In [1]:
```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
import os

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
import tensorflow as tf
from tensorflow import keras
from sklearn.decomposition import PCA
from sklearn.ensemble import StackingClassifier
from sklearn.model_selection import cross_val_score
from sklearn.metrics import log_loss
```

In [2]:
```python
os.getcwd()
```

Out[2]:
```
'C:\\Users\\robtu'
```

In [3]:
```python
os.chdir(r'C:\Users\robtu\Kaggle Competitions')
```

In [4]:
```python
train = pd.read_csv('train.csv')
test = pd.read_csv('test.csv')

test_ids = test['id']
test = test.drop(['id'],axis=1)
```

In [5]:
```python
le = LabelEncoder()
train.target = le.fit_transform(train.target)
features = train.columns[1:51]
train[features].head()
```

Out[5]:

	feature_0	feature_1	feature_2	feature_3	feature_4	feature_5	feature_6	feature_7	feature_8	feature_9	...	feature_40	feature_41	f
0	0	0	1	0	1	0	0	0	0	0	...	3	0	
1	0	0	0	0	2	1	0	0	0	0	...	0	0	
2	0	0	0	0	0	0	0	0	0	2	...	0	0	
3	0	0	0	0	0	0	0	3	0	0	...	0	0	
4	0	0	0	0	0	0	0	0	0	0	...	0	0	

5 rows × 50 columns

In [6]:
```python
#train.head()
```

In [7]:
```python
y_train = train['target']
X_train = train.drop(['target','id'], axis=1)
df = X_train.append(test)
```

In [5]:
```python
#df.info()
```

PCA Dimension Reduction

In [178]:
```python
pca = PCA(n_components = 45)

pca_trans = pca.fit_transform(df)
```

In [179]:
```python
pca_df = pd.DataFrame(data=pca_trans)
```

In [180]:
```python
X_train = pca_df[0:100000]
test = pca_df[100000:150000]
```

In [181]:
```python
X_train.head()
```

Out[181]:

	0	1	2	3	4	5	6	7	8	9	...	35	36
0	-3.005962	-1.635621	-2.561625	-0.639469	-0.885238	-1.176251	-0.682512	0.611503	-1.025236	-0.197477	...	-0.525330	-0.539287
1	-2.982253	-1.750327	-2.564989	-0.725127	-1.032808	-1.269029	-0.878316	1.152172	-1.561140	-1.233076	...	-0.374002	-0.448865
2	0.072336	-0.493942	-1.541736	-0.534115	-0.977030	-1.100344	-0.653076	-0.237646	-0.663316	1.529694	...	0.518562	0.543679
3	0.892799	-0.225742	4.462836	-0.651285	-1.032219	-1.348710	-0.881347	-0.435393	1.744973	-0.353929	...	-0.392054	-0.439311
4	-2.033965	-1.593626	-0.528681	-0.731055	-0.988482	-0.364498	-1.022103	-0.809601	-1.278326	-0.207429	...	-0.737722	-0.597776

5 rows × 45 columns

In [53]:
```python
X_train = df[0:100000]
test = df[100000:150000]
```

In [8]:
```python
X, X_test, y, y_test = train_test_split(X_train, y_train, test_size=0.33, random_state=42)
```

TensorFlow Model

In [60]:
```python
import tensorflow as tf
from tensorflow import keras
from sklearn.preprocessing import LabelEncoder
```

In [61]:
```python
encoder = LabelEncoder()
encoder.fit(y_train)
encoded_Y = encoder.transform(y_train)

dummy_y = tf.keras.utils.to_categorical(encoded_Y)
```

In [62]:
```python
X_train.shape
```

Out[62]:
```
(100000, 40)
```

In [63]:
```python
dummy_y.shape
```

Out[63]:
```
(100000, 4)
```

In [65]:
```python
X_tens = X_train.to_numpy()
test_tens = test.to_numpy()
```

In [66]:
```python
X_conv = X_tens.reshape(X_tens.shape[0],X_tens.shape[1],1)
test_conv = test_tens.reshape(test.shape[0],test.shape[1],1)
```

In [67]:
```python
X_conv.shape
```

Out[67]:
```
(100000, 40, 1)
```

In [68]:
```python
test_conv.shape
```

Out[68]:
```
(50000, 40, 1)
```

In [81]:
```python
model = keras.Sequential([

    keras.layers.Dense(25, activation='sigmoid', input_shape= (42,)),
    keras.layers.Dense(15, activation='sigmoid'),
    keras.layers.Dense(4, activation='sigmoid'),

   ])

model.compile(optimizer='Adam', loss='categorical_crossentropy', metrics=['accuracy'])

model.summary()
```

```
Model: "sequential_11"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
dense_44 (Dense)             (None, 25)                1075      
_________________________________________________________________
dense_45 (Dense)             (None, 15)                390       
_________________________________________________________________
dense_46 (Dense)             (None, 4)                 64        
=================================================================
Total params: 1,529
Trainable params: 1,529
Non-trainable params: 0
_________________________________________________________________
```

In [4]:
```python
#model2 = keras.Sequential([

    #keras.layers.Conv1D(filters=10, kernel_size=3,padding='same', activation='relu',input_shape=(40,
1)),
    #keras.layers.Dense(40, activation='relu'),
   # keras.layers.MaxPooling1D(),
   # keras.layers.Flatten(),
    #keras.layers.Dense(35,activation='relu'),
   # keras.layers.Dense(20,activation='relu'),
   # keras.layers.Dense(10,activation='relu'),
   # keras.layers.Dense(4,activation='softmax')

#])



#metrics = [tf.keras.metrics.CategoricalCrossentropy()]
#loss = tf.keras.losses.CategoricalCrossentropy(from_logits=False,label_smoothing=0,reduction="auto",na
me="categorical_crossentropy")

#model2.compile(optimizer='Adamax',loss=loss,metrics=metrics)

#model2.summary()
```

In [1]:
```python
#history = model.fit(X_tens, dummy_y, validation_split = 0.3, epochs=3, shuffle=True)
```

In [2]:
```python
 #history2 = model2.fit(X_conv, dummy_y, validation_split=0.3, epochs=15, shuffle=True)
```

In [354]:
```python
y_pred = model.predict(test)
```

In [104]:
```python
y_pred2 = model2.predict(test_conv)
```

In [105]:
```python
y_pred2.shape
```

Out[105]:
```
(50000, 4)
```

XGBoost Catboost and LightGBM Models

In [10]:
```python
import xgboost as xgb
from xgboost import plot_importance, XGBClassifier
from catboost import CatBoostClassifier, Pool
import lightgbm as lgb
from lightgbm import LGBMClassifier
```

In [15]:
```python
xgb_params = {
    'n_estimators':1000,
    'learning_rate':0.746463,
    'max_depth':1,
    'lambda':25.46112,
    'random_state':21,
    'objective':'multi:softprob',
    'eval_metric':'mlogloss',
}
```

In [16]:
```python
clf_xgb = xgb.XGBClassifier(**xgb_params)

clf_xgb.fit(X,
            y,
            verbose=True,
            ## the next three arguments set up early stopping.
            early_stopping_rounds=30,
            eval_metric=['mlogloss'],
            eval_set=[(X, y),(X_test, y_test)]
           )
```

```
[0]	validation_0-mlogloss:1.17006	validation_1-mlogloss:1.16744
Multiple eval metrics have been passed: 'validation_1-mlogloss' will be used for early stopping.

Will train until validation_1-mlogloss hasn't improved in 30 rounds.
[1]	validation_0-mlogloss:1.13045	validation_1-mlogloss:1.12621
[2]	validation_0-mlogloss:1.11958	validation_1-mlogloss:1.11438
[3]	validation_0-mlogloss:1.11594	validation_1-mlogloss:1.11034
[4]	validation_0-mlogloss:1.11414	validation_1-mlogloss:1.10808
[5]	validation_0-mlogloss:1.11303	validation_1-mlogloss:1.10704
[6]	validation_0-mlogloss:1.11212	validation_1-mlogloss:1.10633
[7]	validation_0-mlogloss:1.11133	validation_1-mlogloss:1.10564
[8]	validation_0-mlogloss:1.11062	validation_1-mlogloss:1.10494
[9]	validation_0-mlogloss:1.10992	validation_1-mlogloss:1.10430
[10]	validation_0-mlogloss:1.10924	validation_1-mlogloss:1.10368
[11]	validation_0-mlogloss:1.10859	validation_1-mlogloss:1.10310
[12]	validation_0-mlogloss:1.10797	validation_1-mlogloss:1.10267
[13]	validation_0-mlogloss:1.10737	validation_1-mlogloss:1.10224
[14]	validation_0-mlogloss:1.10679	validation_1-mlogloss:1.10157
[15]	validation_0-mlogloss:1.10622	validation_1-mlogloss:1.10106
[16]	validation_0-mlogloss:1.10568	validation_1-mlogloss:1.10047
[17]	validation_0-mlogloss:1.10520	validation_1-mlogloss:1.10006
[18]	validation_0-mlogloss:1.10476	validation_1-mlogloss:1.09957
[19]	validation_0-mlogloss:1.10435	validation_1-mlogloss:1.09924
[20]	validation_0-mlogloss:1.10391	validation_1-mlogloss:1.09872
[21]	validation_0-mlogloss:1.10351	validation_1-mlogloss:1.09854
[22]	validation_0-mlogloss:1.10312	validation_1-mlogloss:1.09826
[23]	validation_0-mlogloss:1.10279	validation_1-mlogloss:1.09799
[24]	validation_0-mlogloss:1.10242	validation_1-mlogloss:1.09759
[25]	validation_0-mlogloss:1.10206	validation_1-mlogloss:1.09744
[26]	validation_0-mlogloss:1.10171	validation_1-mlogloss:1.09728
[27]	validation_0-mlogloss:1.10140	validation_1-mlogloss:1.09685
[28]	validation_0-mlogloss:1.10110	validation_1-mlogloss:1.09664
[29]	validation_0-mlogloss:1.10080	validation_1-mlogloss:1.09640
[30]	validation_0-mlogloss:1.10051	validation_1-mlogloss:1.09613
[31]	validation_0-mlogloss:1.10024	validation_1-mlogloss:1.09582
[32]	validation_0-mlogloss:1.09997	validation_1-mlogloss:1.09558
[33]	validation_0-mlogloss:1.09972	validation_1-mlogloss:1.09551
[34]	validation_0-mlogloss:1.09947	validation_1-mlogloss:1.09535
[35]	validation_0-mlogloss:1.09924	validation_1-mlogloss:1.09513
[36]	validation_0-mlogloss:1.09901	validation_1-mlogloss:1.09503
[37]	validation_0-mlogloss:1.09881	validation_1-mlogloss:1.09484
[38]	validation_0-mlogloss:1.09856	validation_1-mlogloss:1.09476
[39]	validation_0-mlogloss:1.09835	validation_1-mlogloss:1.09451
[40]	validation_0-mlogloss:1.09815	validation_1-mlogloss:1.09429
[41]	validation_0-mlogloss:1.09795	validation_1-mlogloss:1.09418
[42]	validation_0-mlogloss:1.09775	validation_1-mlogloss:1.09396
[43]	validation_0-mlogloss:1.09756	validation_1-mlogloss:1.09378
[44]	validation_0-mlogloss:1.09738	validation_1-mlogloss:1.09360
[45]	validation_0-mlogloss:1.09720	validation_1-mlogloss:1.09347
[46]	validation_0-mlogloss:1.09702	validation_1-mlogloss:1.09330
[47]	validation_0-mlogloss:1.09685	validation_1-mlogloss:1.09321
[48]	validation_0-mlogloss:1.09668	validation_1-mlogloss:1.09302
[49]	validation_0-mlogloss:1.09652	validation_1-mlogloss:1.09287
[50]	validation_0-mlogloss:1.09635	validation_1-mlogloss:1.09273
[51]	validation_0-mlogloss:1.09621	validation_1-mlogloss:1.09257
[52]	validation_0-mlogloss:1.09606	validation_1-mlogloss:1.09246
[53]	validation_0-mlogloss:1.09591	validation_1-mlogloss:1.09244
[54]	validation_0-mlogloss:1.09577	validation_1-mlogloss:1.09234
[55]	validation_0-mlogloss:1.09562	validation_1-mlogloss:1.09216
[56]	validation_0-mlogloss:1.09548	validation_1-mlogloss:1.09215
[57]	validation_0-mlogloss:1.09535	validation_1-mlogloss:1.09215
[58]	validation_0-mlogloss:1.09522	validation_1-mlogloss:1.09195
[59]	validation_0-mlogloss:1.09508	validation_1-mlogloss:1.09188
[60]	validation_0-mlogloss:1.09495	validation_1-mlogloss:1.09174
[61]	validation_0-mlogloss:1.09482	validation_1-mlogloss:1.09163
[62]	validation_0-mlogloss:1.09469	validation_1-mlogloss:1.09152
[63]	validation_0-mlogloss:1.09457	validation_1-mlogloss:1.09146
[64]	validation_0-mlogloss:1.09444	validation_1-mlogloss:1.09140
[65]	validation_0-mlogloss:1.09432	validation_1-mlogloss:1.09130
[66]	validation_0-mlogloss:1.09421	validation_1-mlogloss:1.09126
[67]	validation_0-mlogloss:1.09410	validation_1-mlogloss:1.09112
[68]	validation_0-mlogloss:1.09398	validation_1-mlogloss:1.09100
[69]	validation_0-mlogloss:1.09387	validation_1-mlogloss:1.09098
[70]	validation_0-mlogloss:1.09376	validation_1-mlogloss:1.09094
[71]	validation_0-mlogloss:1.09366	validation_1-mlogloss:1.09091
[72]	validation_0-mlogloss:1.09355	validation_1-mlogloss:1.09083
[73]	validation_0-mlogloss:1.09346	validation_1-mlogloss:1.09071
[74]	validation_0-mlogloss:1.09336	validation_1-mlogloss:1.09065
[75]	validation_0-mlogloss:1.09326	validation_1-mlogloss:1.09067
[76]	validation_0-mlogloss:1.09316	validation_1-mlogloss:1.09061
[77]	validation_0-mlogloss:1.09307	validation_1-mlogloss:1.09059
[78]	validation_0-mlogloss:1.09298	validation_1-mlogloss:1.09055
[79]	validation_0-mlogloss:1.09288	validation_1-mlogloss:1.09044
[80]	validation_0-mlogloss:1.09280	validation_1-mlogloss:1.09045
[81]	validation_0-mlogloss:1.09272	validation_1-mlogloss:1.09044
[82]	validation_0-mlogloss:1.09263	validation_1-mlogloss:1.09040
[83]	validation_0-mlogloss:1.09255	validation_1-mlogloss:1.09033
[84]	validation_0-mlogloss:1.09247	validation_1-mlogloss:1.09024
[85]	validation_0-mlogloss:1.09239	validation_1-mlogloss:1.09015
[86]	validation_0-mlogloss:1.09231	validation_1-mlogloss:1.09009
[87]	validation_0-mlogloss:1.09223	validation_1-mlogloss:1.09004
[88]	validation_0-mlogloss:1.09215	validation_1-mlogloss:1.08995
[89]	validation_0-mlogloss:1.09207	validation_1-mlogloss:1.08984
[90]	validation_0-mlogloss:1.09200	validation_1-mlogloss:1.08981
[91]	validation_0-mlogloss:1.09193	validation_1-mlogloss:1.08976
[92]	validation_0-mlogloss:1.09185	validation_1-mlogloss:1.08973
[93]	validation_0-mlogloss:1.09178	validation_1-mlogloss:1.08964
[94]	validation_0-mlogloss:1.09171	validation_1-mlogloss:1.08963
[95]	validation_0-mlogloss:1.09164	validation_1-mlogloss:1.08957
[96]	validation_0-mlogloss:1.09157	validation_1-mlogloss:1.08961
[97]	validation_0-mlogloss:1.09151	validation_1-mlogloss:1.08960
[98]	validation_0-mlogloss:1.09144	validation_1-mlogloss:1.08954
[99]	validation_0-mlogloss:1.09138	validation_1-mlogloss:1.08953
[100]	validation_0-mlogloss:1.09131	validation_1-mlogloss:1.08953
[101]	validation_0-mlogloss:1.09125	validation_1-mlogloss:1.08957
[102]	validation_0-mlogloss:1.09118	validation_1-mlogloss:1.08952
[103]	validation_0-mlogloss:1.09112	validation_1-mlogloss:1.08951
[104]	validation_0-mlogloss:1.09106	validation_1-mlogloss:1.08946
[105]	validation_0-mlogloss:1.09100	validation_1-mlogloss:1.08946
[106]	validation_0-mlogloss:1.09094	validation_1-mlogloss:1.08935
[107]	validation_0-mlogloss:1.09088	validation_1-mlogloss:1.08927
[108]	validation_0-mlogloss:1.09082	validation_1-mlogloss:1.08922
[109]	validation_0-mlogloss:1.09076	validation_1-mlogloss:1.08914
[110]	validation_0-mlogloss:1.09069	validation_1-mlogloss:1.08918
[111]	validation_0-mlogloss:1.09064	validation_1-mlogloss:1.08909
[112]	validation_0-mlogloss:1.09058	validation_1-mlogloss:1.08905
[113]	validation_0-mlogloss:1.09052	validation_1-mlogloss:1.08906
[114]	validation_0-mlogloss:1.09046	validation_1-mlogloss:1.08899
[115]	validation_0-mlogloss:1.09040	validation_1-mlogloss:1.08897
[116]	validation_0-mlogloss:1.09034	validation_1-mlogloss:1.08891
[117]	validation_0-mlogloss:1.09029	validation_1-mlogloss:1.08888
[118]	validation_0-mlogloss:1.09023	validation_1-mlogloss:1.08890
[119]	validation_0-mlogloss:1.09018	validation_1-mlogloss:1.08889
[120]	validation_0-mlogloss:1.09013	validation_1-mlogloss:1.08882
[121]	validation_0-mlogloss:1.09007	validation_1-mlogloss:1.08883
[122]	validation_0-mlogloss:1.09002	validation_1-mlogloss:1.08882
[123]	validation_0-mlogloss:1.08997	validation_1-mlogloss:1.08880
[124]	validation_0-mlogloss:1.08992	validation_1-mlogloss:1.08876
[125]	validation_0-mlogloss:1.08987	validation_1-mlogloss:1.08875
[126]	validation_0-mlogloss:1.08982	validation_1-mlogloss:1.08871
[127]	validation_0-mlogloss:1.08977	validation_1-mlogloss:1.08867
[128]	validation_0-mlogloss:1.08972	validation_1-mlogloss:1.08868
[129]	validation_0-mlogloss:1.08967	validation_1-mlogloss:1.08872
[130]	validation_0-mlogloss:1.08963	validation_1-mlogloss:1.08868
[131]	validation_0-mlogloss:1.08958	validation_1-mlogloss:1.08866
[132]	validation_0-mlogloss:1.08954	validation_1-mlogloss:1.08865
[133]	validation_0-mlogloss:1.08949	validation_1-mlogloss:1.08865
[134]	validation_0-mlogloss:1.08945	validation_1-mlogloss:1.08858
[135]	validation_0-mlogloss:1.08940	validation_1-mlogloss:1.08858
[136]	validation_0-mlogloss:1.08936	validation_1-mlogloss:1.08862
[137]	validation_0-mlogloss:1.08931	validation_1-mlogloss:1.08860
[138]	validation_0-mlogloss:1.08927	validation_1-mlogloss:1.08860
[139]	validation_0-mlogloss:1.08922	validation_1-mlogloss:1.08855
[140]	validation_0-mlogloss:1.08918	validation_1-mlogloss:1.08853
[141]	validation_0-mlogloss:1.08914	validation_1-mlogloss:1.08854
[142]	validation_0-mlogloss:1.08909	validation_1-mlogloss:1.08857
[143]	validation_0-mlogloss:1.08905	validation_1-mlogloss:1.08857
[144]	validation_0-mlogloss:1.08901	validation_1-mlogloss:1.08853
[145]	validation_0-mlogloss:1.08897	validation_1-mlogloss:1.08848
[146]	validation_0-mlogloss:1.08893	validation_1-mlogloss:1.08846
[147]	validation_0-mlogloss:1.08889	validation_1-mlogloss:1.08847
[148]	validation_0-mlogloss:1.08885	validation_1-mlogloss:1.08842
[149]	validation_0-mlogloss:1.08881	validation_1-mlogloss:1.08839
[150]	validation_0-mlogloss:1.08876	validation_1-mlogloss:1.08836
[151]	validation_0-mlogloss:1.08872	validation_1-mlogloss:1.08836
[152]	validation_0-mlogloss:1.08868	validation_1-mlogloss:1.08835
[153]	validation_0-mlogloss:1.08864	validation_1-mlogloss:1.08834
[154]	validation_0-mlogloss:1.08860	validation_1-mlogloss:1.08831
[155]	validation_0-mlogloss:1.08857	validation_1-mlogloss:1.08834
[156]	validation_0-mlogloss:1.08852	validation_1-mlogloss:1.08830
[157]	validation_0-mlogloss:1.08848	validation_1-mlogloss:1.08832
[158]	validation_0-mlogloss:1.08845	validation_1-mlogloss:1.08827
[159]	validation_0-mlogloss:1.08841	validation_1-mlogloss:1.08827
[160]	validation_0-mlogloss:1.08837	validation_1-mlogloss:1.08826
[161]	validation_0-mlogloss:1.08833	validation_1-mlogloss:1.08824
[162]	validation_0-mlogloss:1.08830	validation_1-mlogloss:1.08824
[163]	validation_0-mlogloss:1.08826	validation_1-mlogloss:1.08817
[164]	validation_0-mlogloss:1.08822	validation_1-mlogloss:1.08824
[165]	validation_0-mlogloss:1.08819	validation_1-mlogloss:1.08818
[166]	validation_0-mlogloss:1.08815	validation_1-mlogloss:1.08815
[167]	validation_0-mlogloss:1.08812	validation_1-mlogloss:1.08815
[168]	validation_0-mlogloss:1.08808	validation_1-mlogloss:1.08810
[169]	validation_0-mlogloss:1.08805	validation_1-mlogloss:1.08810
[170]	validation_0-mlogloss:1.08801	validation_1-mlogloss:1.08809
[171]	validation_0-mlogloss:1.08798	validation_1-mlogloss:1.08808
[172]	validation_0-mlogloss:1.08794	validation_1-mlogloss:1.08809
[173]	validation_0-mlogloss:1.08790	validation_1-mlogloss:1.08803
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[177]	validation_0-mlogloss:1.08777	validation_1-mlogloss:1.08796
[178]	validation_0-mlogloss:1.08773	validation_1-mlogloss:1.08794
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[184]	validation_0-mlogloss:1.08754	validation_1-mlogloss:1.08786
[185]	validation_0-mlogloss:1.08751	validation_1-mlogloss:1.08786
[186]	validation_0-mlogloss:1.08748	validation_1-mlogloss:1.08784
[187]	validation_0-mlogloss:1.08745	validation_1-mlogloss:1.08782
[188]	validation_0-mlogloss:1.08742	validation_1-mlogloss:1.08786
[189]	validation_0-mlogloss:1.08739	validation_1-mlogloss:1.08788
[190]	validation_0-mlogloss:1.08736	validation_1-mlogloss:1.08788
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[196]	validation_0-mlogloss:1.08718	validation_1-mlogloss:1.08773
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[198]	validation_0-mlogloss:1.08712	validation_1-mlogloss:1.08773
[199]	validation_0-mlogloss:1.08709	validation_1-mlogloss:1.08772
[200]	validation_0-mlogloss:1.08706	validation_1-mlogloss:1.08771
[201]	validation_0-mlogloss:1.08703	validation_1-mlogloss:1.08770
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[203]	validation_0-mlogloss:1.08698	validation_1-mlogloss:1.08771
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[213]	validation_0-mlogloss:1.08671	validation_1-mlogloss:1.08755
[214]	validation_0-mlogloss:1.08668	validation_1-mlogloss:1.08755
[215]	validation_0-mlogloss:1.08666	validation_1-mlogloss:1.08752
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[220]	validation_0-mlogloss:1.08653	validation_1-mlogloss:1.08753
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[236]	validation_0-mlogloss:1.08613	validation_1-mlogloss:1.08739
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[255]	validation_0-mlogloss:1.08570	validation_1-mlogloss:1.08733
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[269]	validation_0-mlogloss:1.08540	validation_1-mlogloss:1.08733
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[271]	validation_0-mlogloss:1.08536	validation_1-mlogloss:1.08727
[272]	validation_0-mlogloss:1.08534	validation_1-mlogloss:1.08727
[273]	validation_0-mlogloss:1.08532	validation_1-mlogloss:1.08727
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[275]	validation_0-mlogloss:1.08528	validation_1-mlogloss:1.08728
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[283]	validation_0-mlogloss:1.08513	validation_1-mlogloss:1.08730
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[285]	validation_0-mlogloss:1.08509	validation_1-mlogloss:1.08727
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[299]	validation_0-mlogloss:1.08483	validation_1-mlogloss:1.08721
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[302]	validation_0-mlogloss:1.08478	validation_1-mlogloss:1.08715
[303]	validation_0-mlogloss:1.08476	validation_1-mlogloss:1.08715
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[308]	validation_0-mlogloss:1.08468	validation_1-mlogloss:1.08716
[309]	validation_0-mlogloss:1.08466	validation_1-mlogloss:1.08714
[310]	validation_0-mlogloss:1.08464	validation_1-mlogloss:1.08713
[311]	validation_0-mlogloss:1.08463	validation_1-mlogloss:1.08712
[312]	validation_0-mlogloss:1.08461	validation_1-mlogloss:1.08711
[313]	validation_0-mlogloss:1.08459	validation_1-mlogloss:1.08710
[314]	validation_0-mlogloss:1.08458	validation_1-mlogloss:1.08709
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[316]	validation_0-mlogloss:1.08454	validation_1-mlogloss:1.08710
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[320]	validation_0-mlogloss:1.08448	validation_1-mlogloss:1.08709
[321]	validation_0-mlogloss:1.08446	validation_1-mlogloss:1.08707
[322]	validation_0-mlogloss:1.08445	validation_1-mlogloss:1.08709
[323]	validation_0-mlogloss:1.08443	validation_1-mlogloss:1.08710
[324]	validation_0-mlogloss:1.08441	validation_1-mlogloss:1.08708
[325]	validation_0-mlogloss:1.08439	validation_1-mlogloss:1.08711
[326]	validation_0-mlogloss:1.08438	validation_1-mlogloss:1.08714
[327]	validation_0-mlogloss:1.08436	validation_1-mlogloss:1.08715
[328]	validation_0-mlogloss:1.08435	validation_1-mlogloss:1.08713
[329]	validation_0-mlogloss:1.08433	validation_1-mlogloss:1.08710
[330]	validation_0-mlogloss:1.08432	validation_1-mlogloss:1.08712
[331]	validation_0-mlogloss:1.08430	validation_1-mlogloss:1.08711
[332]	validation_0-mlogloss:1.08428	validation_1-mlogloss:1.08713
[333]	validation_0-mlogloss:1.08427	validation_1-mlogloss:1.08714
[334]	validation_0-mlogloss:1.08425	validation_1-mlogloss:1.08713
[335]	validation_0-mlogloss:1.08424	validation_1-mlogloss:1.08712
[336]	validation_0-mlogloss:1.08422	validation_1-mlogloss:1.08713
[337]	validation_0-mlogloss:1.08420	validation_1-mlogloss:1.08711
[338]	validation_0-mlogloss:1.08419	validation_1-mlogloss:1.08711
[339]	validation_0-mlogloss:1.08417	validation_1-mlogloss:1.08710
[340]	validation_0-mlogloss:1.08416	validation_1-mlogloss:1.08710
[341]	validation_0-mlogloss:1.08414	validation_1-mlogloss:1.08709
[342]	validation_0-mlogloss:1.08413	validation_1-mlogloss:1.08710
[343]	validation_0-mlogloss:1.08411	validation_1-mlogloss:1.08707
[344]	validation_0-mlogloss:1.08410	validation_1-mlogloss:1.08708
[345]	validation_0-mlogloss:1.08408	validation_1-mlogloss:1.08708
[346]	validation_0-mlogloss:1.08407	validation_1-mlogloss:1.08707
[347]	validation_0-mlogloss:1.08405	validation_1-mlogloss:1.08708
[348]	validation_0-mlogloss:1.08404	validation_1-mlogloss:1.08708
[349]	validation_0-mlogloss:1.08403	validation_1-mlogloss:1.08710
[350]	validation_0-mlogloss:1.08401	validation_1-mlogloss:1.08714
[351]	validation_0-mlogloss:1.08400	validation_1-mlogloss:1.08712
Stopping. Best iteration:
[321]	validation_0-mlogloss:1.08446	validation_1-mlogloss:1.08707
```

Out[16]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=1, eval_metric='mlogloss',
              gamma=0, gpu_id=-1, importance_type='gain',
              interaction_constraints='', lambda=25.46112,
              learning_rate=0.746463, max_delta_step=0, max_depth=1,
              min_child_weight=1, missing=nan, monotone_constraints='()',
              n_estimators=1000, n_jobs=0, num_parallel_tree=1,
              objective='multi:softprob', random_state=21, reg_alpha=0,
              reg_lambda=25.4611206, scale_pos_weight=None, subsample=1,
              tree_method='exact', validate_parameters=1, verbosity=None)
```

In [17]:
```python
X.shape
```

Out[17]:
```
(67000, 50)
```

In [11]:
```python
train_pool = Pool(data=X, label=y)
test_pool = Pool(data=X_test, label=y_test.values)
```

In [12]:
```python
params_cb = {
    'n_estimators' : 9000,
    'od_wait' : 300,
    'loss_function': 'MultiClass',
    'eval_metric': 'MultiClass',
    'learning_rate' : 0.0165847,
    'reg_lambda': 17.7924786,
    'subsample': 0.537623 ,
    'depth': 2,
    'min_data_in_leaf': 19,
    'verbose':False,
    'bootstrap_type': 'Bernoulli',
    'random_state' :42,
    'leaf_estimation_method':'Newton',
}

params_cb2 = {
    'iterations': 17000,
    'learning_rate': 0.01,
    'depth': 4,
    'loss_function':'MultiClass',
    'od_wait': 1000,
    'od_type' : 'Iter',
    'min_data_in_leaf' : 1,
    'max_ctr_complexity': 15,

}
```

In [13]:
```python
catmod = CatBoostClassifier(**params_cb)


catmod.fit(train_pool,verbose=1100,plot=True,eval_set=test_pool)
```

```
0:	learn: 1.3764564	test: 1.3763699 best: 1.3763699 (0)	total: 154ms	remaining: 23
m 4s
1100:	learn: 1.0999140	test: 1.0953577 best: 1.0953577 (1100)	total: 42.5s	remaining: 5m
4s
2200:	learn: 1.0931169	test: 1.0906799 best: 1.0906799 (2200)	total: 1m 26s	remaining: 4m
27s
3300:	learn: 1.0894625	test: 1.0889359 best: 1.0889359 (3300)	total: 2m 14s	remaining: 3m
52s
4400:	learn: 1.0869065	test: 1.0880714 best: 1.0880697 (4396)	total: 3m 5s	remaining: 3m
14s
5500:	learn: 1.0848732	test: 1.0875711 best: 1.0875711 (5500)	total: 4m 1s	remaining: 2m
33s
6600:	learn: 1.0831345	test: 1.0872284 best: 1.0872284 (6600)	total: 5m 6s	remaining: 1m
51s
7700:	learn: 1.0816585	test: 1.0870227 best: 1.0870219 (7698)	total: 6m 6s	remaining: 1m
1s
8800:	learn: 1.0802442	test: 1.0869398 best: 1.0869363 (8779)	total: 7m 10s	remaining: 9.
74s
8999:	learn: 1.0800280	test: 1.0869222 best: 1.0869194 (8963)	total: 7m 22s	remaining: 0u
s

bestTest = 1.086919352
bestIteration = 8963

Shrink model to first 8964 iterations.
```

Out[13]:
```
<catboost.core.CatBoostClassifier at 0x25b486d6370>
```

In [14]:
```python
cat_pred1 = catmod.predict_proba(X_test)
cat_pred2 = np.clip(cat_pred1, 0.08, 0.95)
log_loss(y_test,cat_pred2)
```

Out[14]:
```
1.0866426451546274
```

In [22]:
```python
params_lgbm = {
    'learning_rate': 0.03602375,
    'max_depth': 2,
    'min_child_samples':61,
    'min_child_weight' : 0.2569581,
    'metric': 'multi_logloss',
    'random_state': 42,
    'n_estimators': 10000,
    'objective': 'multiclass',
}
```

In [23]:

```python
lgbmod = lgb.LGBMClassifier(**params_lgbm)


lgbmod.fit(
            X,
            y,
            eval_set=[(X_test, y_test)],
            early_stopping_rounds=500,
            verbose=True)
```

```
[1]	valid_0's multi_logloss: 1.1139
Training until validation scores don't improve for 500 rounds
[2]	valid_0's multi_logloss: 1.1136
[3]	valid_0's multi_logloss: 1.11332
[4]	valid_0's multi_logloss: 1.11307
[5]	valid_0's multi_logloss: 1.11279
[6]	valid_0's multi_logloss: 1.11254
[7]	valid_0's multi_logloss: 1.1123
[8]	valid_0's multi_logloss: 1.11206
[9]	valid_0's multi_logloss: 1.11184
[10]	valid_0's multi_logloss: 1.11163
[11]	valid_0's multi_logloss: 1.11141
[12]	valid_0's multi_logloss: 1.11125
[13]	valid_0's multi_logloss: 1.11105
[14]	valid_0's multi_logloss: 1.11089
[15]	valid_0's multi_logloss: 1.11071
[16]	valid_0's multi_logloss: 1.11054
[17]	valid_0's multi_logloss: 1.11039
[18]	valid_0's multi_logloss: 1.11021
[19]	valid_0's multi_logloss: 1.11004
[20]	valid_0's multi_logloss: 1.1099
[21]	valid_0's multi_logloss: 1.10974
[22]	valid_0's multi_logloss: 1.10959
[23]	valid_0's multi_logloss: 1.10946
[24]	valid_0's multi_logloss: 1.1093
[25]	valid_0's multi_logloss: 1.10916
[26]	valid_0's multi_logloss: 1.10901
[27]	valid_0's multi_logloss: 1.10889
[28]	valid_0's multi_logloss: 1.10875
[29]	valid_0's multi_logloss: 1.10861
[30]	valid_0's multi_logloss: 1.1085
[31]	valid_0's multi_logloss: 1.10838
[32]	valid_0's multi_logloss: 1.10825
[33]	valid_0's multi_logloss: 1.10812
[34]	valid_0's multi_logloss: 1.10802
[35]	valid_0's multi_logloss: 1.1079
[36]	valid_0's multi_logloss: 1.10779
[37]	valid_0's multi_logloss: 1.10767
[38]	valid_0's multi_logloss: 1.10755
[39]	valid_0's multi_logloss: 1.10744
[40]	valid_0's multi_logloss: 1.10733
[41]	valid_0's multi_logloss: 1.10722
[42]	valid_0's multi_logloss: 1.10713
[43]	valid_0's multi_logloss: 1.10703
[44]	valid_0's multi_logloss: 1.10693
[45]	valid_0's multi_logloss: 1.10684
[46]	valid_0's multi_logloss: 1.10673
[47]	valid_0's multi_logloss: 1.10664
[48]	valid_0's multi_logloss: 1.10653
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[1746]	valid_0's multi_logloss: 1.08935
[1747]	valid_0's multi_logloss: 1.08935
[1748]	valid_0's multi_logloss: 1.08935
[1749]	valid_0's multi_logloss: 1.08936
[1750]	valid_0's multi_logloss: 1.08936
[1751]	valid_0's multi_logloss: 1.08936
[1752]	valid_0's multi_logloss: 1.08935
[1753]	valid_0's multi_logloss: 1.08936
[1754]	valid_0's multi_logloss: 1.08936
[1755]	valid_0's multi_logloss: 1.08936
[1756]	valid_0's multi_logloss: 1.08937
[1757]	valid_0's multi_logloss: 1.08937
[1758]	valid_0's multi_logloss: 1.08937
[1759]	valid_0's multi_logloss: 1.08938
[1760]	valid_0's multi_logloss: 1.08938
Early stopping, best iteration is:
[1260]	valid_0's multi_logloss: 1.08913
```

Out[23]:
```
LGBMClassifier(learning_rate=0.03602375, max_depth=2, metric='multi_logloss',
               min_child_samples=61, min_child_weight=0.2569581,
               n_estimators=10000, objective='multiclass', random_state=42)
```

In [ ]:

In [18]:
```python
cat_predictions = catmod.predict_proba(test)
cat_predictions2 = np.clip(cat_predictions, 0.08, 0.95)
```

In [172]:
```python
predictions = clf_xgb.predict_proba(X_test)
log_loss(y_test,predictions)
```

Out[172]: 1.1031687413697893

Stacking Classifier

In [24]:
```python
estimators = [('lgbm',LGBMClassifier(**params_lgbm)),('cb',CatBoostClassifier(**params_cb)),('xgb',XGBC
lassifier(**xgb_params))]

stack_mod = StackingClassifier(

        estimators=estimators,
        final_estimator=LGBMClassifier(),
        stack_method='predict_proba',
        n_jobs=-1
)
```

In [3]:
```python
#stack_mod.fit(X,y)

#val = stack_mod.predict_proba(X_test)
#log_loss(y_test,val)
```

In [38]:
```python
stack_pred = stack_mod.predict_proba(test)
```

In [39]:
```python
df_results = pd.DataFrame({'id':test_ids, 'Class_1':stack_pred.T[0], 'Class_2':stack_pred.T[1], 'Class_
3':stack_pred.T[2] ,'Class_4':stack_pred.T[3]})
df_results.head()
```

Out[39]:

	id	Class_1	Class_2	Class_3	Class_4
0	100000	0.085952	0.670329	0.134068	0.109651
1	100001	0.080222	0.694170	0.142469	0.083140
2	100002	0.083926	0.654409	0.166994	0.094671
3	100003	0.083803	0.494589	0.346344	0.075264
4	100004	0.065206	0.713176	0.123030	0.098587

In [19]:
```python
df_results2 = pd.DataFrame({'id':test_ids, 'Class_1':cat_predictions2.T[0], 'Class_2':cat_predictions2.
T[1], 'Class_3':cat_predictions2.T[2] ,'Class_4':cat_predictions2.T[3]})
df_results2.head()
```

Out[19]:

	id	Class_1	Class_2	Class_3	Class_4
0	100000	0.092863	0.638704	0.144634	0.123800
1	100001	0.080000	0.706920	0.130900	0.084291
2	100002	0.092345	0.630468	0.183383	0.093804
3	100003	0.097111	0.536670	0.276161	0.090058
4	100004	0.080000	0.604472	0.186167	0.130002

In [21]:
```python
compression_opts = dict(method='zip',
                        archive_name='results24.csv')

df_results2.to_csv('results24.zip', index=False,
          compression=compression_opts)
```