Tick数据预测报告

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一、模型选取

最开始我选取的是深度学习模型（受到给的示例模型结构的启发，构造了一个DeformConv+ResNeSt网络），但是发现最终的结果不尽人意。一是步子迈的太大，改动太多，并不能掌握每一步的改变是否带来了正向的作用；二是训练的过程中，执着于降低loss，没有考虑到本问题的实际需求（实际上是

需要尽可能的让class0和class2之间的交错减小，至于class1，错判的影响较小），以及数据的实际情况（信噪比低，本身就很难拟合到非常好的水平），用torch封装好的交叉熵损失函数可能效果不好，需要自己重新写一个损失函数，以及在训练的过程中，不能执着于降低loss。

受限于单卡训练的速度问题，可能无法在规定时间内一步一步的研究探索。于是我果断换了模型，采用了xgboost模型。选择的理由有二：

1. 树模型对数据的Scale不敏感，不需要进行较为麻烦的尺度变换预处理
2. 方便用之前探索过程中处理好了的数据

于是最后我选取了 `xgboost` 模型

二、特征构造&数据处理

(1)特征构造

初始输入的矩阵为100*24的矩阵，列为：

```
"feature":[
        "time",
        "close",
        "amount_delta",
        "n_midprice",
        "n_bid1", "n_bsize1", "n_bid2", "n_bsize2", "n_bid3", "n_bsize3", "n_bid4", "n
        "n_ask1", "n_asize1", "n_ask2", "n_asize2", "n_ask3", "n_asize3", "n_ask4", "n
    ],
```

我对此新构造了一些特征，以下将较为详细的列出

①时间特征

```
# time
df['time'] = df['time'].apply(lambda x: int(x.split(':')[0])*3600+int(x.split(':')[1])

df['time_interval'] = df['time'].apply(lambda x: 0 if x<37800 else 1 if x<39600 else 2
```

- `time` :转变为以秒为单位的数
- `time_interval` :我认为，加上时间段的分层，可能对模型理解不同时间段的交易特点更加有利。因此我加入了对时间均匀分层量化(量化间隔为30min)的结果，映射到{0,1,2,3,4,5,6,7}

②量价组合

以下为伪代码，i取1~5~或1~3~

```
# price&size
df['spread_{i}']=df['n_ask{i}']-df['n_bid{i}']

df['mid_price{i}']=(df['n_ask{i}']+df['n_bid{i}'])/2

df['relative_bid-density{i}']=df['n_bsize{i}']/(df['n_bsize{i}']+df['n_asize{i}'])
df['relative_ask-density{i}']=df['n_asize{i}']/(df['n_bsize{i}']+df['n_asize{i}'])

df['weighted_ab{i}']=(df['n_bid{i}']*df['n_asize{i}']+df['n_ask{i}']*df['n_bsize{i}'])

df['vol1_rel_diff']=(df['n_bsize1']-df['n_asize1'])/(df['n_bsize1']+df['n_asize1'])
df['vol3_rel_diff']=(df['n_bsize1']+df['n_bsize2']+df['n_bsize3']-df['n_asize1']-df['n
df['vol5_rel_diff']=(df['n_bsize1']+df['n_bsize2']+df['n_bsize3']+df['n_bsize4']+df['n

df['amount']=df['amount_delta'].map(np.log1p)

# size to log
df['n_bsize{i}'] = df['n_bsize{i}'].map(np.log1p)
df['n_asize{i}'] = df['n_asize{i}'].map(np.log1p)
```

- `mid_price` :计算买i卖i的中间价。我认为这个有利于模型根据股价区间，判断这只股票是低价股还是高价股，更好的判断风格。同时也为后面的滑动平均滤波器做预处理
- `relative_bid-density` / `relative_ask-density` :i级买/卖单的相对密度，判断哪边占有优势，占有优势的一方将会向反方向挤压price。
- `weighted_ab` :获得加权价格，这个价格综合考虑了买卖双方的力量，更能体现当前的真实'mid_price'
- `vol{num}_rel_diff` :在量的衡量下获得买卖的相对差异
- `amount` :虽然树模型对尺度不敏感，但是浮点数有精度问题，还是对数转换一下
- `n_bsize` / `n_asize` :同上。

③前项差分

以下为伪代码，i取1~5~或1~3~

```
df['close_delta1']=df['close'].diff()

df['n_bid{i}_delta1']=df['n_bid1'].diff()
df['n_ask{i}_delta1']=df['n_bid1'].diff()

df['mid_price_delta{i}']=df['mid_price{i}'].diff()

df['n_bsize{i}_diff'] = df['n_bsize1'].diff()
df['n_asize{i}_diff'] = df['n_bsize1'].diff()
```

计算前项差分

④mean&std

```
df['close_mean']=df['close'].rolling(window=10).mean()
df['close_std']=df['close'].rolling(window=10).std()
df['close_vs_mean']=df['close']/df['close_mean']

df['n_bid{i}_mean']=df['n_bid{i}'].rolling(window=10).mean()
df['n_ask{i}_mean']=df['n_ask{i}'].rolling(window=10).mean()
df['n_bid{i}_vs_mean']=df['n_bid{i}']/df['n_bid{i}_mean']
df['n_ask{i}_vs_mean']=df['n_ask{i}']/df['n_bid{i}_mean']
df['n_bid{i}_std']=df['n_bid{i}'].rolling(window=10).std()
df['n_ask{i}_std']=df['n_ask{i}'].rolling(window=10).std()

df['n_bsize{i}_mean'] = df['n_bsize{i}'].rolling(window=10).mean()
df['n_asize{i}_mean'] = df['n_asize{i}'].rolling(window=10).mean()
df['n_bsize{i}_std'] = df['n_bsize{i}'].rolling(window=10).std()
df['n_asize{i}_std'] = df['n_asize{i}'].rolling(window=10).std()
df['n_bsize{i}_vs_mean'] = df['n_bsize{i}'] / df['n_bsize{i}_mean']
df['n_asize{i}_vs_mean'] = df['n_asize{i}'] / df['n_asize{i}_mean']

df['mid_price{i}_mean']=df['mid_price{i}'].rolling(window=10).mean()
df['mid_price{i}_std']=df['mid_price{i}'].rolling(window=10).mean()
```

- `mean` :窗口为10的滑动平均滤波器，让数据更加平滑，减小噪声
- `std` :判断每一时刻，对应指标的波动程度
- `_vs_mean` :用自身值比上滑动平均滤波器的输出，这个比值能判断当前的值偏离预期值的程度，并且有方向的(通过<1或>1判断)

⑤fft

尝试加入了对数据序列的100点fft，获取频域幅度和相位。但是可能是由于100个tick的时间窗口较短，周期性质不明显。因此去除了fft的结果。

(2)数据处理

①异常值处理

在构造特征之后，直接去除撤单的行，包含无穷、空值的行。处理后重新存储为csv文件。

②划分数据集

我采取的是8:2划分，划分是对每一只股票操作的，也就是每只股票按照日期排序，前0.8的为训练集（大约为79*0.8天），剩下的则是测试集。

③滑动取样&迭代器

滑动窗口取样前，数据量是不大的，完全可以放入内存。但是滑动取样后，数据相当于扩大了接近100倍，难以放入内存。我在此根据xgboost官网写了一个迭代器，建立外部储存映射文件（当然这个文件很大），以便后续的训练。

三、训练

训练根据xgboost给的接口，当100次迭代内，训练集或验证集的均方误差没有得到优化就会停止训练。我训练过程调节的参数只有树的深度，最终选取的是6。

在附录1展示了训练日志

四、降低recall

```
def get_predict(y, ratio):
    y=np.array(y)
    y[:,0]=y[:,0]*ratio[0]
    y[:,2]=y[:,2]*ratio[1]
    return np.argmax(y,axis=1)
```

给0和2的类的得分乘一个小于等于1的系数，使得模型对于0和2的判断更加谨慎

五、结果

最终公榜结果如下

450	Team06	0.813197…	0.020322…	0.092378…	4.464147…	0.001465…	label5
450	Team06	0.775086…	0.011927…	0.056177…	4.645900…	0.001786…	label10
450	Team06	0.654450…	0.016687…	0.075715…	7.378713…	0.002033…	label20
450	Team06	0.621317…	0.014138…	0.064792…	8.632402…	0.001941…	label40

私榜结果如下

label5

Team06	0.821122…	0.01852…	0.08494…	3.36849…	0.00160…

label10

Team06	0.789731…	0.009947…	0.047351…	3.804698…	0.002325…

label20

Team06	0.715611…	0.025783…	0.112676…	8.882055…	0.002424…

label40

Team06	0.673591…	0.024895…	0.108442…	11.93154…	0.002233…

六、分析

(1)对我训练出的模型分析

以下是未调参时各个label的训练集和验证集的分类报告。不难发现，其实模型在训练集上的表现并没有幻想中的那么好（六个80%~90%的水平）。我觉得这是金融数据信噪比低的体现。

同时可以发现，间隔的时间越长，预测的效果就越差（这点也在公榜和私榜的结果中可以看出）

label5

```
train:

              precision    recall  f1-score   support

         0.0     0.6819    0.4070    0.5097    346214
         1.0     0.8069    0.9407    0.8686   1606231
         2.0     0.6815    0.4313    0.5283    345345

    accuracy                         0.7837   2297790
   macro avg     0.7234    0.5930    0.6356   2297790
weighted avg     0.7692    0.7837    0.7634   2297790

[[ 140915  184569   20730]
 [  46439 1510925   48867]
 [  19311  177092  148942]]

val:

[1.0, 1.0] test done
              precision    recall  f1-score   support

         0.0     0.5499    0.2855    0.3759     87474
         1.0     0.7817    0.9277    0.8484    419619
         2.0     0.5481    0.3096    0.3957     83496

    accuracy                         0.7452    590589
   macro avg     0.6266    0.5076    0.5400    590589
weighted avg     0.7143    0.7452    0.7144    590589

[[ 24976  56495   6003]
 [ 15031 389273  15315]
 [  5409  52236  25851]]
0 accu:0.8219845318413691
2 accu:0.8115464305895649
```

label10

```
train:

              precision    recall  f1-score   support

         0.0     0.6477    0.4946    0.5609    486284
         1.0     0.7522    0.8752    0.8090   1335314
         2.0     0.6469    0.5064    0.5681    476192

    accuracy                         0.7182   2297790
   macro avg     0.6823    0.6254    0.6460   2297790
weighted avg     0.7082    0.7182    0.7066   2297790

[[ 240538  196957   48789]
 [  83910 1168603   82801]
 [  46948  188118  241126]]

val:

[1.0, 1.0] test done
              precision    recall  f1-score   support

         0.0     0.5347    0.3621    0.4318    125770
         1.0     0.7020    0.8521    0.7698    348092
         2.0     0.5228    0.3714    0.4343    116727

    accuracy                         0.6527    590589
   macro avg     0.5865    0.5285    0.5453    590589
weighted avg     0.6310    0.6527    0.6315    590589

[[ 45540  65897  14333]
 [ 26252 296598  25242]
 [ 13384  59993  43350]]
0 accu:0.7728599551965243
2 accu:0.7515212454275957
```

label20

```
train:

              precision    recall  f1-score   support

         0.0     0.6612    0.3556    0.4625    390223
         1.0     0.7611    0.9367    0.8398   1521694
         2.0     0.6569    0.3662    0.4702    385873

    accuracy                         0.7422   2297790
   macro avg     0.6931    0.5528    0.5909   2297790
weighted avg     0.7266    0.7422    0.7137   2297790

[[ 138770  226266   25187]
 [  47650 1425425   48619]
 [  23458  221111  141304]]

val:
[1.0, 1.0] test done
              precision    recall  f1-score   support

         0.0     0.4941    0.1864    0.2707    101205
         1.0     0.7146    0.9296    0.8080    395378
         2.0     0.4923    0.1992    0.2837     94006

    accuracy                         0.6860    590589
   macro avg     0.5670    0.4384    0.4541    590589
weighted avg     0.6414    0.6860    0.6325    590589

[[ 18863  76803   5539]
 [ 14058 367549  13771]
 [  5259  70019  18728]]
0 accu:0.7819832518033331
2 accu:0.7717476408291095
```

label40

```
train:

              precision    recall  f1-score   support

         0.0     0.5975    0.4273    0.4982    557065
         1.0     0.6714    0.8602    0.7542   1204088
         2.0     0.6003    0.3990    0.4793    536637

    accuracy                         0.6475   2297790
   macro avg     0.6230    0.5622    0.5773   2297790
weighted avg     0.6369    0.6475    0.6279   2297790

[[ 238018  255956   63091]
 [  88798 1035810   79480]
 [  71556  250985  214096]]

val:

[1.0, 1.0] test done
              precision    recall  f1-score   support

         0.0     0.4572    0.2623    0.3334    146937
         1.0     0.5984    0.8291    0.6951    312274
         2.0     0.4367    0.2445    0.3135    131378

    accuracy                         0.5581    590589
   macro avg     0.4974    0.4453    0.4473    590589
weighted avg     0.5273    0.5581    0.5202    590589

[[ 38547  91658  16732]
 [ 28650 258913  24711]
 [ 17117  82133  32128]]
0 accu:0.6924942512216155
2 accu:0.6575521899304134
```

(2)不足与改进

后续需要改进的点有：

1. 参数的优化调整。我在此只调节了一个参数(depth)。其他参数也会带来影响，后续的改进可以做网格进行调参。

2. 理论转实践。实践中可能会有专门的大内存计算集群，可以先拿更多的数据训练一个模型，然后随着时间的推移，将新的数据对模型进行增量训练。
3. 特征的筛选。我构造的特征中，可能有些并没有对模型起到正向作用或者作用很少。处于模型的效果和效率，可以通过特征序列的自相关性来筛选下。
4. 滑动平均滤波器的窗口长度的选取。对于100个tick的窗口，在此主观的选取10，可能有运气的成分。对于其他长度的tick，或者就当前的100个tick，就有可能有更好的滤波器窗口长度取值，也可能是多个长度的滤波器同时用。
5. 如果能获取的数据长度更长一些，可能频域的特征会更明显，采取一些滤波措施，进行fft可能会对模型有正向的效果。

附录1

分别打印的是训练过程的均方误差，验证集上的分类报告、混淆矩阵

label10

```
[0]	train-mlogloss:0.98410	test-mlogloss:0.99084
[1]	train-mlogloss:0.91658	test-mlogloss:0.92754
[2]	train-mlogloss:0.87257	test-mlogloss:0.88688
[3]	train-mlogloss:0.84282	test-mlogloss:0.85955
[4]	train-mlogloss:0.82184	test-mlogloss:0.84045
[5]	train-mlogloss:0.80669	test-mlogloss:0.82690
[6]	train-mlogloss:0.79549	test-mlogloss:0.81716
[7]	train-mlogloss:0.78701	test-mlogloss:0.80986
[8]	train-mlogloss:0.78052	test-mlogloss:0.80452
[9]	train-mlogloss:0.77503	test-mlogloss:0.79986
[10]	train-mlogloss:0.77067	test-mlogloss:0.79628
[11]	train-mlogloss:0.76686	test-mlogloss:0.79311
[12]	train-mlogloss:0.76376	test-mlogloss:0.79063
[13]	train-mlogloss:0.76117	test-mlogloss:0.78862
[14]	train-mlogloss:0.75873	test-mlogloss:0.78663
[15]	train-mlogloss:0.75675	test-mlogloss:0.78513
[16]	train-mlogloss:0.75486	test-mlogloss:0.78374
[17]	train-mlogloss:0.75287	test-mlogloss:0.78233
[18]	train-mlogloss:0.75121	test-mlogloss:0.78116
[19]	train-mlogloss:0.74966	test-mlogloss:0.78003
[20]	train-mlogloss:0.74829	test-mlogloss:0.77899
[21]	train-mlogloss:0.74699	test-mlogloss:0.77817
[22]	train-mlogloss:0.74579	test-mlogloss:0.77748
[23]	train-mlogloss:0.74458	test-mlogloss:0.77664
[24]	train-mlogloss:0.74345	test-mlogloss:0.77598
[25]	train-mlogloss:0.74243	test-mlogloss:0.77535
[26]	train-mlogloss:0.74122	test-mlogloss:0.77462
[27]	train-mlogloss:0.74028	test-mlogloss:0.77420
[28]	train-mlogloss:0.73932	test-mlogloss:0.77366
[29]	train-mlogloss:0.73845	test-mlogloss:0.77307
[30]	train-mlogloss:0.73771	test-mlogloss:0.77268
[31]	train-mlogloss:0.73689	test-mlogloss:0.77219
[32]	train-mlogloss:0.73614	test-mlogloss:0.77186
[33]	train-mlogloss:0.73533	test-mlogloss:0.77154
[34]	train-mlogloss:0.73462	test-mlogloss:0.77116
[35]	train-mlogloss:0.73390	test-mlogloss:0.77083
[36]	train-mlogloss:0.73321	test-mlogloss:0.77043
[37]	train-mlogloss:0.73246	test-mlogloss:0.77005
[38]	train-mlogloss:0.73171	test-mlogloss:0.76964
[39]	train-mlogloss:0.73110	test-mlogloss:0.76939
[40]	train-mlogloss:0.73042	test-mlogloss:0.76911
[41]	train-mlogloss:0.72989	test-mlogloss:0.76889
[42]	train-mlogloss:0.72930	test-mlogloss:0.76868
```

```
[43]	train-mlogloss:0.72866	test-mlogloss:0.76839
[44]	train-mlogloss:0.72802	test-mlogloss:0.76815
[45]	train-mlogloss:0.72739	test-mlogloss:0.76784
[46]	train-mlogloss:0.72684	test-mlogloss:0.76760
[47]	train-mlogloss:0.72617	test-mlogloss:0.76740
[48]	train-mlogloss:0.72566	test-mlogloss:0.76723
[49]	train-mlogloss:0.72505	test-mlogloss:0.76698
[50]	train-mlogloss:0.72456	test-mlogloss:0.76686
[51]	train-mlogloss:0.72409	test-mlogloss:0.76669
[52]	train-mlogloss:0.72357	test-mlogloss:0.76653
[53]	train-mlogloss:0.72306	test-mlogloss:0.76638
[54]	train-mlogloss:0.72242	test-mlogloss:0.76615
[55]	train-mlogloss:0.72189	test-mlogloss:0.76599
[56]	train-mlogloss:0.72133	test-mlogloss:0.76585
[57]	train-mlogloss:0.72086	test-mlogloss:0.76565
[58]	train-mlogloss:0.72034	test-mlogloss:0.76553
[59]	train-mlogloss:0.71971	test-mlogloss:0.76530
[60]	train-mlogloss:0.71927	test-mlogloss:0.76517
[61]	train-mlogloss:0.71876	test-mlogloss:0.76503
[62]	train-mlogloss:0.71826	test-mlogloss:0.76482
[63]	train-mlogloss:0.71784	test-mlogloss:0.76474
[64]	train-mlogloss:0.71735	test-mlogloss:0.76457
[65]	train-mlogloss:0.71682	test-mlogloss:0.76438
[66]	train-mlogloss:0.71635	test-mlogloss:0.76430
[67]	train-mlogloss:0.71583	test-mlogloss:0.76408
[68]	train-mlogloss:0.71537	test-mlogloss:0.76396
[69]	train-mlogloss:0.71491	test-mlogloss:0.76384
[70]	train-mlogloss:0.71441	test-mlogloss:0.76379
[71]	train-mlogloss:0.71396	test-mlogloss:0.76362
[72]	train-mlogloss:0.71359	test-mlogloss:0.76360
[73]	train-mlogloss:0.71317	test-mlogloss:0.76352
[74]	train-mlogloss:0.71275	test-mlogloss:0.76346
[75]	train-mlogloss:0.71231	test-mlogloss:0.76341
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```

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[254]	train-mlogloss:0.64970	test-mlogloss:0.76167
[255]	train-mlogloss:0.64933	test-mlogloss:0.76167
[256]	train-mlogloss:0.64903	test-mlogloss:0.76168
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[258]	train-mlogloss:0.64846	test-mlogloss:0.76172
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[260]	train-mlogloss:0.64791	test-mlogloss:0.76175
[261]	train-mlogloss:0.64758	test-mlogloss:0.76179
[262]	train-mlogloss:0.64725	test-mlogloss:0.76181
[263]	train-mlogloss:0.64693	test-mlogloss:0.76184
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[267]	train-mlogloss:0.64579	test-mlogloss:0.76185
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[269]	train-mlogloss:0.64519	test-mlogloss:0.76188
[270]	train-mlogloss:0.64494	test-mlogloss:0.76190
[271]	train-mlogloss:0.64465	test-mlogloss:0.76193
training model done
```

```
report

              precision    recall  f1-score   support

         0.0       0.53      0.36      0.43    125770
         1.0       0.70      0.85      0.77    348092
         2.0       0.52      0.37      0.43    116727

    accuracy                           0.65    590589
   macro avg       0.59      0.53      0.55    590589
weighted avg       0.63      0.65      0.63    590589

[[ 45540  65897  14333]
 [ 26252 296598  25242]
 [ 13384  59993  43350]]
```

label5

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[0]	train-mlogloss:0.92875	test-mlogloss:0.93035
[1]	train-mlogloss:0.83045	test-mlogloss:0.83286
[2]	train-mlogloss:0.76728	test-mlogloss:0.77058
[3]	train-mlogloss:0.72506	test-mlogloss:0.72940
[4]	train-mlogloss:0.69579	test-mlogloss:0.70112
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[7]	train-mlogloss:0.64951	test-mlogloss:0.65772
[8]	train-mlogloss:0.64127	test-mlogloss:0.65028
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```

```
[43]	train-mlogloss:0.58903	test-mlogloss:0.61107
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[284]	train-mlogloss:0.51702	test-mlogloss:0.60446
[285]	train-mlogloss:0.51677	test-mlogloss:0.60448
training model done
report

              precision    recall  f1-score   support

         0.0       0.55      0.29      0.38     87474
         1.0       0.78      0.93      0.85    419619
         2.0       0.55      0.31      0.40     83496

    accuracy                           0.75    590589
   macro avg       0.63      0.51      0.54    590589
weighted avg       0.71      0.75      0.71    590589

[[ 24976  56495   6003]
 [ 15031 389273  15315]
 [  5409  52236  25851]]
```

label20

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[1]	train-mlogloss:0.88786	test-mlogloss:0.89599
[2]	train-mlogloss:0.83827	test-mlogloss:0.84985
[3]	train-mlogloss:0.80562	test-mlogloss:0.82035
[4]	train-mlogloss:0.78327	test-mlogloss:0.80092
[5]	train-mlogloss:0.76769	test-mlogloss:0.78777
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[179]	train-mlogloss:0.62221	test-mlogloss:0.73394
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[201]	train-mlogloss:0.61409	test-mlogloss:0.73425
[202]	train-mlogloss:0.61372	test-mlogloss:0.73426
[203]	train-mlogloss:0.61336	test-mlogloss:0.73427
[204]	train-mlogloss:0.61289	test-mlogloss:0.73431
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[210]	train-mlogloss:0.61080	test-mlogloss:0.73440
[211]	train-mlogloss:0.61044	test-mlogloss:0.73446
[212]	train-mlogloss:0.61007	test-mlogloss:0.73449
training model done

report

              precision    recall  f1-score   support

         0.0       0.49      0.19      0.27    101205
         1.0       0.71      0.93      0.81    395378
         2.0       0.49      0.20      0.28     94006

    accuracy                           0.69    590589
   macro avg       0.57      0.44      0.45    590589
weighted avg       0.64      0.69      0.63    590589
```

```
[[ 18863  76803   5539]
 [ 14058 367549  13771]
 [  5259  70019  18728]]
```

label40

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[3]	train-mlogloss:0.94736	test-mlogloss:0.96887
[4]	train-mlogloss:0.93485	test-mlogloss:0.95915
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[167]	train-mlogloss:0.78032	test-mlogloss:0.92092
[168]	train-mlogloss:0.77980	test-mlogloss:0.92089
training model done

report

              precision    recall  f1-score   support

         0.0       0.46      0.26      0.33    146937
         1.0       0.60      0.83      0.70    312274
         2.0       0.44      0.24      0.31    131378

    accuracy                           0.56    590589
   macro avg       0.50      0.45      0.45    590589
```

```
weighted avg       0.53      0.56      0.52    590589

[[ 38547  91658  16732]
 [ 28650 258913  24711]
 [ 17117  82133  32128]]
```