So here is what I am going to try in this notebook , I am going to drop experiment feature and keep the time feature as it is. I am simply going to train my model on this data as it is and see the results on the best model.

In [ ]:

```
!wget --header="Host: storage.googleapis.com" --header="User-Agent: Mozilla/5.0 (X11; Li
nux 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/ap
ng,*/*;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.googleapi
s.com/kaggle-competitions-data/kaggle-v2/11835/224935/compressed/train.csv.zip?GoogleAcce
ssId=web-data@kaggle-161607.iam.gserviceaccount.com&Expires=1597053235&Signature=LPrAGyUv
FAFA7ZkkwUWyc0srI5488quzzTLdj1ThHt3H2isET80a8V6dHQQruHzZHJgRq%2FBF%2BGzLxf0DEaB0HB0iYF2An
xlKcxEU3xbWcdZF9at7J8HOfFNB9t3AezeghzCnu6FAcLvKRTHVJrCJnLBQk6wQgFHxgJPwH3dQeuhnJwEVpkj2rF
qBkN2Ray3r2WZeL01xO6VZN8O7zGWg4ORaQikb3I12Vid%2BrN5ubxeljOQ3UfDJ%2B8hDMVMSVu86SHZY6xREyLN
5dvMn%2BLK8j98Gzw4a5dXx3F3WdGl3t5a1%2F%2BPB2H54Ge4j6%2F15AB0gwf%2FWmcgi7%2ByDeNB9xAiMDw%3
D%3D&response-content-disposition=attachment%3B+filename%3Dtrain.csv.zip" -c -O 'train.cs
v.zip'
```

```
--2020-08-08 11:48:18--  https://storage.googleapis.com/kaggle-competitions-data/kaggle-v
2/11835/224935/compressed/train.csv.zip?GoogleAccessId=web-data@kaggle-161607.iam.gservic
eaccount.com&Expires=1597053235&Signature=LPrAGyUvFAFA7ZkkwUWyc0srI5488quzzTLdj1ThHt3H2is
ET80a8V6dHQQruHzZHJgRq%2FBF%2BGzLxf0DEaB0HB0iYF2AnxlKcxEU3xbWcdZF9at7J8HOfFNB9t3AezeghzCn
u6FAcLvKRTHVJrCJnLBQk6wQgFHxgJPwH3dQeuhnJwEVpkj2rFqBkN2Ray3r2WZeL01xO6VZN8O7zGWg4ORaQikb3
I12Vid%2BrN5ubxeljOQ3UfDJ%2B8hDMVMSVu86SHZY6xREyLN5dvMn%2BLK8j98Gzw4a5dXx3F3WdGl3t5a1%2F%
2BPB2H54Ge4j6%2F15AB0gwf%2FWmcgi7%2ByDeNB9xAiMDw%3D%3D&response-content-disposition=attac
hment%3B+filename%3Dtrain.csv.zip
Resolving storage.googleapis.com (storage.googleapis.com)... 173.194.216.128, 173.194.217
.128, 172.217.193.128, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|173.194.216.128|:443... con
nected.
HTTP request sent, awaiting response... 200 OK
Length: 456337398 (435M) [application/zip]
Saving to: ‘train.csv.zip’

train.csv.zip       100%[===================>] 435.20M   119MB/s    in 3.6s

2020-08-08 11:48:22 (119 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')
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tools/_testing.py:19: FutureWarning: p
andas.util.testing is deprecated. Use the functions in the public API at pandas.testing i
nstead.
  import pandas.util.testing as tm
/usr/local/lib/python3.6/dist-packages/sklearn/utils/deprecation.py:144: FutureWarning: T
he sklearn.metrics.classification module is  deprecated in version 0.22 and will be remov
ed in version 0.24. The corresponding classes / functions should instead be imported from
sklearn.metrics. Anything that cannot be imported from sklearn.metrics is now part of the
private API.
  warnings.warn(message, FutureWarning)
```

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)
```

In [ ]:

```
# I didnt do this for LightGBM
train = train.drop(columns=['experiment'],axis=1)
```

In [ ]:

```
col = train.columns
```

In [ ]:

```
# I have used this normalisation only for naive bayes
# from sklearn.preprocessing import MinMaxScaler
# ms = MinMaxScaler()
# train = ms.fit_transform(train)
```

In [ ]:

```
train = pd.DataFrame(train)
```

In [ ]:

```
train.columns = col
```

In [ ]:

```
train.head()
```

Out[ ]:

	crew	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg_fp2	eeg_o1	
0	1	0.011719	1	-5.285156	26.781250	-9.523438	-12.796875	16.718750	33.75000	23.718750	-6.695312	29.234375	24
1	1	0.015625	1	-2.427734	28.437500	-9.320312	-3.757812	15.968750	30.43750	21.015625	-6.476562	26.640625	24
2	1	0.019531	1	10.671875	30.421875	15.351562	24.718750	16.140625	32.15625	25.437500	-0.088684	28.125000	26
3	1	0.023438	1	11.453125	25.609375	2.433594	12.414062	20.531250	31.50000	19.140625	-0.256592	30.656250	24
4	1	0.027344	1	7.285156	25.937500	0.113586	5.746094	19.828125	28.75000	20.578125	-1.953125	31.718750	25

Naive Bayes

In [ ]:

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(train,y,test_size =0.2, random_state=40
)
```

In [ ]:

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(3893936, 26)
(973485, 26)
(3893936,)
(973485,)
```

In [ ]:

```
from sklearn.naive_bayes import MultinomialNB
from sklearn.model_selection import RandomizedSearchCV
param_dist = {"alpha" :[0.0000001,0.000001,0.00001,0.0001,0.001,0.01,0.1,1]}
nb = MultinomialNB()
rsc = RandomizedSearchCV(nb,param_dist,cv=4,verbose=500)
rsc.fit(X_train,y_train)
print("Tuned Multinomial Niave Bayes Parameters: {}".format(rsc.best_params_))
print("Best score is {}".format(rsc.best_score_))
```

```
Fitting 4 folds for each of 8 candidates, totalling 32 fits
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[CV] alpha=1e-07 .....................................................
[CV] ......................... alpha=1e-07, score=0.585, total=   2.5s
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    2.5s remaining:    0.0s
[CV] alpha=1e-07 .....................................................
[CV] ......................... alpha=1e-07, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:    4.9s remaining:    0.0s
[CV] alpha=1e-07 .....................................................
[CV] ......................... alpha=1e-07, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   3 out of   3 | elapsed:    7.3s remaining:    0.0s
[CV] alpha=1e-07 .....................................................
[CV] ......................... alpha=1e-07, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   4 out of   4 | elapsed:    9.7s remaining:    0.0s
[CV] alpha=1e-06 .....................................................
[CV] ......................... alpha=1e-06, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:   12.2s remaining:    0.0s
[CV] alpha=1e-06 .....................................................
[CV] ......................... alpha=1e-06, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   6 out of   6 | elapsed:   14.6s remaining:    0.0s
[CV] alpha=1e-06 .....................................................
[CV] ......................... alpha=1e-06, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   7 out of   7 | elapsed:   17.0s remaining:    0.0s
[CV] alpha=1e-06 .....................................................
[CV] ......................... alpha=1e-06, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done   8 out of   8 | elapsed:   19.5s remaining:    0.0s
[CV] alpha=1e-05 .....................................................
[CV] ......................... alpha=1e-05, score=0.585, total=   2.5s
[Parallel(n_jobs=1)]: Done   9 out of   9 | elapsed:   21.9s remaining:    0.0s
[CV] alpha=1e-05 .....................................................
[CV] ......................... alpha=1e-05, score=0.585, total=   2.5s
[Parallel(n_jobs=1)]: Done  10 out of  10 | elapsed:   24.4s remaining:    0.0s
[CV] alpha=1e-05 .....................................................
[CV] ......................... alpha=1e-05, score=0.585, total=   2.5s
[Parallel(n_jobs=1)]: Done  11 out of  11 | elapsed:   26.8s remaining:    0.0s
[CV] alpha=1e-05 .....................................................
[CV] ......................... alpha=1e-05, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  12 out of  12 | elapsed:   29.3s remaining:    0.0s
[CV] alpha=0.0001 ....................................................
[CV] ........................ alpha=0.0001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  13 out of  13 | elapsed:   31.7s remaining:    0.0s
[CV] alpha=0.0001 ....................................................
[CV] ........................ alpha=0.0001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  14 out of  14 | elapsed:   34.1s remaining:    0.0s
[CV] alpha=0.0001 ....................................................
[CV] ........................ alpha=0.0001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  15 out of  15 | elapsed:   36.6s remaining:    0.0s
[CV] alpha=0.0001 ....................................................
[CV] ........................ alpha=0.0001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  16 out of  16 | elapsed:   39.0s remaining:    0.0s
[CV] alpha=0.001 .....................................................
[CV] ......................... alpha=0.001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  17 out of  17 | elapsed:   41.4s remaining:    0.0s
[CV] alpha=0.001 .....................................................
```

```
[CV] ......................... alpha=0.001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  18 out of  18 | elapsed:   43.8s remaining:    0.0s
[CV] alpha=0.001 .....................................................
[CV] ......................... alpha=0.001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  19 out of  19 | elapsed:   46.2s remaining:    0.0s
[CV] alpha=0.001 .....................................................
[CV] ......................... alpha=0.001, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  20 out of  20 | elapsed:   48.6s remaining:    0.0s
[CV] alpha=0.01 ......................................................
[CV] .......................... alpha=0.01, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  21 out of  21 | elapsed:   51.1s remaining:    0.0s
[CV] alpha=0.01 ......................................................
[CV] .......................... alpha=0.01, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  22 out of  22 | elapsed:   53.5s remaining:    0.0s
[CV] alpha=0.01 ......................................................
[CV] .......................... alpha=0.01, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  23 out of  23 | elapsed:   55.9s remaining:    0.0s
[CV] alpha=0.01 ......................................................
[CV] .......................... alpha=0.01, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  24 out of  24 | elapsed:   58.3s remaining:    0.0s
[CV] alpha=0.1 .......................................................
[CV] ........................... alpha=0.1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  25 out of  25 | elapsed:  1.0min remaining:    0.0s
[CV] alpha=0.1 .......................................................
[CV] ........................... alpha=0.1, score=0.585, total=   2.5s
[Parallel(n_jobs=1)]: Done  26 out of  26 | elapsed:  1.1min remaining:    0.0s
[CV] alpha=0.1 .......................................................
[CV] ........................... alpha=0.1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  27 out of  27 | elapsed:  1.1min remaining:    0.0s
[CV] alpha=0.1 .......................................................
[CV] ........................... alpha=0.1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  28 out of  28 | elapsed:  1.1min remaining:    0.0s
[CV] alpha=1 .........................................................
[CV] ............................. alpha=1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  29 out of  29 | elapsed:  1.2min remaining:    0.0s
[CV] alpha=1 .........................................................
[CV] ............................. alpha=1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  30 out of  30 | elapsed:  1.2min remaining:    0.0s
[CV] alpha=1 .........................................................
[CV] ............................. alpha=1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  31 out of  31 | elapsed:  1.3min remaining:    0.0s
[CV] alpha=1 .........................................................
[CV] ............................. alpha=1, score=0.585, total=   2.4s
[Parallel(n_jobs=1)]: Done  32 out of  32 | elapsed:  1.3min remaining:    0.0s
[Parallel(n_jobs=1)]: Done  32 out of  32 | elapsed:  1.3min finished
Tuned Multinomial Niave Bayes Parameters: {'alpha': 1e-07}
Best score is 0.5852497318908169
```

In [ ]:

```python
from sklearn.metrics import accuracy_score,log_loss,confusion_matrix
clf = MultinomialNB(alpha=1e-07)
clf = clf.fit(X_train,y_train)
y_pred = clf.predict_proba(X_test)
print(log_loss(y_test,y_pred))
```

```
0.9223443374768153
```

Logistic Regression

In [ ]:

```python
from sklearn.linear_model import LogisticRegression
from tqdm.auto import tqdm
from sklearn.model_selection import RandomizedSearchCV
# from sklearn.multiclass import OneVsRestClassifier
param_dist = {"C" : [0.001,0.01,0.1,1,10]}
lr = LogisticRegression(multi_class='ovr')
rsc = RandomizedSearchCV(lr,param_dist,cv=2,verbose=500,n_jobs=1)
rsc.fit(X_train,y_train)
```

```
print("Tuned Logistic Regression Parameters: {}".format(rsc.best_params_))
print("Best score is {}".format(rsc.best_score_))
```

```
Fitting 2 folds for each of 5 candidates, totalling 10 fits
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[CV] C=0.001 .........................................................
[CV] ............................. C=0.001, score=0.583, total= 2.4min
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:  2.4min remaining:    0.0s
[CV] C=0.001 .........................................................
[CV] ............................. C=0.001, score=0.583, total= 2.5min
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:  4.9min remaining:    0.0s
[CV] C=0.01 ..........................................................
[CV] .............................. C=0.01, score=0.583, total= 2.4min
[Parallel(n_jobs=1)]: Done   3 out of   3 | elapsed:  7.3min remaining:    0.0s
[CV] C=0.01 ..........................................................
[CV] .............................. C=0.01, score=0.582, total= 2.4min
[Parallel(n_jobs=1)]: Done   4 out of   4 | elapsed:  9.7min remaining:    0.0s
[CV] C=0.1 ...........................................................
[CV] ............................... C=0.1, score=0.582, total= 2.4min
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed: 12.1min remaining:    0.0s
[CV] C=0.1 ...........................................................
[CV] ............................... C=0.1, score=0.583, total= 2.4min
[Parallel(n_jobs=1)]: Done   6 out of   6 | elapsed: 14.5min remaining:    0.0s
[CV] C=1 .............................................................
[CV] ................................. C=1, score=0.582, total= 2.4min
[Parallel(n_jobs=1)]: Done   7 out of   7 | elapsed: 16.9min remaining:    0.0s
[CV] C=1 .............................................................
[CV] ................................. C=1, score=0.583, total= 2.4min
[Parallel(n_jobs=1)]: Done   8 out of   8 | elapsed: 19.3min remaining:    0.0s
[CV] C=10 ............................................................
[CV] ................................ C=10, score=0.582, total= 2.4min
[Parallel(n_jobs=1)]: Done   9 out of   9 | elapsed: 21.7min remaining:    0.0s
[CV] C=10 ............................................................
[CV] ................................ C=10, score=0.582, total= 2.4min
[Parallel(n_jobs=1)]: Done  10 out of  10 | elapsed: 24.1min remaining:    0.0s
[Parallel(n_jobs=1)]: Done  10 out of  10 | elapsed: 24.1min finished
Tuned Logistic Regression Parameters: {'C': 0.01}
Best score is 0.5826544144536531
```

In [ ]:

```
clf = LogisticRegression(multi_class='ovr',C = 0.01)
clf = clf.fit(X_train,y_train)
pred= clf.predict_proba(X_test)
print(log_loss(y_test,pred))
```

```
0.9206174913509789
```

Decision Tree

In [ ]:

```
from sklearn.tree import DecisionTreeClassifier
from tqdm.auto import tqdm
max_depth =  [10,100,200,300]
for i in tqdm(max_depth):
  print('depth is',i)
  clf = DecisionTreeClassifier(max_depth=i)
  clf.fit(X_train,y_train)
  y_pred = clf.predict_proba(X_test)
  print(log_loss(y_test,y_pred))
```

```
depth is 10
0.49245480396760244
depth is 100
0.04200774665411109
depth is 200
0.04179486955958013
```

```
depth is 300
0.042185144232886884
```

Okay so we observed that the optimum depth size is 200 since it gives us least loss

I am taking the reference of the hyperparamter tuning form the previous model building notebook and training the data to see which one gives best result

In [ ]:

```
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import RandomizedSearchCV
param_dist = {"max_depth" : [200],
              "criterion" : ['entropy'],
              "random_state" : [40],
              "max_features" : ['auto'],
              "max_leaf_nodes" : [1500,2000,2500]
              }
dtc = DecisionTreeClassifier()
rsc = RandomizedSearchCV(dtc,param_dist,cv=2,verbose=500)
rsc.fit(X_train,y_train)
print("Tuned Decision Tree Parameters: {}".format(rsc.best_params_))
print("Best score is {}".format(rsc.best_score_))
```

```
Fitting 2 folds for each of 3 candidates, totalling 6 fits
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[CV] random_state=40, max_leaf_nodes=1500, max_features=auto, max_depth=200, criterion=en
tropy
[CV]  random_state=40, max_leaf_nodes=1500, max_features=auto, max_depth=200, criterion=e
ntropy, score=0.888, total=  22.2s
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:   22.2s remaining:    0.0s
[CV] random_state=40, max_leaf_nodes=1500, max_features=auto, max_depth=200, criterion=en
tropy
[CV]  random_state=40, max_leaf_nodes=1500, max_features=auto, max_depth=200, criterion=e
ntropy, score=0.873, total=  22.9s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:   45.0s remaining:    0.0s
[CV] random_state=40, max_leaf_nodes=2000, max_features=auto, max_depth=200, criterion=en
tropy
[CV]  random_state=40, max_leaf_nodes=2000, max_features=auto, max_depth=200, criterion=e
ntropy, score=0.898, total=  23.2s
[Parallel(n_jobs=1)]: Done   3 out of   3 | elapsed:  1.1min remaining:    0.0s
[CV] random_state=40, max_leaf_nodes=2000, max_features=auto, max_depth=200, criterion=en
tropy
[CV]  random_state=40, max_leaf_nodes=2000, max_features=auto, max_depth=200, criterion=e
ntropy, score=0.884, total=  23.4s
[Parallel(n_jobs=1)]: Done   4 out of   4 | elapsed:  1.5min remaining:    0.0s
[CV] random_state=40, max_leaf_nodes=2500, max_features=auto, max_depth=200, criterion=en
tropy
[CV]  random_state=40, max_leaf_nodes=2500, max_features=auto, max_depth=200, criterion=e
ntropy, score=0.905, total=  23.8s
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:  1.9min remaining:    0.0s
[CV] random_state=40, max_leaf_nodes=2500, max_features=auto, max_depth=200, criterion=en
tropy
[CV]  random_state=40, max_leaf_nodes=2500, max_features=auto, max_depth=200, criterion=e
ntropy, score=0.891, total=  24.2s
[Parallel(n_jobs=1)]: Done   6 out of   6 | elapsed:  2.3min remaining:    0.0s
[Parallel(n_jobs=1)]: Done   6 out of   6 | elapsed:  2.3min finished
Tuned Decision Tree Parameters: {'random_state': 40, 'max_leaf_nodes': 2500, 'max_feature
s': 'auto', 'max_depth': 200, 'criterion': 'entropy'}
Best score is 0.8984171799433787
```

In [ ]:

```
clf = DecisionTreeClassifier(max_depth = 200, criterion= 'entropy', max_leaf_nodes = None
, random_state = 40)
clf = clf.fit(X_train,y_train)
pred = clf.predict_proba(X_test)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
```

```
<ipython-input-14-8faef9408baf> in <module>()
      2 clf = clf.fit(X_train,y_train)
      3 pred = clf.predict_proba(X_test)
----> 4 print(log_loss(y_cv,pred))

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

In [ ]:

```
print(log_loss(y_test,pred))
```

```
0.021429627516119047
```

In [ ]:

```
from sklearn.tree import DecisionTreeClassifier
clf = DecisionTreeClassifier(max_depth = 200,criterion = 'entropy', random_state=40)
clf.fit(X_train,y_train)
```

Out[ ]:

```
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')
```

In [ ]:

```
import joblib
# joblib.dump(clf,'decision_tree.pkl')
```

Out[ ]:

```
['decision_tree.pkl']
```

In [ ]:

```
import joblib
clf = joblib.load('decision_tree.pkl')
# clf.predict_pro
```

In [ ]:

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

LightGBM

For Lightgbm I am not dropping the experiment feature since the I tried it by dropping that feature but I didnt get very good result.

In [ ]:

```
train, train_test, y, y_test = train_test_split(train, y, test_size=0.25, shuffle=False)
train = lgb.Dataset(train, label=y,categorical_feature=[1])
del y
gc.collect()


train_test = lgb.Dataset(train_test, label=y_test,categorical_feature=[1])
del y_test
gc.collect()
```

Out[ ]:

```
0
```

In [ ]:

```
params = {
        "objective" : "multiclass",
        "metric" : "multi_error",
        'num_class':4,
        "num_leaves" : 30,
        "learning_rate" : 0.01,
        "bagging_fraction" : 0.9,
        "bagging_seed" : 0,
        "num_threads" : 4,
        "colsample_bytree" : 0.5,
        'min_data_in_leaf':100,
        'min_split_gain':0.00019
}
model = lgb.train(  params,
                    train_set = train,
                    num_boost_round=2000,
                    early_stopping_rounds=200,
                    verbose_eval=100,
                    valid_sets=[train,train_test]
                  )
```

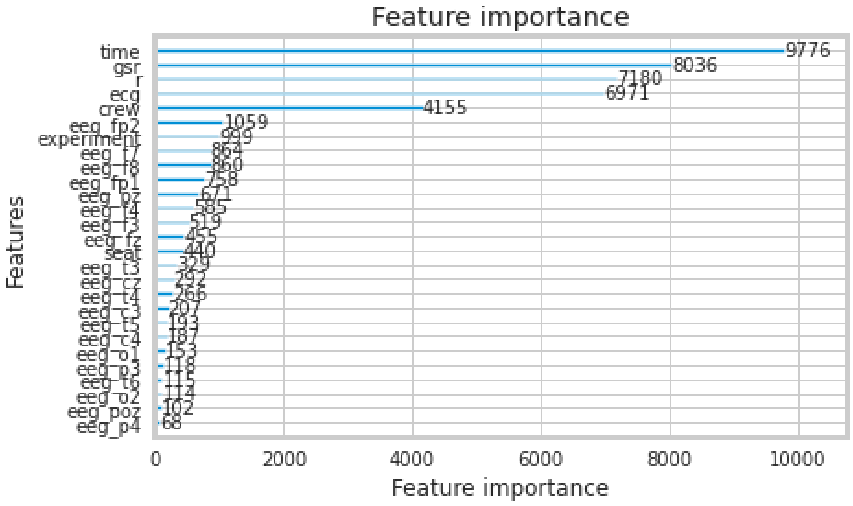
```
Training until validation scores don't improve for 200 rounds.
[100] training's multi_error: 0.0732298 valid_1's multi_error: 0.150007
[200] training's multi_error: 0.0513315 valid_1's multi_error: 0.0836788
[300] training's multi_error: 0.0446361 valid_1's multi_error: 0.0819834
[400] training's multi_error: 0.0376761 valid_1's multi_error: 0.0810803
[500] training's multi_error: 0.0339035 valid_1's multi_error: 0.0818256
Early stopping, best iteration is:
[392] training's multi_error: 0.0380341 valid_1's multi_error: 0.08098
```

In [ ]:

```
lgb.plot_importance(model)
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f5ba1e27470>
```



In [ ]:

```
lgb.create_tree_digraph(model)
```

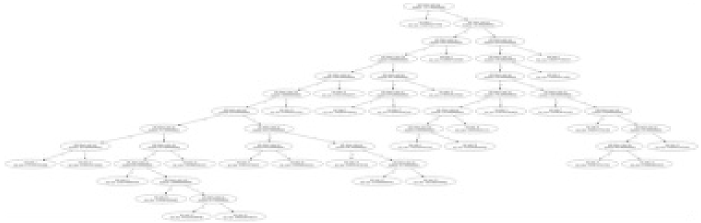
Out[ ]:

In [ ]:

```
lgb.plot_tree(model)
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f5b9dc9d128>
```



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=94731898
9803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%
3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=email%20https%3a%2f%2fwww.googleapis.co
m%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fww
w.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth
%2fpeopleapi.readonly

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(model,'Model_building_LGB(1).pkl')
```

Out[ ]:

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

In [ ]:

```
import joblib
model =joblib.load('Model_building_LGB(1).pkl')
```

In [ ]:

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

In [ ]:

```
!wget --header="Host: storage.googleapis.com" --header="User-Agent: Mozilla/5.0 (X11; Li
nux 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/ap
ng,*/*;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.googleapi
s.com/kaggle-competitions-data/kaggle-v2/11835/224935/compressed/test.csv.zip?GoogleAcces
sId=web-data@kaggle-161607.iam.gserviceaccount.com&Expires=1597062299&Signature=sSEFif%2B
viyz4WtNlQ0YoOIKIdFcDpMHNbPp6WC0PyglcoixHb3mbDv90BDKUgfaGHRdlNL5jZdlYFSKTabezCGvWs2GLuvwj
D5b2DyS61OXgv1zJDoEYiZSaw2P3oCCRjSJKQKv5GZeHEXa4go%2FpMg4jzDFh%2BCnTxCPdFeYntOBu%2F8NgEe7
ntcLUDvbtzn%2BwIrBuud1RDDVyBuv2fNTuzoQLgDvM2U%2B6NzaYZVzkEbxvGJRcieT7b0RxegoC3LRpl%2Bk0WP
Xo6Qy4qq7quVNix%2FjvkjPhXz2txIj27sGcn%2Bg%2FGP8OKCvWitUAPnry7ngQLMxwdhyMASE4iXIkRl4dGA%3D
%3D&response-content-disposition=attachment%3B+filename%3Dtest.csv.zip" -c -O 'test.csv.z
ip'
```

```
--2020-08-08 11:57:06--  https://storage.googleapis.com/kaggle-competitions-data/kaggle-v
2/11835/224935/compressed/test.csv.zip?GoogleAccessId=web-data@kaggle-161607.iam.gservice
account.com&Expires=1597062299&Signature=sSEFif%2Bviyz4WtNlQ0YoOIKIdFcDpMHNbPp6WC0Pyglcoi
xHb3mbDv90BDKUgfaGHRdlNL5jZdlYFSKTabezCGvWs2GLuvwjD5b2DyS61OXgv1zJDoEYiZSaw2P3oCCRjSJKQKv
5GZeHEXa4go%2FpMg4jzDFh%2BCnTxCPdFeYntOBu%2F8NgEe7ntcLUDvbtzn%2BwIrBuud1RDDVyBuv2fNTuzoQL
gDvM2U%2B6NzaYZVzkEbxvGJRcieT7b0RxegoC3LRpl%2Bk0WPXo6Qy4qq7quVNix%2FjvkjPhXz2txIj27sGcn%2
Bg%2FGP8OKCvWitUAPnry7ngQLMxwdhyMASE4iXIkRl4dGA%3D%3D&response-content-disposition=attach
ment%3B+filename%3Dtest.csv.zip
```

```
Resolving storage.googleapis.com (storage.googleapis.com)... 173.194.214.128, 173.194.215
.128, 173.194.216.128, ...
Connecting to storage.googleapis.com (storage.googleapis.com)|173.194.214.128|:443... con
nected.
HTTP request sent, awaiting response... 200 OK
Length: 1791131386 (1.7G) [application/zip]
Saving to: ‘test.csv.zip’

test.csv.zip        100%[===================>]   1.67G   135MB/s    in 14s

2020-08-08 11:57:20 (124 MB/s) - ‘test.csv.zip’ saved [1791131386/1791131386]
```

In [ ]:

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

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

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	-4.222
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 [ ]:

```
test.head()
```

Out[ ]:

	crew	experiment	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg_fp2
0	1	LOFT	0.000000	0	17.906250	6.128906	0.994629	-28.203125	-47.687500	-187.125000	-33.187500	-4.22265
1	1	LOFT	0.000000	1	45.875000	94.750000	23.296875	1.391602	2.060547	-5.144531	6.394531	33.40625

	crew	experiment	time	seat	eeg_fp1	eeg_f7	eeg_f8	eeg_t4	eeg_t6	eeg_t5	eeg_t3	eeg_fp2
2	1	LOFT	0.003906	0	33.125000	28.359375	-7.[illegible]	-7.[illegible]	-25.828125	-107.250000	12.843750	[illegible]
3	1	LOFT	0.003906	1	43.281250	95.875000	18.703125	-1.432617	-4.234375	-8.023438	7.425781	27.34375
4	1	LOFT	0.007812	0	7.929688	3.460938	-10.859375	-26.359375	-25.890625	37.000000	-50.343750	11.67968

In [ ]:

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

In [ ]:

```
y_pred = model.predict(test,num_iteration=model.best_iteration)
```

In [ ]:

```
y_pred
```

Out[ ]:

```
array([[0.97357333, 0.00215279, 0.02030727, 0.00396661],
       [0.96985874, 0.00287824, 0.02312566, 0.00413735],
       [0.97360533, 0.00219119, 0.02011564, 0.00408784],
       ...,
       [0.88274026, 0.00318973, 0.10606072, 0.00800928],
       [0.94154287, 0.00231302, 0.04893579, 0.00720831],
       [0.88331155, 0.00313693, 0.10554946, 0.00800207]])
```

In [ ]:

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

In [ ]:

```
import joblib
joblib.dump(y_pred,'Model_building5_LGB_output(1).pkl')
```

Out[ ]:

```
['Model_building5_LGB_output(1).pkl']
```

In [ ]:

```
import joblib
y_pred = joblib.load('/content/drive/My Drive/ML case study/results/Model_building5_LGB_output(1).pkl')
```

In [ ]:

```
y_pred
```

Out[ ]:

```
array([[0.97357333, 0.00215279, 0.02030727, 0.00396661],
       [0.96985874, 0.00287824, 0.02312566, 0.00413735],
       [0.97360533, 0.00219119, 0.02011564, 0.00408784],
       ...,
       [0.88274026, 0.00318973, 0.10606072, 0.00800928],
       [0.94154287, 0.00231302, 0.04893579, 0.00720831],
       [0.88331155, 0.00313693, 0.10554946, 0.00800207]])
```

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  0.973573  0.002153  0.020307  0.003967
1                1  0.969859  0.002878  0.023126  0.004137
2                2  0.973605  0.002191  0.020116  0.004088
3                3  0.969847  0.002912  0.023105  0.004136
4                4  0.974038  0.002179  0.019839  0.003944
...            ...       ...       ...       ...       ...
17965138  17965138  0.882729  0.003132  0.106111  0.008028
17965139  17965139  0.941786  0.002305  0.048648  0.007261
17965140  17965140  0.882740  0.003190  0.106061  0.008009
17965141  17965141  0.941543  0.002313  0.048936  0.007208
17965142  17965142  0.883312  0.003137  0.105549  0.008002

[17965143 rows x 5 columns]
```

Random Forest

In [ ]:

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import RandomizedSearchCV
param_dist = {"n_estimators":[1,5,10],
              "max_depth" : [200],
              "criterion" : ['entropy'],
              "random_state" : [40],
              "max_features" : ['auto'],
              }
rfc = RandomForestClassifier()
rsc = RandomizedSearchCV(rfc,param_dist,cv=2,verbose=500)
rsc.fit(X_train,y_train)
print("Tuned Decision Tree Parameters: {}".format(rsc.best_params_))
print("Best score is {}".format(rsc.best_score_))
```

In [ ]:

```
from sklearn.ensemble import RandomForestClassifier
from tqdm.auto import tqdm
n_estimators =  [10,25,50]
for i in tqdm(n_estimators):
  print('n_estimators are:',i)
  clf = RandomForestClassifier(n_estimators=i,max_depth=200,criterion='entropy')
  clf.fit(X_train,y_train)
  y_pred = clf.predict_proba(X_test)
  print('Log_loss is:',(log_loss(y_test,y_pred)))
```

```
n_estimators are: 10
Log_loss is: 0.043098855808167656
n_estimators are: 25
Log_loss is: 0.033084208336728135
n_estimators are: 50
Log_loss is: 0.03091853122729293
```

In [ ]:

```

```