,verbose=1,n_jobs=-1,random_state=42,class_weight='balanced',solver='lbfgs')
         model.fit(ohe_train,y_true)

         [Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
         [Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    5.8s finished

Out[71]: LogisticRegression(C=0.6820964947491661, class_weight='balanced', dual=False,
                            fit_intercept=True, intercept_scaling=1, l1_ratio=None,
                            max_iter=100, multi_class='warn', n_jobs=-1, penalty='l2',
                            random_state=42, solver='lbfgs', tol=0.0001, verbose=1,
                            warm_start=False)
```

```
In [72]: predictions = model.predict_proba(ohe_test)[:,1]
         submit = pd.DataFrame()
         submit["Id"] = test["id"]
         submit["ACTION"] = predictions
         submit.to_csv("results/log_regn_ohe.csv", index = False)
```

```
     Kaggle Score(test AUC )                                              private score          public score
```

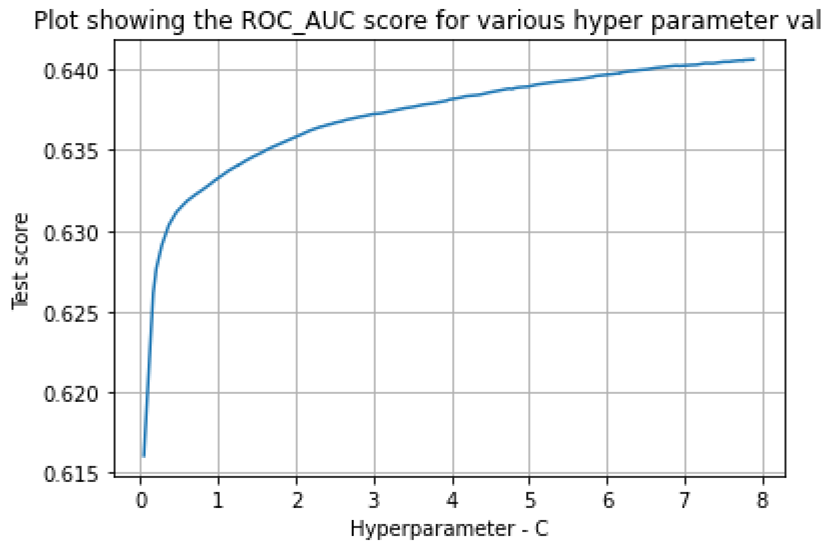
log_regn_ohe.csv 0.87436 0.88167
2 hours ago by shriram

add submission details

Logistic Regression (Using SVD)

```
In [73]: from sklearn.model_selection import RandomizedSearchCV
         from scipy.stats import uniform
         from sklearn.linear_model import LogisticRegression
         C_val = uniform(loc=0, scale=8)
         lr= LogisticRegression(verbose=2,random_state=42,class_weight='balanced',solver='lbfgs',n_jobs=-1,max_iter=500)
         parameters={'C':C_val}
         clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,n_iter=100,scoring='roc_auc',n_jobs=-1)
         best_model = clf.fit(train_svd,y_true)

         Fitting 5 folds for each of 100 candidates, totalling 500 fits

         [Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
         [Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   35.9s
         [Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  2.2min
         [Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  5.3min
         [Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  8.8min finished
         [Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
         [Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:   20.4s finished
```

```
In [74]: results = pd.DataFrame.from_dict(best_model.cv_results_)
         results=results.sort_values('param_C')
         results
         plt.plot(results['param_C'],results['mean_test_score']);
         plt.grid();
         plt.xlabel('Hyperparameter - C');
         plt.ylabel('Test score');
         plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



```
In [75]: best_c=best_model.best_params_['C']
         best_c

Out[75]: 7.895095492804138
```

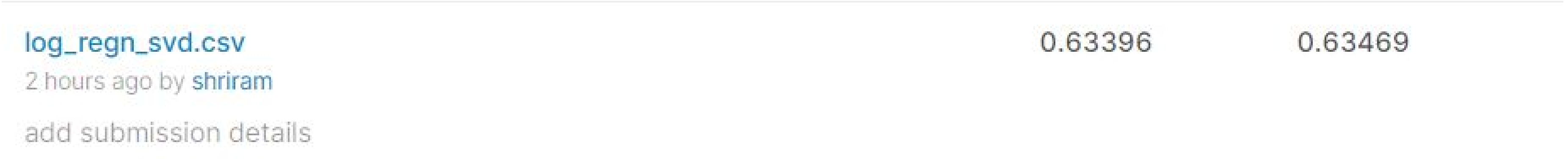
In [76]:
```
model = LogisticRegression(C=best_c,verbose=1,n_jobs=-1,random_state=42,class_weight='balanced',solver='lbfgs')
model.fit(train_svd,y_true)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    8.2s finished
```

Out[76]:
```
LogisticRegression(C=7.895095492804138, class_weight='balanced', dual=False,
                   fit_intercept=True, intercept_scaling=1, l1_ratio=None,
                   max_iter=100, multi_class='warn', n_jobs=-1, penalty='l2',
                   random_state=42, solver='lbfgs', tol=0.0001, verbose=1,
                   warm_start=False)
```

In [77]:
```
predictions = model.predict_proba(test_svd)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/log_regn_svd.csv", index = False)
```

```
Kaggle Score(test AUC )                                                   private score          public score
```



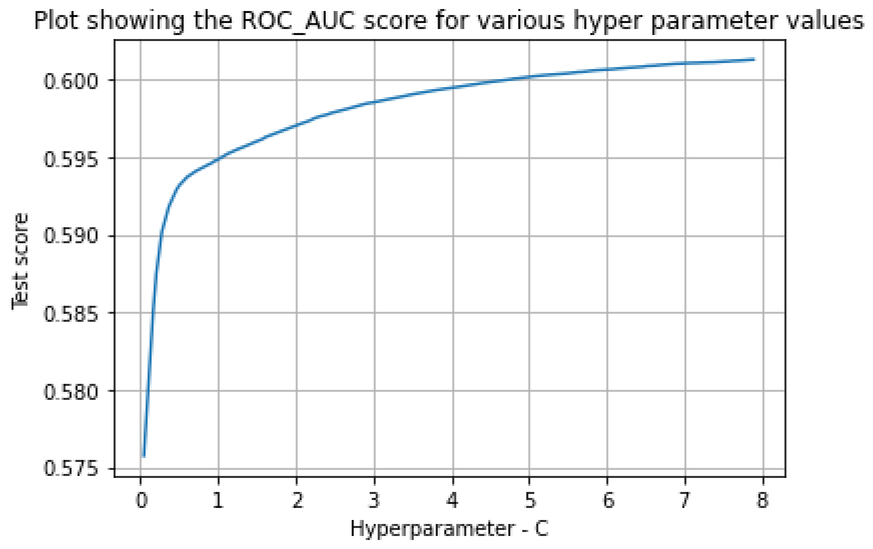
log_regn_svd.csv 0.63396 0.63469
2 hours ago by shriram
add submission details

Logistic Regression (Using Frequency coding)

In [78]:
```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.linear_model import LogisticRegression
C_val = uniform(loc=0, scale=8)
lr= LogisticRegression(verbose=2,random_state=42,class_weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(fc_df_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   12.9s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:   33.8s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  1.2min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  1.6min finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    5.4s finished
```

In [79]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [80]:
```
best_c=best_model.best_params_['C']
best_c
```

Out[80]:
```
7.895095492804138
```

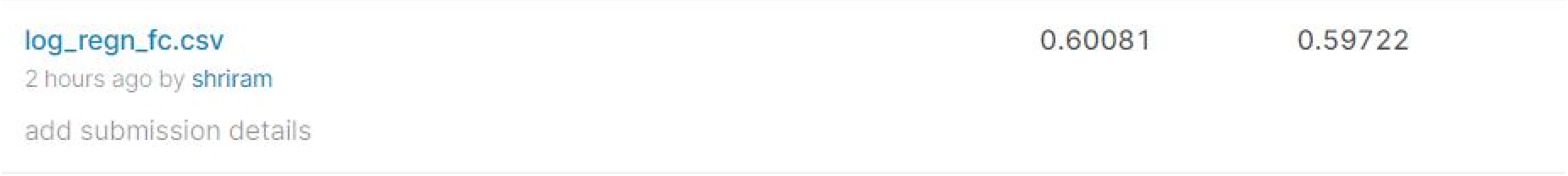
In [81]:
```
model = LogisticRegression(C=best_c,verbose=1,n_jobs=-1,random_state=42,class_weight='balanced',solver='lbfgs')
model.fit(fc_df_train,y_true)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    5.3s finished
```

Out[81]:
```
LogisticRegression(C=7.895095492804138, class_weight='balanced', dual=False,
                   fit_intercept=True, intercept_scaling=1, l1_ratio=None,
                   max_iter=100, multi_class='warn', n_jobs=-1, penalty='l2',
                   random_state=42, solver='lbfgs', tol=0.0001, verbose=1,
                   warm_start=False)
```

In [82]:
```
predictions = model.predict_proba(fc_df_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/log_regn_fc.csv", index = False)
```

```
Kaggle Score(test AUC )                                                   private score          public score
```



log_regn_fc.csv 0.60081 0.59722
2 hours ago by shriram
add submission details

Logistic Regression (Using Response coding)

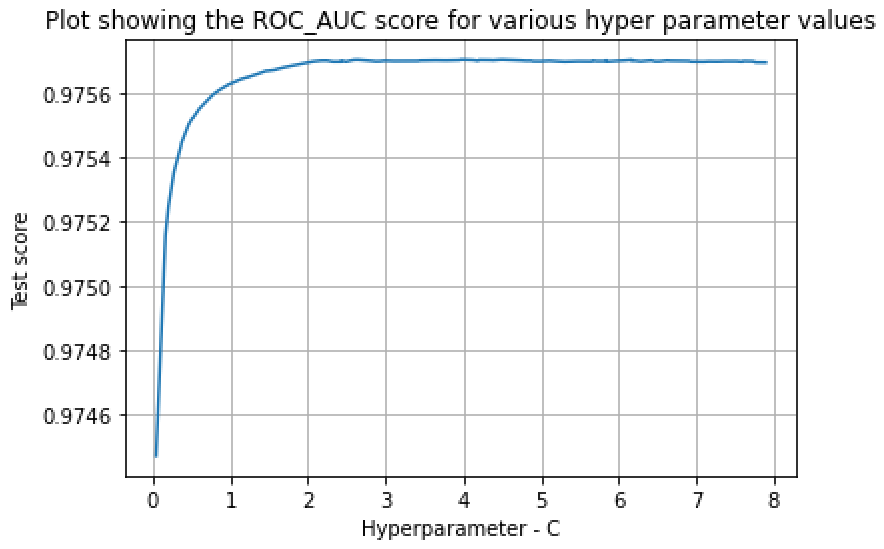
In [83]:

```
from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.linear_model import LogisticRegression
C_val = uniform(loc=0, scale=8)
lr= LogisticRegression(verbose=2,random_state=42,class_weight='balanced',solver='lbfgs',max_iter=600,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=42,cv=5,verbose=2,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(rc_df_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   12.9s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:   35.9s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  1.2min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  1.6min finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    4.7s finished
```

In [84]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
plt.plot(results['param_C'],results['mean_test_score']);
plt.grid();
plt.xlabel('Hyperparameter - C');
plt.ylabel('Test score');
plt.title('Plot showing the ROC_AUC score for various hyper parameter values');
```



In [85]:

```
best_c=best_model.best_params_['C']
best_c
```

Out[85]:

```
3.9614152808901615
```

In [86]:

```
model = LogisticRegression(C=best_c,verbose=1,n_jobs=-1,random_state=42,class_weight='balanced',solver='lbfgs')
model.fit(rc_df_train,y_true)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    5.2s finished
```

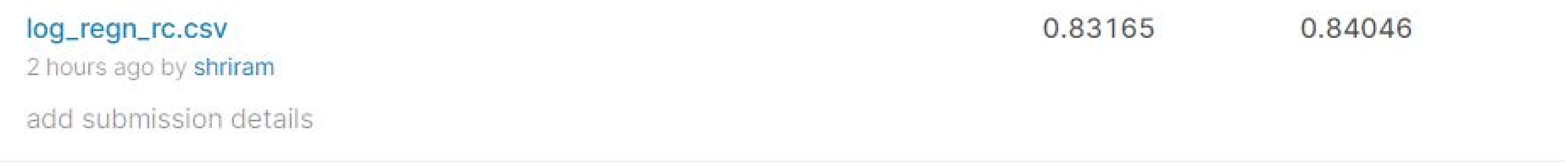
Out[86]:

```
LogisticRegression(C=3.9614152808901615, class_weight='balanced', dual=False,
                   fit_intercept=True, intercept_scaling=1, l1_ratio=None,
                   max_iter=100, multi_class='warn', n_jobs=-1, penalty='l2',
                   random_state=42, solver='lbfgs', tol=0.0001, verbose=1,
                   warm_start=False)
```

In [87]:

```
predictions = model.predict_proba(rc_df_test)[:,1]
submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions
submit.to_csv("results/log_regn_rc.csv", index = False)
```

```
    Kaggle Score(test AUC )                                                   private score          public score
```



log_regn_rc.csv 0.83165 0.84046
2 hours ago by shriram
add submission details

In [170]:

```
#https://stackoverflow.com/questions/36423259/how-to-use-pretty-table-in-python-to-print-out-data-from-multiple-lists
from prettytable import PrettyTable

x=PrettyTable(['Algorithm','Test AUC score'])
x.add_row(['Logistic Regression',0.53034])
x.add_row(['Logistic Regression (using OHE)',0.88167])
x.add_row(['Logistic Regression (Using Frequency coding)',0.59722])
x.add_row(['Logistic Regression (Using Response Coding)',0.84046])
x.add_row(['Logistic Regression (Using SVD)',0.63469])
print(x)
```

```
+----------------------------------------------+----------------+
|                  Algorithm                   | Test AUC score |
+----------------------------------------------+----------------+
|             Logistic Regression              |    0.53034     |
|       Logistic Regression (using OHE)        |    0.88167     |
| Logistic Regression (Using Frequency coding) |    0.59722     |
| Logistic Regression (Using Response Coding)  |    0.84046     |
|       Logistic Regression (Using SVD)        |    0.63469     |
+----------------------------------------------+----------------+
```

OBSERVATIONS

So far , the best model seems to be Logistic Regression with One Hot encoded features as it gives the max. AUC score of 0.882.

Similar to SVM, the Response coded features seems to be more useful when compared to other generated features

Random Forest

In [89]:

```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier(random_state=42,class_weight='balanced',n_jobs=-1)
from scipy import stats
n_estimators = [10,20,50,100,200,500,700,1000]
max_depth = [1,2,5,10,12,15,20,25]
max_features=[1,2,3,4,5]
min_samples_split=[2,5,7,10,20]

params = {'n_estimators':n_estimators,
         'max_depth':max_depth,
         'max_features':max_features,
         'min_samples_split':min_samples_split}

clf = RandomizedSearchCV(rfc,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_data,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:  1.0min
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  7.6min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 18.6min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 20.1min finished
```

In [90]:

```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[90]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean_test_score
78	700	25	2	7	0.862951
62	500	25	3	5	0.862863
79	500	25	1	10	0.862223
55	200	25	2	5	0.860996
22	200	25	4	10	0.860981
85	1000	20	3	7	0.860491
84	1000	25	5	2	0.860339
20	1000	25	3	2	0.860199
33	700	25	4	2	0.859577
82	700	20	5	20	0.858877

In [91]:

```
n_estimators=clf.best_params_['n_estimators']
max_features=clf.best_params_['max_features']
max_depth=clf.best_params_['max_depth']
min_samples_split=clf.best_params_['min_samples_split']
n_estimators,max_features,max_depth,min_samples_split
```

Out[91]:

```
(700, 2, 25, 7)
```

In [92]:

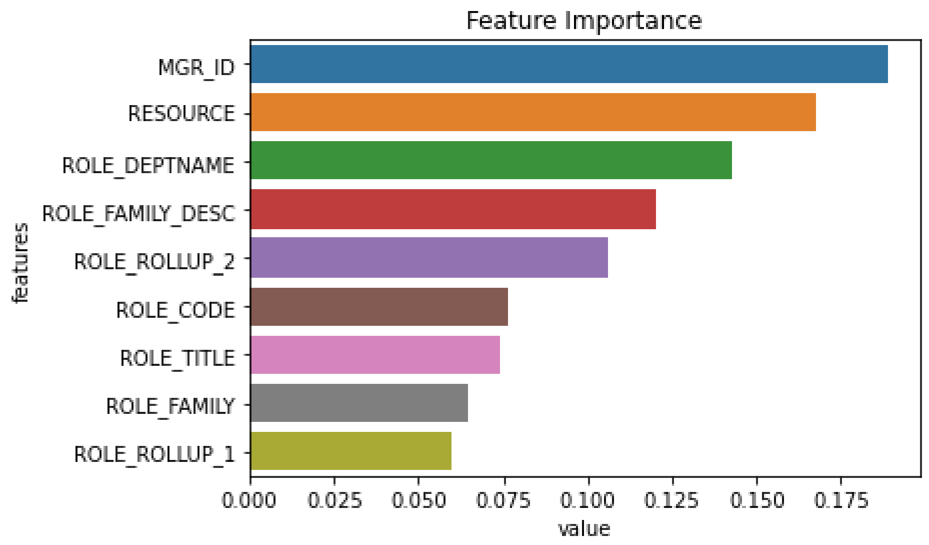
```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_depth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=42,class_weight='balanced',n_jobs=-1)

model.fit(train_data,y_true)
```

Out[92]:

```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
                       criterion='gini', max_depth=25, max_features=2,
                       max_leaf_nodes=None, min_impurity_decrease=0.0,
                       min_impurity_split=None, min_samples_leaf=1,
                       min_samples_split=7, min_weight_fraction_leaf=0.0,
                       n_estimators=700, n_jobs=-1, oob_score=False,
                       random_state=42, verbose=0, warm_start=False)
```

In [93]:

```
features=train_data.columns
importance=model.feature_importances_
res=pd.DataFrame({'features':features,'value':importance})
res=res.sort_values('value',ascending=False)
sb.barplot('value','features',data=res);
plt.title('Feature Importance');
```



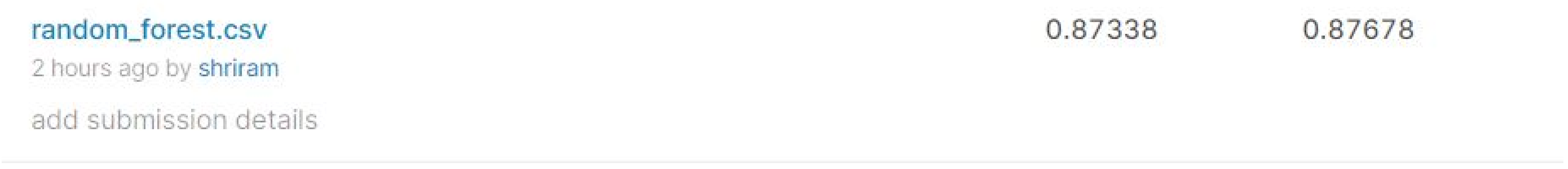
Feature Importances

MGR_ID seems to be the most important feature for this model in predicting the class label followed by RESOURCE , ROLE_DEPTNAME etc...

In [94]:

```
predictions = model.predict_proba(test_data)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/random_forest.csv", index = False)
```

```
Kaggle Score(test AUC )                                                          private score         public score
```



random_forest.csv 0.87338 0.87678

2 hours ago by shriram

add submission details

Random Forest SVD

In [95]:

```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier(random_state=42,class_weight='balanced',n_jobs=-1)
from scipy import stats
n_estimators = [10,20,50,100,200,500,700,1000]
max_depth = [1,2,5,10,12,15,20,25]
max_features=[1,2,3,4,5]
min_samples_split=[2,5,7,10,20]

params = {'n_estimators':n_estimators,
         'max_depth':max_depth,
         'max_features':max_features,
         'min_samples_split':min_samples_split}

clf = RandomizedSearchCV(rfc,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(train_svd,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:  1.5min
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  9.7min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 24.4min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 26.7min finished
```

In [96]:

```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[96]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean_test_score
84	1000	25	5	2	0.853490
33	700	25	4	2	0.853287
20	1000	25	3	2	0.852782
62	500	25	3	5	0.852051
22	200	25	4	10	0.851328
82	700	20	5	20	0.851208
85	1000	20	3	7	0.850869
78	700	25	2	7	0.850621
55	200	25	2	5	0.850441
54	100	20	5	20	0.849401

In [97]:

```
n_estimators=clf.best_params_['n_estimators']
max_features=clf.best_params_['max_features']
max_depth=clf.best_params_['max_depth']
min_samples_split=clf.best_params_['min_samples_split']
n_estimators,max_features,max_depth,min_samples_split
```

Out[97]:

```
(1000, 5, 25, 2)
```

In [98]:

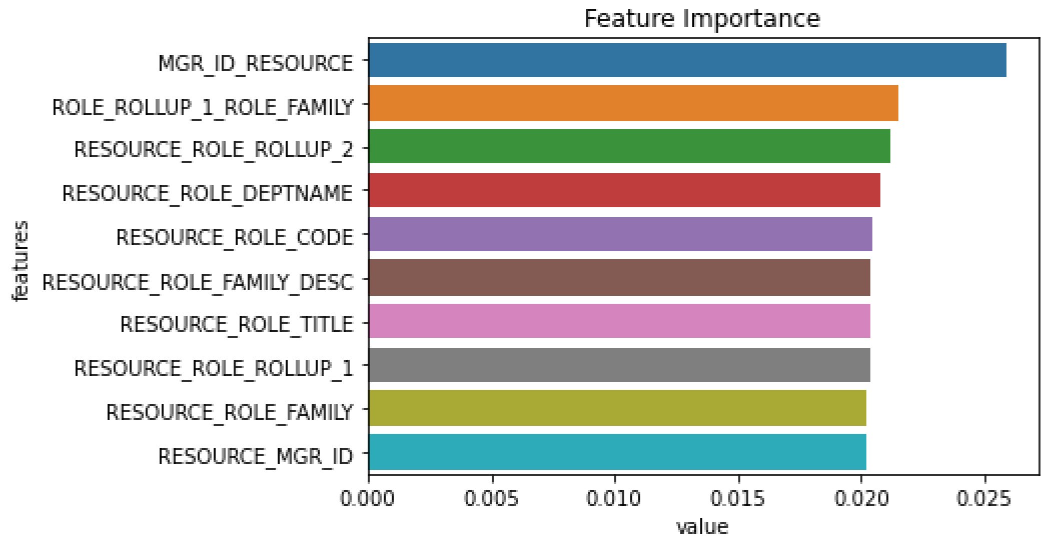
```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_depth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=42,class_weight='balanced',n_jobs=-1)

model.fit(train_svd,y_true)
```

Out[98]:

```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
                       criterion='gini', max_depth=25, max_features=5,
                       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=1000, n_jobs=-1, oob_score=False,
                       random_state=42, verbose=0, warm_start=False)
```

In [99]:

```
features=train_svd.columns
importance=model.feature_importances_
res=pd.DataFrame({'features':features,'value':importance})
res=res.sort_values('value',ascending=False)
sb.barplot('value','features',data=res[:10]);
plt.title('Feature Importance');
```



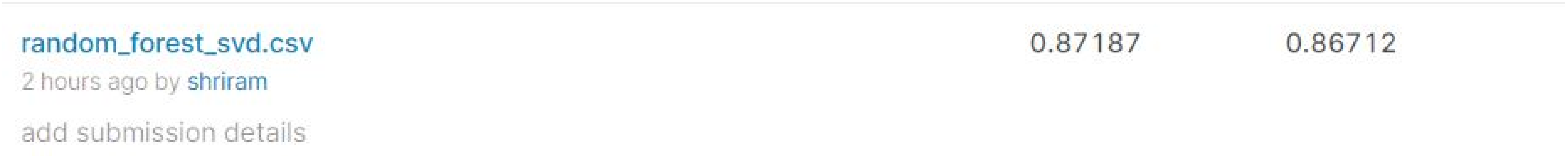
Feature Importance

In this random forest model built using SVD encoded features , MGR_ID_RESOURCE looks like the feature with high importance followed by ROLE_ROLLUP_1_ROLE_FAMILY , RESOURCE_ROLE_ROLLUP_2 and so on...

In [100]:

```
predictions = model.predict_proba(test_svd)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/random_forest_svd.csv", index = False)
```

```
    Kaggle Score(test AUC )                                                      private score          public score
```



random_forest_svd.csv 0.87187 0.86712

2 hours ago by shriram

add submission details

Random Forest _OHE

In [101]:
```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier(random_state=42,class_weight='balanced',n_jobs=-1)
from scipy import stats
n_estimators = [10,20,50,100,200,500,700,1000]
max_depth = [1,2,5,10,12,15,20,25]
max_features=[1,2,3,4,5]
min_samples_split=[2,5,7,10,20]

params = {'n_estimators':n_estimators,
         'max_depth':max_depth,
         'max_features':max_features,
         'min_samples_split':min_samples_split}

clf = RandomizedSearchCV(rfc,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(ohe_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   32.3s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  2.7min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 11.9min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 12.4min finished
```

In [102]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[102]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean_test_score
78	700	25	2	7	0.860103
85	1000	20	3	7	0.856983
62	500	25	3	5	0.854030
11	1000	15	3	7	0.850302
6	500	20	2	5	0.849433
25	700	15	4	7	0.842587
19	700	15	4	5	0.841920
82	700	20	5	20	0.839801
69	500	10	2	20	0.839679
79	500	25	1	10	0.839319

In [103]:
```
n_estimators=clf.best_params_['n_estimators']
max_features=clf.best_params_['max_features']
max_depth=clf.best_params_['max_depth']
min_samples_split=clf.best_params_['min_samples_split']
n_estimators,max_features,max_depth,min_samples_split
```

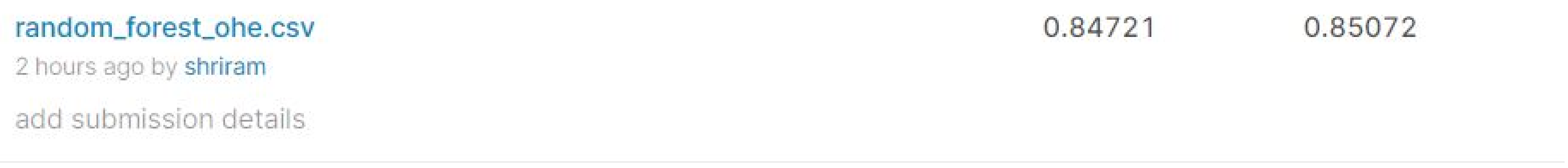
Out[103]:
```
(700, 2, 25, 7)
```

In [104]:
```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_depth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=42,class_weight='balanced',n_jobs=-1)

model.fit(ohe_train,y_true)
```

Out[104]:
```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
                       criterion='gini', max_depth=25, max_features=2,
                       max_leaf_nodes=None, min_impurity_decrease=0.0,
                       min_impurity_split=None, min_samples_leaf=1,
                       min_samples_split=7, min_weight_fraction_leaf=0.0,
                       n_estimators=700, n_jobs=-1, oob_score=False,
                       random_state=42, verbose=0, warm_start=False)
```

In [105]:
```
predictions = model.predict_proba(ohe_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/random_forest_ohe.csv", index = False)
```

```
     Kaggle Score(test AUC )                                                  private score          public score
```



random_forest_ohe.csv 0.84721 0.85072

2 hours ago by shriram

add submission details

Random Forest + Frequency Encoding

In [106]:
```
mod_train = pd.concat((train_data,fc_df_train),axis=1)
mod_train.shape
```

Out[106]:
```
(32769, 18)
```

In [107]:
```
mod_test = pd.concat((test_data,fc_df_test),axis=1)
mod_test.shape
```

Out[107]:
```
(58921, 18)
```

In [108]:
```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier(random_state=42,class_weight='balanced',n_jobs=-1)
from scipy import stats
n_estimators = [10,20,50,100,200,500,700,1000]
max_depth = [1,2,5,10,12,15,20,25]
max_features=[1,2,3,4,5]
min_samples_split=[2,5,7,10,20]

params = {'n_estimators':n_estimators,
         'max_depth':max_depth,
         'max_features':max_features,
         'min_samples_split':min_samples_split}

clf = RandomizedSearchCV(rfc,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model=clf.fit(mod_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   46.8s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  5.4min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 12.9min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 14.0min finished
```

In [109]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[109]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean_test_score
84	1000	25	5	2	0.874714
62	500	25	3	5	0.874459
20	1000	25	3	2	0.874408
33	700	25	4	2	0.874371
79	500	25	1	10	0.873521
78	700	25	2	7	0.873313
55	200	25	2	5	0.872781
85	1000	20	3	7	0.872370
6	500	20	2	5	0.872271
22	200	25	4	10	0.872135

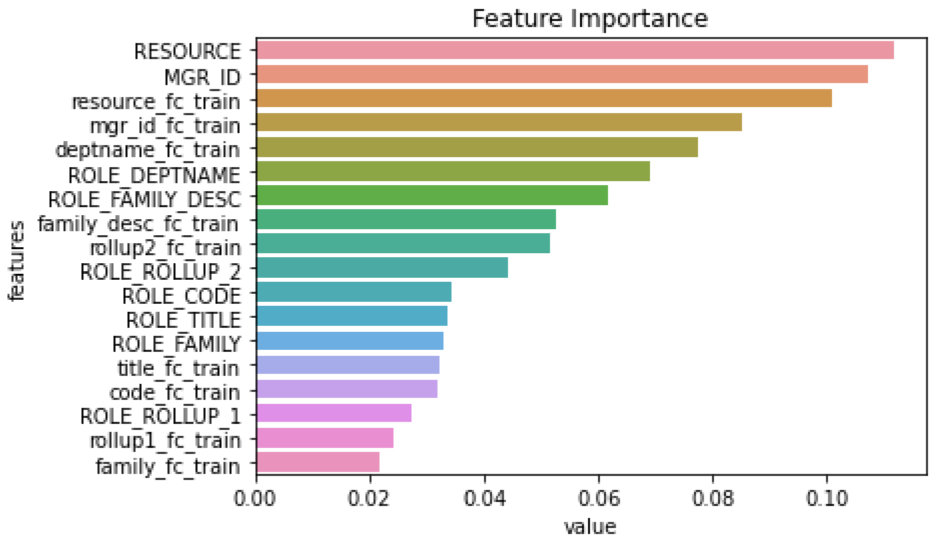
In [110]:
```
n_estimators=clf.best_params_['n_estimators']
max_features=clf.best_params_['max_features']
max_depth=clf.best_params_['max_depth']
min_samples_split=clf.best_params_['min_samples_split']
n_estimators,max_features,max_depth,min_samples_split
```

Out[110]:
```
(1000, 5, 25, 2)
```

In [111]:
```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_depth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=42,class_weight='balanced',n_jobs=-1)

model.fit(mod_train,y_true)
```

Out[111]:
```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
                       criterion='gini', max_depth=25, max_features=5,
                       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=1000, n_jobs=-1, oob_score=False,
                       random_state=42, verbose=0, warm_start=False)
```

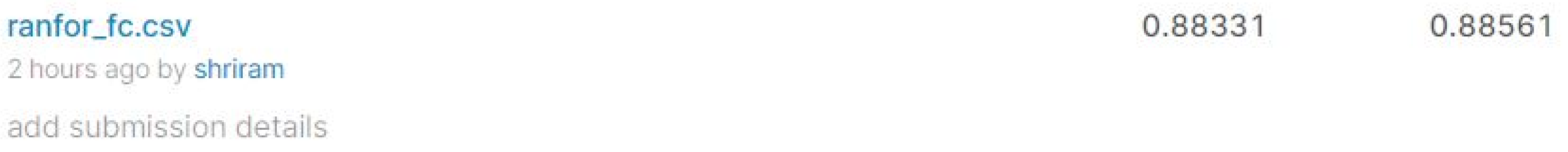
In [112]:
```
features=mod_train.columns
importance=model.feature_importances_
res=pd.DataFrame({'features':features,'value':importance})
res=res.sort_values('value',ascending=False)
sb.barplot('value','features',data=res);
plt.title('Feature Importance');
```



This model too has the REOSOURCE as the most important feature followed by MGR_ID , RESOURCE_FC_Train etc...

In [113]:
```
predictions = model.predict_proba(mod_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/ranfor_fc.csv", index = False)
```

```
Kaggle Score(test AUC )                                                    private score          public score
```


ranfor_fc.csv 0.88331 0.88561
2 hours ago by shriram
add submission details

Random Forest + Response Coding

In [114]:

```
mod_train = pd.concat((train_data,rc_df_train),axis=1)
mod_train.shape
```

Out[114]:

```
(32769, 18)
```

In [115]:

```
mod_test = pd.concat((test_data,rc_df_test),axis=1)
mod_test.shape
```

Out[115]:

```
(58921, 18)
```

In [116]:

```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier(random_state=42,class_weight='balanced',n_jobs=-1)
from scipy import stats
n_estimators = [10,20,50,100,200,500,700,1000]
max_depth = [1,2,5,10,12,15,20,25]
max_features=[1,2,3,4,5]
min_samples_split=[2,5,7,10,20]

params = {'n_estimators':n_estimators,
         'max_depth':max_depth,
         'max_features':max_features,
         'min_samples_split':min_samples_split}

clf = RandomizedSearchCV(rfc,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model=clf.fit(mod_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   40.1s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  4.0min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed:  9.6min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 10.5min finished
```

In [117]:

```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[117]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean_test_score
84	1000	25	5	2	0.987321
82	700	20	5	20	0.987281
54	100	20	5	20	0.986956
22	200	25	4	10	0.986914
51	1000	15	5	5	0.986823
33	700	25	4	2	0.986743
49	100	15	5	10	0.986431
64	700	10	5	7	0.986412
32	100	12	5	10	0.986336
25	700	15	4	7	0.986297

In [118]:

```
n_estimators=clf.best_params_['n_estimators']
max_features=clf.best_params_['max_features']
max_depth=clf.best_params_['max_depth']
min_samples_split=clf.best_params_['min_samples_split']
n_estimators,max_features,max_depth,min_samples_split
```

Out[118]:

```
(1000, 5, 25, 2)
```

In [119]:

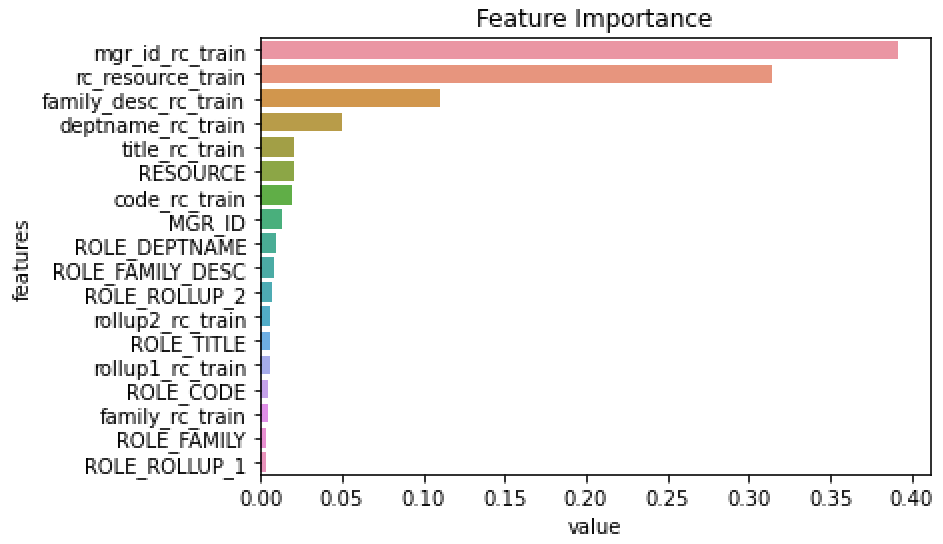
```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_depth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=42,class_weight='balanced',n_jobs=-1)

model.fit(mod_train,y_true)
```

Out[119]:

```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
                       criterion='gini', max_depth=25, max_features=5,
                       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=1000, n_jobs=-1, oob_score=False,
                       random_state=42, verbose=0, warm_start=False)
```

In [120]:

```
features=mod_train.columns
importance=model.feature_importances_
res=pd.DataFrame({'features':features,'value':importance})
res=res.sort_values('value',ascending=False)
sb.barplot('value','features',data=res);
plt.title('Feature Importance');
```



In [121]:

```
predictions = model.predict_proba(mod_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/ranfor_rc.csv", index = False)
```

Kaggle Score(test AUC)   private score   public score

ranfor_rc.csv 0.80621 0.80399

just now by shriram

add submission details

In [171]:
```
#https://stackoverflow.com/questions/36423259/how-to-use-pretty-table-in-python-to-print-out-data-from-multiple-lists
from prettytable import PrettyTable

x=PrettyTable(['Algorithm','Test AUC score'])
x.add_row(['Random Forest',0.87678])
x.add_row(['Random Forest (One hot encoding)',0.85072])
x.add_row(['Random Forest (Using Frequency coding)',0.88561])
x.add_row(['Random Forest (Using Response Coding)',0.80399])
x.add_row(['Random Forest (Using SVD)',0.86712])
print(x)
```

```
+----------------------------------------+----------------+
|               Algorithm                | Test AUC score |
+----------------------------------------+----------------+
|             Random Forest              |    0.87678     |
|    Random Forest (One hot encoding)    |    0.85072     |
| Random Forest (Using Frequency coding) |    0.88561     |
| Random Forest (Using Response Coding)  |    0.80399     |
|       Random Forest (Using SVD)        |    0.86712     |
+----------------------------------------+----------------+
```

OBSERVATIONS

When we apply random forest model on the given data (no feature transforms), it performs pretty well (AUC score 0.87678)

If we add the frequency encoded features and then apply random forest , the model's performance seems to improve (value increases to 0.88561)

XGBoost

In [123]:
```
# https://stackoverflow.com/questions/43927725/python-hyperparameter-optimization-for-xgbclassifier-using-randomizedsearchcv
from xgboost import XGBClassifier
from scipy import stats
params = {'n_estimators': [10,20,50,100,200,500,750,1000],
              'learning_rate': stats.uniform(0.01, 0.6),
              'subsample': stats.uniform(),
              'max_depth': [3, 4, 5, 6, 7, 8, 9],
              'colsample_bytree': stats.uniform(),
              'min_child_weight': [1, 2, 3, 4]
             }
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model=clf.fit(train_data,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   35.4s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  3.2min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed:  9.0min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 11.0min finished
```

In [124]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[124]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsample_bytree	param_min_child_weight	mean_test_score
18	1000	0.048135	0.665922	9	0.330898	2	0.860375
97	750	0.232385	0.907694	6	0.374271	1	0.857483
44	1000	0.060484	0.606429	6	0.642032	2	0.855331
96	500	0.0979629	0.98664	7	0.891897	1	0.853714
62	500	0.0663892	0.328153	9	0.375583	3	0.852542
84	200	0.571989	0.967581	6	0.348337	1	0.850602
53	200	0.540096	0.928319	6	0.27956	1	0.849569
86	1000	0.475848	0.858413	9	0.372018	2	0.848867
49	500	0.160277	0.393098	8	0.636333	2	0.847747
8	750	0.0686033	0.683264	6	0.304614	4	0.846221

In [125]:
```
colsample_bytree = clf.best_params_['colsample_bytree']
learning_rate=clf.best_params_['learning_rate']
max_depth=clf.best_params_['max_depth']
min_child_weight=clf.best_params_['min_child_weight']
n_estimators=clf.best_params_['n_estimators']
subsample=clf.best_params_['subsample']
colsample_bytree,learning_rate,max_depth,min_child_weight,n_estimators,subsample
```

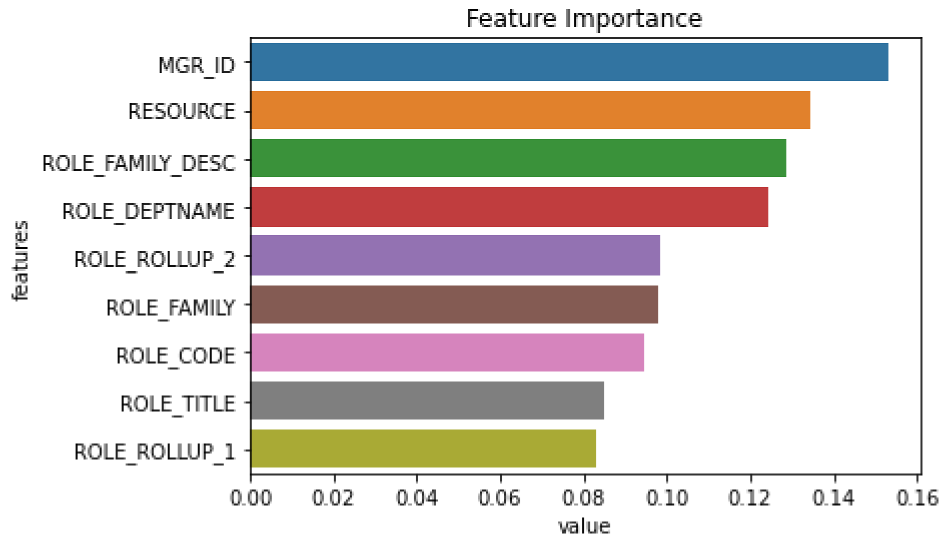
Out[125]:
```
(0.3308980248526492, 0.04813501017161418, 9, 2, 1000, 0.6659223566174967)
```

In [126]:
```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=learning_rate,max_depth=max_depth,
                      min_child_weight=min_child_weight,n_estimators=n_estimators,subsample=subsample,n_jobs=-1)

model.fit(train_data,y_true)
```

Out[126]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3308980248526492, gamma=0,
              learning_rate=0.04813501017161418, max_delta_step=0, max_depth=9,
              min_child_weight=2, missing=None, n_estimators=1000, 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=0.6659223566174967, verbosity=1)
```

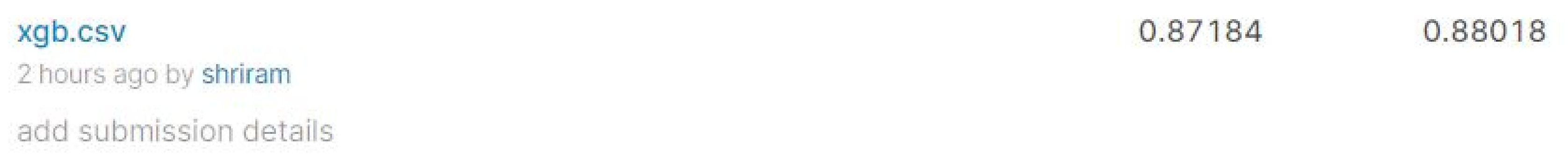
In [ ]:

In [127]:
```
features=train_data.columns
importance=model.feature_importances_
res=pd.DataFrame({'features':features,'value':importance})
res=res.sort_values('value',ascending=False)
sb.barplot('value','features',data=res);
plt.title('Feature Importance');
```



In [128]:
```
predictions = model.predict_proba(test_data)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/xgb.csv", index = False)
```

```
Kaggle Score(test AUC )                                                            private score          public score
```


xgb.csv 0.87184 0.88018
2 hours ago by shriram
add submission details

XGBoost OHE

In [129]:
```
# https://stackoverflow.com/questions/43927725/python-hyperparameter-optimization-for-xgbclassifier-using-randomizedsearchcv
from xgboost import XGBClassifier
from scipy import stats
params = {'n_estimators': [10,20,50,100,200,500,750,1000],
              'learning_rate': stats.uniform(0.01, 0.6),
              'subsample': stats.uniform(),
              'max_depth': [3, 4, 5, 6, 7, 8, 9],
              'colsample_bytree': stats.uniform(),
              'min_child_weight': [1, 2, 3, 4]
             }
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model=clf.fit(ohe_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   55.5s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  4.8min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 12.4min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 14.4min finished
```

In [130]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[130]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsample_bytree	param_min_child_weight	mean_test_score
97	750	0.232385	0.907694	6	0.374271	1	0.849761
80	1000	0.385564	0.905351	3	0.820639	1	0.846298
14	200	0.374221	0.802197	7	0.965255	1	0.841194
86	1000	0.475848	0.858413	9	0.372018	2	0.840755
84	200	0.571989	0.967581	6	0.348337	1	0.839749
53	200	0.540096	0.928319	6	0.27956	1	0.839370
96	500	0.0979629	0.98664	7	0.891897	1	0.836363
50	500	0.388683	0.645103	4	0.892047	1	0.835977
92	200	0.478778	0.49442	9	0.946195	1	0.834962
22	1000	0.391846	0.695516	6	0.0314292	1	0.833850

In [131]:
```
colsample_bytree = clf.best_params_['colsample_bytree']
learning_rate=clf.best_params_['learning_rate']
max_depth=clf.best_params_['max_depth']
min_child_weight=clf.best_params_['min_child_weight']
n_estimators=clf.best_params_['n_estimators']
subsample=clf.best_params_['subsample']
colsample_bytree,learning_rate,max_depth,min_child_weight,n_estimators,subsample
```

Out[131]:
```
(0.3742707957561203, 0.23238528824013455, 6, 1, 750, 0.9076937063485463)
```

In [132]:
```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=learning_rate,max_depth=max_depth,
                      min_child_weight=min_child_weight,n_estimators=n_estimators,subsample=subsample,n_jobs=-1)

model.fit(ohe_train,y_true)
```

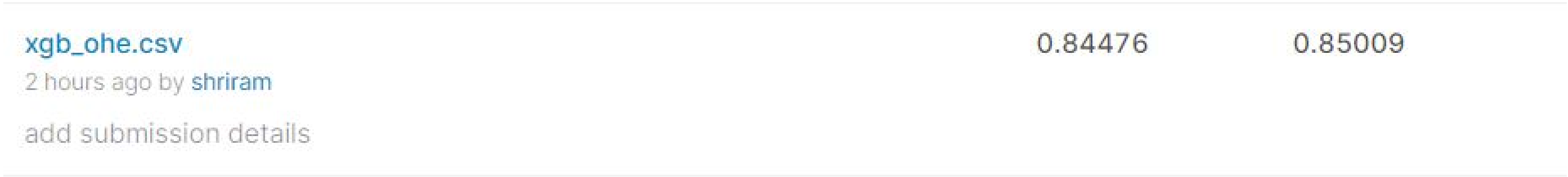
Out[132]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3742707957561203, gamma=0,
              learning_rate=0.23238528824013455, max_delta_step=0, max_depth=6,
              min_child_weight=1, missing=None, n_estimators=750, 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=0.9076937063485463, verbosity=1)
```

In [ ]:

In [ ]:

In [133]:
```
predictions = model.predict_proba(ohe_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/xgb_ohe.csv", index = False)
```

```
     Kaggle Score(test AUC )                                                  private score          public score
```



xgb_ohe.csv 0.84476 0.85009

2 hours ago by shriram

add submission details

XGboost + freq.coding

In [134]:
```
mod_train = pd.concat((train_data,fc_df_train),axis=1)
mod_train.shape
```

Out[134]:
```
(32769, 18)
```

In [135]:
```
mod_test = pd.concat((test_data,fc_df_test),axis=1)
mod_test.shape
```

Out[135]:
```
(58921, 18)
```

In [136]:
```
from scipy import sparse
mod_train=sparse.csr_matrix(mod_train)
mod_test=sparse.csr_matrix(mod_test)
mod_train.shape,mod_test.shape
```

Out[136]:
```
((32769, 18), (58921, 18))
```

In [137]:
```
# https://stackoverflow.com/questions/43927725/python-hyperparameter-optimization-for-xgbclassifier-using-randomizedsearchcv
from xgboost import XGBClassifier
from scipy import stats
params = {'n_estimators': [10,20,50,100,200,500,750,1000],
              'learning_rate': stats.uniform(0.01, 0.6),
              'subsample': stats.uniform(),
              'max_depth': [3, 4, 5, 6, 7, 8, 9],
              'colsample_bytree': stats.uniform(),
              'min_child_weight': [1, 2, 3, 4]
             }
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(mod_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   49.3s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  4.7min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 12.8min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 15.1min finished
```

In [138]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[138]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsample_bytree	param_min_child_weight	mean_test_score
18	1000	0.048135	0.665922	9	0.330898	2	0.869517
62	500	0.0663892	0.328153	9	0.375583	3	0.863794
44	1000	0.060484	0.606429	6	0.642032	2	0.863719
8	750	0.0686033	0.683264	6	0.304614	4	0.862736
97	750	0.232385	0.907694	6	0.374271	1	0.861853
96	500	0.0979629	0.98664	7	0.891897	1	0.860932
49	500	0.160277	0.393098	8	0.636333	2	0.860655
86	1000	0.475848	0.858413	9	0.372018	2	0.858084
77	100	0.310624	0.615851	7	0.933436	1	0.854542
40	750	0.334869	0.659984	4	0.209072	3	0.854135

In [139]:
```
colsample_bytree = clf.best_params_['colsample_bytree']
learning_rate=clf.best_params_['learning_rate']
max_depth=clf.best_params_['max_depth']
min_child_weight=clf.best_params_['min_child_weight']
n_estimators=clf.best_params_['n_estimators']
subsample=clf.best_params_['subsample']
colsample_bytree,learning_rate,max_depth,min_child_weight,n_estimators,subsample
```

Out[139]:
```
(0.3308980248526492, 0.04813501017161418, 9, 2, 1000, 0.6659223566174967)
```

In [140]:

```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=learning_rate,max_depth=max_depth,
                      min_child_weight=min_child_weight,n_estimators=n_estimators,subsample=subsample,n_jobs=-1)

model.fit(mod_train,y_true)
```

Out[140]:

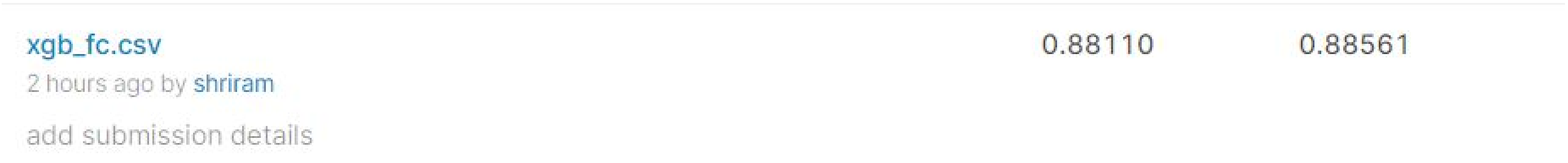
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3308980248526492, gamma=0,
              learning_rate=0.04813501017161418, max_delta_step=0, max_depth=9,
              min_child_weight=2, missing=None, n_estimators=1000, n_jobs=-1,
              nthread=None, objective='binary:logistic', random_state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
              silent=None, subsample=0.6659223566174967, verbosity=1)
```

In [ ]:

In [141]:

```
predictions = model.predict_proba(mod_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/xgb_fc.csv", index = False)
```

```
Kaggle Score(test AUC )                                                       private score          public score
```



xgb_fc.csv 0.88110 0.88561

2 hours ago by shriram

add submission details

XGboost + Response Coding

In [142]:

```
mod_train = pd.concat((train_data,rc_df_train),axis=1)
mod_train.shape
```

Out[142]:

```
(32769, 18)
```

In [143]:

```
mod_test = pd.concat((test_data,rc_df_test),axis=1)
mod_test.shape
```

Out[143]:

```
(58921, 18)
```

In [144]:

```
from scipy import sparse
mod_train=sparse.csr_matrix(mod_train)
mod_test=sparse.csr_matrix(mod_test)
mod_train.shape,mod_test.shape
```

Out[144]:

```
((32769, 18), (58921, 18))
```

In [145]:

```
# https://stackoverflow.com/questions/43927725/python-hyperparameter-optimization-for-xgbclassifier-using-randomizedsearchcv
from xgboost import XGBClassifier
from scipy import stats
params = {'n_estimators': [10,20,50,100,200,500,750,1000],
              'learning_rate': stats.uniform(0.01, 0.6),
              'subsample': stats.uniform(),
              'max_depth': [3, 4, 5, 6, 7, 8, 9],
              'colsample_bytree': stats.uniform(),
              'min_child_weight': [1, 2, 3, 4]
             }
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(mod_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:   49.1s
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed:  4.6min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 13.1min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 15.6min finished
```

In [146]:

```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[146]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsample_bytree	param_min_child_weight	mean_test_score
7	500	0.017959	0.808397	3	0.450499	4	0.988997
28	500	0.0141713	0.222108	5	0.860731	1	0.988988
1	200	0.0699849	0.601115	5	0.445833	4	0.988958
98	50	0.220131	0.777147	6	0.591889	3	0.988894
41	20	0.34312	0.996254	6	0.817222	1	0.988640
58	50	0.454461	0.708911	3	0.877373	1	0.988404
91	50	0.185926	0.212728	3	0.448446	4	0.988392
33	100	0.153737	0.447783	4	0.908266	1	0.988390
90	20	0.416062	0.631837	6	0.956801	3	0.988299
85	50	0.264083	0.412618	5	0.547972	1	0.988267

In [147]:

```
colsample_bytree = clf.best_params_['colsample_bytree']
learning_rate=clf.best_params_['learning_rate']
max_depth=clf.best_params_['max_depth']
min_child_weight=clf.best_params_['min_child_weight']
n_estimators=clf.best_params_['n_estimators']
subsample=clf.best_params_['subsample']
colsample_bytree,learning_rate,max_depth,min_child_weight,n_estimators,subsample
```

Out[147]:

```
(0.450499251969543, 0.017958976695919917, 3, 4, 500, 0.8083973481164611)
```

In [148]:

```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=learning_rate,max_depth=max_depth,
                     min_child_weight=min_child_weight,n_estimators=n_estimators,subsample=subsample,n_jobs=-1)

model.fit(mod_train,y_true)
```

Out[148]:

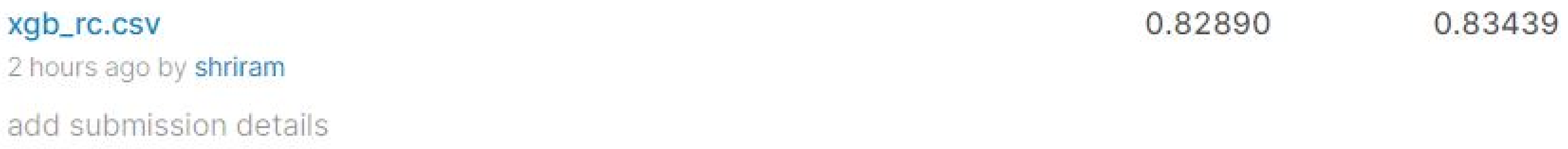
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.450499251969543, gamma=0,
              learning_rate=0.017958976695919917, max_delta_step=0, max_depth=3,
              min_child_weight=4, missing=None, n_estimators=500, n_jobs=-1,
              nthread=None, objective='binary:logistic', random_state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
              silent=None, subsample=0.8083973481164611, verbosity=1)
```

In [ ]:

In [149]:

```
predictions = model.predict_proba(mod_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/xgb_rc.csv", index = False)
```

```
Kaggle Score(test AUC )                                                  private score          public score
```



xgb_rc.csv
2 hours ago by shriram
add submission details
0.82890 0.83439

XGboost + SVD

In [150]:

```
mod_train = pd.concat((train_data,train_svd),axis=1)
mod_train.shape
```

Out[150]:

```
(32769, 81)
```

In [151]:

```
mod_test = pd.concat((test_data,test_svd),axis=1)
mod_test.shape
```

Out[151]:

```
(58921, 81)
```

In [152]:

```
from scipy import sparse
mod_train=sparse.csr_matrix(mod_train)
mod_test=sparse.csr_matrix(mod_test)
mod_train.shape,mod_test.shape
```

Out[152]:

```
((32769, 81), (58921, 81))
```

In [153]:

```
# https://stackoverflow.com/questions/43927725/python-hyperparameter-optimization-for-xgbclassifier-using-randomizedsearchcv
from xgboost import XGBClassifier
from scipy import stats
params = {'n_estimators': [10,20,50,100,200,500,750,1000],
              'learning_rate': stats.uniform(0.01, 0.6),
              'subsample': stats.uniform(),
              'max_depth': [3, 4, 5, 6, 7, 8, 9],
              'colsample_bytree': stats.uniform(),
              'min_child_weight': [1, 2, 3, 4]
             }
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,params,random_state=42,cv=5,verbose=1,n_iter=100,scoring='roc_auc',n_jobs=-1)
best_model = clf.fit(mod_train,y_true)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed:  2.9min
[Parallel(n_jobs=-1)]: Done 184 tasks      | elapsed: 18.6min
[Parallel(n_jobs=-1)]: Done 434 tasks      | elapsed: 54.4min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 64.6min finished
```

In [154]:

```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
a=['param_'+str(each) for each in params.keys()]
a.append('mean_test_score')
results[a].head(10)
```

Out[154]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsample_bytree	param_min_child_weight	mean_test_score
8	750	0.0686033	0.683264	6	0.304614	4	0.863774
18	1000	0.048135	0.665922	9	0.330898	2	0.863765
44	1000	0.060484	0.606429	6	0.642032	2	0.862712
96	500	0.0979629	0.98664	7	0.891897	1	0.862369
62	500	0.0663892	0.328153	9	0.375583	3	0.860342
97	750	0.232385	0.907694	6	0.374271	1	0.857866
49	500	0.160277	0.393098	8	0.636333	2	0.856536
86	1000	0.475848	0.858413	9	0.372018	2	0.853534
14	200	0.374221	0.802197	7	0.965255	1	0.852723
77	100	0.310624	0.615851	7	0.933436	1	0.852379

In [155]:

```
colsample_bytree = clf.best_params_['colsample_bytree']
learning_rate=clf.best_params_['learning_rate']
max_depth=clf.best_params_['max_depth']
min_child_weight=clf.best_params_['min_child_weight']
n_estimators=clf.best_params_['n_estimators']
subsample=clf.best_params_['subsample']
colsample_bytree,learning_rate,max_depth,min_child_weight,n_estimators,subsample
```

Out[155]:

```
(0.3046137691733707, 0.06860326840383031, 6, 4, 750, 0.6832635188254582)
```

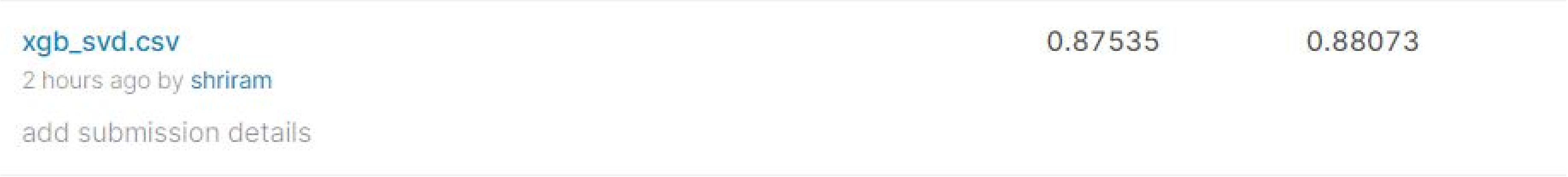
In [156]:
```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=learning_rate,max_depth=max_depth,
                      min_child_weight=min_child_weight,n_estimators=n_estimators,subsample=subsample,n_jobs=-1)

model.fit(mod_train,y_true)
```

Out[156]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3046137691733707, gamma=0,
              learning_rate=0.06860326840383031, max_delta_step=0, max_depth=6,
              min_child_weight=4, missing=None, n_estimators=750, 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=0.6832635188254582, verbosity=1)
```

In [ ]:

In [157]:
```
predictions = model.predict_proba(mod_test)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/xgb_svd.csv", index = False)
```

```
     Kaggle Score(test AUC )                                                        private score          public score
```



xgb_svd.csv 0.87535 0.88073

2 hours ago by shriram

add submission details

In [172]:
```
#https://stackoverflow.com/questions/36423259/how-to-use-pretty-table-in-python-to-print-out-data-from-multiple-lists
from prettytable import PrettyTable

x=PrettyTable(['Algorithm','Test AUC score'])
x.add_row(['XGBOOST',0.88018])
x.add_row(['XGBOOST (Using Frequency coding)',0.88561])
x.add_row(['XGBOOST (Using OHE)',0.85009])
x.add_row(['XGBOOST (Using SVD)',0.88073])
x.add_row(['XGBOOST (Using Response Coding)',0.83439])
print(x)
```

```
+----------------------------------+----------------+
|            Algorithm             | Test AUC score |
+----------------------------------+----------------+
|             XGBOOST              |    0.88018     |
| XGBOOST (Using Frequency coding) |    0.88561     |
|       XGBOOST (Using OHE)        |    0.85009     |
|       XGBOOST (Using SVD)        |    0.88073     |
| XGBOOST (Using Response Coding)  |    0.83439     |
+----------------------------------+----------------+
```

OBSERVATIONS

XGBOOST seems to do well when compared to Random Forest as it gives a better AUC score of 0.880 when applied on raw data The performance improves further when we use Frequency encoded features

https://catboost.ai/ (https://catboost.ai/)

CatBoost

CatBoost is a high-performance open source library for gradient boosting on decision trees

Advantages:

1. Reduce time spent on parameter tuning, because CatBoost provides great results with default parameters
2. Improve your training results with CatBoost that allows you to use non-numeric factors, instead of having to pre-process your data or spend time and effort turning it to numbers.
3. Reduce overfitting when constructing your models with a novel gradient-boosting scheme.
4. Apply your trained model quickly and efficiently even to latency-critical tasks using CatBoost's model applier

In [159]:
```
# https://www.kaggle.com/mitribunskiy/tutorial-catboost-overview
```

In [160]:
```
# https://www.kaggle.com/prashant111/catboost-classifier-tutorial
```

In [161]:
```
train_data=train.drop(columns=['ACTION'],axis=1)
train_data.shape
```

Out[161]:
```
(32769, 9)
```

In [162]:
```
y_true = train['ACTION']
y_true.shape
```

Out[162]:
```
(32769,)
```

In [163]:
```
test_data=test.drop(columns=['id'],axis=1)
test_data.shape
```

Out[163]:
```
(58921, 9)
```

In [164]:
```
categorical_features = list(range(train_data.shape[1]))
categorical_features
```

Out[164]:
```
[0, 1, 2, 3, 4, 5, 6, 7, 8]
```

In [165]:
```
from catboost import CatBoostClassifier
params = {'loss_function':'Logloss',
         'eval_metric':'AUC',
          'cat_features':categorical_features,
         'verbose':200,
         'random_seed':42}

clf= CatBoostClassifier(**params)
#clf.fit(x_tr,y_tr,eval_set=(x_val,y_val),use_best_model=True)
clf.fit(train_data,y_true)
```

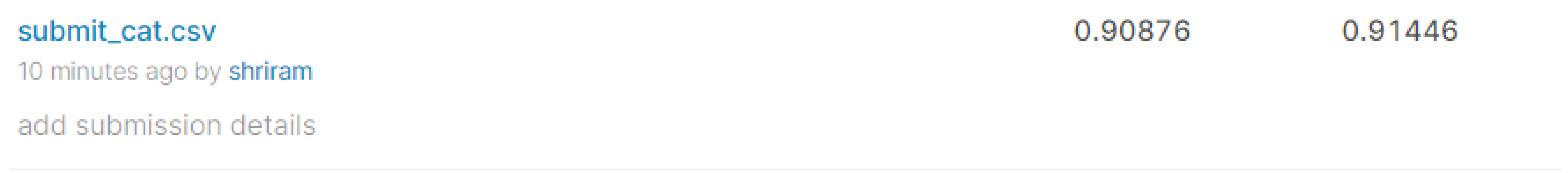
```
Learning rate set to 0.045713
0:      total: 248ms    remaining: 4m 7s
200:    total: 28.8s    remaining: 1m 54s
400:    total: 1m 2s    remaining: 1m 33s
600:    total: 1m 35s   remaining: 1m 3s
800:    total: 2m 7s    remaining: 31.7s
999:    total: 2m 40s   remaining: 0us
```

Out[165]:
```
<catboost.core.CatBoostClassifier at 0x183802a72b0>
```

In [166]:

```
predictions = clf.predict_proba(test_data)[:,1]

submit = pd.DataFrame()
submit["Id"] = test["id"]
submit["ACTION"] = predictions

submit.to_csv("results/submit_cat.csv", index = False)
```

```
Kaggle Score(test AUC )                                                  private score          public score
```



submit_cat.csv 0.90876 0.91446

10 minutes ago by shriram

add submission details

Of all the models that were used, CatBoost model seems to be best model as it gives the best AUC score of 0.9144 Also the training time is also faster as compared to other models

In [167]:

```
import joblib
joblib.dump(clf,'catboost_model.pkl')
```

Out[167]:

```
['catboost_model.pkl']
```