In [1]:

```
# import warnings
# warnings.filterwarnings('ignore')
```

In [2]:

```
# import libraries
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from scipy import sparse
%matplotlib inline

from sklearn.model_selection import RandomizedSearchCV
from scipy.stats import uniform
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import LinearSVC
from sklearn.calibration import CalibratedClassifierCV
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
from catboost import CatBoostClassifier
import pickle
```

Amazon Employee Access Challenge

In [3]:

```
train = pd.read_csv('data/train.csv')
test = pd.read_csv('data/test.csv')
```

In [4]:

```
train.shape
```

Out[4]:

```
(32769, 10)
```

In [5]:

```
test.shape
```

```
Out[5]: (58921, 10)
```

```
In [6]: y_train = train['ACTION']
```

```
In [7]: y_train.shape
```

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

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

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

```
In [9]: test_data = test.drop('id', axis=1)
        test_data.shape
```

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

Common Variables

```
In [10]: # define variables
         random_state = 42
         cv = 5
         scoring = 'roc_auc'
         verbose=2
```

Common functions

```
In [11]: def save_submission(predictions, filename):
             '''
             Save predictions into csv file
             '''
             global test
             submission = pd.DataFrame()
```

```
    submission["Id"] = test["id"]
    submission["ACTION"] = predictions
    filepath = "result/sampleSubmission_"+filename
    submission.to_csv(filepath, index = False)
```

In [12]:

```
def print_graph(results, param1, param2, xlabel, ylabel, title='Plot sh
owing the ROC_AUC score for various hyper parameter values'):
    '''
    Plot the graph
    '''
    plt.plot(results[param1],results[param2]);
    plt.grid();
    plt.xlabel(xlabel);
    plt.ylabel(ylabel);
    plt.title(title);
```

In [13]:

```
def get_rf_params():
    '''
    Return dictionary of parameters for random forest
    '''
    params = {
         '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]
    }

    return params
```

In [14]:

```
def get_xgb_params():
    '''
    Return dictionary of parameters for xgboost
    '''
    params = {
        'n_estimators': [10,20,50,100,200,500,750,1000],
        'learning_rate': uniform(0.01, 0.6),
        'subsample': uniform(),
        'max_depth': [3, 4, 5, 6, 7, 8, 9],
        'colsample_bytree': uniform(),
        'min_child_weight': [1, 2, 3, 4]
    }

    return params
```

We will try following models

1. KNN
2. SVM
3. Logistic Regression
4. Random Forest
5. Xgboost

Build Models on the raw data

1.1 KNN with raw features

In [15]:

```
parameters={'n_neighbors':np.arange(1,100, 5)}
clf = RandomizedSearchCV(KNeighborsClassifier(n_jobs=-1),parameters,ran
dom_state=random_state,cv=cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_data,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    5.2s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:    8.8s finished
```

In [16]:

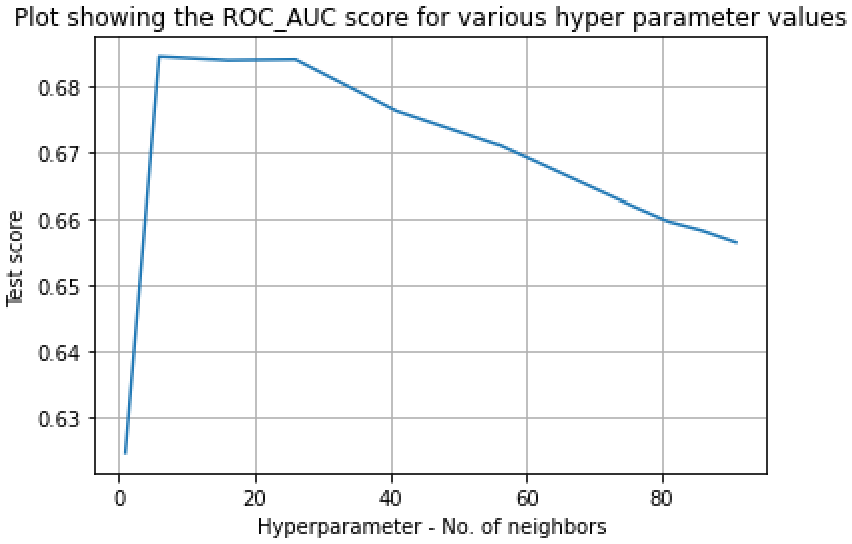
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
results
```

Out[16]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_neighbors	param
0	0.083934	0.007898	0.265385	0.036920	1	{'n_neighbors
3	0.240013	0.066697	0.500296	0.106391	6	{'n_neighbors
7	0.226630	0.185183	0.727930	0.213502	16	{'n_neighbors 1
5	0.243259	0.052800	0.871988	0.100550	26	{'n_neighbors 2
4	0.183503	0.043958	0.783068	0.125342	41	{'n_neighbors 4
6	0.228750	0.048025	1.059379	0.235010	56	{'n_neighbors 5
2	0.311753	0.040799	1.216632	0.265773	76	{'n_neighbors 7
9	0.270957	0.199804	0.948423	0.458374	81	{'n_neighbors 8
1	0.168152	0.078784	1.293272	0.219475	86	{'n_neighbors 8
8	0.108329	0.024517	1.590826	0.059955	91	{'n_neighbors 9

In [17]:

```
print_graph(results, 'param_n_neighbors', 'mean_test_score', 'Hyperpara
meter - No. of neighbors', 'Test score')
```



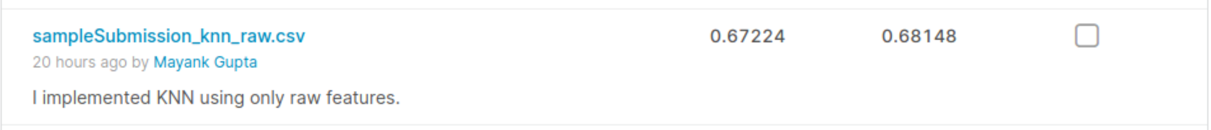
In [18]:
```
best_c=best_model.best_params_['n_neighbors']
best_c
```

Out[18]:
```
6
```

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

Out[19]:
```
KNeighborsClassifier(n_jobs=-1, n_neighbors=6)
```

In [20]:
```
predictions = model.predict_proba(test_data)[:,1]
save_submission(predictions, "knn_raw.csv")
```



sampleSubmission_knn_raw.csv 0.67224 0.68148 □

20 hours ago by Mayank Gupta

I implemented KNN using only raw features.

1.2 SVM with raw feature

In [21]:
```
C_val = uniform(loc=0, scale=4)
model= LinearSVC(verbose=verbose,random_state=random_state,class_weight
='balanced',max_iter=2000)
parameters={'C':C_val}
clf = RandomizedSearchCV(model,parameters,random_state=random_state,cv=
cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_data,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:  1.3min
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:  2.0min finished
```

```
[LibLinear]
```

```
/home/auw-mayank/.local/lib/python3.6/site-packages/sklearn/svm/_base.p
y:977: ConvergenceWarning: Liblinear failed to converge, increase the n
umber of iterations.
  "the number of iterations.", ConvergenceWarning)
```

In [22]:
```
best_c=best_model.best_params_['C']
best_c
```

Out[22]:
```
1.49816047538945
```

In [23]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

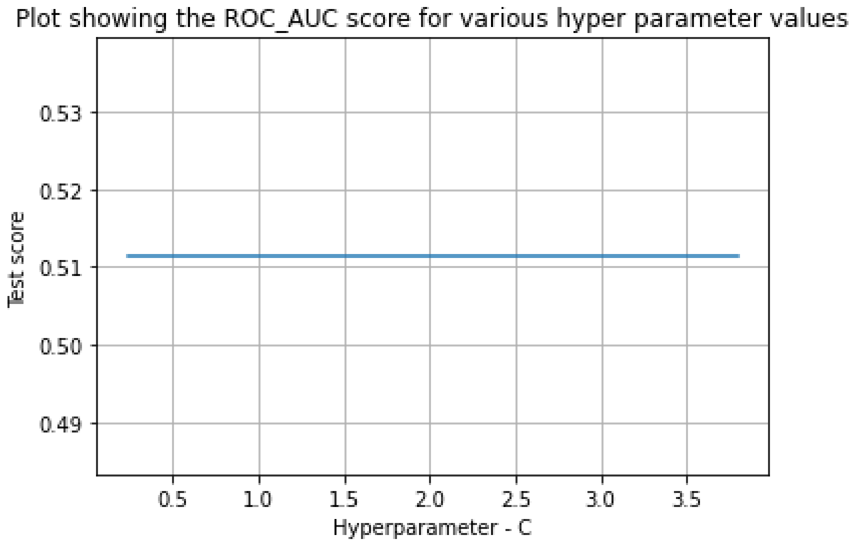
Out[23]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
6	18.684481	0.499781	0.009284	0.000217	0.232334	{'C': 0.23233444867279784}
5	19.870518	0.305372	0.009752	0.000904	0.623978	{'C': 0.6239780813448106}

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
4	19.918902	0.358008	0.011202	0.001661	0.624075	{'C': 0.6240745617697461}
0	19.442288	0.216182	0.009220	0.000190	1.49816	{'C': 1.49816047538945}
3	19.357509	0.560751	0.009917	0.000562	2.39463	{'C': 2.3946339367881464}
8	18.831271	0.356759	0.008356	0.001407	2.40446	{'C': 2.404460046972835}
9	14.130057	5.223100	0.006211	0.001171	2.83229	{'C': 2.832290311184182}
2	18.946967	0.453250	0.009577	0.000543	2.92798	{'C': 2.9279757672456204}
7	18.603018	0.394303	0.009629	0.000678	3.4647	{'C': 3.4647045830997407}
1	19.380741	0.234885	0.009244	0.000622	3.80286	{'C': 3.8028572256396647}

In [24]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [25]:
```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-dec
ision-function-to-probabilities-scikit-learn-python
model = LinearSVC(C=best_c,verbose=verbose,random_state=random_state,cl
ass_weight='balanced',max_iter=2000)
model = CalibratedClassifierCV(model)
model.fit(train_data,y_train)
```

```
[LibLinear]
```

```
/home/auw-mayank/.local/lib/python3.6/site-packages/sklearn/svm/_base.p
y:977: ConvergenceWarning: Liblinear failed to converge, increase the n
umber of iterations.
  "the number of iterations.", ConvergenceWarning)
```

```
[LibLinear]
```

```
/home/auw-mayank/.local/lib/python3.6/site-packages/sklearn/svm/_base.p
y:977: ConvergenceWarning: Liblinear failed to converge, increase the n
umber of iterations.
  "the number of iterations.", ConvergenceWarning)
```

```
[LibLinear]
```

```
/home/auw-mayank/.local/lib/python3.6/site-packages/sklearn/svm/_base.p
y:977: ConvergenceWarning: Liblinear failed to converge, increase the n
umber of iterations.
  "the number of iterations.", ConvergenceWarning)
```

```
[LibLinear]
```

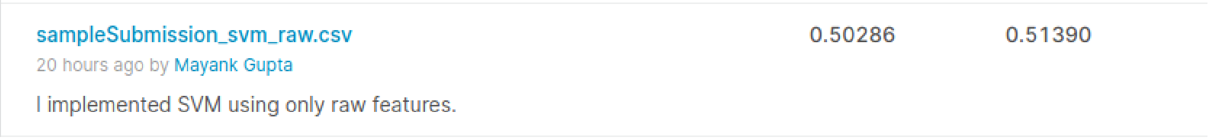
```
/home/auw-mayank/.local/lib/python3.6/site-packages/sklearn/svm/_base.p
y:977: ConvergenceWarning: Liblinear failed to converge, increase the n
umber of iterations.
  "the number of iterations.", ConvergenceWarning)
```

```
[LibLinear]
```

```
/home/auw-mayank/.local/lib/python3.6/site-packages/sklearn/svm/_base.p
y:977: ConvergenceWarning: Liblinear failed to converge, increase the n
umber of iterations.
  "the number of iterations.", ConvergenceWarning)
```

```
Out[25]: CalibratedClassifierCV(base_estimator=LinearSVC(C=1.49816047538945,
                                                class_weight='balance
         d',
                                                max_iter=2000, random_s
         tate=42,
                                                verbose=2))
```

```
In [26]: predictions = model.predict_proba(test_data)[:,1]
         save_submission(predictions, 'svm_raw.csv')
```



sampleSubmission_svm_raw.csv 0.50286 0.51390

20 hours ago by Mayank Gupta

I implemented SVM using only raw features.

1.3 Logistic Regression with Raw Feature

In [27]:
```
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=verbose,random_state=random_state,class_
weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=random_state,cv=cv,
verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_data,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    1.2s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:    6.1s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:   14.3s
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:   20.5s finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.3s finished
```

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

Out[28]:
```
1.49816047538945
```

In [29]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

Out[29]:

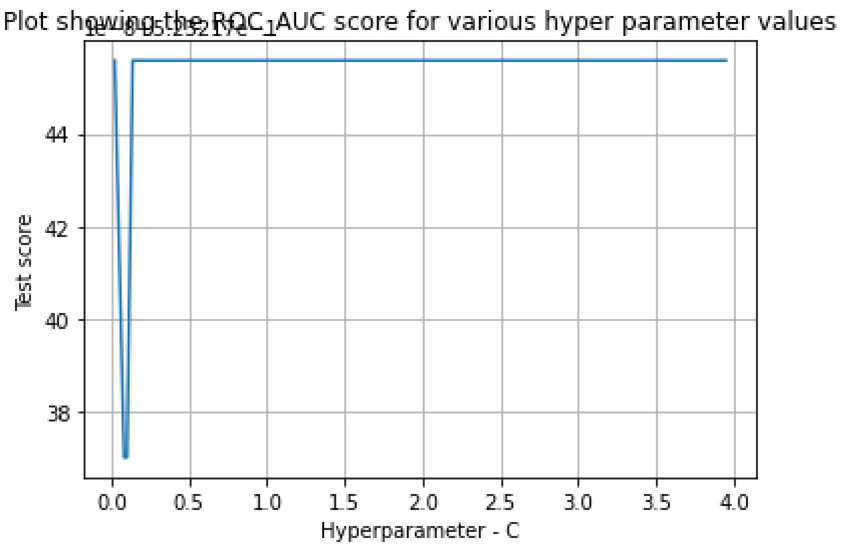
	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	parai
72	0.305453	0.042840	0.007123	0.001411	0.0220885	{' 0.0220884684944095
10	0.299544	0.043052	0.009865	0.001636	0.082338	{' 0.082337977183209
98	0.324737	0.029356	0.009632	0.001840	0.101677	{' 0.101676506976380

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	para
42	0.322684	0.047769	0.008097	0.001223	0.137554	{' 0.137554084460873
58	0.312479	0.040692	0.010287	0.003491	0.180909	{' 0.180909155642152
...	...	...	...	...	...	
1	0.330116	0.064433	0.008579	0.001581	3.80286	{' 3.80285722563966
34	0.307352	0.038496	0.009020	0.000806	3.86253	{' 3.86252813229823
50	0.286139	0.050608	0.008554	0.001624	3.87834	{' 3.87833851105823
11	0.311766	0.046068	0.009899	0.002444	3.87964	{' 3.87963940864797
69	0.288068	0.053532	0.009172	0.001290	3.94755	{' 3.9475477464020

100 rows × 14 columns

In [30]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```

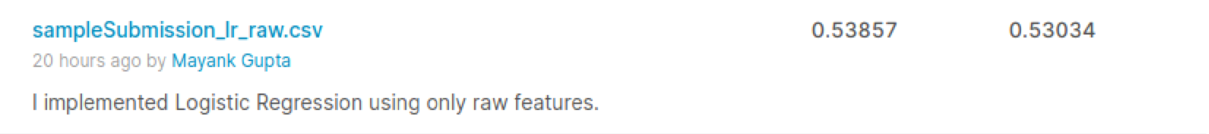


In [31]:
```
model = LogisticRegression(C=best_c,verbose=verbose,n_jobs=-1,random_st
ate=random_state,class_weight='balanced',solver='lbfgs')
model.fit(train_data,y_train)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.3s finished
```

Out[31]:
```
LogisticRegression(C=1.49816047538945, class_weight='balanced', n_jobs=
-1,
                   random_state=42, verbose=2)
```

In [32]:
```
predictions = model.predict_proba(test_data)[:,1]
save_submission(predictions, 'lr_raw.csv')
```


sampleSubmission_lr_raw.csv 0.53857 0.53034

20 hours ago by Mayank Gupta

I implemented Logistic Regression using only raw features.

1.4 Random Forest with Raw Feature

In [33]:

```
rfc = RandomForestClassifier(random_state=random_state,class_weight='ba
lanced',n_jobs=-1)
clf = RandomizedSearchCV(rfc,get_rf_params(),random_state=random_state,
cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_data,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   21.1s
/home/auw-mayank/.local/lib/python3.6/site-packages/joblib/externals/lo
ky/process_executor.py:691: UserWarning: A worker stopped while some jo
bs were given to the executor. This can be caused by a too short worker
timeout or by a memory leak.
  "timeout or by a memory leak.", UserWarning
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  4.6min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed: 10.3min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 15.1min finished
```

In [34]:

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

Out[34]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean
78	700	25	2	7	
62	500	25	3	5	
79	500	25	1	10	
55	200	25	2	5	
22	200	25	4	10	

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean
20	1000	25	3	2	
85	1000	20	3	7	
33	700	25	4	2	
84	1000	25	5	2	
27	50	25	2	10	

In [35]:

```
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[35]:

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

In [36]:

```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_de
pth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=random_state,class_weight='ba
lanced',n_jobs=-1)

model.fit(train_data,y_train)
```

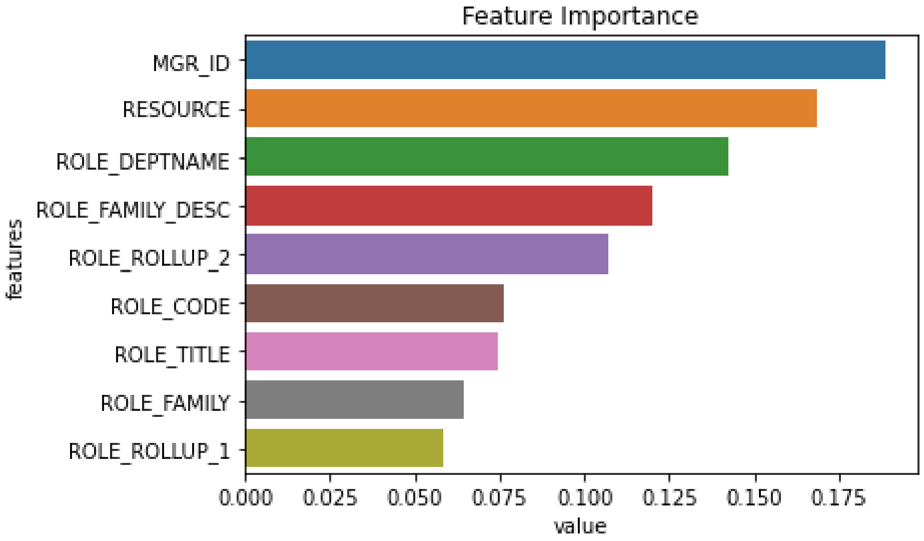
Out[36]:

```
RandomForestClassifier(class_weight='balanced', max_depth=25, max_featu
res=2,
                       min_samples_split=7, n_estimators=700, n_jobs=-
1,
                       random_state=42)
```

In [37]:

```
features=train_data.columns
importance=model.feature_importances_
features=pd.DataFrame({'features':features,'value':importance})
features=features.sort_values('value',ascending=False)
```

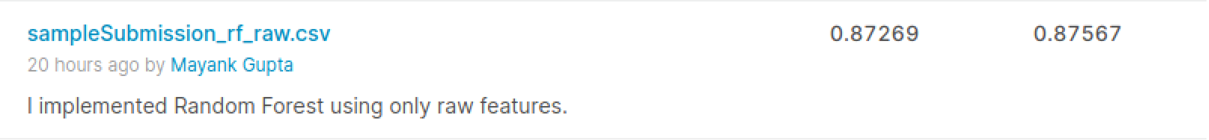
```
sns.barplot('value','features',data=features);
plt.title('Feature Importance');
```



Features Observations:

1. MGR_ID is the most important feature followed by RESOURCE and ROLE_DEPTNAME

In [38]:
```
predictions = model.predict_proba(test_data)[:,1]
save_submission(predictions, 'rf_raw.csv')
```



sampleSubmission_rf_raw.csv 0.87269 0.87567

20 hours ago by Mayank Gupta

I implemented Random Forest using only raw features.

1.5 Xgboost with Raw Feature

In [39]:
```
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,get_xgb_params(),random_state=random_state
,cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model=clf.fit(train_data,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    7.2s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  1.5min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  4.1min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  6.9min finished
```

In [40]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
param_keys=['param_'+str(each) for each in get_xgb_params().keys()]
param_keys.append('mean_test_score')
results[param_keys].head(10)
```

Out[40]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
18	1000	0.048135	0.665922	9	
44	1000	0.060484	0.606429	6	
97	750	0.232385	0.907694	6	
96	500	0.0979629	0.98664	7	
62	500	0.0663892	0.328153	9	
49	500	0.160277	0.393098	8	
84	200	0.571989	0.967581	6	
53	200	0.540096	0.928319	6	
86	1000	0.475848	0.858413	9	
8	750	0.0686033	0.683264	6	

In [41]:

```
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[41]:

```
(0.3308980248526492, 0.04813501017161418, 9, 2, 1000, 0.665922356617496
7)
```

In [42]:

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

model.fit(train_data,y_train)
```

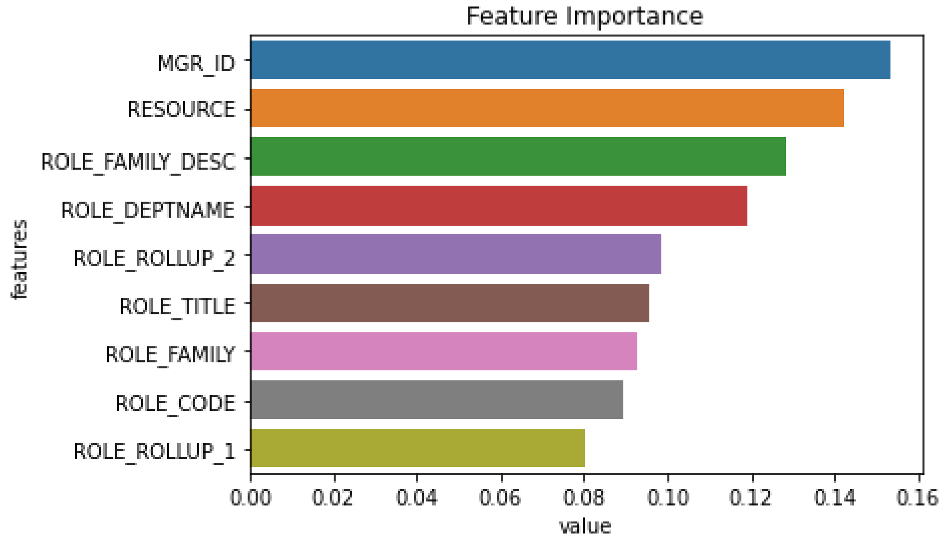
Out[42]:

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3308980248526492,
gamma=0,
              gpu_id=-1, importance_type='gain', interaction_constraint
s='',
              learning_rate=0.04813501017161418, max_delta_step=0, max_
depth=9,
              min_child_weight=2, missing=nan, monotone_constraints
='()',
              n_estimators=1000, n_jobs=-1, num_parallel_tree=1, random
_state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1,
              subsample=0.6659223566174967, tree_method='exact',
              validate_parameters=1, verbosity=None)
```

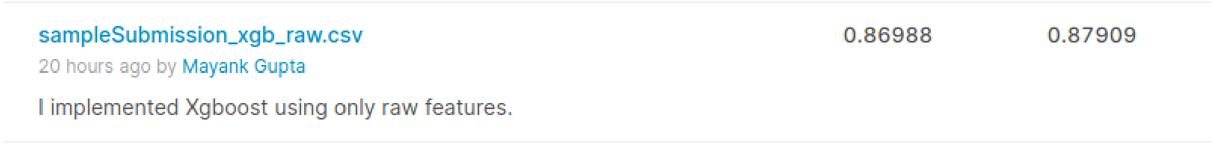
In [43]:

```
features=train_data.columns
importance=model.feature_importances_
features=pd.DataFrame({'features':features,'value':importance})
features=features.sort_values('value',ascending=False)
```

```
sns.barplot('value','features',data=features);
plt.title('Feature Importance');
```



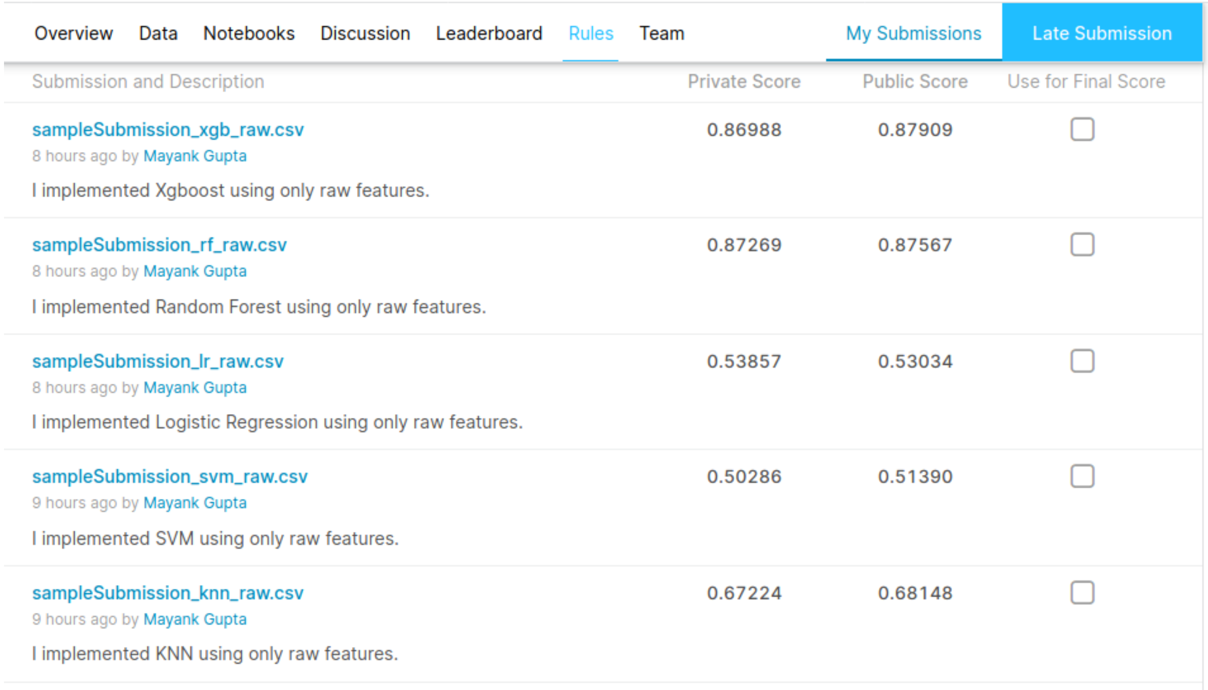
In [44]:
```
predictions = model.predict_proba(test_data)[:,1]
save_submission(predictions, 'xgb_raw.csv')
```



sampleSubmission_xgb_raw.csv   0.86988   0.87909

20 hours ago by Mayank Gupta

I implemented Xgboost using only raw features.



Submission and Description	Private Score	Public Score	Use for Final Score
sampleSubmission_xgb_raw.csv 8 hours ago by Mayank Gupta I implemented Xgboost using only raw features.	0.86988	0.87909	□
sampleSubmission_rf_raw.csv 8 hours ago by Mayank Gupta I implemented Random Forest using only raw features.	0.87269	0.87567	□
sampleSubmission_lr_raw.csv 8 hours ago by Mayank Gupta I implemented Logistic Regression using only raw features.	0.53857	0.53034	□
sampleSubmission_svm_raw.csv 9 hours ago by Mayank Gupta I implemented SVM using only raw features.	0.50286	0.51390	□
sampleSubmission_knn_raw.csv 9 hours ago by Mayank Gupta I implemented KNN using only raw features.	0.67224	0.68148	□

In [45]:

```
from prettytable import PrettyTable

x = PrettyTable(['Model', 'Feature', 'Private Score', 'Public Score'])
x.add_row(['KNN','Raw', 0.67224, 0.68148])
x.add_row(['SVM', 'Raw', 0.50286, 0.51390])
x.add_row(['Logistic Regression', 'Raw', 0.53857, 0.53034])
x.add_row(['Random Forest', 'Raw', 0.87269, 0.87567])
x.add_row(['Xgboost', 'Raw', 0.86988, 0.87909])

print(x)
```

```
+---------------------+---------+---------------+--------------+
|        Model        | Feature | Private Score | Public Score |
+---------------------+---------+---------------+--------------+
|         KNN         |   Raw   |    0.67224    |   0.68148    |
|         SVM         |   Raw   |    0.50286    |    0.5139    |
| Logistic Regression |   Raw   |    0.53857    |   0.53034    |
|    Random Forest    |   Raw   |    0.87269    |   0.87567    |
|       Xgboost        |   Raw   |    0.86988     |    0.87909    |
+----------------------+---------+----------------+---------------+
```

Observations:

1. Xgboost perform best on the raw features
2. Random forest also perform good on raw features
3. Tree based models performs better than linear models for raw features

Build model on one hot encoded features

2.1 KNN with one hot encoded features

In [46]:
```
train_ohe = sparse.load_npz('data/train_ohe.npz')
test_ohe = sparse.load_npz('data/test_ohe.npz')

train_ohe.shape, test_ohe.shape, y_train.shape
```

Out[46]:
```
((32769, 4500), (58921, 4500), (32769,))
```

In [47]:
```
parameters={'n_neighbors':np.arange(1,100, 5)}
clf = RandomizedSearchCV(KNeighborsClassifier(n_jobs=-1),parameters,ran
dom_state=random_state,cv=cv,verbose=verbose,scoring=scoring,n_jobs=4)
best_model = clf.fit(train_ohe,y_train)
```

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

```
[Parallel(n_jobs=4)]: Using backend LokyBackend with 4 concurrent worke
rs.
[Parallel(n_jobs=4)]: Done  33 tasks      | elapsed:  2.4min
[Parallel(n_jobs=4)]: Done  50 out of  50 | elapsed:  3.2min finished
```

In [48]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
```

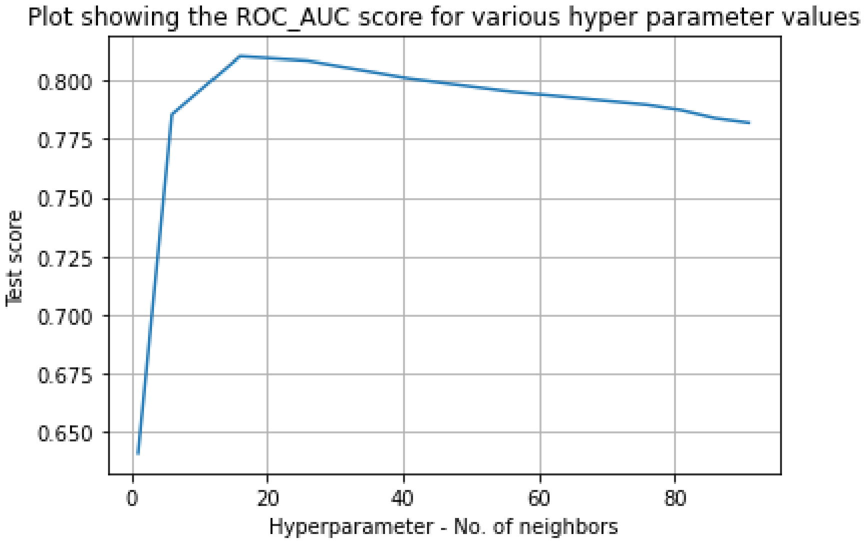
```
results=results.sort_values('param_n_neighbors')
results
```

Out[48]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_neighbors	param
0	0.008579	0.000699	12.889389	1.630046	1	{'n_neighbors 1
3	0.218653	0.141987	13.355838	1.399583	6	{'n_neighbors 6
7	0.014216	0.010986	11.480899	0.587346	16	{'n_neighbors 16
5	0.007408	0.000506	11.399296	0.072001	26	{'n_neighbors 26
4	0.029331	0.037009	11.730860	0.352833	41	{'n_neighbors 41
6	0.017152	0.013375	12.010613	0.940570	56	{'n_neighbors 56
2	0.325559	0.159848	31.339497	13.256170	76	{'n_neighbors 76
9	0.013539	0.006507	9.540637	2.054831	81	{'n_neighbors 81
1	0.103347	0.155776	24.211115	9.506957	86	{'n_neighbors 86
8	0.016657	0.008175	11.831052	0.749635	91	{'n_neighbors 91

In [49]:

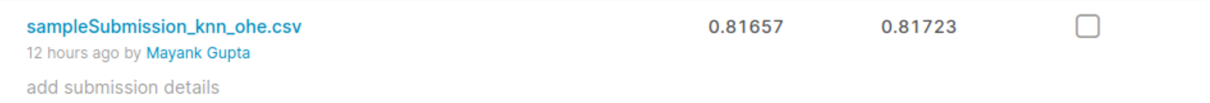
```
print_graph(results, 'param_n_neighbors', 'mean_test_score', 'Hyperpara
meter - No. of neighbors', 'Test score')
```



```
In [50]: best_c=best_model.best_params_['n_neighbors']
         best_c
Out[50]: 16
```

```
In [51]: model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
         model.fit(train_ohe,y_train)
Out[51]: KNeighborsClassifier(n_jobs=-1, n_neighbors=16)
```

```
In [52]: predictions = model.predict_proba(test_ohe)[:,1]
         save_submission(predictions, "knn_ohe.csv")
```


sampleSubmission_knn_ohe.csv 0.81657 0.81723 □
12 hours ago by Mayank Gupta
add submission details

2.2 SVM with one hot encoded features

In [53]:

```
C_val = uniform(loc=0, scale=4)
model= LinearSVC(verbose=verbose,random_state=random_state,class_weight
='balanced',max_iter=2000)
parameters={'C':C_val}
clf = RandomizedSearchCV(model,parameters,random_state=random_state,cv=
cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_ohe,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   31.0s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   41.7s finished
```

```
[LibLinear]
```

In [54]:

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

Out[54]:

```
0.23233444867279784
```

In [55]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

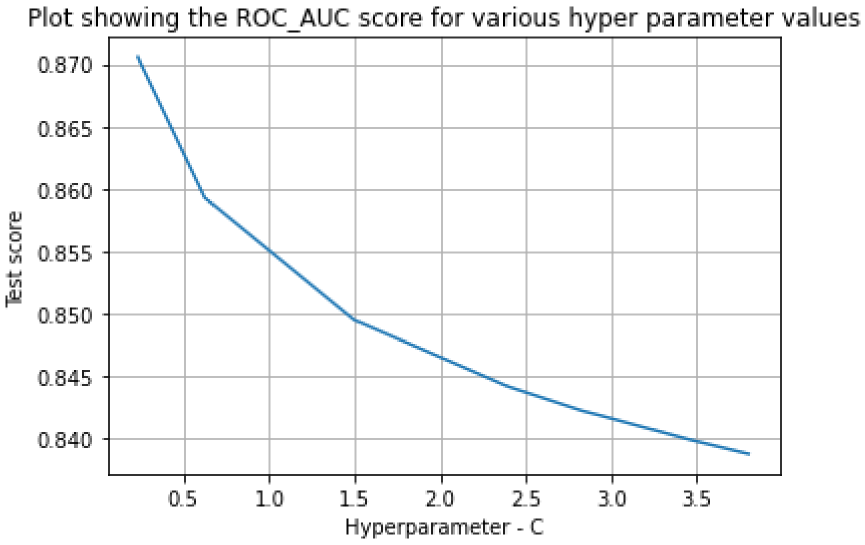
Out[55]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
6	1.730894	0.069332	0.005605	0.000029	0.232334	{'C': 0.23233444867279784}
5	3.315943	0.201073	0.005879	0.000622	0.623978	{'C': 0.6239780813448106}
4	3.583880	0.365580	0.005711	0.000297	0.624075	{'C': 0.6240745617697461}
0	5.492834	0.287928	0.006418	0.000139	1.49816	{'C': 1.49816047538945}

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
3	4.961631	0.298074	0.005662	0.000146	2.39463	{'C': 2.3946339367881464}
8	4.833444	0.644881	0.004830	0.000888	2.40446	{'C': 2.404460046972835}
9	3.986315	0.360801	0.003652	0.000362	2.83229	{'C': 2.832290311184182}
2	4.873211	0.174700	0.006166	0.000985	2.92798	{'C': 2.9279757672456204}
7	4.817450	0.265487	0.005635	0.000099	3.4647	{'C': 3.4647045830997407}
1	4.685154	0.254005	0.006274	0.000241	3.80286	{'C': 3.8028572256396647}

In [56]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [57]:

```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-dec
```

```
ision-function-to-probabilities-scikit-learn-python
model = LinearSVC(C=best_c,verbose=verbose,random_state=random_state,cl
ass_weight='balanced',max_iter=2000)
model = CalibratedClassifierCV(model)
model.fit(train_ohe,y_train)
```

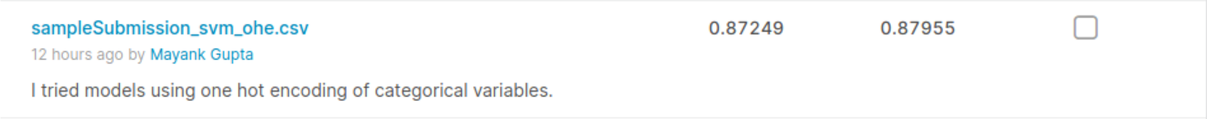
```
[LibLinear][LibLinear][LibLinear][LibLinear][LibLinear]
```

Out[57]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=0.23233444867279784,
                                                class_weight='balance
d',
                                                max_iter=2000, random_s
tate=42,
                                                verbose=2))
```

In [58]:

```
predictions = model.predict_proba(test_ohe)[:,1]
save_submission(predictions, 'svm_ohe.csv')
```



sampleSubmission_svm_ohe.csv 0.87249 0.87955 □

12 hours ago by Mayank Gupta

I tried models using one hot encoding of categorical variables.

2.3 Logistic Regression with one hot encoded features

In [59]:

```
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=verbose,random_state=random_state,class_
weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=random_state,cv=cv,
verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_ohe,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
```

```
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    7.2s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:   32.8s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  1.4min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  2.0min finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.8s finished
```

In [60]:

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

Out[60]:

```
0.6820964947491661
```

In [61]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

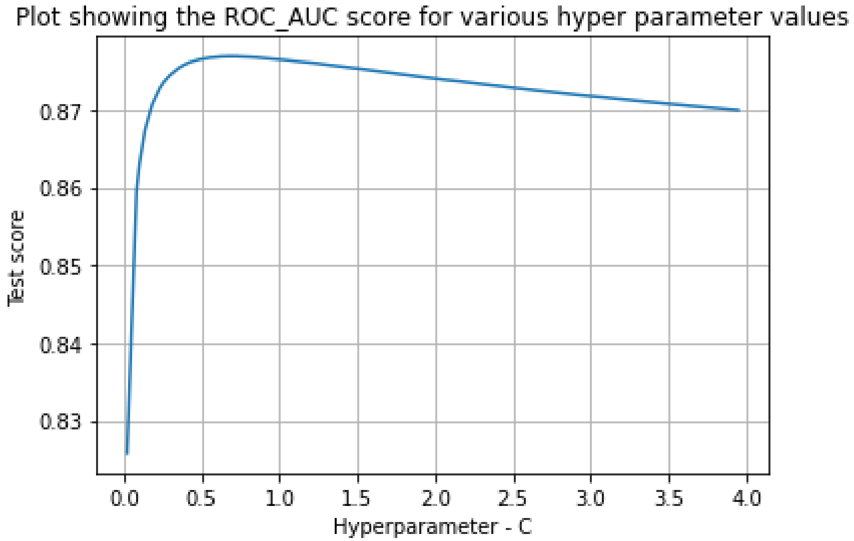
Out[61]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	parai
72	0.439680	0.041474	0.006678	0.000959	0.0220885	{' 0.02208846849440959
10	0.650064	0.051074	0.006208	0.001374	0.082338	{' 0.082337977183209
98	0.776743	0.046280	0.006456	0.000961	0.101677	{' 0.101676506976380
42	0.886947	0.055574	0.008943	0.003785	0.137554	{' 0.137554084460873
58	0.928974	0.072238	0.006947	0.000977	0.180909	{' 0.180909155642152
...	...	...	...	...	...	
1	2.534207	0.214963	0.006663	0.000782	3.80286	{' 3.80285722563966
34	2.376340	0.051137	0.006265	0.000269	3.86253	{' 3.86252813229823

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	para
50	2.498738	0.052591	0.007061	0.000964	3.87834	{' 3.87833851105823
11	2.401271	0.107580	0.006628	0.001671	3.87964	{' 3.87963940864797
69	2.674097	0.153710	0.007042	0.000979	3.94755	{' 3.94754774640206

100 rows × 14 columns

```
In [62]: print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
         , 'Test score')
```



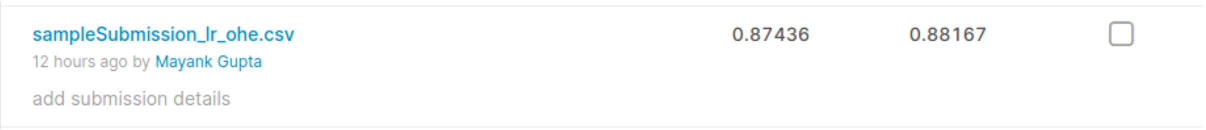
```
In [63]: model = LogisticRegression(C=best_c,verbose=verbose,n_jobs=-1,random_st
         ate=random_state,class_weight='balanced',solver='lbfgs')
         model.fit(train_ohe,y_train)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

```
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.5s finished
```

```
Out[63]: LogisticRegression(C=0.6820964947491661, class_weight='balanced', n_job
         s=-1,
                            random_state=42, verbose=2)
```

```
In [64]: predictions = model.predict_proba(test_ohe)[:,1]
         save_submission(predictions, 'lr_ohe.csv')
```



sampleSubmission_lr_ohe.csv 0.87436 0.88167 □

12 hours ago by Mayank Gupta

add submission details

2.4 Random Forest with one hot encoded features

```
In [65]: rfc = RandomForestClassifier(random_state=random_state,class_weight='ba
         lanced',n_jobs=-1)
         clf = RandomizedSearchCV(rfc,get_rf_params(),random_state=random_state,
         cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
         best_model = clf.fit(train_ohe,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    9.8s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  1.6min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  3.6min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  5.3min finished
```

```
In [66]: results = pd.DataFrame(best_model.cv_results_)
         results.sort_values('mean_test_score',ascending=False,inplace=True)
         param_keys=['param_'+str(each) for each in get_rf_params().keys()]
         param_keys.append('mean_test_score')
         results[param_keys].head(10)
```

Out[66]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean
78	700	25	2	7	
85	1000	20	3	7	
62	500	25	3	5	
6	500	20	2	5	
11	1000	15	3	7	
25	700	15	4	7	
19	700	15	4	5	
22	200	25	4	10	
79	500	25	1	10	
82	700	20	5	20	

In [67]:

```
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[67]:

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

In [68]:

```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_de
pth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=random_state,class_weight='ba
lanced',n_jobs=-1)

model.fit(train_ohe,y_train)
```

Out[68]:

```
RandomForestClassifier(class_weight='balanced', max_depth=25, max_featu
res=2,
                       min_samples_split=7, n_estimators=700, n_jobs=-
1,
                       random_state=42)
```

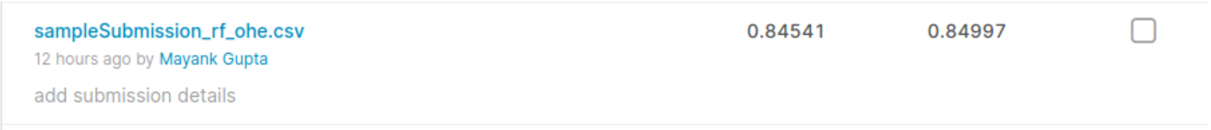
```
                     random_state=42)
```

In [69]:

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

In [70]:

```
predictions = model.predict_proba(test_ohe)[:,1]
save_submission(predictions, 'rf_ohe.csv')
```



sampleSubmission_rf_ohe.csv 0.84541 0.84997 □

12 hours ago by Mayank Gupta

add submission details

2.5 Xgboost with one hot encoded features

In [71]:

```
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,get_xgb_params(),random_state=random_state
,cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model=clf.fit(train_ohe,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    8.0s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  1.6min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  4.3min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  7.1min finished
```

In [72]:

```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
param_keys=['param_'+str(each) for each in get_xgb_params().keys()]
```

```
param_keys.append('mean_test_score')
results[param_keys].head(10)
```

Out[72]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
97	750	0.232385	0.907694	6	
80	1000	0.385564	0.905351	3	
86	1000	0.475848	0.858413	9	
84	200	0.571989	0.967581	6	
14	200	0.374221	0.802197	7	
50	500	0.388683	0.645103	4	
53	200	0.540096	0.928319	6	
92	200	0.478778	0.49442	9	
96	500	0.0979629	0.98664	7	
22	1000	0.391846	0.695516	6	

In [73]:

```
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[73]:

```
(0.3742707957561203, 0.23238528824013455, 6, 1, 750, 0.907693706348546
3)
```

In [74]:

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

```
model.fit(train_ohe,y_train)
```

Out[74]:

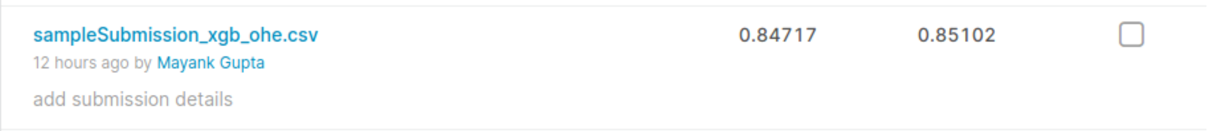
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3742707957561203,
gamma=0,
              gpu_id=-1, importance_type='gain', interaction_constraint
s='',
              learning_rate=0.23238528824013455, max_delta_step=0, max_
depth=6,
              min_child_weight=1, missing=nan, monotone_constraints
='()',
              n_estimators=750, n_jobs=-1, num_parallel_tree=1, random_
state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1,
              subsample=0.9076937063485463, tree_method='exact',
              validate_parameters=1, verbosity=None)
```

In [75]:

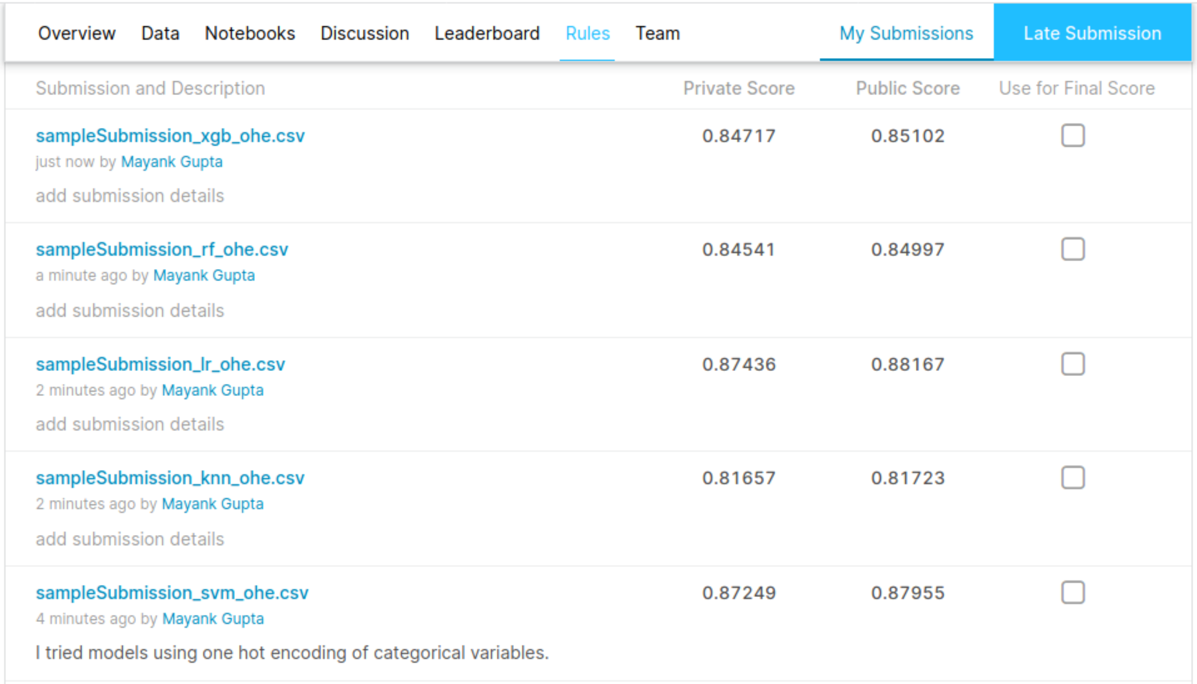
```
# features=train_ohe.columns
# importance=model.feature_importances_
# features=pd.DataFrame({'features':features,'value':importance})
# features=features.sort_values('value',ascending=False)
# sns.barplot('value','features',data=features);
# plt.title('Feature Importance');
```

In [76]:

```
predictions = model.predict_proba(test_ohe)[:,1]
save_submission(predictions, 'xgb_ohe.csv')
```



sampleSubmission_xgb_ohe.csv 0.84717 0.85102 □
12 hours ago by Mayank Gupta
add submission details



Submission and Description	Private Score	Public Score	Use for Final Score
sampleSubmission_xgb_ohe.csv just now by Mayank Gupta add submission details	0.84717	0.85102	□
sampleSubmission_rf_ohe.csv a minute ago by Mayank Gupta add submission details	0.84541	0.84997	□
sampleSubmission_lr_ohe.csv 2 minutes ago by Mayank Gupta add submission details	0.87436	0.88167	□
sampleSubmission_knn_ohe.csv 2 minutes ago by Mayank Gupta add submission details	0.81657	0.81723	□
sampleSubmission_svm_ohe.csv 4 minutes ago by Mayank Gupta I tried models using one hot encoding of categorical variables.	0.87249	0.87955	□

In [77]:

```
from prettytable import PrettyTable

x = PrettyTable(['Model', 'Feature', 'Private Score', 'Public Score'])
x.add_row(['KNN','ohe', 0.81657, 0.81723])
x.add_row(['SVM', 'ohe', 0.87249, 0.87955])
x.add_row(['Logistic Regression', 'ohe', 0.87436, 0.88167])
x.add_row(['Random Forest', 'ohe', 0.84541, 0.84997])
x.add_row(['Xgboost', 'ohe', 0.84717, 0.85102])

print(x)
```

```
+---------------------+---------+---------------+--------------+
|        Model        | Feature | Private Score | Public Score |
+---------------------+---------+---------------+--------------+
|         KNN         |   ohe   |    0.81657    |   0.81723    |
|         SVM         |   ohe   |    0.87249    |   0.87955    |
| Logistic Regression |   ohe   |    0.87436    |   0.88167    |
|    Random Forest    |   ohe   |    0.84541    |   0.84997    |
|        Xgboost        |   ohe   |    0.84717    |   0.85102    |
+-----------------------+---------+---------------+--------------+
```

Observations:

1. One hot encoding features performs better than other encoding technique
2. Linear models (Logistic Regression and SVM) performs better on higher dimension

3 Build Model on frequency encoding feature

3.1 KNN with frequency encoding

In [78]:
```
train_df_fc = pd.read_csv('data/train_df_fc.csv')
test_df_fc = pd.read_csv('data/test_df_fc.csv')
```

In [79]:
```
train_df_fc.shape, test_df_fc.shape, y_train.shape
```

Out[79]:
```
((32769, 9), (58921, 9), (32769,))
```

In [80]:
```
parameters={'n_neighbors':np.arange(1,100, 5)}
clf = RandomizedSearchCV(KNeighborsClassifier(n_jobs=-1),parameters,ran
dom_state=random_state,cv=cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_fc,y_train)
```

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

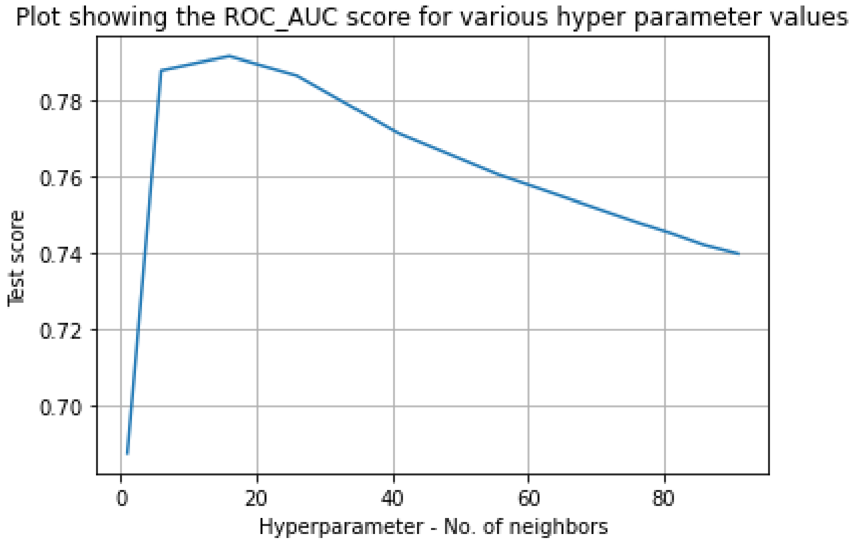
```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    5.8s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   10.4s finished
```

In [81]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
results
```

Out[81]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_neighbors	param
0	1.245504	0.191884	0.444588	0.057236	1	{'n_neighbors
3	0.966955	0.192374	0.425104	0.082150	6	{'n_neighbors
7	0.915347	0.088786	0.510648	0.062272	16	{'n_neighbors 1
5	0.910787	0.067158	0.587300	0.075423	26	{'n_neighbors 2
4	0.867675	0.145174	0.647190	0.063128	41	{'n_neighbors 4
6	0.877225	0.208047	0.709570	0.113621	56	{'n_neighbors 5
2	0.947447	0.128830	0.768725	0.107211	76	{'n_neighbors 7
9	0.934347	0.100315	0.597521	0.257969	81	{'n_neighbors 8
1	1.011318	0.326486	0.772521	0.073501	86	{'n_neighbors 8
8	0.832900	0.196410	0.861454	0.065058	91	{'n_neighbors 9

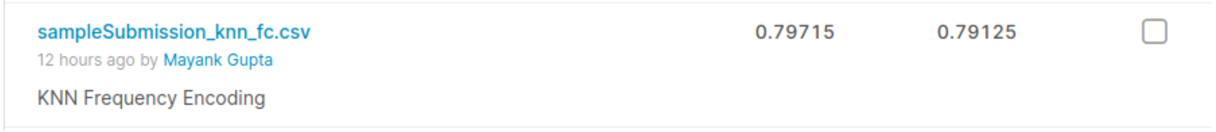
In [82]:
```
print_graph(results, 'param_n_neighbors', 'mean_test_score', 'Hyperpara
meter - No. of neighbors', 'Test score')
```



```
In [83]: best_c=best_model.best_params_['n_neighbors']
         best_c

Out[83]: 16
```

```
In [84]: model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
         model.fit(train_df_fc,y_train)

Out[84]: KNeighborsClassifier(n_jobs=-1, n_neighbors=16)
```

```
In [85]: predictions = model.predict_proba(test_df_fc)[:,1]
         save_submission(predictions, "knn_fc.csv")
```



sampleSubmission_knn_fc.csv 0.79715 0.79125 □

12 hours ago by Mayank Gupta

KNN Frequency Encoding

3.2 SVM with frequency encoding

In [86]:

```
C_val = uniform(loc=0, scale=4)
model= LinearSVC(verbose=verbose,random_state=random_state,class_weight
='balanced',max_iter=2000)
parameters={'C':C_val}
clf = RandomizedSearchCV(model,parameters,random_state=random_state,cv=
cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_fc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   17.8s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   31.9s finished
```

```
[LibLinear]
```

In [87]:

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

Out[87]:

```
3.4647045830997407
```

In [88]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

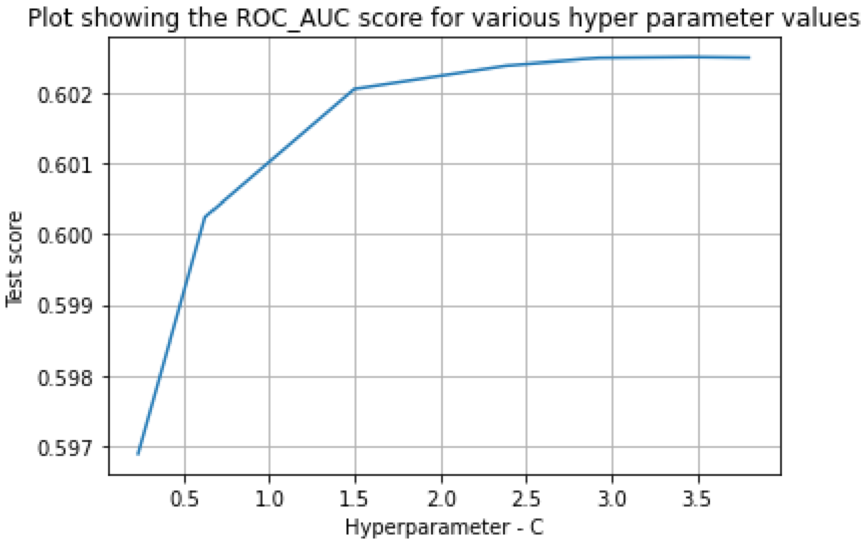
Out[88]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
6	0.707697	0.038330	0.009112	0.000330	0.232334	{'C': 0.23233444867279784}
5	1.619894	0.069040	0.009326	0.000816	0.623978	{'C': 0.6239780813448106}
4	1.579539	0.025513	0.008887	0.000250	0.624075	{'C': 0.6240745617697461}
0	3.577643	0.097967	0.009332	0.000580	1.49816	{'C': 1.49816047538945}

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
3	5.732613	0.118254	0.009076	0.000258	2.39463	{'C': 2.3946339367881464}
8	5.664490	0.136819	0.009409	0.001280	2.40446	{'C': 2.404460046972835}
9	5.364426	0.630964	0.005462	0.000641	2.83229	{'C': 2.832290311184182}
2	6.995208	0.140802	0.009158	0.000407	2.92798	{'C': 2.9279757672456204}
7	8.412424	0.706659	0.009016	0.000114	3.4647	{'C': 3.4647045830997407}
1	9.626733	0.661829	0.008899	0.000069	3.80286	{'C': 3.8028572256396647}

In [89]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [90]:

```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-dec
```

```
ision-function-to-probabilities-scikit-learn-python
model = LinearSVC(C=best_c,verbose=verbose,random_state=random_state,cl
ass_weight='balanced',max_iter=2000)
model = CalibratedClassifierCV(model)
model.fit(train_df_fc,y_train)
```

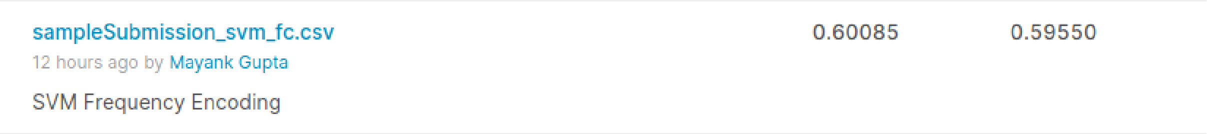
```
[LibLinear][LibLinear][LibLinear][LibLinear][LibLinear]
```

Out[90]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=3.4647045830997407,
                                                class_weight='balance
d',
                                                max_iter=2000, random_s
tate=42,
                                                verbose=2))
```

In [91]:

```
predictions = model.predict_proba(test_df_fc)[:,1]
save_submission(predictions, 'svm_fc.csv')
```



sampleSubmission_svm_fc.csv 0.60085 0.59550

12 hours ago by Mayank Gupta

SVM Frequency Encoding

3.3 Logistic Regression with frequency encoding

In [92]:

```
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=verbose,random_state=random_state,class_
weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=random_state,cv=cv,
verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_fc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

```
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    1.7s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:    8.3s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:   20.2s
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:   29.2s finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.4s finished
```

In [93]:

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

Out[93]:

```
3.947547746402069
```

In [94]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

Out[94]:

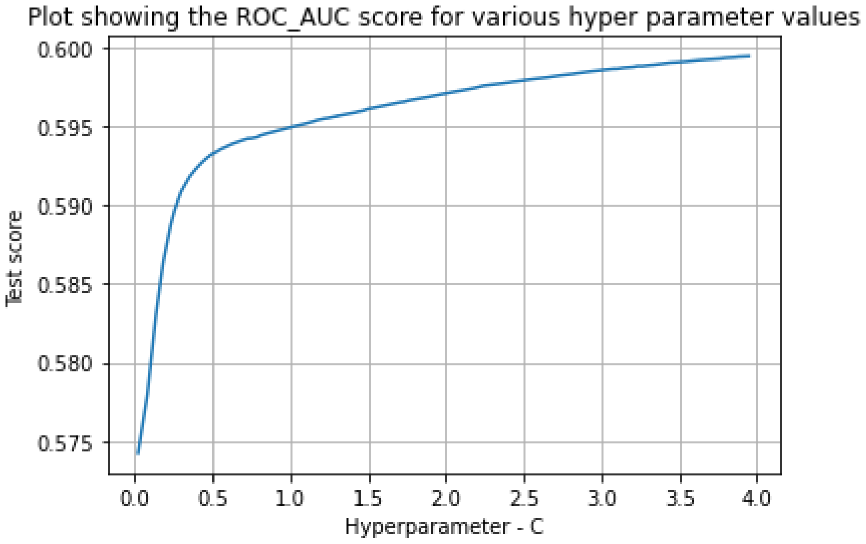
	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	parar
72	0.182546	0.056575	0.010424	0.001924	0.0220885	{' 0.0220884684944095
10	0.230978	0.011034	0.010079	0.002740	0.082338	{' 0.082337977183209
98	0.246538	0.040240	0.008149	0.000789	0.101677	{' 0.101676506976380
42	0.264855	0.051649	0.007584	0.001100	0.137554	{' 0.137554084460873
58	0.294973	0.058159	0.009848	0.001887	0.180909	{' 0.180909155642152
...	...	...	...	...	...	
1	0.544588	0.077972	0.010987	0.002171	3.80286	{' 3.80285722563966
34	0.517311	0.047540	0.010529	0.004522	3.86253	{' 3.86252813229823

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	para
50	0.546014	0.078366	0.011045	0.001893	3.87834	{' 3.87833851105823
11	0.487671	0.048548	0.010200	0.002548	3.87964	{' 3.87963940864797
69	0.589011	0.053345	0.010957	0.001444	3.94755	{' 3.94754774640206

100 rows × 14 columns

In [95]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [96]:

```
model = LogisticRegression(C=best_c,verbose=verbose,n_jobs=-1,random_st
ate=random_state,class_weight='balanced',solver='lbfgs')
model.fit(train_df_fc,y_train)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

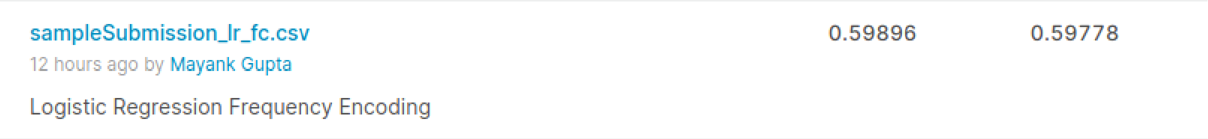
```
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.5s finished
```

Out[96]:

```
LogisticRegression(C=3.947547746402069, class_weight='balanced', n_jobs
=-1,
                   random_state=42, verbose=2)
```

In [97]:

```
predictions = model.predict_proba(test_df_fc)[:,1]
save_submission(predictions, 'lr_fc.csv')
```



sampleSubmission_lr_fc.csv 0.59896 0.59778

12 hours ago by Mayank Gupta

Logistic Regression Frequency Encoding

3.4 Random Forest with frequency encoding

In [98]:

```
rfc = RandomForestClassifier(random_state=random_state,class_weight='ba
lanced',n_jobs=-1)
clf = RandomizedSearchCV(rfc,get_rf_params(),random_state=random_state,
cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_fc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   18.9s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  3.5min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  8.3min
/home/auw-mayank/.local/lib/python3.6/site-packages/joblib/externals/lo
ky/process_executor.py:691: UserWarning: A worker stopped while some jo
bs were given to the executor. This can be caused by a too short worker
timeout or by a memory leak.
  "timeout or by a memory leak.", UserWarning
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 12.3min finished
```

In [99]:

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

Out[99]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean
78	700	25	2	7	
79	500	25	1	10	
85	1000	20	3	7	
55	200	25	2	5	
27	50	25	2	10	
62	500	25	3	5	
22	200	25	4	10	
6	500	20	2	5	
76	50	25	1	5	
84	1000	25	5	2	

In [100]:

```
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[100]:

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

In [101]:

```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_de
pth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=random_state,class_weight='ba
lanced',n_jobs=-1)
```

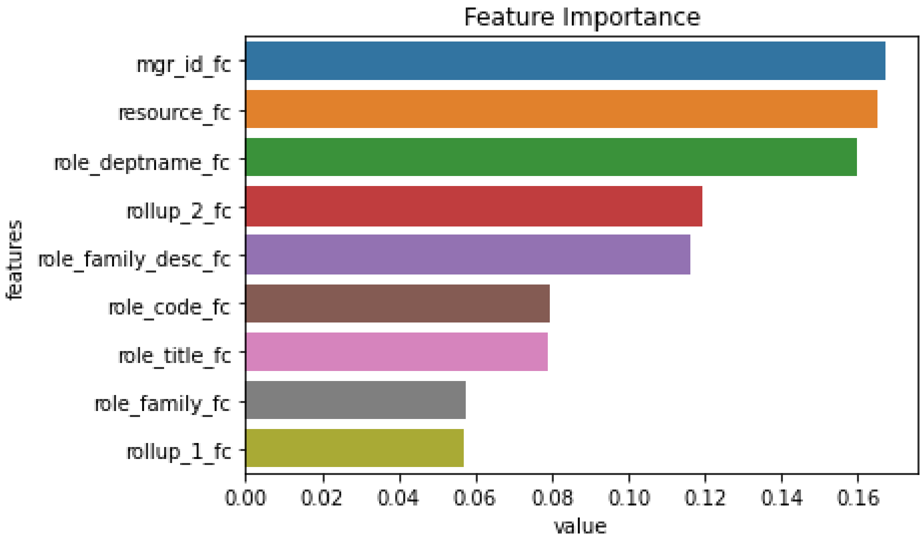
```
model.fit(train_df_fc,y_train)
```

Out[101]:

```
RandomForestClassifier(class_weight='balanced', max_depth=25, max_featu
res=2,
                       min_samples_split=7, n_estimators=700, n_jobs=-
1,
                       random_state=42)
```

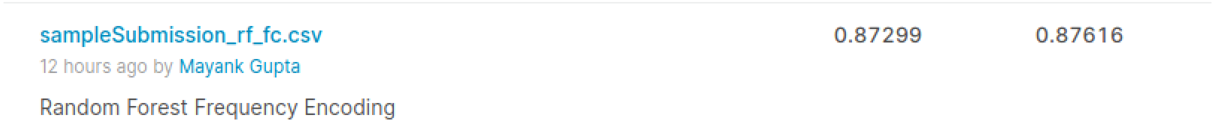
In [103]:

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



In [106]:

```
predictions = model.predict_proba(test_df_fc)[:,1]
save_submission(predictions, 'rf_fc.csv')
```



sampleSubmission_rf_fc.csv

12 hours ago by Mayank Gupta

Random Forest Frequency Encoding

0.87299 0.87616

3.5 Xgboost with frequency encoding

In [107]:

```
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,get_xgb_params(),random_state=random_state
,cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model=clf.fit(train_df_fc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    8.5s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  1.6min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  4.4min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  7.3min finished
```

In [108]:

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

Out[108]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
18	1000	0.048135	0.665922	9	
96	500	0.0979629	0.98664	7	
44	1000	0.060484	0.606429	6	
97	750	0.232385	0.907694	6	
86	1000	0.475848	0.858413	9	

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
53	200	0.540096	0.928319	6	
84	200	0.571989	0.967581	6	
49	500	0.160277	0.393098	8	
62	500	0.0663892	0.328153	9	
14	200	0.374221	0.802197	7	

In [109]:

```
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[109]:

```
(0.3308980248526492, 0.04813501017161418, 9, 2, 1000, 0.665922356617496
7)
```

In [110]:

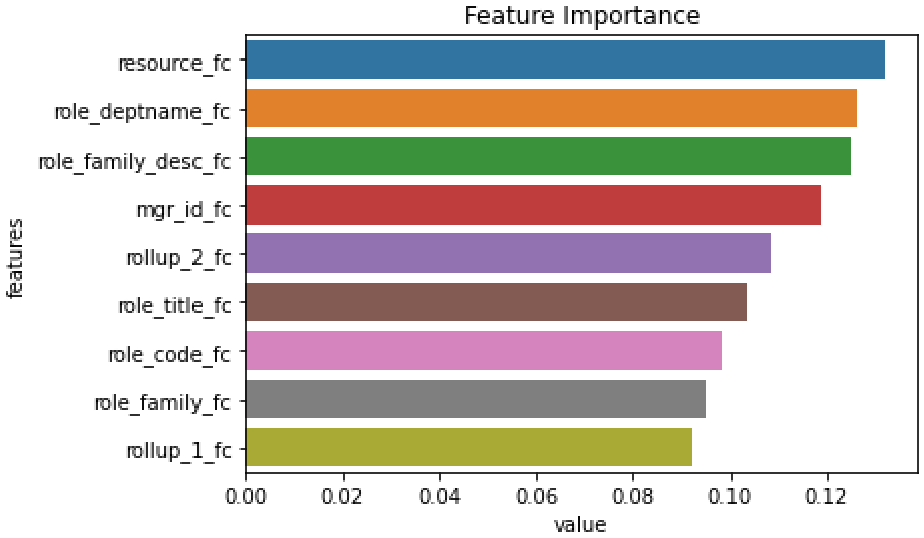
```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=l
earning_rate,max_depth=max_depth,
                     min_child_weight=min_child_weight,n_estimators=n_e
stimators,subsample=subsample,n_jobs=-1)

model.fit(train_df_fc,y_train)
```

Out[110]:

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.3308980248526492,
gamma=0,
              gpu_id=-1, importance_type='gain', interaction_constraint
s='',
              learning_rate=0.04813501017161418, max_delta_step=0, max_
depth=9,
              min_child_weight=2, missing=nan, monotone_constraints
='()',
              n_estimators=1000, n_jobs=-1, num_parallel_tree=1, random
_state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1,
              subsample=0.6659223566174967, tree_method='exact',
              validate_parameters=1, verbosity=None)
```

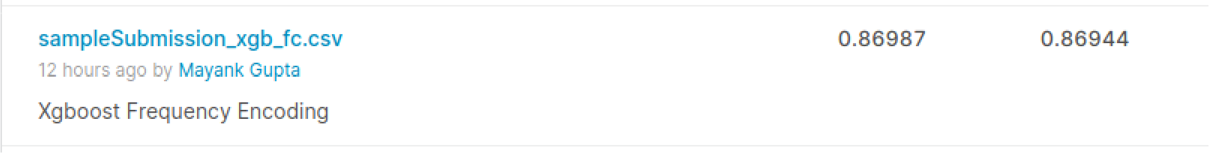
In [111]:

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



In [112]:

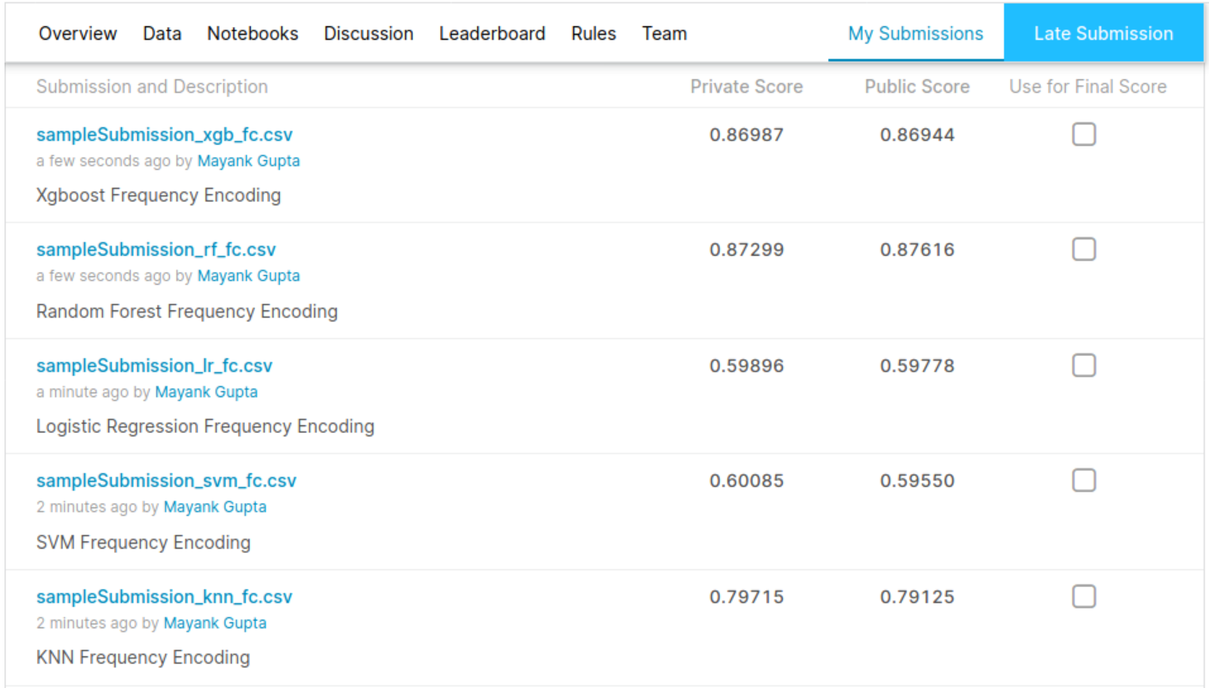
```
predictions = model.predict_proba(test_df_fc)[:,1]
save_submission(predictions, 'xgb_fc.csv')
```



sampleSubmission_xgb_fc.csv 0.86987 0.86944

12 hours ago by Mayank Gupta

Xgboost Frequency Encoding



Submission and Description	Private Score	Public Score	Use for Final Score
sampleSubmission_xgb_fc.csv a few seconds ago by Mayank Gupta Xgboost Frequency Encoding	0.86987	0.86944	□
sampleSubmission_rf_fc.csv a few seconds ago by Mayank Gupta Random Forest Frequency Encoding	0.87299	0.87616	□
sampleSubmission_lr_fc.csv a minute ago by Mayank Gupta Logistic Regression Frequency Encoding	0.59896	0.59778	□
sampleSubmission_svm_fc.csv 2 minutes ago by Mayank Gupta SVM Frequency Encoding	0.60085	0.59550	□
sampleSubmission_knn_fc.csv 2 minutes ago by Mayank Gupta KNN Frequency Encoding	0.79715	0.79125	□

In [113]:
```
from prettytable import PrettyTable

x = PrettyTable(['Model', 'Feature', 'Private Score', 'Public Score'])
x.add_row(['KNN','fc', 0.79715, 0.79125])
x.add_row(['SVM', 'fc', 0.60085, 0.59550])
x.add_row(['Logistic Regression', 'fc', 0.59896, 0.59778])
x.add_row(['Random Forest', 'fc', 0.87299, 0.87616])
x.add_row(['Xgboost', 'fc', 0.86987, 0.86944])

print(x)
```

```
+---------------------+---------+---------------+--------------+
|        Model        | Feature | Private Score | Public Score |
+---------------------+---------+---------------+--------------+
|         KNN         |    fc   |    0.79715    |   0.79125    |
|         SVM         |    fc   |    0.60085    |    0.5955    |
| Logistic Regression |    fc   |    0.59896    |   0.59778    |
|    Random Forest     |    fc   |     0.87299    |    0.87616    |
|       Xgboost        |    fc   |     0.86987    |    0.86944    |
+----------------------+---------+----------------+---------------+
```

Observations:

1. Tree based models performs better for this feature than linear models
2. KNN is doing good for every feature

4 Build Model using response encoding feature

In [114]:

```
train_df_rc = pd.read_csv('data/train_df_rc.csv')
test_df_rc = pd.read_csv('data/test_df_rc.csv')
```

In [115]:

```
train_df_rc.shape, test_df_rc.shape, y_train.shape
```

Out[115]:

```
((32769, 9), (58921, 9), (32769,))
```

4.1 KNN with response encoding

In [116]:

```
parameters={'n_neighbors':np.arange(1,100, 5)}
clf = RandomizedSearchCV(KNeighborsClassifier(n_jobs=-1),parameters,ran
dom_state=random_state,cv=cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_rc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    5.2s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   10.7s finished
```

In [117]:

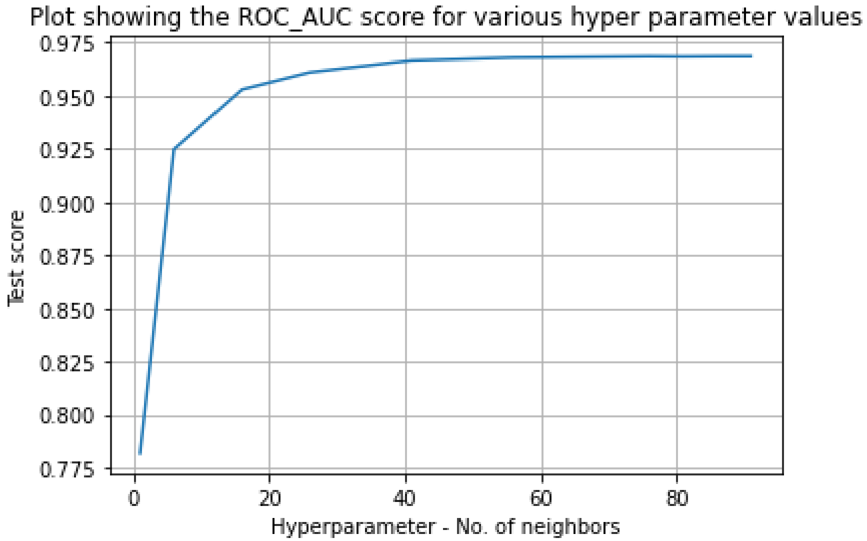
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
results
```

Out[117]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_neighbors	param
0	0.087703	0.003754	0.270912	0.118324	1	{'n_neighbors
3	0.161678	0.063581	0.749612	0.191282	6	{'n_neighbors
7	0.365460	0.149200	1.097595	0.234131	16	{'n_neighbors 1
5	0.274667	0.128723	1.106008	0.062541	26	{'n_neighbors 2
4	0.196924	0.091312	1.247186	0.043935	41	{'n_neighbors 4
6	0.121391	0.037696	1.616742	0.078125	56	{'n_neighbors 5
2	0.257782	0.047633	1.718469	0.251959	76	{'n_neighbors 7
9	0.259518	0.169725	1.463110	0.571909	81	{'n_neighbors 8
1	0.166987	0.110239	2.083340	0.073632	86	{'n_neighbors 8
8	0.215055	0.138284	2.578594	0.120702	91	{'n_neighbors 9

In [118]:

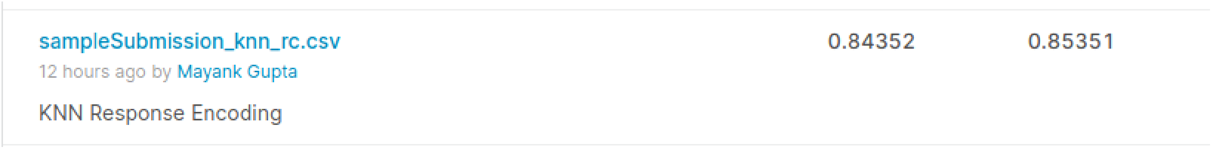
```
print_graph(results, 'param_n_neighbors', 'mean_test_score', 'Hyperpara
meter - No. of neighbors', 'Test score')
```



```
In [119]: best_c=best_model.best_params_['n_neighbors']
          best_c

Out[119]: 91
```

```
In [120]: model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
          model.fit(train_df_rc,y_train)

Out[120]: KNeighborsClassifier(n_jobs=-1, n_neighbors=91)
```

```
In [121]: predictions = model.predict_proba(test_df_rc)[:,1]
          save_submission(predictions, "knn_rc.csv")
```



sampleSubmission_knn_rc.csv 0.84352 0.85351

12 hours ago by Mayank Gupta

KNN Response Encoding

4.2 SVM with response encoding

```
In [122]: C_val = uniform(loc=0, scale=4)
          model= LinearSVC(verbose=verbose,random_state=random_state,class_weight
          ='balanced',max_iter=2000)
          parameters={'C':C_val}
          clf = RandomizedSearchCV(model,parameters,random_state=random_state,cv=
          cv,verbose=verbose,scoring=scoring,n_jobs=-1)
          best_model = clf.fit(train_df_rc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   59.3s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:  1.6min finished
```

```
[LibLinear]
```

```
In [123]: best_c=best_model.best_params_['C']
          best_c
```

```
Out[123]: 0.23233444867279784
```

```
In [124]: results = pd.DataFrame.from_dict(best_model.cv_results_)
          results=results.sort_values('param_C')
          results
```

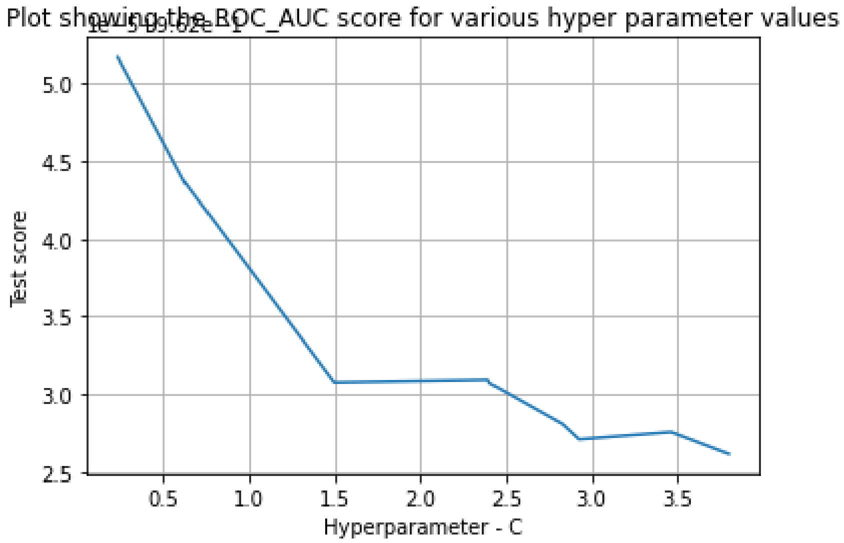
Out[124]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
6	3.726326	0.130475	0.009511	0.000833	0.232334	{'C': 0.23233444867279784}
5	9.815611	0.452051	0.009016	0.000450	0.623978	{'C': 0.6239780813448106}
4	9.402443	0.604710	0.009335	0.000597	0.624075	{'C': 0.6240745617697461}
0	20.009992	0.735768	0.009698	0.000943	1.49816	{'C': 1.49816047538945}

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
3	19.451480	0.384670	0.013516	0.008621	2.39463	{'C': 2.3946339367881464}
8	17.116975	1.498897	0.008659	0.001653	2.40446	{'C': 2.404460046972835}
9	14.348889	1.305182	0.005841	0.001067	2.83229	{'C': 2.832290311184182}
2	19.717969	0.395682	0.010328	0.002716	2.92798	{'C': 2.9279757672456204}
7	18.970401	0.625358	0.009083	0.000206	3.4647	{'C': 3.4647045830997407}
1	20.206970	0.710743	0.009152	0.000238	3.80286	{'C': 3.8028572256396647}

In [125]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [126]:

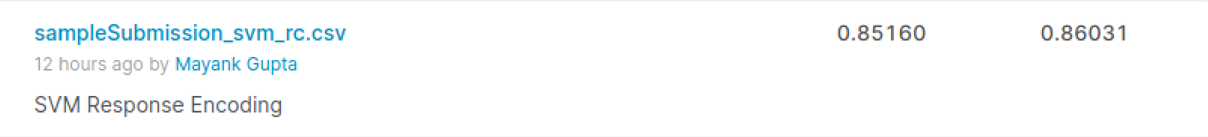
```
#https://stackoverflow.com/questions/26478000/converting-linearsvcs-dec
```

```
ision-function-to-probabilities-scikit-learn-python
model = LinearSVC(C=best_c,verbose=verbose,random_state=random_state,cl
ass_weight='balanced',max_iter=2000)
model = CalibratedClassifierCV(model)
model.fit(train_df_rc,y_train)
```

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

Out[126]:
```
CalibratedClassifierCV(base_estimator=LinearSVC(C=0.23233444867279784,
                                                class_weight='balance
d',
                                                max_iter=2000, random_s
tate=42,
                                                verbose=2))
```

In [127]:
```
predictions = model.predict_proba(test_df_rc)[:,1]
save_submission(predictions, 'svm_rc.csv')
```



```
sampleSubmission_svm_rc.csv                          0.85160        0.86031
12 hours ago by Mayank Gupta
SVM Response Encoding
```

4.3 Logistic Regression with response encoding

In [128]:
```
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=verbose,random_state=random_state,class_
weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=random_state,cv=cv,
verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_rc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

```
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    1.8s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:    9.9s
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:   24.2s
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:   34.9s finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.5s finished
```

In [129]:

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

Out[129]:

```
3.8783385110582342
```

In [130]:

```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

Out[130]:

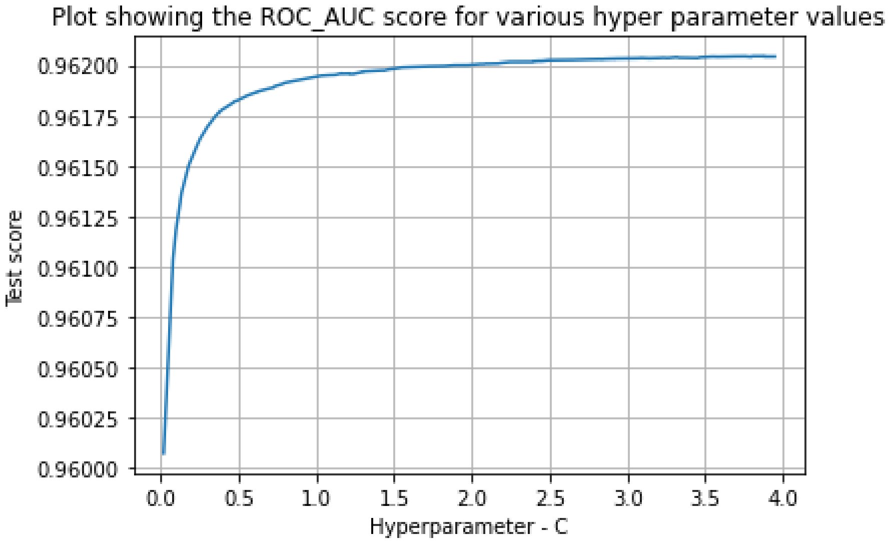
	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	para
72	0.419037	0.018913	0.014351	0.004590	0.0220885	{' 0.02208846849440959
10	0.377327	0.053768	0.012779	0.002567	0.082338	{' 0.0823379771832097
98	0.375209	0.049318	0.010560	0.000751	0.101677	{' 0.1016765069763807
42	0.392769	0.045860	0.014432	0.004220	0.137554	{' 0.1375540844608735
58	0.438569	0.077177	0.013336	0.003642	0.180909	{' 0.1809091556421522
...	...	...	...	...	...	
1	0.506320	0.115184	0.009774	0.001500	3.80286	{' 3.802857225639664
34	0.435505	0.063518	0.010841	0.001308	3.86253	{' 3.862528132298237

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	para
50	0.560126	0.144761	0.012199	0.003007	3.87834	{' 3.87833851105823
11	0.493065	0.118567	0.013844	0.004191	3.87964	{' 3.87963940864797
69	0.649569	0.209739	0.016016	0.005468	3.94755	{' 3.9475477464020

100 rows × 14 columns

In [131]:

```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [132]:

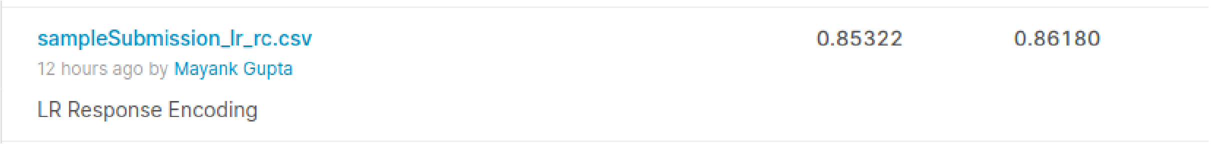
```
model = LogisticRegression(C=best_c,verbose=verbose,n_jobs=-1,random_st
ate=random_state,class_weight='balanced',solver='lbfgs')
model.fit(train_df_rc,y_train)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

```
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    0.4s finished
```

Out[132]:
```
LogisticRegression(C=3.8783385110582342, class_weight='balanced', n_job
s=-1,
                   random_state=42, verbose=2)
```

In [133]:
```
predictions = model.predict_proba(test_df_rc)[:,1]
save_submission(predictions, 'lr_rc.csv')
```


sampleSubmission_lr_rc.csv 0.85322 0.86180
12 hours ago by Mayank Gupta
LR Response Encoding

4.4 Random Forest with response encoding

In [134]:
```
rfc = RandomForestClassifier(random_state=random_state,class_weight='ba
lanced',n_jobs=-1)
clf = RandomizedSearchCV(rfc,get_rf_params(),random_state=random_state,
cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_df_rc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   19.0s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  3.0min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  7.0min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 10.3min finished
```

In [135]:
```
results = pd.DataFrame(best_model.cv_results_)
results.sort_values('mean_test_score',ascending=False,inplace=True)
param_keys=['param_'+str(each) for each in get_rf_params().keys()]
param_keys.append('mean_test_score')
results[param_keys].head(10)
```

Out[135]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean
68	1000	10	4	20	
26	700	12	4	20	
64	700	10	5	7	
82	700	20	5	20	
41	500	10	3	7	
96	100	10	3	10	
87	200	10	5	2	
11	1000	15	3	7	
85	1000	20	3	7	
25	700	15	4	7	

In [136]:

```
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[136]:

```
(1000, 4, 10, 20)
```

In [137]:

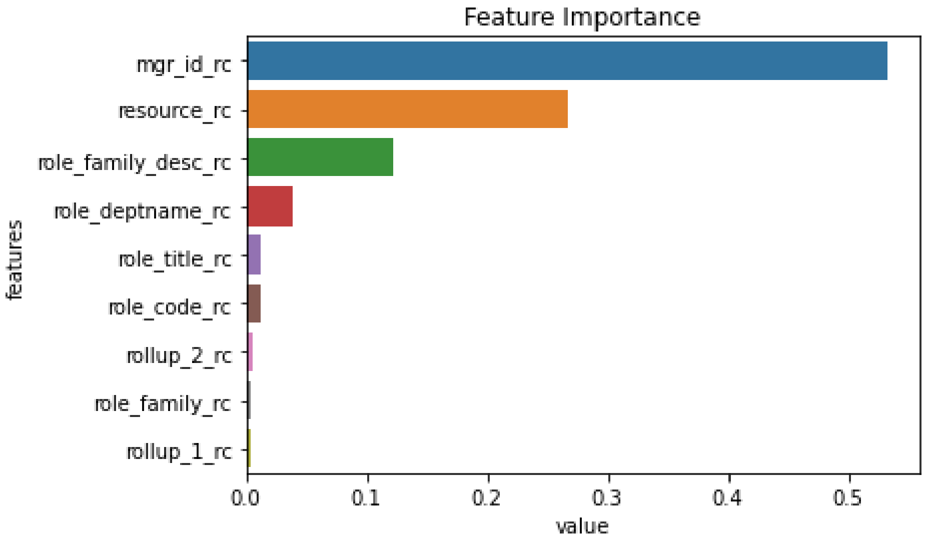
```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_de
pth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=random_state,class_weight='ba
lanced',n_jobs=-1)

model.fit(train_df_rc,y_train)
```

Out[137]:

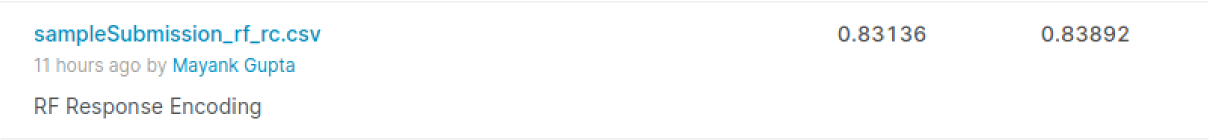
```
RandomForestClassifier(class_weight='balanced', max_depth=10, max_featu
res=4,
                       min_samples_split=20, n_estimators=1000, n_jobs=
-1,
                       random_state=42)
```

```
random_state=42)
```

In [138]:
```
features=train_df_rc.columns
importance=model.feature_importances_
features=pd.DataFrame({'features':features,'value':importance})
features=features.sort_values('value',ascending=False)
sns.barplot('value','features',data=features);
plt.title('Feature Importance');
```



In [139]:
```
predictions = model.predict_proba(test_df_rc)[:,1]
save_submission(predictions, 'rf_rc.csv')
```


sampleSubmission_rf_rc.csv 0.83136 0.83892
11 hours ago by Mayank Gupta
RF Response Encoding

4.5 Xgboost with response encoding

In [140]:

```
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,get_xgb_params(),random_state=random_state
,cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model=clf.fit(train_df_rc,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    7.3s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  1.5min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  4.0min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  6.7min finished
```

In [141]:

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

Out[141]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
1	200	0.0699849	0.601115	5	
28	500	0.0141713	0.222108	5	
7	500	0.017959	0.808397	3	
98	50	0.220131	0.777147	6	
41	20	0.34312	0.996254	6	
58	50	0.454461	0.708911	3	
33	100	0.153737	0.447783	4	
74	20	0.432195	0.763364	6	
94	20	0.591191	0.618218	3	
88	200	0.307937	0.895523	3	

```
In [142]: 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
```

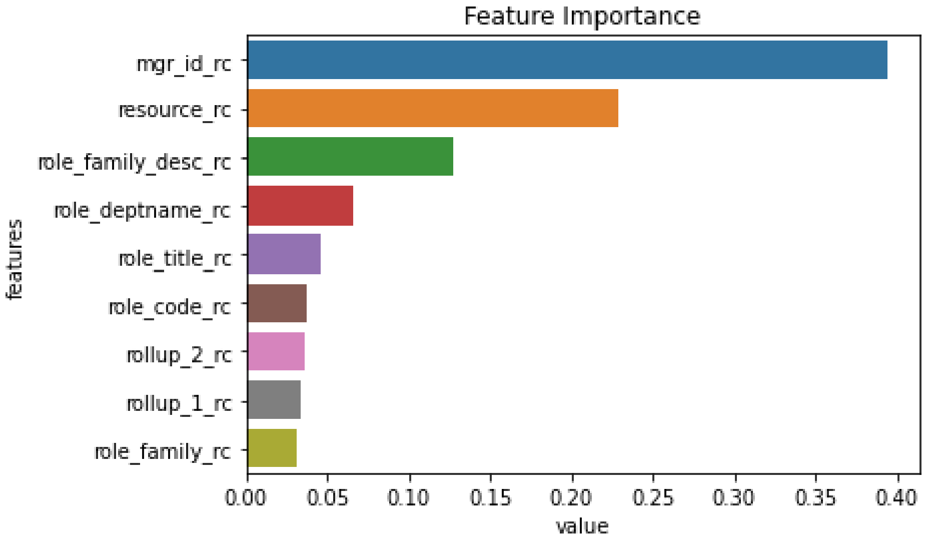
```
Out[142]: (0.44583275285359114, 0.06998494949080172, 5, 4, 200, 0.601115011743208
          8)
```

```
In [143]: model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=l
          earning_rate,max_depth=max_depth,
                                min_child_weight=min_child_weight,n_estimators=n_e
          stimators,subsample=subsample,n_jobs=-1)

          model.fit(train_df_rc,y_train)
```

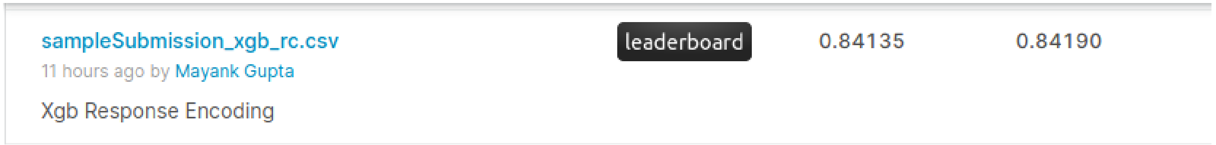
```
Out[143]: XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
                        colsample_bynode=1, colsample_bytree=0.44583275285359114,
          gamma=0,
                        gpu_id=-1, importance_type='gain', interaction_constraint
          s='',
                        learning_rate=0.06998494949080172, max_delta_step=0, max_
          depth=5,
                        min_child_weight=4, missing=nan, monotone_constraints
          ='()',
                        n_estimators=200, n_jobs=-1, num_parallel_tree=1, random_
          state=0,
                        reg_alpha=0, reg_lambda=1, scale_pos_weight=1,
                        subsample=0.6011150117432088, tree_method='exact',
                        validate_parameters=1, verbosity=None)
```

```
In [144]: features=train_df_rc.columns
          importance=model.feature_importances_
          features=pd.DataFrame({'features':features,'value':importance})
          features=features.sort_values('value',ascending=False)
```

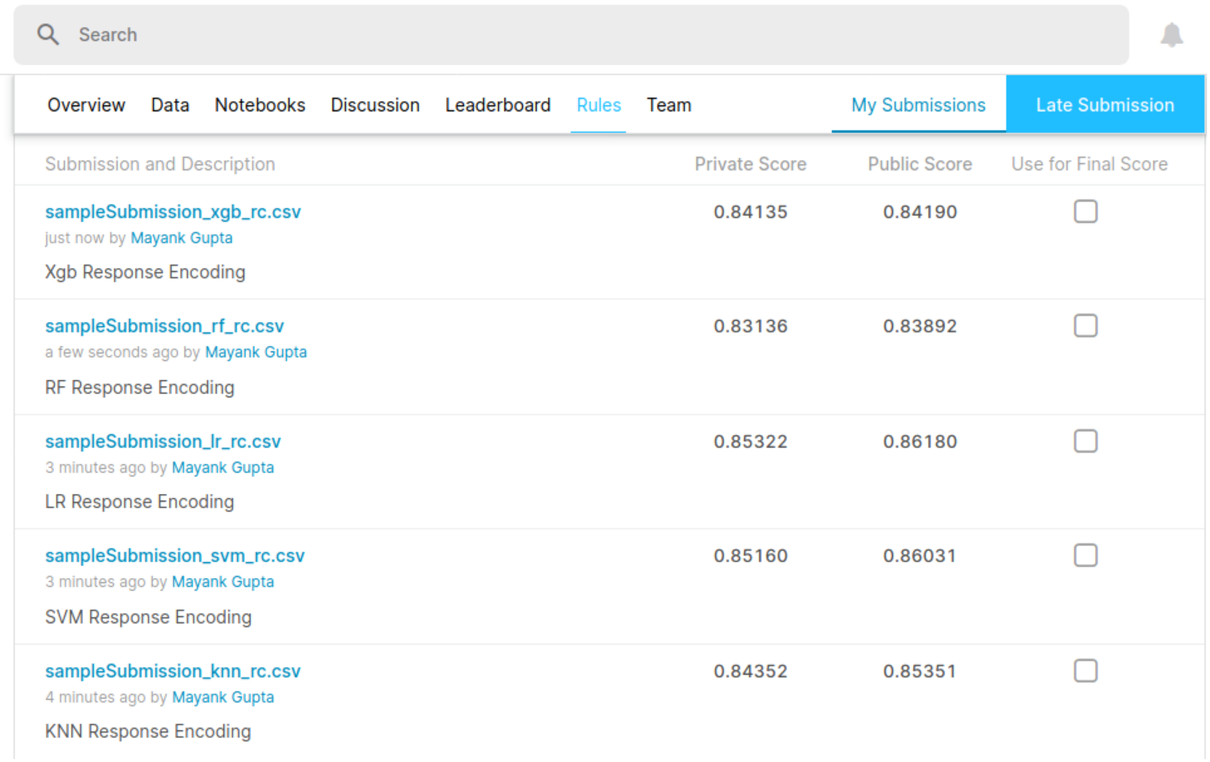
```
sns.barplot('value','features',data=features);
plt.title('Feature Importance');
```



In [145]:
```
predictions = model.predict_proba(test_df_rc)[:,1]
save_submission(predictions, 'xgb_rc.csv')
```


sampleSubmission_xgb_rc.csv
11 hours ago by Mayank Gupta
Xgb Response Encoding

0.84135 0.84190



Submission and Description	Private Score	Public Score	Use for Final Score
sampleSubmission_xgb_rc.csv just now by Mayank Gupta Xgb Response Encoding	0.84135	0.84190	☐
sampleSubmission_rf_rc.csv a few seconds ago by Mayank Gupta RF Response Encoding	0.83136	0.83892	☐
sampleSubmission_lr_rc.csv 3 minutes ago by Mayank Gupta LR Response Encoding	0.85322	0.86180	☐
sampleSubmission_svm_rc.csv 3 minutes ago by Mayank Gupta SVM Response Encoding	0.85160	0.86031	☐
sampleSubmission_knn_rc.csv 4 minutes ago by Mayank Gupta KNN Response Encoding	0.84352	0.85351	☐

In [146]:

```
from prettytable import PrettyTable

x = PrettyTable(['Model', 'Feature', 'Private Score', 'Public Score'])
x.add_row(['KNN','rc', 0.84352, 0.85351])
x.add_row(['SVM', 'rc', 0.85160, 0.86031])
x.add_row(['Logistic Regression', 'rc', 0.85322, 0.86180])
x.add_row(['Random Forest', 'rc', 0.83136, 0.83892])
x.add_row(['Xgboost', 'rc', 0.84135, 0.84190])

print(x)
```

```
+---------------------+---------+---------------+--------------+
|        Model        | Feature | Private Score | Public Score |
+---------------------+---------+---------------+--------------+
|         KNN         |    rc   |    0.84352    |   0.85351    |
|         SVM         |    rc   |     0.8516    |   0.86031    |
| Logistic Regression |    rc    |    0.85322     |    0.8618     |
|    Random Forest    |    rc    |    0.83136     |   0.83892     |
|       Xgboost       |    rc    |    0.84135     |    0.8419     |
+---------------------+----------+----------------+---------------+
```

Observations:

1. Every model performs good for this feature
2. Linear models performs better than Tree based models

5 Build model on SVD feature

In [147]:
```
train_svd = pd.read_csv('data/train_svd.csv')
test_svd = pd.read_csv('data/test_svd.csv')
```

In [148]:
```
train_svd.shape, test_svd.shape, y_train.shape
```

Out[148]:
```
((32769, 72), (58921, 72), (32769,))
```

5.1 KNN with SVD

In [149]:
```
parameters={'n_neighbors':np.arange(1,100, 5)}
clf = RandomizedSearchCV(KNeighborsClassifier(n_jobs=-1),parameters,ran
dom_state=random_state,cv=cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_svd,y_train)
```

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

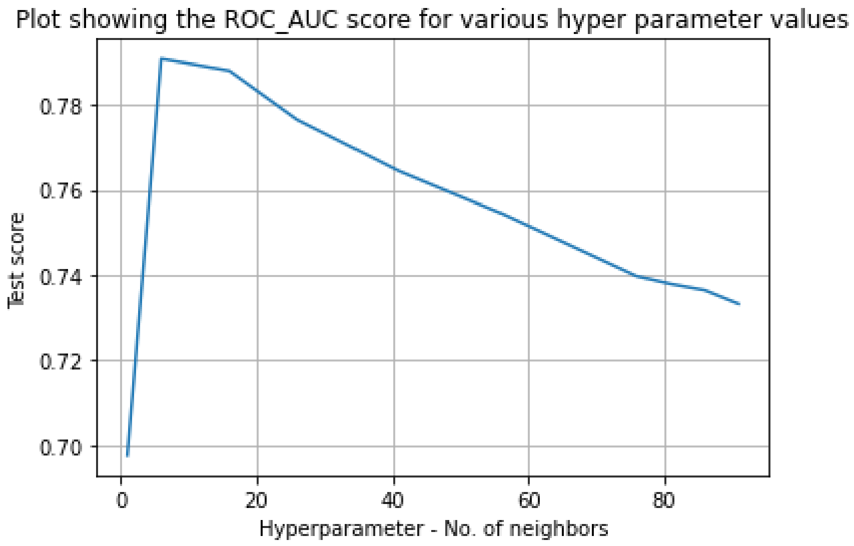
```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   19.0s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:   38.0s finished
```

In [150]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_n_neighbors')
results
```

Out[150]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_neighbors	param
0	0.526564	0.011169	1.004034	0.149404	1	{'n_neighbors
3	1.944336	0.551025	1.655248	0.153292	6	{'n_neighbors
7	2.016851	0.954735	3.149633	0.351339	16	{'n_neighbors 1
5	2.240037	0.818733	3.354217	0.898707	26	{'n_neighbors 2
4	1.967969	0.228458	3.715187	1.218701	41	{'n_neighbors 4
6	1.281747	0.189357	5.637847	0.125865	56	{'n_neighbors 5
2	2.475243	0.578326	5.100802	0.859254	76	{'n_neighbors 7
9	2.189955	1.122140	3.499732	1.791585	81	{'n_neighbors 8
1	1.204084	0.808660	5.773037	0.319467	86	{'n_neighbors 8
8	0.703830	0.153865	7.607220	0.172469	91	{'n_neighbors 9

In [151]:
```
print_graph(results, 'param_n_neighbors', 'mean_test_score', 'Hyperpara
meter - No. of neighbors', 'Test score')
```



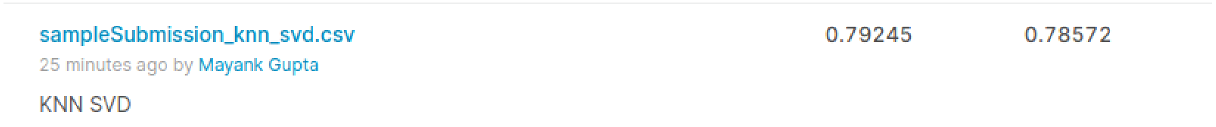
```
In [152]: best_c=best_model.best_params_['n_neighbors']
          best_c
```

```
Out[152]: 6
```

```
In [153]: model = KNeighborsClassifier(n_neighbors=best_c,n_jobs=-1)
          model.fit(train_svd,y_train)
```

```
Out[153]: KNeighborsClassifier(n_jobs=-1, n_neighbors=6)
```

```
In [154]: predictions = model.predict_proba(test_svd)[:,1]
          save_submission(predictions, "knn_svd.csv")
```


sampleSubmission_knn_svd.csv 0.79245 0.78572
25 minutes ago by Mayank Gupta
KNN SVD

5.2 SVM with SVD

In [155]:

```
C_val = uniform(loc=0, scale=4)
model= LinearSVC(verbose=verbose,random_state=random_state,class_weight
='balanced',max_iter=2000)
parameters={'C':C_val}
clf = RandomizedSearchCV(model,parameters,random_state=random_state,cv=
cv,verbose=verbose,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_svd,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:  1.5min
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:  2.7min finished
```

```
[LibLinear]
```

In [156]:

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

Out[156]:

```
3.8028572256396647
```

In [157]:

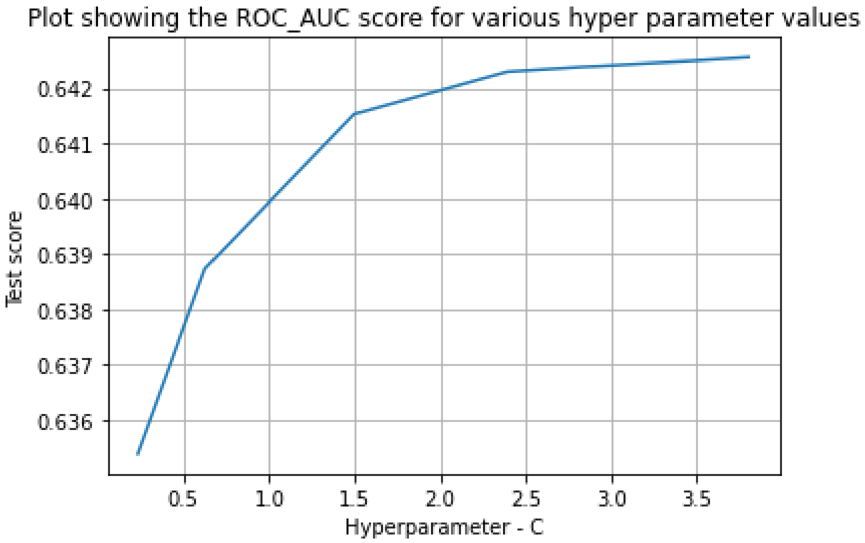
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

Out[157]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
6	2.968880	0.150177	0.016558	0.002776	0.232334	{'C': 0.23233444867279784}
5	6.587434	0.301619	0.012963	0.000876	0.623978	{'C': 0.6239780813448106}
4	6.343227	0.065596	0.012513	0.000442	0.624075	{'C': 0.6240745617697461}
0	17.291072	1.080804	0.016185	0.007285	1.49816	{'C': 1.49816047538945}

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	params
3	29.455153	0.767611	0.015290	0.003827	2.39463	{'C': 2.3946339367881464}
8	29.985117	1.952692	0.012303	0.002009	2.40446	{'C': 2.404460046972835}
9	27.816009	2.354661	0.007257	0.000748	2.83229	{'C': 2.832290311184182}
2	36.411890	2.210566	0.012634	0.000489	2.92798	{'C': 2.9279757672456204}
7	44.704208	1.334583	0.012921	0.000702	3.4647	{'C': 3.4647045830997407}
1	48.909459	2.384907	0.016626	0.005413	3.80286	{'C': 3.8028572256396647}

```
In [158]: print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
          , 'Test score')
```



```
In [159]: #https://stackoverflow.com/questions/26478000/converting-linearsvcs-dec
```

```
ision-function-to-probabilities-scikit-learn-python
model = LinearSVC(C=best_c,verbose=verbose,random_state=random_state,cl
ass_weight='balanced',max_iter=2000)
model = CalibratedClassifierCV(model)
model.fit(train_svd,y_train)
```

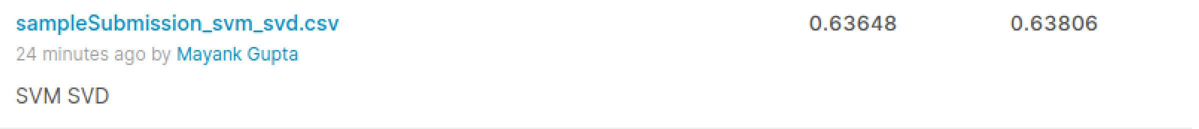
```
[LibLinear][LibLinear][LibLinear][LibLinear][LibLinear]
```

Out[159]:

```
CalibratedClassifierCV(base_estimator=LinearSVC(C=3.8028572256396647,
                                                class_weight='balance
d',
                                                max_iter=2000, random_s
tate=42,
                                                verbose=2))
```

In [160]:

```
predictions = model.predict_proba(test_svd)[:,1]
save_submission(predictions, 'svm_svd.csv')
```



sampleSubmission_svm_svd.csv 0.63648 0.63806

24 minutes ago by Mayank Gupta

SVM SVD

5.3 Logistic Regression with SVD

In [161]:

```
C_val = uniform(loc=0, scale=4)
lr= LogisticRegression(verbose=verbose,random_state=random_state,class_
weight='balanced',solver='lbfgs',max_iter=500,n_jobs=-1)
parameters={'C':C_val}
clf = RandomizedSearchCV(lr,parameters,random_state=random_state,cv=cv,
verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_svd,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

```
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   18.9s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  1.4min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed:  3.4min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:  5.1min finished
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:   14.7s finished
```

In [162]:
```
best_c=best_model.best_params_['C']
best_c
```

Out[162]:
```
3.947547746402069
```

In [163]:
```
results = pd.DataFrame.from_dict(best_model.cv_results_)
results=results.sort_values('param_C')
results
```

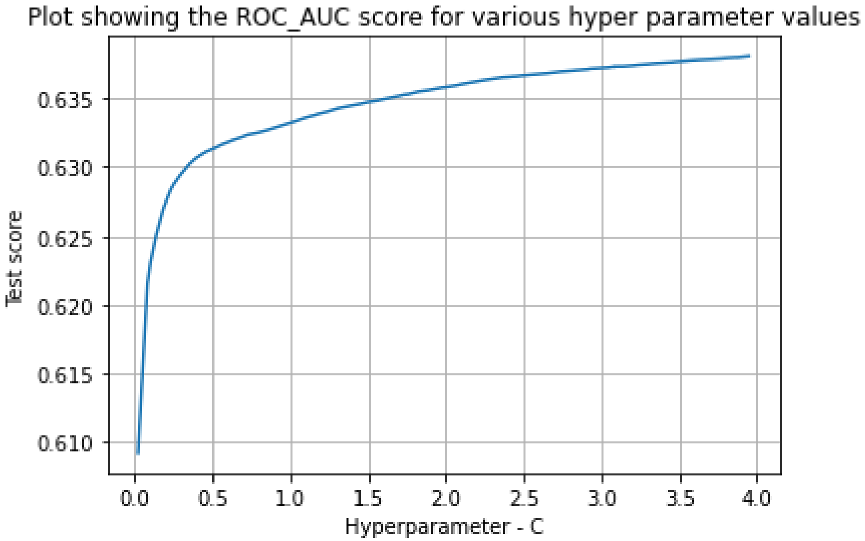
Out[163]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	para
72	1.042337	0.102578	0.035350	0.017093	0.0220885	{' 0.02208846849440959
10	1.598916	0.145812	0.029739	0.011829	0.082338	{' 0.0823379771832097
98	1.946853	0.134926	0.031715	0.005840	0.101677	{' 0.1016765069763807
42	1.629183	0.083901	0.022801	0.003346	0.137554	{' 0.1375540844608735
58	1.859177	0.136240	0.025097	0.007581	0.180909	{' 0.1809091556421522
...	...	...	...	...	...	
1	7.015733	0.438911	0.026228	0.005973	3.80286	{' 3.802857225639664
34	6.146194	0.345854	0.028273	0.008512	3.86253	{' 3.862528132298237

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_C	parar
50	6.477816	0.289469	0.026133	0.013208	3.87834	{' 3.87833851105823
11	6.560687	0.689193	0.033242	0.007402	3.87964	{' 3.87963940864797
69	7.289347	0.445322	0.030326	0.003518	3.94755	{' 3.9475477464020

100 rows × 14 columns

In [164]:
```
print_graph(results, 'param_C', 'mean_test_score', 'Hyperparameter - C'
, 'Test score')
```



In [165]:
```
model = LogisticRegression(C=best_c,verbose=verbose,n_jobs=-1,random_st
ate=random_state,class_weight='balanced',solver='lbfgs')
model.fit(train_svd,y_train)
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
```

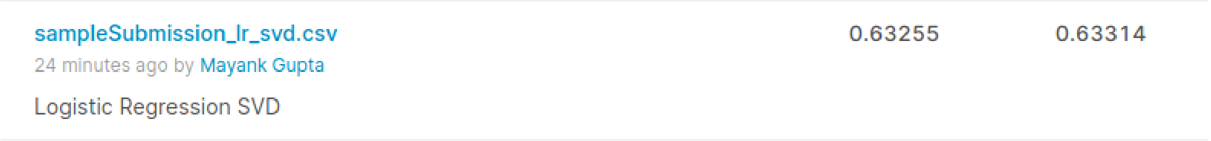
```
[Parallel(n_jobs=-1)]: Done   1 out of   1 | elapsed:    3.5s finished
```

Out[165]:

```
LogisticRegression(C=3.947547746402069, class_weight='balanced', n_jobs
=-1,
                   random_state=42, verbose=2)
```

In [166]:

```
predictions = model.predict_proba(test_svd)[:,1]
save_submission(predictions, 'lr_svd.csv')
```



sampleSubmission_lr_svd.csv 0.63255 0.63314

24 minutes ago by Mayank Gupta

Logistic Regression SVD

5.4 Random Forest with SVD

In [167]:

```
rfc = RandomForestClassifier(random_state=random_state,class_weight='ba
lanced',n_jobs=-1)
clf = RandomizedSearchCV(rfc,get_rf_params(),random_state=random_state,
cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model = clf.fit(train_svd,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   36.2s
/home/auw-mayank/.local/lib/python3.6/site-packages/joblib/externals/lo
ky/process_executor.py:691: UserWarning: A worker stopped while some jo
bs were given to the executor. This can be caused by a too short worker
timeout or by a memory leak.
  "timeout or by a memory leak.", UserWarning
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  6.8min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed: 16.5min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 24.5min finished
```

In [168]:

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

Out[168]:

	param_n_estimators	param_max_depth	param_max_features	param_min_samples_split	mean
84	1000	25	5	2	
20	1000	25	3	2	
33	700	25	4	2	
22	200	25	4	10	
78	700	25	2	7	
85	1000	20	3	7	
62	500	25	3	5	
82	700	20	5	20	
79	500	25	1	10	
92	500	20	3	2	

In [169]:

```
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[169]:

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

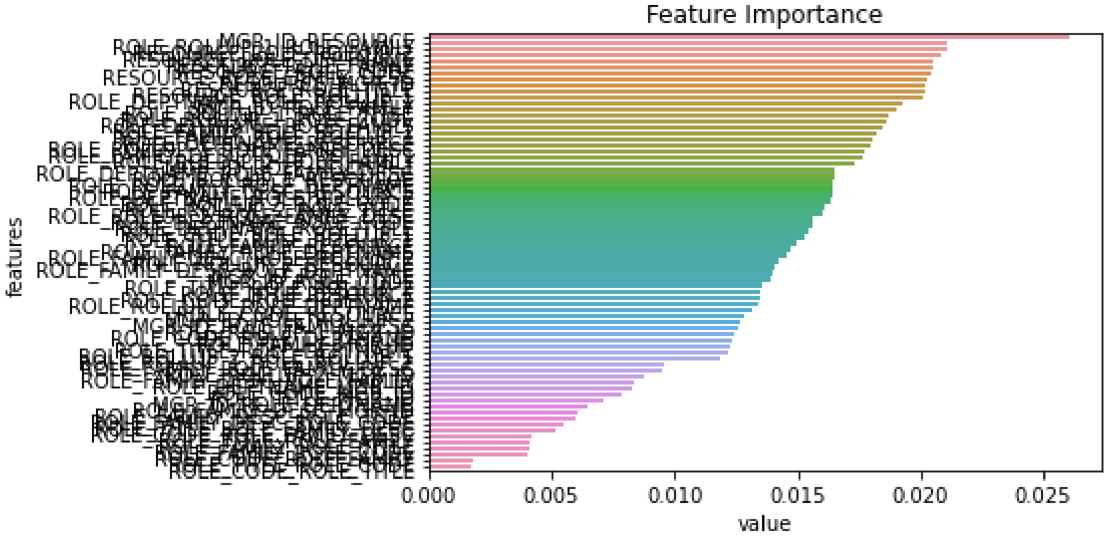
In [170]:

```
model=RandomForestClassifier(n_estimators=n_estimators,max_depth=max_de
pth,max_features=max_features,
                             min_samples_split=min_samples_split,
                             random_state=random_state,class_weight='ba
lanced',n_jobs=-1)
```

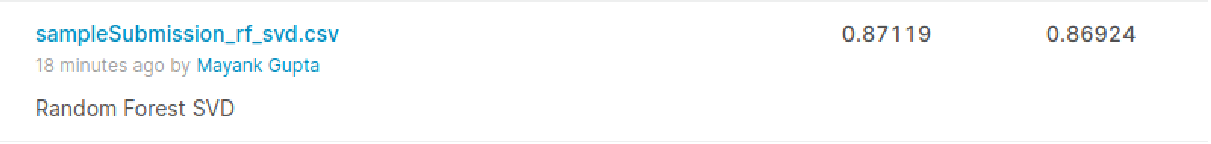
```
model.fit(train_svd,y_train)
```

```
Out[170]: RandomForestClassifier(class_weight='balanced', max_depth=25, max_featu
res=5,
                       n_estimators=1000, n_jobs=-1, random_state=42)
```

```
In [171]: features=train_svd.columns
importance=model.feature_importances_
features=pd.DataFrame({'features':features,'value':importance})
features=features.sort_values('value',ascending=False)
sns.barplot('value','features',data=features);
plt.title('Feature Importance');
```



```
In [172]: predictions = model.predict_proba(test_svd)[:,1]
save_submission(predictions, 'rf_svd.csv')
```



sampleSubmission_rf_svd.csv 0.87119 0.86924

18 minutes ago by Mayank Gupta

Random Forest SVD

5.5 Xgboost with SVD

In [173]:

```
xgb = XGBClassifier()
clf = RandomizedSearchCV(xgb,get_xgb_params(),random_state=random_state
,cv=cv,verbose=verbose,n_iter=100,scoring=scoring,n_jobs=-1)
best_model=clf.fit(train_svd,y_train)
```

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

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent work
ers.
/home/auw-mayank/.local/lib/python3.6/site-packages/joblib/externals/lo
ky/process_executor.py:691: UserWarning: A worker stopped while some jo
bs were given to the executor. This can be caused by a too short worker
timeout or by a memory leak.
  "timeout or by a memory leak.", UserWarning
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:   54.6s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:  9.9min
[Parallel(n_jobs=-1)]: Done 349 tasks      | elapsed: 28.0min
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed: 50.8min finished
```

In [174]:

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

Out[174]:

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
62	500	0.0663892	0.328153	9	
18	1000	0.048135	0.665922	9	
96	500	0.0979629	0.98664	7	
44	1000	0.060484	0.606429	6	
8	750	0.0686033	0.683264	6	

	param_n_estimators	param_learning_rate	param_subsample	param_max_depth	param_colsan
97	750	0.232385	0.907694	6	
49	500	0.160277	0.393098	8	
80	1000	0.385564	0.905351	3	
53	200	0.540096	0.928319	6	
78	1000	0.576551	0.94023	6	

In [175]:

```
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[175]:

```
(0.375582952639944, 0.06638916390452139, 9, 3, 500, 0.3281526674747319
3)
```

In [176]:

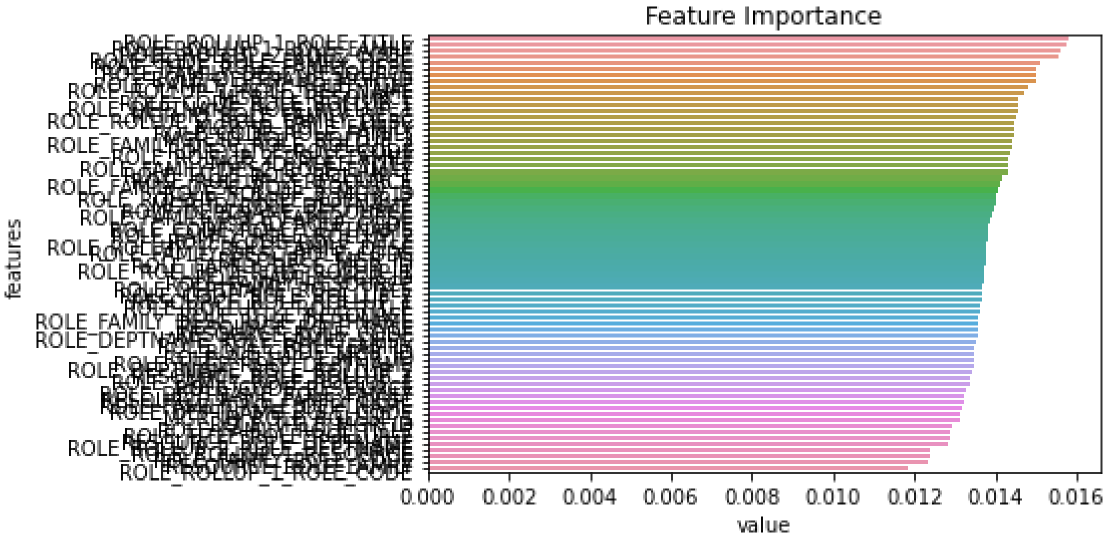
```
model = XGBClassifier(colsample_bytree=colsample_bytree,learning_rate=l
earning_rate,max_depth=max_depth,
                      min_child_weight=min_child_weight,n_estimators=n_e
stimators,subsample=subsample,n_jobs=-1)

model.fit(train_svd,y_train)
```

Out[176]:

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=0.375582952639944, g
amma=0,
              gpu_id=-1, importance_type='gain', interaction_constraint
s='',
              learning_rate=0.06638916390452139, max_delta_step=0, max_
depth=9,
              min_child_weight=3, missing=nan, monotone_constraints
='()',
              n_estimators=500, n_jobs=-1, num_parallel_tree=1, random_
state=0,
              reg_alpha=0, reg_lambda=1, scale_pos_weight=1,
              subsample=0.32815266747473193, tree_method='exact',
              validate_parameters=1, verbosity=None)
```

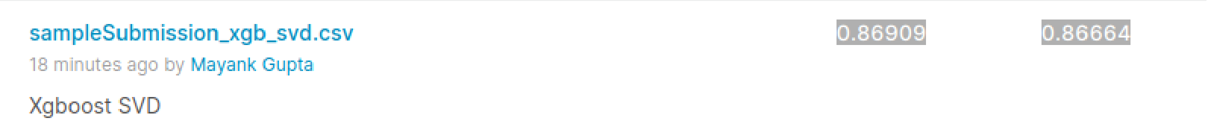
In [177]:

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



In [178]:

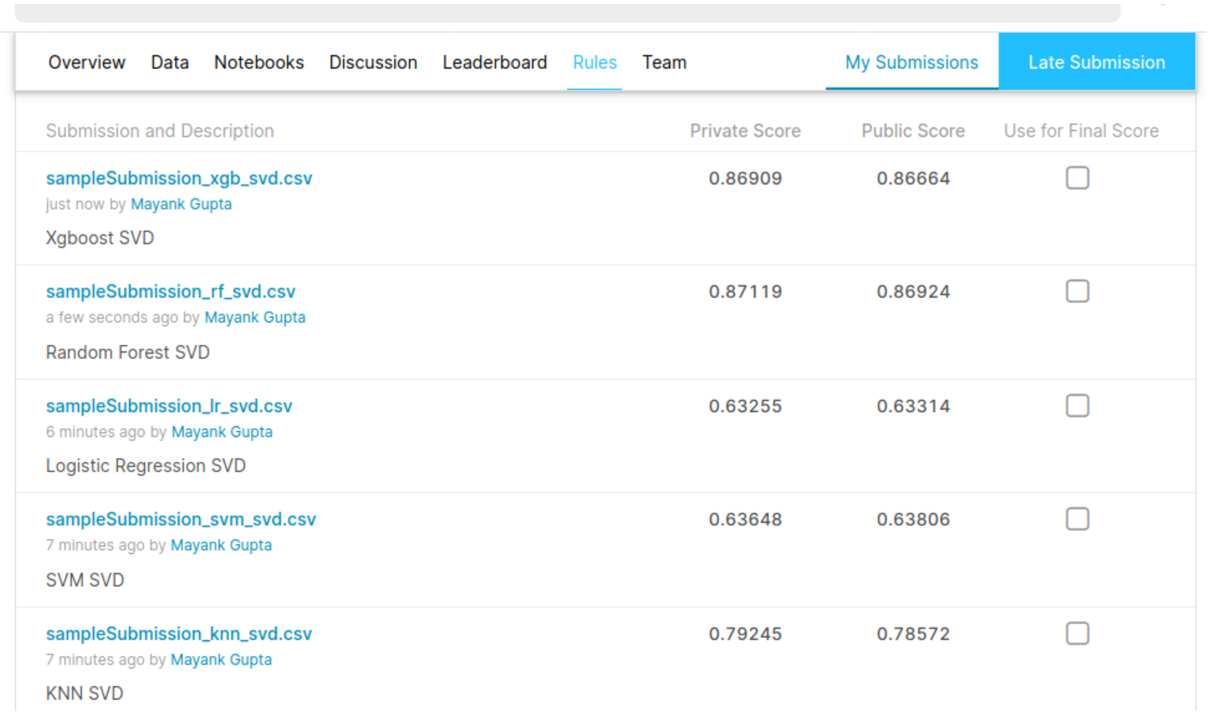
```
predictions = model.predict_proba(test_svd)[:,1]
save_submission(predictions, 'xgb_svd.csv')
```



sampleSubmission_xgb_svd.csv 0.86909 0.86664

18 minutes ago by Mayank Gupta

Xgboost SVD



Submission and Description	Private Score	Public Score	Use for Final Score
sampleSubmission_xgb_svd.csv just now by Mayank Gupta Xgboost SVD	0.86909	0.86664	□
sampleSubmission_rf_svd.csv a few seconds ago by Mayank Gupta Random Forest SVD	0.87119	0.86924	□
sampleSubmission_lr_svd.csv 6 minutes ago by Mayank Gupta Logistic Regression SVD	0.63255	0.63314	□
sampleSubmission_svm_svd.csv 7 minutes ago by Mayank Gupta SVM SVD	0.63648	0.63806	□
sampleSubmission_knn_svd.csv 7 minutes ago by Mayank Gupta KNN SVD	0.79245	0.78572	□

In [179]:

```
from prettytable import PrettyTable

x = PrettyTable(['Model', 'Feature', 'Private Score', 'Public Score'])
x.add_row(['KNN','svd', 0.79245, 0.78572])
x.add_row(['SVM', 'svd', 0.63648, 0.63806])
x.add_row(['Logistic Regression', 'svd', 0.63255, 0.63314])
x.add_row(['Random Forest', 'svd', 0.87119, 0.86924])
x.add_row(['Xgboost', 'svd', 0.86909, 0.86664])

print(x)
```

```
+---------------------+---------+---------------+--------------+
|        Model        | Feature | Private Score | Public Score |
+---------------------+---------+---------------+--------------+
|         KNN         |   svd   |    0.79245    |   0.78572    |
|         SVM         |   svd   |    0.63648    |   0.63806    |
| Logistic Regression |   svd   |    0.63255    |   0.63314    |
|    Random Forest     |   svd   |    0.87119     |   0.86924    |
|       Xgboost        |   svd   |    0.86909     |   0.86664    |
+----------------------+---------+----------------+--------------+
```

Observations:

1. Tree based models works better than linear model
2. KNN is performing overall good

We have to improve our model to reach into 5-10% on kaggle

In [180]:
```
# https://www.kaggle.com/mitribunskiy/tutorial-catboost-overview
```

In [181]:
```
# https://www.kaggle.com/prashant111/catboost-classifier-tutorial
```

https://catboost.ai/

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

About

CatBoost is an algorithm for gradient boosting on decision trees. It is developed by Yandex researchers and engineers, and is used for search, recommendation systems, personal assistant, self-driving cars, weather prediction and many other tasks at Yandex and in other companies, including CERN, Cloudflare, Careem taxi. It is in open-source and can be used by anyone.

Features

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 [182]:

```
params = {
            'loss_function':'Logloss',
            'eval_metric':'AUC',
            'cat_features':list(range(train_data.shape[1])),
            'verbose':100,
            'random_seed':random_state
        }
```

In [183]:

```
clf= CatBoostClassifier(**params)
clf.fit(train_data,y_train)
```

```
Learning rate set to 0.045713
0:      total: 99.2ms   remaining: 1m 39s
100:    total: 2.33s    remaining: 20.7s
200:    total: 5.6s     remaining: 22.3s
300:    total: 8.79s    remaining: 20.4s
400:    total: 11.9s    remaining: 17.8s
500:    total: 15.2s    remaining: 15.2s
600:    total: 18.4s    remaining: 12.2s
700:    total: 21.7s    remaining: 9.27s
800:    total: 24.8s    remaining: 6.16s
900:    total: 28s      remaining: 3.08s
999:    total: 31.1s    remaining: 0us
```

Out[183]:

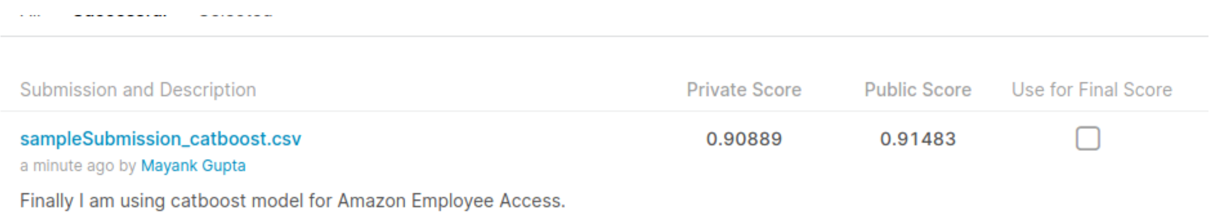
```
<catboost.core.CatBoostClassifier at 0x7f361d4d8780>
```

In [184]:

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

In [185]:

```
save_submission(predictions, 'catboost.csv')
```



Submission and Description	Private Score	Public Score	Use for Final Score
sampleSubmission_catboost.csv a minute ago by Mayank Gupta Finally I am using catboost model for Amazon Employee Access.	0.90889	0.91483	□

Catboost perform better than all our previous models and it's AUC score is much better than previous models so I am selecting this for predicting future data

In [186]:

```
# Save model on disk
pickle.dump(clf, open('models/catboost_model.pkl', 'wb'))
```

In [ ]: