In this notebook I am trying to implement ensemble models like stacking and voting classifier on the data.

In [ ]:

```
!wget --header="Host: storage.googleapis.com" --header="User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/84.0.4147.105 Safari/537.36" --header="Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9" --header="Accept-Language: en-GB,en-US;q=0.9,en;q=0.8" --header="Referer: https://www.kaggle.com/" "https://storage.googleapis.com/kaggle-competitions-data/kaggle-v2/11835/224935/compressed/train.csv.zip?GoogleAccessId=web-data@kaggle-161607.iam.gserviceaccount.com&Expires=1597288911&Signature=TnxuH0loGUxP0ci3MkeZAQhfVvvCeUpiKCM%2FSEW2QzpP%2FtNhdZg8TVKC5TIO4YE2FVa3KV5I2sTYC7fr%2FVekk6ZOA%2BF4A2vWp8Ku%2FWyeaVmMEVCRG5ZeYEV%2FZnRcsQrJocFJPwBNt5yfXnyzw2LNuZwX7wYdEWm3mIOqnBivVNj%2BY99uZ7r7jpOmSM1qZw7yuICrpHGIA5ixn6ygb02GmMxSGQsp59UeN222orKRIwmc9lHkMbTtsgH68UJ4hBrfUj927I9oeIynNesooj6Ex41OjOtOJ2iraZShwHqU9A469BPK3rM8JmcbDvIAdCcyFacfpXFWcl8Lit0MVC6fWA%3D%3D&response-content-disposition=attachment%3B+filename%3Dtrain.csv.zip" -c -O 'train.csv.zip'
```

```
--2020-08-11 12:25:28--  https://storage.googleapis.com/kaggle-competitions-data/kaggle-v2/11835/224935/compressed/train.csv.zip?GoogleAccessId=web-data@kaggle-161607.iam.gserviceaccount.com&Expires=1597288911&Signature=TnxuH0loGUxP0ci3MkeZAQhfVvvCeUpiKCM%2FSEW2QzpP%2FtNhdZg8TVKC5TIO4YE2FVa3KV5I2sTYC7fr%2FVekk6ZOA%2BF4A2vWp8Ku%2FWyeaVmMEVCRG5ZeYEV%2FZnRcsQrJocFJPwBNt5yfXnyzw2LNuZwX7wYdEWm3mIOqnBivVNj%2BY99uZ7r7jpOmSM1qZw7yuICrpHGIA5ixn6ygb02GmMxSGQsp59UeN222orKRIwmc9lHkMbTtsgH68UJ4hBrfUj927I9oeIynNesooj6Ex41OjOtOJ2iraZShwHqU9A469BPK3rM8JmcbDvIAdCcyFacfpXFWcl8Lit0MVC6fWA%3D%3D&response-content-disposition=attachment%3B+filename%3Dtrain.csv.zip
Resolving storage.googleapis.com (storage.googleapis.com)... 64.233.189.128, 108.177.97.128, 108.177.125.128, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|64.233.189.128|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 456337398 (435M) [application/zip]
Saving to: 'train.csv.zip'

train.csv.zip       100%[===================>] 435.20M  32.7MB/s    in 12s

2020-08-11 12:25:40 (36.6 MB/s) - 'train.csv.zip' saved [456337398/456337398]
```

In [ ]:

```
!unzip train.csv.zip
```

```
Archive:  train.csv.zip
  inflating: train.csv
```

In [ ]:

```
import warnings
import itertools
import numpy as np
import pandas as pd
import seaborn as sns
import lightgbm as lgb
import matplotlib.pyplot as plt
from tqdm import tqdm_notebook as tqdm
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, log_loss
import dask.dataframe as dd
import dask
import gc

from yellowbrick.text import TSNEVisualizer

%matplotlib inline
plt.style.use("fivethirtyeight")
warnings.filterwarnings(action='ignore')
sns.set_style('whitegrid')
```

In [ ]:

```
# This is to be used for memory optimization because the data is very large.
def reduce_mem_usage(df):
    """ iterate through all the columns of a dataframe and modify the data type
        to reduce memory usage.
    """
    start_mem = df.memory_usage().sum() / 1024**2
    print('Memory usage of dataframe is {:.2f} MB'.format(start_mem))

    for col in df.columns:
        col_type = df[col].dtype

        if col_type != object:
            c_min = df[col].min()
            c_max = df[col].max()
            if str(col_type)[:3] == 'int':
                if c_min > np.iinfo(np.int8).min and c_max < np.iinfo(np.int8).max:
                    df[col] = df[col].astype(np.int8)
                elif c_min > np.iinfo(np.int16).min and c_max < np.iinfo(np.int16).max:
                    df[col] = df[col].astype(np.int16)
                elif c_min > np.iinfo(np.int32).min and c_max < np.iinfo(np.int32).max:
                    df[col] = df[col].astype(np.int32)
                elif c_min > np.iinfo(np.int64).min and c_max < np.iinfo(np.int64).max:
                    df[col] = df[col].astype(np.int64)
            else:
                if c_min > np.finfo(np.float16).min and c_max < np.finfo(np.float16).max
:
                    df[col] = df[col].astype(np.float16)
                elif c_min > np.finfo(np.float32).min and c_max < np.finfo(np.float32).m
ax:
                    df[col] = df[col].astype(np.float32)
                else:
                    df[col] = df[col].astype(np.float64)
        else:
              df[col] = df[col].astype('category')

    end_mem = df.memory_usage().sum() / 1024**2
    print('Memory usage after optimization is: {:.2f} MB'.format(end_mem))
    print('Decreased by {:.1f}%'.format(100 * (start_mem - end_mem) / start_mem))

    return df
def featureModify(isTrain, numRows):
    if isTrain:
        df = dd.read_csv('train.csv',nrows=numRows)
        df = df.compute()
        # df['pilot'] = 100*df['crew']+df['seat']
        df = reduce_mem_usage(df)
        df['event'] = df['event'].map({
            'A':0,
            'B':1,
            'C':2,
            'D':3
        })
    else:
        df = dd.read_csv('test.csv',nrows=numRows)
        df = df.compute()
        # df['pilot'] = 100*df['crew']+df['seat']
        df = reduce_mem_usage(df)

    return df
train = featureModify(True, None)
y = train['event']
train = train.drop('event',axis=1)
print(train.shape)
print(train.columns)
```

```
Memory usage of dataframe is 1076.93 MB
Memory usage after optimization is: 278.52 MB
Decreased by 74.1%
(4867421, 27)
```

```
Index(['crew', 'experiment', 'time', 'seat', 'eeg_fp1', 'eeg_f7', 'eeg_f8',
       'eeg_t4', 'eeg_t6', 'eeg_t5', 'eeg_t3', 'eeg_fp2', 'eeg_o1', 'eeg_p3',
       'eeg_pz', 'eeg_f3', 'eeg_fz', 'eeg_f4', 'eeg_c4', 'eeg_p4', 'eeg_poz',
       'eeg_c3', 'eeg_cz', 'eeg_o2', 'ecg', 'r', 'gsr'],
      dtype='object')
```

In [ ]:

```
train.head()
```

Out[ ]:

	crew	experiment	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg_fp2	
0	1	CA	0.011719	1	-5.285156	26.781250	-9.523438	-12.796875	16.718750	33.75000	23.718750	-6.695312	2
1	1	CA	0.015625	1	-2.427734	28.437500	-9.320312	-3.757812	15.968750	30.43750	21.015625	-6.476562	2
2	1	CA	0.019531	1	10.671875	30.421875	15.351562	24.718750	16.140625	32.15625	25.437500	-0.088684	2
3	1	CA	0.023438	1	11.453125	25.609375	2.433594	12.414062	20.531250	31.50000	19.140625	-0.256592	3
4	1	CA	0.027344	1	7.285156	25.937500	0.113586	5.746094	19.828125	28.75000	20.578125	-1.953125	3

In [ ]:

```
train.columns
```

Out[ ]:

```
Index(['crew', 'experiment', 'time', 'seat', 'eeg_fp1', 'eeg_f7', 'eeg_f8',
       'eeg_t4', 'eeg_t6', 'eeg_t5', 'eeg_t3', 'eeg_fp2', 'eeg_o1', 'eeg_p3',
       'eeg_pz', 'eeg_f3', 'eeg_fz', 'eeg_f4', 'eeg_c4', 'eeg_p4', 'eeg_poz',
       'eeg_c3', 'eeg_cz', 'eeg_o2', 'ecg', 'r', 'gsr'],
      dtype='object')
```

In [ ]:

```
feature = ['eeg_fp1', 'eeg_f7', 'eeg_f8',
       'eeg_t4', 'eeg_t6', 'eeg_t5', 'eeg_t3', 'eeg_fp2', 'eeg_o1', 'eeg_p3',
       'eeg_pz', 'eeg_f3', 'eeg_fz', 'eeg_f4', 'eeg_c4', 'eeg_p4', 'eeg_poz',
       'eeg_c3', 'eeg_cz', 'eeg_o2', 'ecg', 'r', 'gsr']
```

In [ ]:

```
from sklearn.preprocessing import MinMaxScaler
mn = MinMaxScaler()
for i in feature:
  train[i] = mn.fit_transform(np.array(train[i]).reshape(-1,1))
```

In [ ]:

```
train.head()
```

Out[ ]:

	crew	experiment	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg_fp2	eeg_o
0	1	CA	0.011719	1	0.406738	0.443115	0.431396	0.463135	0.583496	0.531738	0.466309	0.396484	0.61181
1	1	CA	0.015625	1	0.407715	0.443604	0.431396	0.465820	0.583008	0.530273	0.465332	0.396484	0.61084
2	1	CA	0.019531	1	0.411621	0.444092	0.437988	0.474609	0.583496	0.531250	0.466797	0.398438	0.61132
3	1	CA	0.023438	1	0.411865	0.442871	0.434570	0.470947	0.585449	0.530762	0.464600	0.398438	0.61181
4	1	CA	0.027344	1	0.410645	0.442871	0.433838	0.468750	0.584961	0.529785	0.465088	0.397949	0.61230

In [ ]:

```
dic1 = {'CA':0,'DA':1,'SS':3,'LOFT':4}
train['experiment'] = train['experiment'].apply(lambda x: dic1[x])
train['experiment'] = train['experiment'].astype('int8')
```

In [ ]:

```
from sklearn import model_selection
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
from sklearn.ensemble import RandomForestClassifier,VotingClassifier
from sklearn.tree import DecisionTreeClassifier
from lightgbm import LGBMClassifier
from sklearn import model_selection
from mlxtend.classifier import EnsembleVoteClassifier
from sklearn.metrics import log_loss
```

Voting Classifier

A Voting Classifier is a machine learning model that trains on an ensemble of numerous models and predicts an output (class) based on their highest probability of chosen class as the output.

In [ ]:

```
clf1 = LogisticRegression(random_state=1, C=0.01)
clf2 = RandomForestClassifier(random_state=1,n_estimators = 50, max_depth = 200, criteri
on = 'entropy')
clf3 = MultinomialNB(alpha=1e-07)
clf4 = DecisionTreeClassifier(max_depth =200, criterion = 'entropy', random_state =40)
clf5 = LGBMClassifier(    objective='multiclass',
                          metric='multi_error',
                          num_class=4,
                          num_leaves=30,
                          learning_rate = 0.01,
                          num_threads=4,
                          colsample_bytree=0.5,
                          min_data_in_leaf=100,
                          min_split_gain=0.00019,
                          bagging_fraction = 0.9,
                          bagging_seed=0)
```

In [ ]:

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(train,y,test_size=0.25,random_state=40)
```

In [ ]:

```
eclf1 = VotingClassifier(estimators=[('lgb',clf5), ('mnb', clf3), ('rf', clf2), ('lr', c
lf1), ('DT',clf4)], voting='soft')
eclf1.fit(X_train,y_train)
```

Out[ ]:

```
VotingClassifier(estimators=[('lgb',
                              LGBMClassifier(bagging_fraction=0.9,
                                             bagging_seed=0,
                                             boosting_type='gbdt',
                                             class_weight=None,
                                             colsample_bytree=0.5,
                                             importance_type='split',
                                             learning_rate=0.01, max_depth=-1,
                                             metric='multi_error',
                                             min_child_samples=20,
                                             min_child_weight=0.001,
                                             min_data_in_leaf=100,
                                             min_split_gain=0.00019,
                                             n_estimators=100, n_jobs=-1
```

```
                                        num_class=4...
                              DecisionTreeClassifier(ccp_alpha=0.0,
                                                     class_weight=None,
                                                     criterion='entropy',
                                                     max_depth=200,
                                                     max_features=None,
                                                     max_leaf_nodes=None,
                                                     min_impurity_decrease=0.0,
                                                     min_impurity_split=None,
                                                     min_samples_leaf=1,
                                                     min_samples_split=2,
                                                     min_weight_fraction_leaf=0.0,
                                                     presort='deprecated',
                                                     random_state=40,
                                                     splitter='best'))],
                       flatten_transform=True, n_jobs=None, voting='soft',
                       weights=None)
```

In [ ]:

```
import os
os.chdir('/content/drive/My Drive/ML case study/models')
```

In [ ]:

```
import joblib
joblib.dump(eclf1,'voting_classifier(1).pkl')
```

Out[ ]:

```
['voting_classifier(1).pkl']
```

In [ ]:

```
y_pred = eclf1.predict_proba(X_test)
```

In [ ]:

```
y_pred
```

Out[ ]:

```
array([[0.92994889, 0.03118097, 0.03171215, 0.00715799],
       [0.09489309, 0.00410205, 0.88611002, 0.01489484],
       [0.07022134, 0.00356289, 0.91097268, 0.01524309],
       ...,
       [0.86321356, 0.0312255 , 0.04371111, 0.06184983],
       [0.08433996, 0.00370177, 0.89485315, 0.01710512],
       [0.92420922, 0.02859831, 0.03546824, 0.01172423]])
```

In [ ]:

```
log_loss(y_test,y_pred)
```

Out[ ]:

```
0.17574586453615432
```

In [ ]:

```
import joblib
model = joblib.load('/content/drive/My Drive/ML case study/models/voting_classifier(1).pkl')
```

In [ ]:

```
model
```

Out[ ]:

```
VotingClassifier(estimators=[('lgb',
                              LGBMClassifier(bagging_fraction=0.9,
```

```
                                        bagging_seed=0,
                                        boosting_type='gbdt',
                                        class_weight=None,
                                        colsample_bytree=0.5,
                                        importance_type='split',
                                        learning_rate=0.01, max_depth=-1,
                                        metric='multi_error',
                                        min_child_samples=20,
                                        min_child_weight=0.001,
                                        min_data_in_leaf=100,
                                        min_split_gain=0.00019,
                                        n_estimators=100, n_jobs=-1,
                                        num_class=4...
                                DecisionTreeClassifier(ccp_alpha=0.0,
                                                       class_weight=None,
                                                       criterion='entropy',
                                                       max_depth=200,
                                                       max_features=None,
                                                       max_leaf_nodes=None,
                                                       min_impurity_decrease=0.0,
                                                       min_impurity_split=None,
                                                       min_samples_leaf=1,
                                                       min_samples_split=2,
                                                       min_weight_fraction_leaf=0.0,
                                                       presort='deprecated',
                                                       random_state=40,
                                                       splitter='best'))],
                        flatten_transform=True, n_jobs=None, voting='soft',
                        weights=None)
```

In [ ]:

```
os.chdir('/content')
```

In [ ]:

```
!wget --header="Host: storage.googleapis.com" --header="User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/84.0.4147.105 Safari/537.36" --header="Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9" --header="Accept-Language: en-GB,en-US;q=0.9,en;q=0.8" --header="Referer: https://www.kaggle.com/" "https://storage.googleapis.com/kaggle-competitions-data/kaggle-v2/11835/224935/compressed/test.csv.zip?GoogleAccessId=web-data@kaggle-161607.iam.gserviceaccount.com&Expires=1597317006&Signature=RFZIgHU2QfPyXomx2CB0mTu0SAWvD89f1Gjd9tgjN1vLYho2Bstu6SoTu%2BkzFXrPuuuJtfYTQs%2BgQIO2kthGiViz%2BvIKCN02zjTG6VsBCpfIbbMS2csp5LYN3GGOp1XvfpT2FbTVf9HMczleZF%2BIPzD1GEIJi75oWVvUb3BD5o1hHrSsRm0t%2F1fv8c%2FozoRAOOtrN8QxUg9xezjW7TdVTQOey7WZao6SF4IUMNQNwqvz4%2BdOlLcE%2BMiQQN45UV7APiFtlsMpN%2Bz%2F2bFx%2F%2Fb%2FCxt00rmHlIuuQoxzd8znJAfA9SxxOVHaC4Z0eHIATvWGD%2FoyuEqiA1khMz11uwpSOA%3D%3D&response-content-disposition=attachment%3B+filename%3Dtest.csv.zip" -c -O 'test.csv.zip'
```

```
--2020-08-11 12:26:50--  https://storage.googleapis.com/kaggle-competitions-data/kaggle-v2/11835/224935/compressed/test.csv.zip?GoogleAccessId=web-data@kaggle-161607.iam.gserviceaccount.com&Expires=1597317006&Signature=RFZIgHU2QfPyXomx2CB0mTu0SAWvD89f1Gjd9tgjN1vLYho2Bstu6SoTu%2BkzFXrPuuuJtfYTQs%2BgQIO2kthGiViz%2BvIKCN02zjTG6VsBCpfIbbMS2csp5LYN3GGOp1XvfpT2FbTVf9HMczleZF%2BIPzD1GEIJi75oWVvUb3BD5o1hHrSsRm0t%2F1fv8c%2FozoRAOOtrN8QxUg9xezjW7TdVTQOey7WZao6SF4IUMNQNwqvz4%2BdOlLcE%2BMiQQN45UV7APiFtlsMpN%2Bz%2F2bFx%2F%2Fb%2FCxt00rmHlIuuQoxzd8znJAfA9SxxOVHaC4Z0eHIATvWGD%2FoyuEqiA1khMz11uwpSOA%3D%3D&response-content-disposition=attachment%3B+filename%3Dtest.csv.zip
Resolving storage.googleapis.com (storage.googleapis.com)... 74.125.203.128, 64.233.188.128, 64.233.189.128, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|74.125.203.128|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1791131386 (1.7G) [application/zip]
Saving to: ‘test.csv.zip’

test.csv.zip        100%[===================>]   1.67G  93.6MB/s    in 20s

2020-08-11 12:27:10 (87.0 MB/s) - ‘test.csv.zip’ saved [1791131386/1791131386]
```

In [ ]:

```
!unzip test.csv.zip
```

```
Archive:  test.csv.zip
  inflating: test.csv
```

In [ ]:

```
from sklearn import model_selection
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB
from sklearn.ensemble import RandomForestClassifier,VotingClassifier
from sklearn.tree import DecisionTreeClassifier
from lightgbm import LGBMClassifier
from sklearn import model_selection
from mlxtend.classifier import EnsembleVoteClassifier
from sklearn.metrics import log_loss
```

In [ ]:

```
test = featureModify(False,None)
print('Done Test Read')
```

```
Memory usage of dataframe is 3974.83 MB
Memory usage after optimization is: 1079.37 MB
Decreased by 72.8%
Done Test Read
```

In [ ]:

```
test.head()
```

Out[ ]:

	id	crew	experiment	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg
0	0	1	LOFT	0.000000	0	17.906250	6.128906	0.994629	-28.203125	-47.687500	-187.125000	-33.187500	-4.22
1	1	1	LOFT	0.000000	1	45.875000	94.750000	23.296875	1.391602	2.060547	-5.144531	6.394531	33.40
2	2	1	LOFT	0.003906	0	33.125000	28.359375	-7.238281	-7.691406	-25.828125	-107.250000	12.843750	1.21
3	3	1	LOFT	0.003906	1	43.281250	95.875000	18.703125	-1.432617	-4.234375	-8.023438	7.425781	27.34
4	4	1	LOFT	0.007812	0	7.929688	3.460938	-10.859375	-26.359375	-25.890625	37.000000	-50.343750	11.67

In [ ]:

```
df_sub = pd.DataFrame()
df_sub['id'] = test['id']
test = test.drop('id',axis=1)
```

In [ ]:

```
feature = ['eeg_fp1', 'eeg_f7', 'eeg_f8',
       'eeg_t4', 'eeg_t6', 'eeg_t5', 'eeg_t3', 'eeg_fp2', 'eeg_o1', 'eeg_p3',
       'eeg_pz', 'eeg_f3', 'eeg_fz', 'eeg_f4', 'eeg_c4', 'eeg_p4', 'eeg_poz',
       'eeg_c3', 'eeg_cz', 'eeg_o2', 'ecg', 'r', 'gsr']
```

In [ ]:

```
from sklearn.preprocessing import MinMaxScaler
mn = MinMaxScaler()
for i in feature:
  test[i] = mn.fit_transform(np.array(test[i]).reshape(-1,1))
```

In [ ]:

```
test.head()
```

Out[ ]:

	crew	experiment	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg_fp2	eeg_o
0	1	LOFT	0.000000	0	0.495361	0.500488	0.493164	0.491699	0.489258	0.475342	0.491455	0.494629	0.50146
1	1	LOFT	0.000000	1	0.498291	0.509766	0.495605	0.494873	0.494629	0.494873	0.495605	0.498779	0.46728
2	1	LOFT	0.003906	0	0.496826	0.502930	0.492432	0.493896	0.491699	0.483887	0.496338	0.495361	0.50195
3	1	LOFT	0.003906	1	0.498047	0.510254	0.495117	0.494385	0.493896	0.494385	0.495605	0.498047	0.46533
4	1	LOFT	0.007812	0	0.494141	0.500000	0.491943	0.491699	0.491699	0.499268	0.489502	0.493896	0.50048

In [ ]:

```
dic1 = {'CA':0,'DA':1,'SS':3,'LOFT':4}
test['experiment'] = test['experiment'].apply(lambda x: dic1[x])
test['experiment'] = test['experiment'].astype('int8')
```

In [ ]:

```
y_pred = model.predict_proba(test)
```

In [ ]:

```
y_pred
```

Out[ ]:

```
array([[0.85903671, 0.05541984, 0.07509567, 0.01044778],
       [0.87725464, 0.04538119, 0.05571262, 0.02165154],
       [0.85904952, 0.0554075 , 0.07509567, 0.01044731],
       ...,
       [0.68104471, 0.00780678, 0.07783888, 0.23330963],
       [0.72996542, 0.01540105, 0.04099227, 0.21364126],
       [0.68104448, 0.00780678, 0.07783888, 0.23330986]])
```

In [ ]:

```
import os
os.chdir('/content/drive/My Drive/ML case study/results')
```

In [ ]:

```
df_sub = pd.DataFrame(np.concatenate((np.arange(len(test))[:, np.newaxis], y_pred), axis
=1), columns=['id', 'A', 'B', 'C', 'D'])
df_sub['id'] = df_sub['id'].astype(int)
print(df_sub)
df_sub.to_csv("Model_building5_LGBop.csv", index=False)
```

```
                id         A         B         C         D
0                0  0.859037  0.055420  0.075096  0.010448
1                1  0.877255  0.045381  0.055713  0.021652
2                2  0.859050  0.055408  0.075096  0.010447
3                3  0.881251  0.045385  0.055713  0.017652
4                4  0.859043  0.055414  0.075096  0.010448
...            ...       ...       ...       ...       ...
17965138  17965138  0.677046  0.011807  0.077839  0.233308
17965139  17965139  0.729966  0.015401  0.040992  0.213640
17965140  17965140  0.681045  0.007807  0.077839  0.233310
17965141  17965141  0.729965  0.015401  0.040992  0.213641
17965142  17965142  0.681044  0.007807  0.077839  0.233310

[17965143 rows x 5 columns]
```

Stacking Classifier

Stacking Classifier

Stacked generalization consists in stacking the output of individual estimator and use a classifier to compute the final prediction. Stacking allows to use the strength of each individual estimator by using their output as input of a final estimator.

In [ ]:

```
from sklearn.ensemble import StackingClassifier
clf1 = LogisticRegression(random_state=1, C=0.01)
clf2 = RandomForestClassifier(random_state=1,n_estimators = 10, max_depth = 200, criteri
on = 'entropy')
clf3 = MultinomialNB(alpha=1e-07)
clf4 = DecisionTreeClassifier(max_depth =200, criterion = 'entropy', random_state =40)
clf5 = LGBMClassifier(    objective='multiclass',
                          metric='multi_error',
                          num_class=4,
                          num_leaves=30,
                          learning_rate = 0.01,
                          num_threads=4,
                          colsample_bytree=0.5,
                          min_data_in_leaf=100,
                          min_split_gain=0.00019,
                          bagging_fraction = 0.9,
                          bagging_seed=0)
```

In [ ]:

```
estimators = [
     ('dt', clf4),
     ('lgb', clf5),
     ('rf',clf2)
              ]
```

In [ ]:

```
clf = StackingClassifier(estimators=estimators,stack_method='auto',verbose=500,cv=2)
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(train,y,test_size=0.2,random_state=40)
```

In [ ]:

```
clf.fit(X_train,y_train)
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:   31.7s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  1.0min remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  1.1min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:  2.2min remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  4.5min remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  4.5min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:  3.1min remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  6.1min remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  6.1min finished
```

Out[ ]:

```
StackingClassifier(cv=2,
                   estimators=[('dt',
                                DecisionTreeClassifier(ccp_alpha=0.0,
                                                       class_weight=None,
                                                       criterion='entropy',
                                                       max_depth=200,
                                                       max_features=None,
                                                       max_leaf_nodes=None,
                                                       min_impurity_decrease=0.0,
                                                       min_impurity_split=None,
                                                       min_samples_leaf=1,
                                                       min_samples_split=2,
                                                       min_weight_fraction_leaf=0.0
```

```
                                                min_weight_fraction_leaf 0.0,
                                                presort='deprecated',
                                                random_state=40,
                                                splitter='best')),
                                ('lgb',
                                 L...
                                                max_depth=200,
                                                max_features='auto',
                                                max_leaf_nodes=None,
                                                max_samples=None,
                                                min_impurity_decrease=0.0,
                                                min_impurity_split=None,
                                                min_samples_leaf=1,
                                                min_samples_split=2,
                                                min_weight_fraction_leaf=0.0,
                                                n_estimators=10,
                                                n_jobs=None,
                                                oob_score=False,
                                                random_state=1,
                                                verbose=0,
                                                warm_start=False))],
                    final_estimator=None, n_jobs=None, passthrough=False,
                    stack_method='auto', verbose=500)
```

In [ ]:

```
y_pred = clf.predict_proba(X_test)
print(y_pred)
from sklearn.metrics import log_loss
print(log_loss(y_test,y_pred))
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-18-91df5320d0c2> in <module>()
----> 1 y_pred = clf.predict_proba(X_test)
      2 print(y_pred)
      3 from sklearn.metrics import log_loss
      4 print(log_loss(y_test,y_pred))

NameError: name 'X_test' is not defined
```

In [ ]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&scope=email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly&response_type=code

Enter your authorization code:
··········
Mounted at /content/drive
```

In [ ]:

```
import os
os.chdir('/content/drive/My Drive/ML case study/models')
```

In [ ]:

```
import joblib
joblib.dump(clf,'stacking_classifer(1).pkl')
```

Out[ ]:

```
['stacking_classifer(1).pkl']
```

In [ ]:

```
import joblib
clf = joblib.load('stacking_classifer(1).pkl')
```

In [ ]:

```
y_pred = clf.predict_proba(test)
```

In [ ]:

```
y_pred
```

Out[ ]:

```
array([[9.99599839e-01, 8.83706626e-05, 2.31596274e-05, 2.88630510e-04],
       [9.99805754e-01, 3.91820473e-05, 2.99227209e-06, 1.52071679e-04],
       [9.99599839e-01, 8.83706626e-05, 2.31596274e-05, 2.88630510e-04],
       ...,
       [9.98276114e-01, 6.54340388e-04, 3.15275662e-04, 7.54269753e-04],
       [9.99062115e-01, 5.57535162e-04, 1.59893688e-05, 3.64360467e-04],
       [9.98276114e-01, 6.54340388e-04, 3.15275662e-04, 7.54269753e-04]])
```

In [ ]:

```
os.chdir('/content/drive/My Drive/ML case study/results')
```

In [ ]:

```
df_sub = pd.DataFrame(np.concatenate((np.arange(len(test))[:, np.newaxis], y_pred), axis
=1), columns=['id', 'A', 'B', 'C', 'D'])
df_sub['id'] = df_sub['id'].astype(int)
print(df_sub)
df_sub.to_csv("stacking_op(1).csv", index=False)
```

```
                id         A         B         C         D
0                0  0.999600  0.000088  0.000023  0.000289
1                1  0.999806  0.000039  0.000003  0.000152
2                2  0.999600  0.000088  0.000023  0.000289
3                3  0.999806  0.000039  0.000003  0.000152
4                4  0.999600  0.000088  0.000023  0.000289
...            ...       ...       ...       ...       ...
17965138  17965138  0.998276  0.000654  0.000315  0.000754
17965139  17965139  0.999062  0.000558  0.000016  0.000364
17965140  17965140  0.998276  0.000654  0.000315  0.000754
17965141  17965141  0.999062  0.000558  0.000016  0.000364
17965142  17965142  0.998276  0.000654  0.000315  0.000754

[17965143 rows x 5 columns]
```

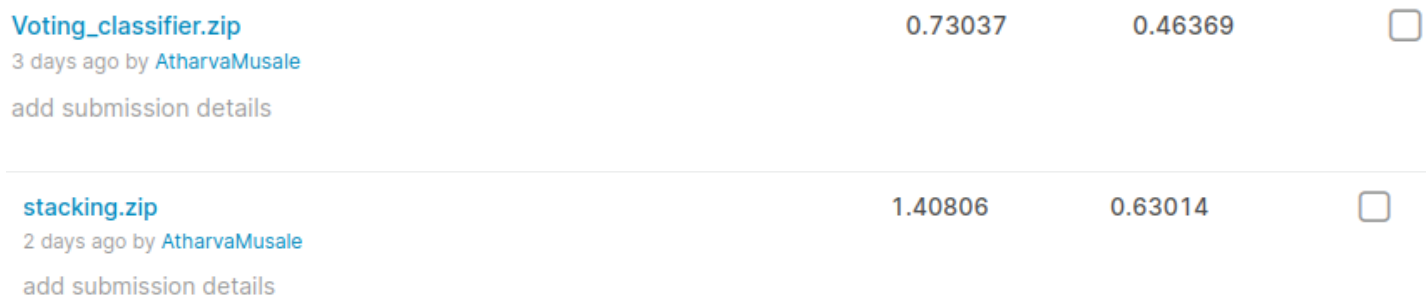
In [ ]:

```
y_pred.shape
```

Out[ ]:

```
(17965143, 4)
```

The results on kaggle submission are as follows For voting classifier I got public scre of 0.463 and private score of 0.73. For stacking classifier I got the public score of 0.63 and private score of 1.408.



In [ ]: