

Feature Importance

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In [1]:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
import optuna
from optuna._imports import try_import
from optuna.integration import _lightgbm_tuner as tuner
from sklearn.model_selection import KFold
import lightgbm as lgb
from lightgbm import LGBMClassifier
from featimp import *
import shap

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

Why we care about feature importance?

- **Feature Selection:** Algorithms like tree based models (e.g. LightGBM, XGBoost) can handle a large amount of features pretty well without feature selection, whereas feature selection is still extremely helpful. 1. Many features will introduce noise into the dataset, in such case your models are likely to overfit and give you a false feeling of good performance. 2. It will reduce the running time of training your algorithm, as well as meet the low latency requirement after deploying your model into use. 3. More comprehensible to humans. Feature importance facilitates choosing the right features.
- **Explanatory Analysis:** Machine learning is not always about higher prediction power, sometimes we want to open the blackbox and see the underlying secrets about the data. Explanatory analysis is becoming more and more important in the data science world. It's an essential tool to find the key players in your analysis. Feature importance helps you find these key features and their relationship with the target variable.

Load data (already preprocessed)

This dataset is from a public Kaggle dataset. I already cleaned this dataset and downsampled it in order to have better performance for this feature importance project.

The reason why I choose this dataset: In financial companies, feature importance is critical for guiding the risk management, marketing strategy, customer management, etc. People want to know what are the **"North Star"** factors influence their businesses.

Dataset Link: <https://www.kaggle.com/mlg-ulb/creditcardfraud>

```
In [2]: df = pd.read_csv('creditcard_down.csv')
```

```
In [3]: df.head()
```

```
Out[3]:
```

	Time	V1	V2	V3	V4	V5	V6	V7	
0	406.0	-2.312227	1.951992	-1.609851	3.997906	-0.522188	-1.426545	-2.537387	1
1	472.0	-3.043541	-3.157307	1.088463	2.288644	1.359805	-1.064823	0.325574	-0
2	4462.0	-2.303350	1.759247	-0.359745	2.330243	-0.821628	-0.075788	0.562320	-0
3	6986.0	-4.397974	1.358367	-2.592844	2.679787	-1.128131	-1.706536	-3.496197	-0
4	7519.0	1.234235	3.019740	-4.304597	4.732795	3.624201	-1.357746	1.713445	-0.

5 rows × 31 columns

```
In [35]: df.Class.value_counts()
```

```
Out[35]: 0    4920  
        1     492  
        Name: Class, dtype: int64
```

This dataset contains 30 features, 28 of which are unknown features. Class column is the label, where 0 means non-fraud and 1 means fraud.

Now let's open the door of feature importance. We will talk about following feature importance methods:

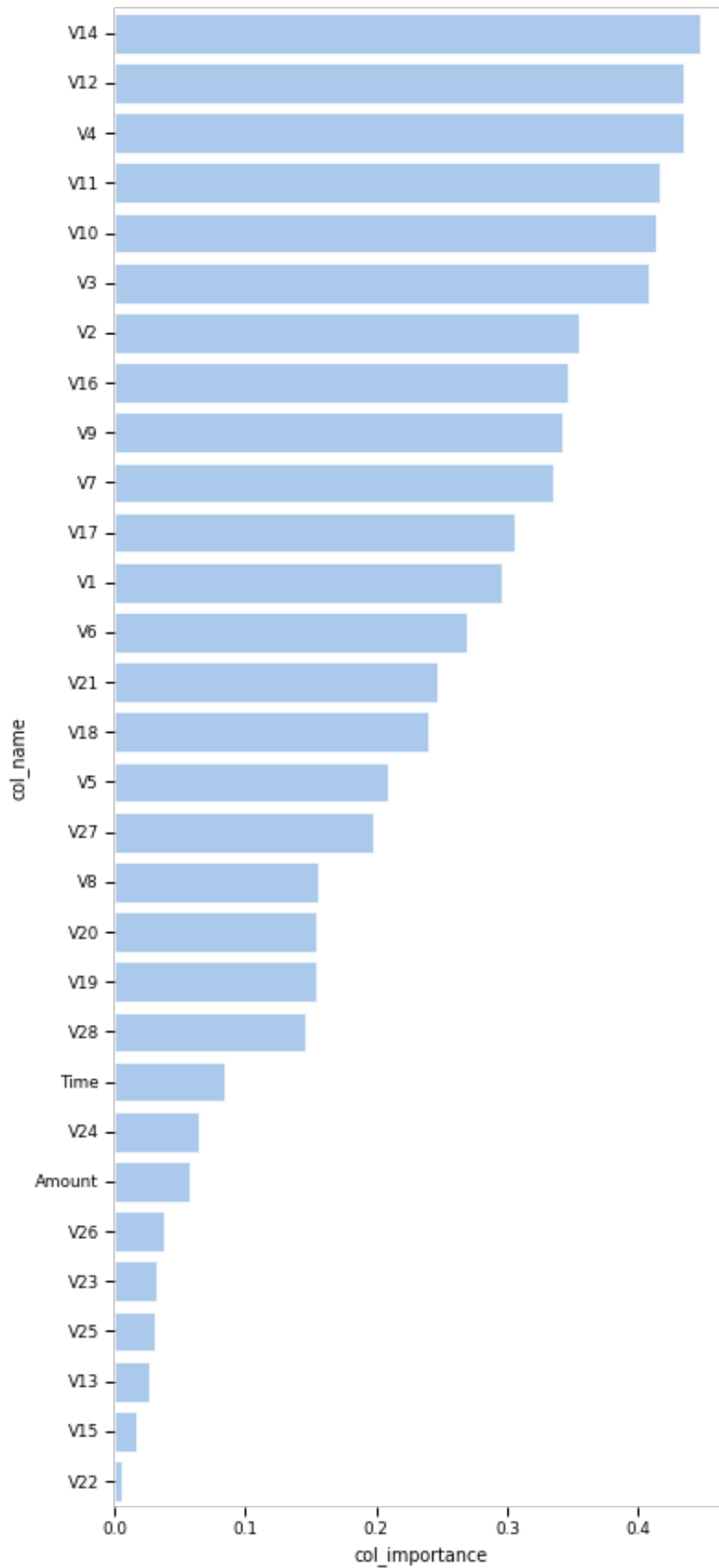
- Spearman
- PCA
- mRMR
- Model Based
 - Drop Column Importance with accuracy
 - Drop Column Importance with log loss
 - Permutation Importance with accuracy
 - Permutation Importance with log loss
 - LightGBM default: feature_imp
 - Shap: feature_importance

Then we will compare the performance of these methods. The best one will be used for our automatic feature searching algorithm.

Spearman Ranking

Spearman Correlation is a rank based Pearson Correlation method. We calculate each variable and it's correlation with target variable. This methods ignore the multicollinearity problem, some features with similar information will have the same importance.

```
In [5]: importance_spearman = spearman_ranking(df, 'Class', absolute = True)  
        importance_plot(importance_spearman)
```

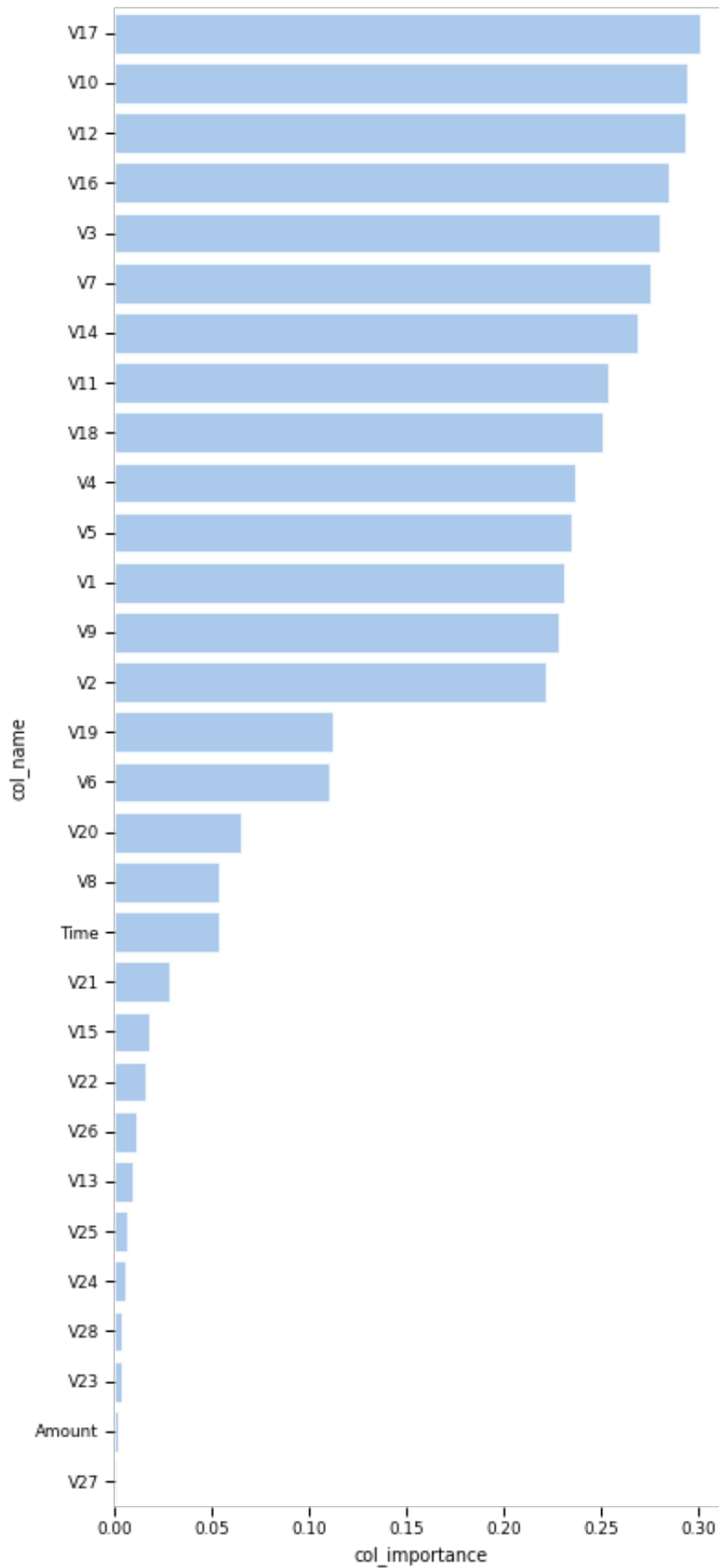


PCA Ranking

PCA can also be used to find features with the most information. This method only explores the information carried by all independent variables (X). The hypothesis is that if the first component carries most information, then the weight of each feature can explain its importance. Here we extract the first component after dimension reduction. Each feature's importance is just its weight from the first component.

```
In [6]: importance_pca = pca_ranking(df, 'Class', absolute = True)
         importance_plot(importance_pca)
```

Explained variance for the first component:0.3007450183478879



For this particular problem, only 30% of feature's information is explained by the first component. We might need to have a second thought about this result.

Minimal Redundancy Maximal Relevance (mRMR)

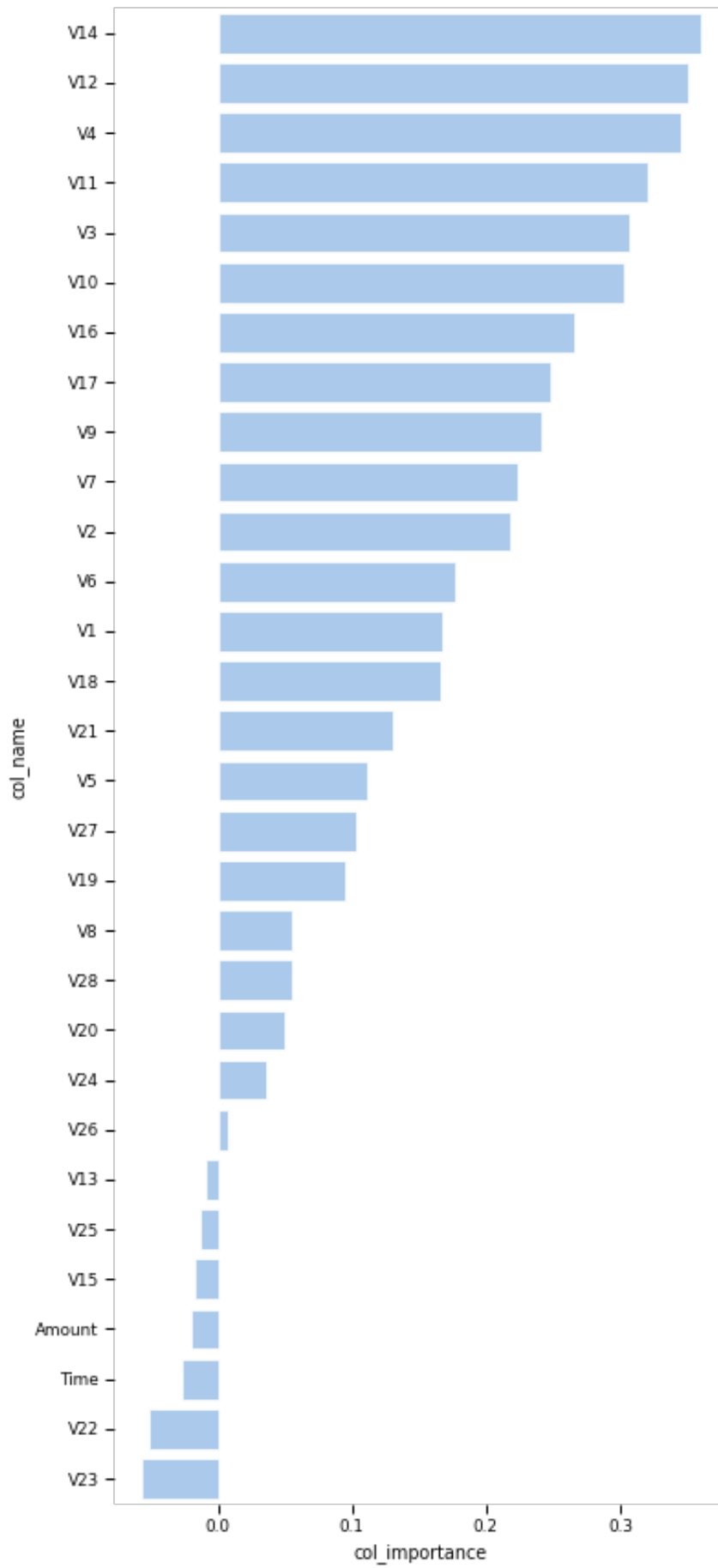
This method considers correlation with target variable and other features. The formula is as follows:

$$f^{mRMR}(X_i) = I(Y, X_i) - \frac{1}{|S|} \sum_{X_s \in S} I(X_s, X_i)$$

- Y is the target variable
- I () is the correlation calculation (e.g. mutual information, spearman correlation). For this notebook, I use the **Spearman Correlation**.
- S is the size of features minus 1.
- Xs is all features except the one for calculation.

In [7]:

```
importance_mRMR = mrmr_ranking(df, 'Class')
importance_plot(importance_mRMR)
```



Model Based Ranking (LightGBM as example)

Some models have build-in feature importance. The default feature importance for random forest might be misleading, here I borrow and test the idea of **permutation importance** and **drop column importance**.

Here is an link to the article: <https://explained.ai/rf-importance/index.html> In this part, we implement for different model based feature importance methods:

- Drop column
- Permutation
- LGBM default
- SHAP

Model Training with Optuna

First we train the best model with all features using LightGBM and Optuna as hyperparameter tuning method.

In [8]:

```
x = df.iloc[:, :-1]
y = df.iloc[:, -1]
# Split data with balanced class
X_train, X_valid, y_train, y_valid = train_test_split(X, y, random_state = 42)
```

In [9]:

```
X_train = X_train.reset_index(drop = True)
y_train = y_train.reset_index(drop = True)
```

In [10]:

```

def objective(trial, return_info=False):
    folds = 5
    seed = 42
    shuffle = True
    kf = KFold(n_splits=folds, shuffle=shuffle, random_state=seed)

    param = {
        'objective': 'binary',
        'metric': 'binary_logloss',
        # 'learning_rate': 0.1,
        'verbosity': -1,
        'lambda_l1': trial.suggest_loguniform('lambda_l1', 1e-8, 10.0),
        'lambda_l2': trial.suggest_loguniform('lambda_l2', 1e-8, 10.0),
        'num_leaves': trial.suggest_int('num_leaves', 2, 100),
        'feature_fraction': trial.suggest_uniform('feature_fraction', 0.4,
        'bagging_fraction': trial.suggest_uniform('bagging_fraction', 0.4,
        'bagging_freq': trial.suggest_int('bagging_freq', 1, 7),
        'min_child_samples': trial.suggest_int('min_child_samples', 5, 100
        'max_depth': trial.suggest_int('max_depth', 5, 15)
    }

    models = []
    valid_score = 0
    losses = []
    for train_idx, valid_idx in kf.split(X_train, y_train):
        train_x, train_y = X_train.iloc[train_idx, :], y_train[train_idx]
        valid_x, valid_y = X_train.iloc[valid_idx, :], y_train[valid_idx]
        d_train = lgb.Dataset(train_x, train_y)
        d_valid = lgb.Dataset(valid_x, valid_y)
        watchlist = [d_train, d_valid]
        early_stop = 20
        verbose_eval = 20
        model = lgb.train(param,
                           train_set=d_train,
                           num_boost_round=1500,
                           valid_sets=watchlist,
                           verbose_eval=verbose_eval,
                           early_stopping_rounds=early_stop)
        y_pred_valid = model.predict(X_valid, num_iteration=model.best_iter

    print('best_score', model.best_score)
    log = {'train': model.best_score['training']['binary_logloss'],
          'valid': model.best_score['valid_1']['binary_logloss']}

    models.append(model)
    valid_score += log["valid"]
    valid_score /= len(models)

    if return_info:
        return valid_score, models
    else:
        return valid_score
study = optuna.create_study()
study.optimize(objective, n_trials=40)

```

```

[I 2021-05-09 16:11:47,761] A new study created in memory with name: no-name-592225d0-4a56-4a06-9844-fa2b1227bc27
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0507272   valid_1's binary_logloss: 0.06573
[40]   training's binary_logloss: 0.0150443   valid_1's binary_logloss: 0.0567853
Early stopping, best iteration is:
[38]   training's binary_logloss: 0.0165177   valid_1's binary_logloss: 0.0565588
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.016517735792337708)]), 'valid_1': OrderedDict([('binary_logloss', 0.056558800419588086)])})
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0494324   valid_1's binary_logloss: 0.0667666
[40]   training's binary_logloss: 0.0172871   valid_1's binary_logloss: 0.0547138
[60]   training's binary_logloss: 0.00556194   valid_1's binary_logloss: 0.0595703
Early stopping, best iteration is:
[42]   training's binary_logloss: 0.0155086   valid_1's binary_logloss: 0.0544605
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.015508567178900135)]), 'valid_1': OrderedDict([('binary_logloss', 0.05446054712700445)])})
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0487415   valid_1's binary_logloss: 0.081049
[40]   training's binary_logloss: 0.0165352   valid_1's binary_logloss: 0.0709796
Early stopping, best iteration is:
[32]   training's binary_logloss: 0.0244842   valid_1's binary_logloss: 0.0695818
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.024484162913839064)]), 'valid_1': OrderedDict([('binary_logloss', 0.06958182046975707)])})
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0471131   valid_1's binary_logloss: 0.0771325
[40]   training's binary_logloss: 0.0151912   valid_1's binary_logloss: 0.0696484
Early stopping, best iteration is:
[33]   training's binary_logloss: 0.0218805   valid_1's binary_logloss: 0.0681917
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.021880517459795423)]), 'valid_1': OrderedDict([('binary_logloss', 0.06819167744412048)])})
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0488955   valid_1's binary_logloss: 0.0904981
[40]   training's binary_logloss: 0.0185003   valid_1's binary_logloss: 0.0883637
Early stopping, best iteration is:
[33]   training's binary_logloss: 0.0253776   valid_1's binary_logloss: 0.0847471

```

```
[I 2021-05-09 16:11:48,877] Trial 0 finished with value: 0.0667079835767990
1 and parameters: {'lambda_11': 1.4600853313136385e-08, 'lambda_12': 3.0858
59593181914e-06, 'num_leaves': 32, 'feature_fraction': 0.8863497661782209,
'bagging_fraction': 0.6184496400408785, 'bagging_freq': 6, 'min_child_sampl
es': 20, 'max_depth': 13}. Best is trial 0 with value: 0.06670798357679901.
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.025377585388408057)]), 'valid_1': OrderedDict
([('binary_logloss', 0.084747072423525)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0568518 valid_1's binary_logloss: 0
.06482
[40] training's binary_logloss: 0.0206714 valid_1's binary_logloss: 0
.0498893
[60] training's binary_logloss: 0.00818582 valid_1's binary_logloss: 0
.0503603
Early stopping, best iteration is:
[45] training's binary_logloss: 0.0161845 valid_1's binary_logloss: 0
.0492355
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.016184481898631527)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04923551389013561)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0578435 valid_1's binary_logloss: 0
.0693137
[40] training's binary_logloss: 0.0211407 valid_1's binary_logloss: 0
.0523971
[60] training's binary_logloss: 0.00858507 valid_1's binary_logloss: 0
.0532151
Early stopping, best iteration is:
[44] training's binary_logloss: 0.0177299 valid_1's binary_logloss: 0
.0508577
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.017729942350920642)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0508577494632097)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0535274 valid_1's binary_logloss: 0
.0822598
[40] training's binary_logloss: 0.0211119 valid_1's binary_logloss: 0
.0687696
[60] training's binary_logloss: 0.00832585 valid_1's binary_logloss: 0
.0691524
Early stopping, best iteration is:
[44] training's binary_logloss: 0.0172018 valid_1's binary_logloss: 0
.0675489
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.017201796983329028)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0675488515060031)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0562056 valid_1's binary_logloss: 0
.077609
[40] training's binary_logloss: 0.0206955 valid_1's binary_logloss: 0
.0673064
Early stopping, best iteration is:
[37] training's binary_logloss: 0.0237438 valid_1's binary_logloss: 0
.0672372
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.023743832265400496)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06723716319625381)]))
```

```
[I 2021-05-09 16:11:49,672] Trial 1 finished with value: 0.0634239439727885
7 and parameters: {'lambda_11': 3.103463192793918e-06, 'lambda_12': 0.30973
019046738615, 'num_leaves': 50, 'feature_fraction': 0.6939741834727797, 'ba
gging_fraction': 0.8035136322507228, 'bagging_freq': 3, 'min_child_samples'
: 40, 'max_depth': 13}. Best is trial 1 with value: 0.06342394397278857.
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.056551   valid_1's binary_logloss: 0
.0937422
[40]   training's binary_logloss: 0.0206528   valid_1's binary_logloss: 0
.083574
Early stopping, best iteration is:
[36]   training's binary_logloss: 0.0253301   valid_1's binary_logloss: 0
.0822404
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.025330091818095563)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.08224044180834059)]))}
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0816848   valid_1's binary_logloss: 0
.0777094
[40]   training's binary_logloss: 0.0536683   valid_1's binary_logloss: 0
.0571285
[60]   training's binary_logloss: 0.040993    valid_1's binary_logloss: 0
.053067
[80]   training's binary_logloss: 0.0326449   valid_1's binary_logloss: 0
.0518713
[100]  training's binary_logloss: 0.0266622   valid_1's binary_logloss: 0
.0505005
[120]  training's binary_logloss: 0.022124    valid_1's binary_logloss: 0
.0493653
[140]  training's binary_logloss: 0.0188468   valid_1's binary_logloss: 0
.0492567
[160]  training's binary_logloss: 0.0161696   valid_1's binary_logloss: 0
.0495911
Early stopping, best iteration is:
[151]  training's binary_logloss: 0.0171922   valid_1's binary_logloss: 0
.0485268
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01719217158030082)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.04852675760186831)]))}
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.082286    valid_1's binary_logloss: 0
.0780537
[40]   training's binary_logloss: 0.0536364   valid_1's binary_logloss: 0
.0547515
[60]   training's binary_logloss: 0.0402308   valid_1's binary_logloss: 0
.0508405
[80]   training's binary_logloss: 0.0325277   valid_1's binary_logloss: 0
.0496772
[100]  training's binary_logloss: 0.0267881   valid_1's binary_logloss: 0
.0498351
[120]  training's binary_logloss: 0.0222179   valid_1's binary_logloss: 0
.0479996
[140]  training's binary_logloss: 0.0189421   valid_1's binary_logloss: 0
.0485326
Early stopping, best iteration is:
[124]  training's binary_logloss: 0.0215078   valid_1's binary_logloss: 0
.0475602
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02150779591186651)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.0475601878944724)]))}
```

```

Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0794436   valid_1's binary_logloss: 0
.0954764
[40]   training's binary_logloss: 0.0513439   valid_1's binary_logloss: 0
.0742789
[60]   training's binary_logloss: 0.040093    valid_1's binary_logloss: 0
.0700882
[80]   training's binary_logloss: 0.0311627   valid_1's binary_logloss: 0
.0669096
[100]  training's binary_logloss: 0.0255998   valid_1's binary_logloss: 0
.0661347
[120]  training's binary_logloss: 0.0211837   valid_1's binary_logloss: 0
.0655576
Early stopping, best iteration is:
[111]  training's binary_logloss: 0.0227865   valid_1's binary_logloss: 0
.0649838
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02278653195196317)]), 'valid_1': OrderedDict([('binary_logloss', 0.06498379075152619)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.080251    valid_1's binary_logloss: 0
.0868033
[40]   training's binary_logloss: 0.0512859   valid_1's binary_logloss: 0
.0681986
[60]   training's binary_logloss: 0.0388222   valid_1's binary_logloss: 0
.0657817
[80]   training's binary_logloss: 0.0301546   valid_1's binary_logloss: 0
.0658098
[100]  training's binary_logloss: 0.024915    valid_1's binary_logloss: 0
.0659053
[I 2021-05-09 16:11:50,545] Trial 2 finished with value: 0.061303036267541855 and parameters: {'lambda_l1': 2.6406265350738883e-08, 'lambda_l2': 5.802874382490537, 'num_leaves': 21, 'feature_fraction': 0.5304817958797946, 'bagging_fraction': 0.5686575701925095, 'bagging_freq': 2, 'min_child_samples': 51, 'max_depth': 6}. Best is trial 2 with value: 0.061303036267541855.
Early stopping, best iteration is:
[93]   training's binary_logloss: 0.0263515   valid_1's binary_logloss: 0
.0652253
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.026351490202100054)]), 'valid_1': OrderedDict([('binary_logloss', 0.06522529663855313)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0773574   valid_1's binary_logloss: 0
.101272
[40]   training's binary_logloss: 0.04947     valid_1's binary_logloss: 0
.0823431
[60]   training's binary_logloss: 0.0374905   valid_1's binary_logloss: 0
.0808358
Early stopping, best iteration is:
[55]   training's binary_logloss: 0.0395425   valid_1's binary_logloss: 0
.0802191
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03954252223138683)]), 'valid_1': OrderedDict([('binary_logloss', 0.08021914845128926)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0764269   valid_1's binary_logloss: 0
.0722903
[40]   training's binary_logloss: 0.0457884   valid_1's binary_logloss: 0
.0556739
[60]   training's binary_logloss: 0.0300414   valid_1's binary_logloss: 0

```



```

.0553018
[80]   training's binary_logloss: 0.0196518   valid_1's binary_logloss: 0
.0544515
Early stopping, best iteration is:
[67]   training's binary_logloss: 0.0257961   valid_1's binary_logloss: 0
.0527046
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02579610017760718)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.05270463943283259)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0748125   valid_1's binary_logloss: 0
.0724288
[40]   training's binary_logloss: 0.0475743   valid_1's binary_logloss: 0
.0475533
[60]   training's binary_logloss: 0.0284798   valid_1's binary_logloss: 0
.0420177
[80]   training's binary_logloss: 0.0177405   valid_1's binary_logloss: 0
.0414533
Early stopping, best iteration is:
[78]   training's binary_logloss: 0.0188514   valid_1's binary_logloss: 0
.0408046
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.018851386962483466)]), 'valid_1': OrderedDict
[('binary_logloss', 0.04080460186217717)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0716403   valid_1's binary_logloss: 0
.0876895
[40]   training's binary_logloss: 0.0418399   valid_1's binary_logloss: 0
.0665998
[60]   training's binary_logloss: 0.0277575   valid_1's binary_logloss: 0
.0650661
Early stopping, best iteration is:
[58]   training's binary_logloss: 0.029119   valid_1's binary_logloss: 0
.0641857
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.029119034525325493)]), 'valid_1': OrderedDict
[('binary_logloss', 0.06418567468596732)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.075044   valid_1's binary_logloss: 0
.0819316
[40]   training's binary_logloss: 0.0428533   valid_1's binary_logloss: 0
.0665808
[60]   training's binary_logloss: 0.0263642   valid_1's binary_logloss: 0
.0660217
[I 2021-05-09 16:11:51,260] Trial 3 finished with value: 0.0605333956934574
8 and parameters: {'lambda_11': 0.01934086811550025, 'lambda_12': 1.8515248
392708896e-06, 'num_leaves': 93, 'feature_fraction': 0.5337615529395082, 'b
agging_fraction': 0.4788603336852342, 'bagging_freq': 7, 'min_child_samples
': 84, 'max_depth': 7}. Best is trial 3 with value: 0.06053339569345748.
[80]   training's binary_logloss: 0.0178494   valid_1's binary_logloss: 0
.0668063
Early stopping, best iteration is:
[69]   training's binary_logloss: 0.0210956   valid_1's binary_logloss: 0
.0637295
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02109555318694714)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06372949312082513)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0711609   valid_1's binary_logloss: 0
.0947727

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[40]    training's binary_logloss: 0.0423958    valid_1's binary_logloss: 0
      .0840842
Early stopping, best iteration is:
[36]    training's binary_logloss: 0.0469297    valid_1's binary_logloss: 0
      .0812426
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.046929716431082395)]), 'valid_1': OrderedDict
([('binary_logloss', 0.08124256936548523)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0312748    valid_1's binary_logloss: 0
      .0605835
[40]    training's binary_logloss: 0.00558376    valid_1's binary_logloss: 0
      .0536449
Early stopping, best iteration is:
[32]    training's binary_logloss: 0.0112586    valid_1's binary_logloss: 0
      .0528799
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.011258571421088668)]), 'valid_1': OrderedDict
([('binary_logloss', 0.05287993229637969)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0325705    valid_1's binary_logloss: 0
      .0667693
[40]    training's binary_logloss: 0.00612237    valid_1's binary_logloss: 0
      .0582174
Early stopping, best iteration is:
[33]    training's binary_logloss: 0.0107895    valid_1's binary_logloss: 0
      .0557419
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.010789461730219342)]), 'valid_1': OrderedDict
([('binary_logloss', 0.055741927856009676)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0298443    valid_1's binary_logloss: 0
      .0821199
[40]    training's binary_logloss: 0.00558586    valid_1's binary_logloss: 0
      .081553
Early stopping, best iteration is:
[27]    training's binary_logloss: 0.0162199    valid_1's binary_logloss: 0
      .0752634
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.016219887541462186)]), 'valid_1': OrderedDict
([('binary_logloss', 0.07526337618122651)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.031424    valid_1's binary_logloss: 0
      .0754685
[40]    training's binary_logloss: 0.00575578    valid_1's binary_logloss: 0
      .075229
Early stopping, best iteration is:
[27]    training's binary_logloss: 0.0171977    valid_1's binary_logloss: 0
      .0709311
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01719770949391655)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.07093112672856505)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0316421    valid_1's binary_logloss: 0
      .08766
[I 2021-05-09 16:11:53,407] Trial 4 finished with value: 0.0681069967579222
4 and parameters: {'lambda_11': 0.0002704570670727591, 'lambda_12': 1.75015
52166807053e-05, 'num_leaves': 70, 'feature_fraction': 0.9892908038990758,
'bagging_fraction': 0.9497266668347862, 'bagging_freq': 7, 'min_child_sampl
es': 11, 'max_depth': 12}. Best is trial 3 with value: 0.06053339569345748.
[40]    training's binary_logloss: 0.00566189    valid_1's binary_logloss: 0

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.0922749
Early stopping, best iteration is:
[24]   training's binary_logloss: 0.0221863   valid_1's binary_logloss: 0
.0857186
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02218630496273775)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.08571862072743032)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.074085   valid_1's binary_logloss: 0
.0709813
[40]   training's binary_logloss: 0.0436415   valid_1's binary_logloss: 0
.0562278
Early stopping, best iteration is:
[38]   training's binary_logloss: 0.0454838   valid_1's binary_logloss: 0
.0561171
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04548382294389425)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.05611711344412995)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0727718   valid_1's binary_logloss: 0
.0687065
[40]   training's binary_logloss: 0.0426558   valid_1's binary_logloss: 0
.0479464
[60]   training's binary_logloss: 0.0258839   valid_1's binary_logloss: 0
.0474363
[80]   training's binary_logloss: 0.0160385   valid_1's binary_logloss: 0
.0463897
Early stopping, best iteration is:
[70]   training's binary_logloss: 0.0194554   valid_1's binary_logloss: 0
.0459042
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.019455420968631097)]), 'valid_1': OrderedDict
[('binary_logloss', 0.04590421322055345)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0693171   valid_1's binary_logloss: 0
.0864167
[40]   training's binary_logloss: 0.038818   valid_1's binary_logloss: 0
.068616
[60]   training's binary_logloss: 0.0251256   valid_1's binary_logloss: 0
.0727447
Early stopping, best iteration is:
[50]   training's binary_logloss: 0.030966   valid_1's binary_logloss: 0
.0665429
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.030966027609458577)]), 'valid_1': OrderedDict
[('binary_logloss', 0.06654286798802261)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0725328   valid_1's binary_logloss: 0
.0807315
[40]   training's binary_logloss: 0.0396408   valid_1's binary_logloss: 0
.0689321
[60]   training's binary_logloss: 0.0232481   valid_1's binary_logloss: 0
.0680095
Early stopping, best iteration is:
[56]   training's binary_logloss: 0.0250792   valid_1's binary_logloss: 0
.0679057
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02507917079727775)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06790567726713198)]))
Training until validation scores don't improve for 20 rounds

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[20]    training's binary_logloss: 0.0704741    valid_1's binary_logloss: 0
.0943178
[40]    training's binary_logloss: 0.0409107    valid_1's binary_logloss: 0
.0808254
[60]    training's binary_logloss: 0.0289246    valid_1's binary_logloss: 0
.0844495
[I 2021-05-09 16:11:54,864] Trial 5 finished with value: 0.0633197451057974
5 and parameters: {'lambda_l1': 1.6157671761882597e-08, 'lambda_l2': 5.1063
48572324795e-06, 'num_leaves': 88, 'feature_fraction': 0.7500939759866629,
'bagging_fraction': 0.47373313998851496, 'bagging_freq': 6, 'min_child_samp
les': 77, 'max_depth': 10}. Best is trial 3 with value: 0.06053339569345748
.
Early stopping, best iteration is:
[53]    training's binary_logloss: 0.0319481    valid_1's binary_logloss: 0
.0801289
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.03194811753131265)]), 'valid_1': OrderedDict([
('binary_logloss', 0.08012885360914931)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0647174    valid_1's binary_logloss: 0
.0662965
[40]    training's binary_logloss: 0.026746     valid_1's binary_logloss: 0
.0495885
[60]    training's binary_logloss: 0.0104613    valid_1's binary_logloss: 0
.0501167
Early stopping, best iteration is:
[50]    training's binary_logloss: 0.0165143    valid_1's binary_logloss: 0
.0477471
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.016514259480263)]), 'valid_1': OrderedDict([
('binary_logloss', 0.04774708624203151)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0652857    valid_1's binary_logloss: 0
.0708706
[40]    training's binary_logloss: 0.0262396    valid_1's binary_logloss: 0
.0509103
[60]    training's binary_logloss: 0.0102888    valid_1's binary_logloss: 0
.0514873
Early stopping, best iteration is:
[47]    training's binary_logloss: 0.0190936    valid_1's binary_logloss: 0
.0498432
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.019093586895106655)]), 'valid_1': OrderedDict([
('binary_logloss', 0.04984322485050078)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0615112    valid_1's binary_logloss: 0
.083928
[40]    training's binary_logloss: 0.026432     valid_1's binary_logloss: 0
.0677542
[60]    training's binary_logloss: 0.0104432    valid_1's binary_logloss: 0
.0687025
Early stopping, best iteration is:
[52]    training's binary_logloss: 0.0150784    valid_1's binary_logloss: 0
.0670301
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.015078413085169355)]), 'valid_1': OrderedDict([
('binary_logloss', 0.06703009025007199)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0626003    valid_1's binary_logloss: 0
.07878

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[40]      training's binary_logloss: 0.0256528      valid_1's binary_logloss: 0
.0645218
Early stopping, best iteration is:
[38]      training's binary_logloss: 0.0278547      valid_1's binary_logloss: 0
.0644413
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.027854721007173584)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06444133122064413)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0607967      valid_1's binary_logloss: 0
.0940947
[40]      training's binary_logloss: 0.0237415      valid_1's binary_logloss: 0
.080089
[I 2021-05-09 16:11:57,036] Trial 6 finished with value: 0.0617541663600739
3 and parameters: {'lambda_l1': 3.522563766547364e-07, 'lambda_l2': 5.07861
67276694224e-08, 'num_leaves': 81, 'feature_fraction': 0.4030978538620843,
'bagging_fraction': 0.9272506587305207, 'bagging_freq': 3, 'min_child_sampl
es': 76, 'max_depth': 14}. Best is trial 3 with value: 0.06053339569345748.
Early stopping, best iteration is:
[39]      training's binary_logloss: 0.0249393      valid_1's binary_logloss: 0
.0797091
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02493930716452545)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.07970909923712123)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0626859      valid_1's binary_logloss: 0
.0647221
[40]      training's binary_logloss: 0.0277776      valid_1's binary_logloss: 0
.0485577
[60]      training's binary_logloss: 0.0145709      valid_1's binary_logloss: 0
.0490628
Early stopping, best iteration is:
[42]      training's binary_logloss: 0.0261104      valid_1's binary_logloss: 0
.0475914
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.026110387143961123)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04759144886791538)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.064418      valid_1's binary_logloss: 0
.0651286
[40]      training's binary_logloss: 0.0305877      valid_1's binary_logloss: 0
.0469006
[60]      training's binary_logloss: 0.0144863      valid_1's binary_logloss: 0
.0462991
Early stopping, best iteration is:
[53]      training's binary_logloss: 0.0186139      valid_1's binary_logloss: 0
.0429718
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01861390620479091)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.04297177958199312)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.060639      valid_1's binary_logloss: 0
.0848625
[40]      training's binary_logloss: 0.0284889      valid_1's binary_logloss: 0
.0667741
[60]      training's binary_logloss: 0.0153499      valid_1's binary_logloss: 0
.0671995
Early stopping, best iteration is:
[48]      training's binary_logloss: 0.0214141      valid_1's binary_logloss: 0
.0664325

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best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.021414064403913982)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06643250677417988)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0625144    valid_1's binary_logloss: 0
.0798966
[40]    training's binary_logloss: 0.0279362    valid_1's binary_logloss: 0
.0654083
[60]    training's binary_logloss: 0.0159237    valid_1's binary_logloss: 0
.0697302
Early stopping, best iteration is:
[48]    training's binary_logloss: 0.0215757    valid_1's binary_logloss: 0
.0650271
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02157565935424884)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.06502710292562339)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0599467    valid_1's binary_logloss: 0
.0944653
[I 2021-05-09 16:11:57,690] Trial 7 finished with value: 0.0611280548843997
3 and parameters: {'lambda_11': 0.0007643024211513445, 'lambda_12': 0.03907
0307649516765, 'num_leaves': 14, 'feature_fraction': 0.46484811552015, 'bag
ging_fraction': 0.4460449954730465, 'bagging_freq': 3, 'min_child_samples':
26, 'max_depth': 9}. Best is trial 3 with value: 0.06053339569345748.
[40]    training's binary_logloss: 0.0281341    valid_1's binary_logloss: 0
.0852589
Early stopping, best iteration is:
[37]    training's binary_logloss: 0.0313424    valid_1's binary_logloss: 0
.0836174
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03134237235485677)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.08361743627228688)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.054696    valid_1's binary_logloss: 0
.0672829
[40]    training's binary_logloss: 0.0210606    valid_1's binary_logloss: 0
.0520419
[60]    training's binary_logloss: 0.0106789    valid_1's binary_logloss: 0
.0511928
[80]    training's binary_logloss: 0.00617714    valid_1's binary_logloss: 0
.0516027
Early stopping, best iteration is:
[73]    training's binary_logloss: 0.0074383    valid_1's binary_logloss: 0
.050902
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.007438298983413243)]), 'valid_1': OrderedDict
([('binary_logloss', 0.050901970292557185)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0540102    valid_1's binary_logloss: 0
.0676772
[40]    training's binary_logloss: 0.0211434    valid_1's binary_logloss: 0
.0503351
[60]    training's binary_logloss: 0.0108454    valid_1's binary_logloss: 0
.0481006
Early stopping, best iteration is:
[59]    training's binary_logloss: 0.0111163    valid_1's binary_logloss: 0
.0478323
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.011116319744377023)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04783228550210846)]))

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Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0511232   valid_1's binary_logloss: 0
      .0831389
[40]   training's binary_logloss: 0.0200611   valid_1's binary_logloss: 0
      .0684292
[60]   training's binary_logloss: 0.0103789   valid_1's binary_logloss: 0
      .0676406
Early stopping, best iteration is:
[59]   training's binary_logloss: 0.0107076   valid_1's binary_logloss: 0
      .0674207
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01070762371118346)]), 'valid_1': OrderedDict([('binary_logloss', 0.06742066744468633)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0531774   valid_1's binary_logloss: 0
      .0769844
[40]   training's binary_logloss: 0.0206333   valid_1's binary_logloss: 0
      .0646803
Early stopping, best iteration is:
[39]   training's binary_logloss: 0.0214372   valid_1's binary_logloss: 0
      .0646521
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02143719338480714)]), 'valid_1': OrderedDict([('binary_logloss', 0.06465209756668988)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0532125   valid_1's binary_logloss: 0
      .091994
[I 2021-05-09 16:12:00,778] Trial 8 finished with value: 0.0622229176474663
9 and parameters: {'lambda_11': 0.0010272165348601374, 'lambda_12': 1.50281
98708074811, 'num_leaves': 42, 'feature_fraction': 0.44349677763670425, 'ba
gging_fraction': 0.8756643948540728, 'bagging_freq': 5, 'min_child_samples'
: 13, 'max_depth': 8}. Best is trial 3 with value: 0.06053339569345748.
[40]   training's binary_logloss: 0.0211788   valid_1's binary_logloss: 0
      .0807021
[60]   training's binary_logloss: 0.0109769   valid_1's binary_logloss: 0
      .0842483
Early stopping, best iteration is:
[42]   training's binary_logloss: 0.0198602   valid_1's binary_logloss: 0
      .0803076
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01986022732665103)]), 'valid_1': OrderedDict([('binary_logloss', 0.08030756743129011)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0737497   valid_1's binary_logloss: 0
      .0722103
[40]   training's binary_logloss: 0.0421248   valid_1's binary_logloss: 0
      .0576005
[60]   training's binary_logloss: 0.024454    valid_1's binary_logloss: 0
      .0556093
Early stopping, best iteration is:
[59]   training's binary_logloss: 0.0253525   valid_1's binary_logloss: 0
      .0551219
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02535249424772201)]), 'valid_1': OrderedDict([('binary_logloss', 0.05512192983494384)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0740776   valid_1's binary_logloss: 0
      .0718994
[40]   training's binary_logloss: 0.0436208   valid_1's binary_logloss: 0
      .0526783

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[60]      training's binary_logloss: 0.0257758      valid_1's binary_logloss: 0
.0564821
Early stopping, best iteration is:
[44]      training's binary_logloss: 0.0389199      valid_1's binary_logloss: 0
.0515248
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03891992890681431)]), 'valid_1': OrderedDict([
([('binary_logloss', 0.051524839380310834)])})
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0700956      valid_1's binary_logloss: 0
.0858108
[40]      training's binary_logloss: 0.0427924      valid_1's binary_logloss: 0
.0711625
[60]      training's binary_logloss: 0.02733        valid_1's binary_logloss: 0
.0736908
Early stopping, best iteration is:
[40]      training's binary_logloss: 0.0427924      valid_1's binary_logloss: 0
.0711625
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0427923651601229)]), 'valid_1': OrderedDict([
('binary_logloss', 0.0711624549911196)])})
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.074166       valid_1's binary_logloss: 0
.0808259
[40]      training's binary_logloss: 0.0421977      valid_1's binary_logloss: 0
.0665392
[60]      training's binary_logloss: 0.0237652      valid_1's binary_logloss: 0
.0694816
Early stopping, best iteration is:
[40]      training's binary_logloss: 0.0421977      valid_1's binary_logloss: 0
.0665392
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04219770472850102)]), 'valid_1': OrderedDict([
([('binary_logloss', 0.06653915775691424)])})
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0710445      valid_1's binary_logloss: 0
.0948297
[40]      training's binary_logloss: 0.0404877      valid_1's binary_logloss: 0
.0777946
[60]      training's binary_logloss: 0.0256998      valid_1's binary_logloss: 0
.0803121
[I 2021-05-09 16:12:01,924] Trial 9 finished with value: 0.0642575026641472
9 and parameters: {'lambda_11': 9.311110797164379e-05, 'lambda_12': 0.00049
42439637750851, 'num_leaves': 88, 'feature_fraction': 0.9160985767808698, '
bagging_fraction': 0.4930354152990425, 'bagging_freq': 2, 'min_child_sample
s': 89, 'max_depth': 6}. Best is trial 3 with value: 0.06053339569345748.
Early stopping, best iteration is:
[42]      training's binary_logloss: 0.0384938      valid_1's binary_logloss: 0
.0769391
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03849383006353206)]), 'valid_1': OrderedDict([
([('binary_logloss', 0.07693913135744787)])})
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0777535      valid_1's binary_logloss: 0
.0739792
[40]      training's binary_logloss: 0.0489195      valid_1's binary_logloss: 0
.0555499
[60]      training's binary_logloss: 0.033326       valid_1's binary_logloss: 0
.0520788
[80]      training's binary_logloss: 0.0233417      valid_1's binary_logloss: 0

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.0519053
[100] training's binary_logloss: 0.0181969 valid_1's binary_logloss: 0
.0523859
Early stopping, best iteration is:
[87] training's binary_logloss: 0.0212791 valid_1's binary_logloss: 0
.050901
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.021279084532802837)]), 'valid_1': OrderedDict([('binary_logloss', 0.050900969678193776)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0775034 valid_1's binary_logloss: 0
.0750426
[40] training's binary_logloss: 0.0494359 valid_1's binary_logloss: 0
.0525439
[60] training's binary_logloss: 0.0346096 valid_1's binary_logloss: 0
.0493247
[80] training's binary_logloss: 0.0255294 valid_1's binary_logloss: 0
.0477704
Early stopping, best iteration is:
[78] training's binary_logloss: 0.0261961 valid_1's binary_logloss: 0
.0472774
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02619611013581971)]), 'valid_1': OrderedDict([('binary_logloss', 0.047277407390084625)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0739835 valid_1's binary_logloss: 0
.0913144
[40] training's binary_logloss: 0.0455635 valid_1's binary_logloss: 0
.0695449
[60] training's binary_logloss: 0.0313965 valid_1's binary_logloss: 0
.0629923
[80] training's binary_logloss: 0.0235015 valid_1's binary_logloss: 0
.0644255
Early stopping, best iteration is:
[63] training's binary_logloss: 0.0297234 valid_1's binary_logloss: 0
.0627111
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.029723374457320515)]), 'valid_1': OrderedDict([('binary_logloss', 0.06271109608144405)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.076185 valid_1's binary_logloss: 0
.079969
[40] training's binary_logloss: 0.0462405 valid_1's binary_logloss: 0
.0650797
[60] training's binary_logloss: 0.0300342 valid_1's binary_logloss: 0
.0634693
Early stopping, best iteration is:
[53] training's binary_logloss: 0.0348209 valid_1's binary_logloss: 0
.0625054
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03482092523048532)]), 'valid_1': OrderedDict([('binary_logloss', 0.06250535552427362)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0708827 valid_1's binary_logloss: 0
.0960692
[40] training's binary_logloss: 0.0430982 valid_1's binary_logloss: 0
.0813027
[60] training's binary_logloss: 0.0318702 valid_1's binary_logloss: 0
.0806138
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[I 2021-05-09 16:12:02,996] Trial 10 finished with value: 0.059921126695384
7 and parameters: {'lambda_11': 1.549925567966534, 'lambda_12': 2.464692627
7047614e-08, 'num_leaves': 70, 'feature_fraction': 0.589180527693883, 'bagg
ing_fraction': 0.7153899472443699, 'bagging_freq': 7, 'min_child_samples':
98, 'max_depth': 5}. Best is trial 10 with value: 0.0599211266953847.
[80]    training's binary_logloss: 0.0235057    valid_1's binary_logloss: 0
.0763925
[100]   training's binary_logloss: 0.0184147    valid_1's binary_logloss: 0
.07803
Early stopping, best iteration is:
[82]    training's binary_logloss: 0.0229457    valid_1's binary_logloss: 0
.0762108
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.022945715903487714)]), 'valid_1': OrderedDict
([('binary_logloss', 0.07621080480292738)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.078018    valid_1's binary_logloss: 0
.0732178
[40]    training's binary_logloss: 0.0493931    valid_1's binary_logloss: 0
.0579256
[60]    training's binary_logloss: 0.0345611    valid_1's binary_logloss: 0
.0531223
[80]    training's binary_logloss: 0.024689    valid_1's binary_logloss: 0
.0531628
Early stopping, best iteration is:
[70]    training's binary_logloss: 0.0294152    valid_1's binary_logloss: 0
.0523126
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.029415246298766084)]), 'valid_1': OrderedDict
([('binary_logloss', 0.05231257799998877)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0777854    valid_1's binary_logloss: 0
.0745555
[40]    training's binary_logloss: 0.0497458    valid_1's binary_logloss: 0
.0524784
[60]    training's binary_logloss: 0.0346705    valid_1's binary_logloss: 0
.0492963
[80]    training's binary_logloss: 0.0260305    valid_1's binary_logloss: 0
.0478287
Early stopping, best iteration is:
[75]    training's binary_logloss: 0.0278438    valid_1's binary_logloss: 0
.0475823
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.027843817893281372)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04758230643556933)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0739882    valid_1's binary_logloss: 0
.0906868
[40]    training's binary_logloss: 0.0459166    valid_1's binary_logloss: 0
.0699919
[60]    training's binary_logloss: 0.0318769    valid_1's binary_logloss: 0
.0652138
[80]    training's binary_logloss: 0.023609    valid_1's binary_logloss: 0
.0666422
Early stopping, best iteration is:
[63]    training's binary_logloss: 0.030014    valid_1's binary_logloss: 0
.0650527
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.030014034922350098)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06505269178659212)]))

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Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0760486   valid_1's binary_logloss: 0
.0804445
[40]   training's binary_logloss: 0.0462895   valid_1's binary_logloss: 0
.0651104
[60]   training's binary_logloss: 0.0309068   valid_1's binary_logloss: 0
.063831
Early stopping, best iteration is:
[53]   training's binary_logloss: 0.0354952   valid_1's binary_logloss: 0
.0631877
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.035495184651643544)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06318773467902768)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0715876   valid_1's binary_logloss: 0
.0963503
[40]   training's binary_logloss: 0.0441778   valid_1's binary_logloss: 0
.0825869
[I 2021-05-09 16:12:04,102] Trial 11 finished with value: 0.061584287021359
56 and parameters: {'lambda_l1': 1.780143752470679, 'lambda_l2': 1.04131535
98568047e-08, 'num_leaves': 66, 'feature_fraction': 0.6005857153089216, 'ba
gging_fraction': 0.728041277527194, 'bagging_freq': 7, 'min_child_samples':
97, 'max_depth': 5}. Best is trial 10 with value: 0.0599211266953847.
[60]   training's binary_logloss: 0.0326492   valid_1's binary_logloss: 0
.0823164
[80]   training's binary_logloss: 0.0248285   valid_1's binary_logloss: 0
.0808349
Early stopping, best iteration is:
[75]   training's binary_logloss: 0.0263993   valid_1's binary_logloss: 0
.0797861
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.026399326195101)]), 'valid_1': OrderedDict([('
binary_logloss', 0.07978612420561991)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0778885   valid_1's binary_logloss: 0
.074204
[40]   training's binary_logloss: 0.0487738   valid_1's binary_logloss: 0
.0560448
[60]   training's binary_logloss: 0.0331431   valid_1's binary_logloss: 0
.0512699
[80]   training's binary_logloss: 0.0232866   valid_1's binary_logloss: 0
.0509711
[100]  training's binary_logloss: 0.018357    valid_1's binary_logloss: 0
.0512418
Early stopping, best iteration is:
[91]   training's binary_logloss: 0.0201188   valid_1's binary_logloss: 0
.0496801
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02011884749511364)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.049680113140000426)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0778219   valid_1's binary_logloss: 0
.0753893
[40]   training's binary_logloss: 0.0497072   valid_1's binary_logloss: 0
.0519926
[60]   training's binary_logloss: 0.0349997   valid_1's binary_logloss: 0
.0485606
[80]   training's binary_logloss: 0.0259149   valid_1's binary_logloss: 0
.0480313
Early stopping, best iteration is:

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[69]    training's binary_logloss: 0.0307532    valid_1's binary_logloss: 0
      .047309
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.030753180036375637)]), 'valid_1': OrderedDict([('binary_logloss', 0.04730900843157531)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0747052    valid_1's binary_logloss: 0
      .0919703
[40]    training's binary_logloss: 0.0459656    valid_1's binary_logloss: 0
      .0699169
[60]    training's binary_logloss: 0.0323214    valid_1's binary_logloss: 0
      .0666172
[80]    training's binary_logloss: 0.0237527    valid_1's binary_logloss: 0
      .068317
Early stopping, best iteration is:
[65]    training's binary_logloss: 0.0292429    valid_1's binary_logloss: 0
      .0658703
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02924290255445369)]), 'valid_1': OrderedDict([('binary_logloss', 0.0658703255363799)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0761009    valid_1's binary_logloss: 0
      .0814623
[40]    training's binary_logloss: 0.0460997    valid_1's binary_logloss: 0
      .0665475
[I 2021-05-09 16:12:04,922] Trial 12 finished with value: 0.061021091963470
94 and parameters: {'lambda_l1': 1.7174230022054697, 'lambda_l2': 1.5071724
51012707e-07, 'num_leaves': 100, 'feature_fraction': 0.6158669487073364, 'b
agging_fraction': 0.714051097214322, 'bagging_freq': 7, 'min_child_samples'
: 99, 'max_depth': 7}. Best is trial 10 with value: 0.0599211266953847.
[60]    training's binary_logloss: 0.0296676    valid_1's binary_logloss: 0
      .0660707
Early stopping, best iteration is:
[53]    training's binary_logloss: 0.0344846    valid_1's binary_logloss: 0
      .0649181
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03448455200161861)]), 'valid_1': OrderedDict([('binary_logloss', 0.0649181367400713)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0712987    valid_1's binary_logloss: 0
      .0962976
[40]    training's binary_logloss: 0.0435532    valid_1's binary_logloss: 0
      .0814634
[60]    training's binary_logloss: 0.0317029    valid_1's binary_logloss: 0
      .0803428
[80]    training's binary_logloss: 0.023381    valid_1's binary_logloss: 0
      .0782744
Early stopping, best iteration is:
[78]    training's binary_logloss: 0.0239749    valid_1's binary_logloss: 0
      .0773279
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.023974933743736052)]), 'valid_1': OrderedDict([('binary_logloss', 0.07732787596932779)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0738602    valid_1's binary_logloss: 0
      .0718336
[40]    training's binary_logloss: 0.0397732    valid_1's binary_logloss: 0
      .0528137
[60]    training's binary_logloss: 0.0234267    valid_1's binary_logloss: 0
      .053643

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Early stopping, best iteration is:
[45]   training's binary_logloss: 0.0348296   valid_1's binary_logloss: 0
      .0515113
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03482955153153271)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.05151133948787077)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0710279   valid_1's binary_logloss: 0
      .0704005
[40]   training's binary_logloss: 0.0376485   valid_1's binary_logloss: 0
      .0503756
[60]   training's binary_logloss: 0.0224266   valid_1's binary_logloss: 0
      .0475956
[80]   training's binary_logloss: 0.0147466   valid_1's binary_logloss: 0
      .0495042
Early stopping, best iteration is:
[62]   training's binary_logloss: 0.021464   valid_1's binary_logloss: 0
      .0469988
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.021464021995350226)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.04699878664135155)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0676944   valid_1's binary_logloss: 0
      .0866832
[40]   training's binary_logloss: 0.0374431   valid_1's binary_logloss: 0
      .0708743
[60]   training's binary_logloss: 0.0233996   valid_1's binary_logloss: 0
      .0684757
[80]   training's binary_logloss: 0.0129575   valid_1's binary_logloss: 0
      .0733227
Early stopping, best iteration is:
[60]   training's binary_logloss: 0.0233996   valid_1's binary_logloss: 0
      .0684757
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02339959582568555)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06847574239879814)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0701524   valid_1's binary_logloss: 0
      .07953
[I 2021-05-09 16:12:05,658] Trial 13 finished with value: 0.060783894865444
2 and parameters: {'lambda_11': 0.04914005309937112, 'lambda_12': 5.8465798
11439404e-07, 'num_leaves': 99, 'feature_fraction': 0.5604360770071173, 'ba
gging_fraction': 0.6144123843529192, 'bagging_freq': 5, 'min_child_samples'
: 73, 'max_depth': 5}. Best is trial 10 with value: 0.0599211266953847.
[40]   training's binary_logloss: 0.0377733   valid_1's binary_logloss: 0
      .0629612
[60]   training's binary_logloss: 0.021866   valid_1's binary_logloss: 0
      .0638354
Early stopping, best iteration is:
[48]   training's binary_logloss: 0.0299351   valid_1's binary_logloss: 0
      .0600425
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.029935114751704676)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06004248333634328)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0677689   valid_1's binary_logloss: 0
      .0948603
[40]   training's binary_logloss: 0.0380416   valid_1's binary_logloss: 0
      .0808742
[60]   training's binary_logloss: 0.0229462   valid_1's binary_logloss: 0

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.0783221
Early stopping, best iteration is:
[56]   training's binary_logloss: 0.0247686   valid_1's binary_logloss: 0
.0768911
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02476864590817972)]), 'valid_1': OrderedDict([('binary_logloss', 0.07689112246285727)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0624277   valid_1's binary_logloss: 0
.0670265
[40]   training's binary_logloss: 0.0252465   valid_1's binary_logloss: 0
.0513756
[60]   training's binary_logloss: 0.0115926   valid_1's binary_logloss: 0
.0529248
Early stopping, best iteration is:
[47]   training's binary_logloss: 0.018752   valid_1's binary_logloss: 0
.0512568
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.018752002334911467)]), 'valid_1': OrderedDict([('binary_logloss', 0.051256848992203626)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0638704   valid_1's binary_logloss: 0
.067733
[40]   training's binary_logloss: 0.0283591   valid_1's binary_logloss: 0
.0477833
[60]   training's binary_logloss: 0.0125597   valid_1's binary_logloss: 0
.0495056
Early stopping, best iteration is:
[40]   training's binary_logloss: 0.0283591   valid_1's binary_logloss: 0
.0477833
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.028359064418525908)]), 'valid_1': OrderedDict([('binary_logloss', 0.047783318024477904)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0603047   valid_1's binary_logloss: 0
.0828424
[40]   training's binary_logloss: 0.0255334   valid_1's binary_logloss: 0
.0661344
[60]   training's binary_logloss: 0.0106984   valid_1's binary_logloss: 0
.0704539
Early stopping, best iteration is:
[49]   training's binary_logloss: 0.0172294   valid_1's binary_logloss: 0
.0654446
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01722936196244617)]), 'valid_1': OrderedDict([('binary_logloss', 0.06544455787048456)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0596806   valid_1's binary_logloss: 0
.0791057
[40]   training's binary_logloss: 0.0249386   valid_1's binary_logloss: 0
.0665346
[60]   training's binary_logloss: 0.010119   valid_1's binary_logloss: 0
.070655
Early stopping, best iteration is:
[46]   training's binary_logloss: 0.018649   valid_1's binary_logloss: 0
.065972
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01864903177321208)]), 'valid_1': OrderedDict([('binary_logloss', 0.06597200374912061)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0601007   valid_1's binary_logloss: 0
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.0922356

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[I 2021-05-09 16:12:06,450] Trial 14 finished with value: 0.062067952887397
78 and parameters: {'lambda_11': 0.04033188569668525, 'lambda_12': 0.000233
29181939133058, 'num_leaves': 67, 'feature_fraction': 0.7006853329769245, '
bagging_fraction': 0.7946784493448518, 'bagging_freq': 6, 'min_child_sample
s': 64, 'max_depth': 8}. Best is trial 10 with value: 0.0599211266953847.
[40]    training's binary_logloss: 0.0266613    valid_1's binary_logloss: 0
.0801241
[60]    training's binary_logloss: 0.0107503    valid_1's binary_logloss: 0
.083902
Early stopping, best iteration is:
[47]    training's binary_logloss: 0.0204037    valid_1's binary_logloss: 0
.079883
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.020403676903765763)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.0798830358007022)]))}
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0749109    valid_1's binary_logloss: 0
.0727713
[40]    training's binary_logloss: 0.0444436    valid_1's binary_logloss: 0
.0550195
[60]    training's binary_logloss: 0.0263833    valid_1's binary_logloss: 0
.0517516
Early stopping, best iteration is:
[53]    training's binary_logloss: 0.0312077    valid_1's binary_logloss: 0
.0492538
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.03120771089968267)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.04925383837785147)]))}
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0751605    valid_1's binary_logloss: 0
.0721209
[40]    training's binary_logloss: 0.0439013    valid_1's binary_logloss: 0
.0519471
[60]    training's binary_logloss: 0.0263359    valid_1's binary_logloss: 0
.0484604
Early stopping, best iteration is:
[58]    training's binary_logloss: 0.0279651    valid_1's binary_logloss: 0
.0475402
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.027965072752863345)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.04754018773886847)]))}
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0710649    valid_1's binary_logloss: 0
.0881666
[40]    training's binary_logloss: 0.0421889    valid_1's binary_logloss: 0
.0711632
[60]    training's binary_logloss: 0.0280083    valid_1's binary_logloss: 0
.0703896
[80]    training's binary_logloss: 0.0157833    valid_1's binary_logloss: 0
.0696464
Early stopping, best iteration is:
[64]    training's binary_logloss: 0.0237939    valid_1's binary_logloss: 0
.0675029
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.02379386889731306)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.06750287078479593)]))}
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0727001    valid_1's binary_logloss: 0
.0808846
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[40]    training's binary_logloss: 0.0417262    valid_1's binary_logloss: 0
      .0647046
[60]    training's binary_logloss: 0.0252921    valid_1's binary_logloss: 0
      .0648506
Early stopping, best iteration is:
[42]    training's binary_logloss: 0.0387516    valid_1's binary_logloss: 0
      .0636945
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03875157453528381)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06369449599748629)]))
Training until validation scores don't improve for 20 rounds
[I 2021-05-09 16:12:07,129] Trial 15 finished with value: 0.061112122064051
74 and parameters: {'lambda_l1': 0.0668185597154472, 'lambda_l2': 1.0695824
350177772e-08, 'num_leaves': 76, 'feature_fraction': 0.48682350794395385, '
bagging_fraction': 0.5446017091214111, 'bagging_freq': 5, 'min_child_sample
s': 90, 'max_depth': 10}. Best is trial 10 with value: 0.0599211266953847.
[20]    training's binary_logloss: 0.0713375    valid_1's binary_logloss: 0
      .09589
[40]    training's binary_logloss: 0.0434302    valid_1's binary_logloss: 0
      .0817522
[60]    training's binary_logloss: 0.0254749    valid_1's binary_logloss: 0
      .0780035
Early stopping, best iteration is:
[59]    training's binary_logloss: 0.0259462    valid_1's binary_logloss: 0
      .0775692
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.025946170730579046)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.07756921742125655)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0854631    valid_1's binary_logloss: 0
      .0797797
[40]    training's binary_logloss: 0.0658692    valid_1's binary_logloss: 0
      .0624544
[60]    training's binary_logloss: 0.0602522    valid_1's binary_logloss: 0
      .0586113
[80]    training's binary_logloss: 0.0588739    valid_1's binary_logloss: 0
      .0573575
[100]   training's binary_logloss: 0.0574957    valid_1's binary_logloss: 0
      .0568216
[120]   training's binary_logloss: 0.0569082    valid_1's binary_logloss: 0
      .0564632
[140]   training's binary_logloss: 0.0567057    valid_1's binary_logloss: 0
      .0565402
Early stopping, best iteration is:
[122]   training's binary_logloss: 0.0568873    valid_1's binary_logloss: 0
      .0564429
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.05688732008533542)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.056442907861237436)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0872121    valid_1's binary_logloss: 0
      .0818236
[40]    training's binary_logloss: 0.0656957    valid_1's binary_logloss: 0
      .0600011
[60]    training's binary_logloss: 0.0588046    valid_1's binary_logloss: 0
      .0546876
[80]    training's binary_logloss: 0.0573107    valid_1's binary_logloss: 0
      .0528947
[100]   training's binary_logloss: 0.0567984    valid_1's binary_logloss: 0
      .0524899

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[120]   training's binary_logloss: 0.0561016   valid_1's binary_logloss: 0
      .0514647
[140]   training's binary_logloss: 0.0535362   valid_1's binary_logloss: 0
      .0507956
Early stopping, best iteration is:
[138]   training's binary_logloss: 0.0537577   valid_1's binary_logloss: 0
      .0507282
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.053757724170014606)]), 'valid_1': OrderedDict
([('binary_logloss', 0.05072816811341833)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0832668   valid_1's binary_logloss: 0
      .0979803
[40]   training's binary_logloss: 0.0616235   valid_1's binary_logloss: 0
      .0798258
[60]   training's binary_logloss: 0.0553944   valid_1's binary_logloss: 0
      .0753375
[80]   training's binary_logloss: 0.0540977   valid_1's binary_logloss: 0
      .0748781
[100]  training's binary_logloss: 0.0534543   valid_1's binary_logloss: 0
      .0745261
[120]  training's binary_logloss: 0.0520051   valid_1's binary_logloss: 0
      .073409
Early stopping, best iteration is:
[119]  training's binary_logloss: 0.0520051   valid_1's binary_logloss: 0
      .073409
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.052005136916109806)]), 'valid_1': OrderedDict
([('binary_logloss', 0.07340899147000755)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0844313   valid_1's binary_logloss: 0
      .0854169
[40]   training's binary_logloss: 0.0622483   valid_1's binary_logloss: 0
      .0696806
[60]   training's binary_logloss: 0.0561924   valid_1's binary_logloss: 0
      .0662164
[80]   training's binary_logloss: 0.0560084   valid_1's binary_logloss: 0
      .0661234
[100]  training's binary_logloss: 0.0551029   valid_1's binary_logloss: 0
      .0655864
[120]  training's binary_logloss: 0.0543473   valid_1's binary_logloss: 0
      .0653768
[140]  training's binary_logloss: 0.0523319   valid_1's binary_logloss: 0
      .0648854
[160]  training's binary_logloss: 0.0512579   valid_1's binary_logloss: 0
      .0651385
Early stopping, best iteration is:
[140]  training's binary_logloss: 0.0523319   valid_1's binary_logloss: 0
      .0648854
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.052331945139954435)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06488538784943511)]))
[I 2021-05-09 16:12:07,877] Trial 16 finished with value: 0.065480307181454
24 and parameters: {'lambda_l1': 9.270574136627706, 'lambda_l2': 7.64380917
0893614e-05, 'num_leaves': 57, 'feature_fraction': 0.6549293469073768, 'bag
ging_fraction': 0.6576954052681953, 'bagging_freq': 7, 'min_child_samples':
86, 'max_depth': 5}. Best is trial 10 with value: 0.0599211266953847.
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0814084   valid_1's binary_logloss: 0
      .103018

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[40]    training's binary_logloss: 0.0597959    valid_1's binary_logloss: 0
.0869156
[60]    training's binary_logloss: 0.0550733    valid_1's binary_logloss: 0
.0844856
[80]    training's binary_logloss: 0.0539771    valid_1's binary_logloss: 0
.083227
[100]   training's binary_logloss: 0.0525669    valid_1's binary_logloss: 0
.0829013
[120]   training's binary_logloss: 0.0513633    valid_1's binary_logloss: 0
.0820522
[140]   training's binary_logloss: 0.0512829    valid_1's binary_logloss: 0
.0819679
[160]   training's binary_logloss: 0.0507427    valid_1's binary_logloss: 0
.0821945
Early stopping, best iteration is:
[151]   training's binary_logloss: 0.0512252    valid_1's binary_logloss: 0
.0819361
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.05122521769800995)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.0819360806131728)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.066343     valid_1's binary_logloss: 0
.0696445
[40]    training's binary_logloss: 0.0302074     valid_1's binary_logloss: 0
.0549697
[60]    training's binary_logloss: 0.014654     valid_1's binary_logloss: 0
.0535369
Early stopping, best iteration is:
[55]    training's binary_logloss: 0.0177218     valid_1's binary_logloss: 0
.0519354
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.017721807652010424)]), 'valid_1': OrderedDict
[('binary_logloss', 0.05193539581452895)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0663093     valid_1's binary_logloss: 0
.0679861
[40]    training's binary_logloss: 0.0308831     valid_1's binary_logloss: 0
.0510764
[60]    training's binary_logloss: 0.015581     valid_1's binary_logloss: 0
.0498956
Early stopping, best iteration is:
[58]    training's binary_logloss: 0.0166449     valid_1's binary_logloss: 0
.0494684
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.016644867891319005)]), 'valid_1': OrderedDict
[('binary_logloss', 0.049468399995851155)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0616578     valid_1's binary_logloss: 0
.0834472
[40]    training's binary_logloss: 0.0271126     valid_1's binary_logloss: 0
.0662144
[60]    training's binary_logloss: 0.0132907     valid_1's binary_logloss: 0
.0644313
Early stopping, best iteration is:
[45]    training's binary_logloss: 0.021895     valid_1's binary_logloss: 0
.0638861
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0218950290439609)]), 'valid_1': OrderedDict([
('binary_logloss', 0.06388612718977278)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0648089     valid_1's binary_logloss: 0

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.0790497

[I 2021-05-09 16:12:08,646] Trial 17 finished with value: 0.060991279999016726 and parameters: {'lambda_11': 0.3997568086184113, 'lambda_12': 0.004666015060615487, 'num_leaves': 93, 'feature_fraction': 0.7639186893665711, 'bagging_fraction': 0.7620166790257517, 'bagging_freq': 1, 'min_child_samples': 62, 'max_depth': 7}. Best is trial 10 with value: 0.0599211266953847.

[40] training's binary_logloss: 0.0280179 valid_1's binary_logloss: 0.0639835

[60] training's binary_logloss: 0.0136514 valid_1's binary_logloss: 0.0678764

Early stopping, best iteration is:

[45] training's binary_logloss: 0.0231526 valid_1's binary_logloss: 0.0634186

best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.023152593642109278)]}, 'valid_1': OrderedDict([('binary_logloss', 0.06341861361187782)]))

Training until validation scores don't improve for 20 rounds

[20] training's binary_logloss: 0.0627715 valid_1's binary_logloss: 0.0933024

[40] training's binary_logloss: 0.0279171 valid_1's binary_logloss: 0.0767862

Early stopping, best iteration is:

[38] training's binary_logloss: 0.0305217 valid_1's binary_logloss: 0.0762479

best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.030521658380675117)]}, 'valid_1': OrderedDict([('binary_logloss', 0.07624786338305288)]))

Training until validation scores don't improve for 20 rounds

[20] training's binary_logloss: 0.0718661 valid_1's binary_logloss: 0.0687434

[40] training's binary_logloss: 0.0412917 valid_1's binary_logloss: 0.053846

[60] training's binary_logloss: 0.0248506 valid_1's binary_logloss: 0.048878

Early stopping, best iteration is:

[59] training's binary_logloss: 0.025264 valid_1's binary_logloss: 0.0485589

best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.025264009266932445)]}, 'valid_1': OrderedDict([('binary_logloss', 0.04855887396412952)]))

Training until validation scores don't improve for 20 rounds

[20] training's binary_logloss: 0.0687159 valid_1's binary_logloss: 0.0672466

[40] training's binary_logloss: 0.0406028 valid_1's binary_logloss: 0.043781

[60] training's binary_logloss: 0.0254212 valid_1's binary_logloss: 0.0459203

Early stopping, best iteration is:

[42] training's binary_logloss: 0.0388463 valid_1's binary_logloss: 0.0432086

best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03884633921095206)]}, 'valid_1': OrderedDict([('binary_logloss', 0.043208564456698906)]))

Training until validation scores don't improve for 20 rounds

[20] training's binary_logloss: 0.0677111 valid_1's binary_logloss: 0.081563

[40] training's binary_logloss: 0.0356211 valid_1's binary_logloss: 0.0687473

[60] training's binary_logloss: 0.023 valid_1's binary_logloss: 0.0695524

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Early stopping, best iteration is:
[54]   training's binary_logloss: 0.0248287   valid_1's binary_logloss: 0.0666083
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.024828679675131294)]), 'valid_1': OrderedDict([('binary_logloss', 0.06660833820930696)])})
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0691152   valid_1's binary_logloss: 0.0798205
[40]   training's binary_logloss: 0.0374963   valid_1's binary_logloss: 0.0623495
Early stopping, best iteration is:
[39]   training's binary_logloss: 0.0384525   valid_1's binary_logloss: 0.0618909
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03845247745480643)]), 'valid_1': OrderedDict([('binary_logloss', 0.06189094433198296)])})
Training until validation scores don't improve for 20 rounds
[I 2021-05-09 16:12:09,201] Trial 18 finished with value: 0.06041770970180408 and parameters: {'lambda_l1': 0.005305277102439596, 'lambda_l2': 4.3680813423669813e-07, 'num_leaves': 56, 'feature_fraction': 0.534861054538176, 'bagging_fraction': 0.40692077835070667, 'bagging_freq': 6, 'min_child_samples': 47, 'max_depth': 6}. Best is trial 10 with value: 0.0599211266953847.
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[20]      training's binary_logloss: 0.0655712      valid_1's binary_logloss: 0
.09267
[40]      training's binary_logloss: 0.0381836      valid_1's binary_logloss: 0
.0820752
Early stopping, best iteration is:
[32]      training's binary_logloss: 0.0459427      valid_1's binary_logloss: 0
.0818218
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04594269828314388)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.08182182754690204)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0531564      valid_1's binary_logloss: 0
.0635859
[40]      training's binary_logloss: 0.0158476      valid_1's binary_logloss: 0
.0483177
[60]      training's binary_logloss: 0.00525338      valid_1's binary_logloss: 0
.0515214
Early stopping, best iteration is:
[41]      training's binary_logloss: 0.0149403      valid_1's binary_logloss: 0
.0481217
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.014940272425662449)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.04812171554024856)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.052318      valid_1's binary_logloss: 0
.0675083
[40]      training's binary_logloss: 0.0162839      valid_1's binary_logloss: 0
.0500283
Early stopping, best iteration is:
[39]      training's binary_logloss: 0.0172898      valid_1's binary_logloss: 0
.0497607
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01728976829467802)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.04976071505393456)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0500116      valid_1's binary_logloss: 0
.0790754
[40]      training's binary_logloss: 0.0164844      valid_1's binary_logloss: 0
.0684344
Early stopping, best iteration is:
[37]      training's binary_logloss: 0.0193701      valid_1's binary_logloss: 0
.0676091
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.019370131710748015)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06760910955464962)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0527478      valid_1's binary_logloss: 0
.0778064
[40]      training's binary_logloss: 0.0160078      valid_1's binary_logloss: 0
.0684087
[60]      training's binary_logloss: 0.00526834      valid_1's binary_logloss: 0
.0749241
Early stopping, best iteration is:
[40]      training's binary_logloss: 0.0160078      valid_1's binary_logloss: 0
.0684087
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01600775125434466)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.0684087482026522)]))
Training until validation scores don't improve for 20 rounds

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[I 2021-05-09 16:12:10,150] Trial 19 finished with value: 0.061895218191454
77 and parameters: {'lambda_11': 0.003789209663570481, 'lambda_12': 9.70432
2959082797e-08, 'num_leaves': 54, 'feature_fraction': 0.7946380027876847, '
bagging_fraction': 0.8342296062370663, 'bagging_freq': 4, 'min_child_sample
s': 37, 'max_depth': 11}. Best is trial 10 with value: 0.0599211266953847.
[20]   training's binary_logloss: 0.050611      valid_1's binary_logloss: 0
.0893949
[40]   training's binary_logloss: 0.0168122      valid_1's binary_logloss: 0
.0779546
Early stopping, best iteration is:
[36]   training's binary_logloss: 0.0212695      valid_1's binary_logloss: 0
.0755758
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.021269480771854275)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.07557580260578896)]))}
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.094589      valid_1's binary_logloss: 0
.086589
[40]   training's binary_logloss: 0.0757455      valid_1's binary_logloss: 0
.068049
[60]   training's binary_logloss: 0.070159      valid_1's binary_logloss: 0
.0633247
[80]   training's binary_logloss: 0.068037      valid_1's binary_logloss: 0
.0620768
[100]  training's binary_logloss: 0.0668753      valid_1's binary_logloss: 0
.0613184
[120]  training's binary_logloss: 0.0660439      valid_1's binary_logloss: 0
.0613022
[140]  training's binary_logloss: 0.0653779      valid_1's binary_logloss: 0
.0608269
[160]  training's binary_logloss: 0.0650061      valid_1's binary_logloss: 0
.0605758
[180]  training's binary_logloss: 0.0647372      valid_1's binary_logloss: 0
.0604301
[200]  training's binary_logloss: 0.0644436      valid_1's binary_logloss: 0
.0602512
[220]  training's binary_logloss: 0.0640337      valid_1's binary_logloss: 0
.0599885
[240]  training's binary_logloss: 0.0636839      valid_1's binary_logloss: 0
.0597388
[260]  training's binary_logloss: 0.0633331      valid_1's binary_logloss: 0
.0593506
[280]  training's binary_logloss: 0.0632515      valid_1's binary_logloss: 0
.0592654
[300]  training's binary_logloss: 0.0629869      valid_1's binary_logloss: 0
.0588334
[320]  training's binary_logloss: 0.0624036      valid_1's binary_logloss: 0
.0587549
[340]  training's binary_logloss: 0.0620548      valid_1's binary_logloss: 0
.0584011
[360]  training's binary_logloss: 0.0619017      valid_1's binary_logloss: 0
.0584055
Early stopping, best iteration is:
[351]  training's binary_logloss: 0.0619528      valid_1's binary_logloss: 0
.058392
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.06195281919878288)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.058391953541819905)]))}
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0963664      valid_1's binary_logloss: 0

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.0884923
[40]   training's binary_logloss: 0.0769678   valid_1's binary_logloss: 0
.067059
[60]   training's binary_logloss: 0.0717208   valid_1's binary_logloss: 0
.0613844
[80]   training's binary_logloss: 0.0699016   valid_1's binary_logloss: 0
.0587488
[100]  training's binary_logloss: 0.0688513   valid_1's binary_logloss: 0
.0572372
[120]  training's binary_logloss: 0.0679833   valid_1's binary_logloss: 0
.0565663
[140]  training's binary_logloss: 0.0677012   valid_1's binary_logloss: 0
.0562972
[160]  training's binary_logloss: 0.0672038   valid_1's binary_logloss: 0
.0559288
[180]  training's binary_logloss: 0.0668585   valid_1's binary_logloss: 0
.0554868
[200]  training's binary_logloss: 0.0664101   valid_1's binary_logloss: 0
.0548383
[220]  training's binary_logloss: 0.066209    valid_1's binary_logloss: 0
.054491
[240]  training's binary_logloss: 0.065758    valid_1's binary_logloss: 0
.0540706
[260]  training's binary_logloss: 0.0654472   valid_1's binary_logloss: 0
.0540592
Early stopping, best iteration is:
[242]  training's binary_logloss: 0.0656915   valid_1's binary_logloss: 0
.0539369
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.06569146764873765)]), 'valid_1': OrderedDict([('binary_logloss', 0.05393694962669071)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0900613   valid_1's binary_logloss: 0
.103249
[40]   training's binary_logloss: 0.0703517   valid_1's binary_logloss: 0
.0848495
[60]   training's binary_logloss: 0.0652984   valid_1's binary_logloss: 0
.0809352
[80]   training's binary_logloss: 0.0634153   valid_1's binary_logloss: 0
.0797186
[100]  training's binary_logloss: 0.0625027   valid_1's binary_logloss: 0
.0792501
[120]  training's binary_logloss: 0.0618334   valid_1's binary_logloss: 0
.0787132
[140]  training's binary_logloss: 0.0615183   valid_1's binary_logloss: 0
.078472
[160]  training's binary_logloss: 0.061025    valid_1's binary_logloss: 0
.0780685
[180]  training's binary_logloss: 0.0607682   valid_1's binary_logloss: 0
.0779784
[200]  training's binary_logloss: 0.060354    valid_1's binary_logloss: 0
.077762
[220]  training's binary_logloss: 0.0601715   valid_1's binary_logloss: 0
.0777909
Early stopping, best iteration is:
[209]  training's binary_logloss: 0.0603042   valid_1's binary_logloss: 0
.0776915
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.06030421972424167)]), 'valid_1': OrderedDict([('binary_logloss', 0.07769150621628369)]))
Training until validation scores don't improve for 20 rounds

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[20]    training's binary_logloss: 0.0946435    valid_1's binary_logloss: 0
.0905915
[40]    training's binary_logloss: 0.0751642    valid_1's binary_logloss: 0
.0735307
[60]    training's binary_logloss: 0.0691313    valid_1's binary_logloss: 0
.0691739
[80]    training's binary_logloss: 0.0666567    valid_1's binary_logloss: 0
.0678391
[100]   training's binary_logloss: 0.065304     valid_1's binary_logloss: 0
.0669954
[120]   training's binary_logloss: 0.0642883    valid_1's binary_logloss: 0
.066711
[140]   training's binary_logloss: 0.0638862    valid_1's binary_logloss: 0
.0664828
[160]   training's binary_logloss: 0.0636318    valid_1's binary_logloss: 0
.0663079

[I 2021-05-09 16:12:10,862] Trial 20 finished with value: 0.067892465833385
39 and parameters: {'lambda_l1': 9.73937950642874, 'lambda_l2': 2.926534853
8739113e-08, 'num_leaves': 2, 'feature_fraction': 0.5942609578451848, 'bagg
ing_fraction': 0.6633724457556189, 'bagging_freq': 6, 'min_child_samples':
48, 'max_depth': 6}. Best is trial 10 with value: 0.0599211266953847.
[180]   training's binary_logloss: 0.0632926    valid_1's binary_logloss: 0
.0662091
[200]   training's binary_logloss: 0.0630382    valid_1's binary_logloss: 0
.0660718
[220]   training's binary_logloss: 0.0627098    valid_1's binary_logloss: 0
.0660803
Early stopping, best iteration is:
[201]   training's binary_logloss: 0.0630323    valid_1's binary_logloss: 0
.0660617
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0630323387993812)]), 'valid_1': OrderedDict([
('binary_logloss', 0.06606174313208509)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0900738    valid_1's binary_logloss: 0
.109787
[40]    training's binary_logloss: 0.0700791    valid_1's binary_logloss: 0
.0922065
[60]    training's binary_logloss: 0.0651749    valid_1's binary_logloss: 0
.0879642
[80]    training's binary_logloss: 0.0631234    valid_1's binary_logloss: 0
.0863552
[100]   training's binary_logloss: 0.0615763    valid_1's binary_logloss: 0
.085343
[120]   training's binary_logloss: 0.0606952    valid_1's binary_logloss: 0
.0843336
[140]   training's binary_logloss: 0.0605951    valid_1's binary_logloss: 0
.0841938
[160]   training's binary_logloss: 0.0598876    valid_1's binary_logloss: 0
.0840088
[180]   training's binary_logloss: 0.0595045    valid_1's binary_logloss: 0
.0837708
[200]   training's binary_logloss: 0.0592401    valid_1's binary_logloss: 0
.0834025
Early stopping, best iteration is:
[197]   training's binary_logloss: 0.0592619    valid_1's binary_logloss: 0
.0833802
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.05926185940869259)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.08338017665004756)]))

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Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0745638   valid_1's binary_logloss: 0
      .0717155
[40]   training's binary_logloss: 0.045371   valid_1's binary_logloss: 0
      .0526851
[60]   training's binary_logloss: 0.0285803   valid_1's binary_logloss: 0
      .0527629
[80]   training's binary_logloss: 0.0193466   valid_1's binary_logloss: 0
      .0546696
Early stopping, best iteration is:
[63]   training's binary_logloss: 0.0266644   valid_1's binary_logloss: 0
      .0519142
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.026664407509001793)]), 'valid_1': OrderedDict
([('binary_logloss', 0.05191416479327825)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0726712   valid_1's binary_logloss: 0
      .0729813
[40]   training's binary_logloss: 0.0447173   valid_1's binary_logloss: 0
      .0500753
[60]   training's binary_logloss: 0.0266482   valid_1's binary_logloss: 0
      .0535154
Early stopping, best iteration is:
[46]   training's binary_logloss: 0.0388356   valid_1's binary_logloss: 0
      .0494445
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03883560904071577)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.049444542764136186)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0708424   valid_1's binary_logloss: 0
      .0871669
[40]   training's binary_logloss: 0.0395365   valid_1's binary_logloss: 0
      .0690379
[60]   training's binary_logloss: 0.0250332   valid_1's binary_logloss: 0
      .0662225
Early stopping, best iteration is:
[58]   training's binary_logloss: 0.0267639   valid_1's binary_logloss: 0
      .0652747
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.026763931391699188)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06527470476637443)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0730124   valid_1's binary_logloss: 0
      .0801835
[40]   training's binary_logloss: 0.0420944   valid_1's binary_logloss: 0
      .0651278
[60]   training's binary_logloss: 0.0263328   valid_1's binary_logloss: 0
      .0634661
Early stopping, best iteration is:
[46]   training's binary_logloss: 0.0362421   valid_1's binary_logloss: 0
      .0627746
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.036242129356112165)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06277456095054601)]))
[I 2021-05-09 16:12:11,665] Trial 21 finished with value: 0.062216212560495
66 and parameters: {'lambda_l1': 0.010088798066984265, 'lambda_l2': 7.66063
9718235148e-07, 'num_leaves': 44, 'feature_fraction': 0.5053651807453146, '
bagging_fraction': 0.40909658663193854, 'bagging_freq': 7, 'min_child_sampl
es': 58, 'max_depth': 7}. Best is trial 10 with value: 0.0599211266953847.
Training until validation scores don't improve for 20 rounds

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[20]    training's binary_logloss: 0.069439    valid_1's binary_logloss: 0
      .0949583
[40]    training's binary_logloss: 0.0403384    valid_1's binary_logloss: 0
      .0828907
Early stopping, best iteration is:
[35]    training's binary_logloss: 0.0461417    valid_1's binary_logloss: 0
      .0816731
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04614174494987827)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.0816730895281434)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0716681    valid_1's binary_logloss: 0
      .0702157
[40]    training's binary_logloss: 0.040425    valid_1's binary_logloss: 0
      .0534517
[60]    training's binary_logloss: 0.024627    valid_1's binary_logloss: 0
      .0492677
[80]    training's binary_logloss: 0.0148197    valid_1's binary_logloss: 0
      .0487334
Early stopping, best iteration is:
[63]    training's binary_logloss: 0.0227388    valid_1's binary_logloss: 0
      .0484492
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.022738843893817733)]), 'valid_1': OrderedDict
[('binary_logloss', 0.04844915700283163)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0694798    valid_1's binary_logloss: 0
      .0687714
[40]    training's binary_logloss: 0.0403794    valid_1's binary_logloss: 0
      .0512376
[60]    training's binary_logloss: 0.0256175    valid_1's binary_logloss: 0
      .0525848
Early stopping, best iteration is:
[47]    training's binary_logloss: 0.0349017    valid_1's binary_logloss: 0
      .0508844
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.034901746763929625)]), 'valid_1': OrderedDict
[('binary_logloss', 0.05088444164498065)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0675012    valid_1's binary_logloss: 0
      .0848429
[40]    training's binary_logloss: 0.0361255    valid_1's binary_logloss: 0
      .0673599
[60]    training's binary_logloss: 0.0238842    valid_1's binary_logloss: 0
      .0668353
Early stopping, best iteration is:
[55]    training's binary_logloss: 0.0257473    valid_1's binary_logloss: 0
      .0655976
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.025747332759962105)]), 'valid_1': OrderedDict
[('binary_logloss', 0.06559763491676537)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0676947    valid_1's binary_logloss: 0
      .0785854
[40]    training's binary_logloss: 0.0385944    valid_1's binary_logloss: 0
      .0675913
[60]    training's binary_logloss: 0.0247174    valid_1's binary_logloss: 0
      .0701039
Early stopping, best iteration is:
[43]    training's binary_logloss: 0.0367838    valid_1's binary_logloss: 0
      .0675066

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best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.036783771038760286)]), 'valid_1': OrderedDict([('binary_logloss', 0.06750655340192357)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0653075 valid_1's binary_logloss: 0.0939187

[I 2021-05-09 16:12:12,334] Trial 22 finished with value: 0.06324502500237039 and parameters: {'lambda_l1': 1.86024516352072e-05, 'lambda_l2': 7.927622631299296e-07, 'num_leaves': 58, 'feature_fraction': 0.40239233031141275, 'bagging_fraction': 0.42971283459539844, 'bagging_freq': 6, 'min_child_samples': 39, 'max_depth': 5}. Best is trial 10 with value: 0.0599211266953847.
[40] training's binary_logloss: 0.0381509 valid_1's binary_logloss: 0.0879008
[60] training's binary_logloss: 0.0254189 valid_1's binary_logloss: 0.0882241
[80] training's binary_logloss: 0.0142621 valid_1's binary_logloss: 0.0848008
Early stopping, best iteration is:
[77] training's binary_logloss: 0.0156173 valid_1's binary_logloss: 0.0837873
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01561730033882248)]), 'valid_1': OrderedDict([('binary_logloss', 0.08378733804535071)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0797135 valid_1's binary_logloss: 0.0748755
[40] training's binary_logloss: 0.0500105 valid_1's binary_logloss: 0.054579
[60] training's binary_logloss: 0.0345774 valid_1's binary_logloss: 0.0498118
[80] training's binary_logloss: 0.0238885 valid_1's binary_logloss: 0.0471856
[100] training's binary_logloss: 0.0173879 valid_1's binary_logloss: 0.0476656
Early stopping, best iteration is:
[81] training's binary_logloss: 0.0235523 valid_1's binary_logloss: 0.0470705
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.023552250583847727)]), 'valid_1': OrderedDict([('binary_logloss', 0.04707054663677251)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0782248 valid_1's binary_logloss: 0.0751587
[40] training's binary_logloss: 0.0520484 valid_1's binary_logloss: 0.0524491
[60] training's binary_logloss: 0.0333811 valid_1's binary_logloss: 0.0488617
[80] training's binary_logloss: 0.0242354 valid_1's binary_logloss: 0.0445844
Early stopping, best iteration is:
[76] training's binary_logloss: 0.0259797 valid_1's binary_logloss: 0.0437195
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.02597972187747291)]), 'valid_1': OrderedDict([('binary_logloss', 0.043719493648308204)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0753096 valid_1's binary_logloss: 0.0917864
[40] training's binary_logloss: 0.0459249 valid_1's binary_logloss: 0.0713452

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[60]    training's binary_logloss: 0.0324155    valid_1's binary_logloss: 0
.0674775
[80]    training's binary_logloss: 0.0245882    valid_1's binary_logloss: 0
.0665713
[100]   training's binary_logloss: 0.0175598    valid_1's binary_logloss: 0
.0673845
Early stopping, best iteration is:
[93]    training's binary_logloss: 0.0192491    valid_1's binary_logloss: 0
.0657621
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01924913622554451)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06576210247064943)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.076936     valid_1's binary_logloss: 0
.0810722
[40]    training's binary_logloss: 0.0469424     valid_1's binary_logloss: 0
.0653734
[60]    training's binary_logloss: 0.0320858     valid_1's binary_logloss: 0
.0645118
Early stopping, best iteration is:
[55]    training's binary_logloss: 0.0363553     valid_1's binary_logloss: 0
.0633827

[I 2021-05-09 16:12:12,997] Trial 23 finished with value: 0.060627475238761
754 and parameters: {'lambda_l1': 0.7369384512952254, 'lambda_l2': 1.024134
6650003145e-05, 'num_leaves': 75, 'feature_fraction': 0.5408816768250956, '
bagging_fraction': 0.5410251085131459, 'bagging_freq': 7, 'min_child_sample
s': 99, 'max_depth': 8}. Best is trial 10 with value: 0.0599211266953847.
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.036355320996011485)]), 'valid_1': OrderedDict
[('binary_logloss', 0.06338272576120269)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0731358     valid_1's binary_logloss: 0
.0968854
[40]    training's binary_logloss: 0.046645     valid_1's binary_logloss: 0
.0841269
Early stopping, best iteration is:
[38]    training's binary_logloss: 0.0482276     valid_1's binary_logloss: 0
.0832025
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.048227566162420306)]), 'valid_1': OrderedDict
[('binary_logloss', 0.08320250767687594)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0755819     valid_1's binary_logloss: 0
.0728157
[40]    training's binary_logloss: 0.0461423     valid_1's binary_logloss: 0
.0546877
[60]    training's binary_logloss: 0.0311447     valid_1's binary_logloss: 0
.0539089
Early stopping, best iteration is:
[53]    training's binary_logloss: 0.0348938     valid_1's binary_logloss: 0
.0512149
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03489379463745979)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.05121491447136182)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0740064     valid_1's binary_logloss: 0
.0685096
[40]    training's binary_logloss: 0.0451522     valid_1's binary_logloss: 0
.0504218
[60]    training's binary_logloss: 0.0286195     valid_1's binary_logloss: 0

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.0477856
Early stopping, best iteration is:
[54]   training's binary_logloss: 0.0336016   valid_1's binary_logloss: 0
.0459093
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.033601632369445904)]), 'valid_1': OrderedDict([('binary_logloss', 0.045909338996384844)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0701318   valid_1's binary_logloss: 0
.08425
[40]   training's binary_logloss: 0.0422944   valid_1's binary_logloss: 0
.0689251
[60]   training's binary_logloss: 0.0291898   valid_1's binary_logloss: 0
.0699441
Early stopping, best iteration is:
[56]   training's binary_logloss: 0.0307226   valid_1's binary_logloss: 0
.0662178
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.030722614143929475)]), 'valid_1': OrderedDict([('binary_logloss', 0.0662178372731376)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0722596   valid_1's binary_logloss: 0
.07882
[40]   training's binary_logloss: 0.0435477   valid_1's binary_logloss: 0
.067196
[60]   training's binary_logloss: 0.0285521   valid_1's binary_logloss: 0
.067736
Early stopping, best iteration is:
[53]   training's binary_logloss: 0.0310189   valid_1's binary_logloss: 0
.0636795
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03101887103148442)]), 'valid_1': OrderedDict([('binary_logloss', 0.06367950188897434)]))
[I 2021-05-09 16:12:13,686] Trial 24 finished with value: 0.06137691599267083 and parameters: {'lambda_11': 0.008577654107839117, 'lambda_12': 2.1710177690715825e-07, 'num_leaves': 61, 'feature_fraction': 0.6446612536550301, 'bagging_fraction': 0.41363236333121184, 'bagging_freq': 5, 'min_child_samples': 71, 'max_depth': 6}. Best is trial 10 with value: 0.0599211266953847.
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0706686   valid_1's binary_logloss: 0
.0951047
[40]   training's binary_logloss: 0.0450062   valid_1's binary_logloss: 0
.0868777
[60]   training's binary_logloss: 0.0287334   valid_1's binary_logloss: 0
.0835286
[80]   training's binary_logloss: 0.0209466   valid_1's binary_logloss: 0
.087947
Early stopping, best iteration is:
[67]   training's binary_logloss: 0.0244867   valid_1's binary_logloss: 0
.079863
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.024486725104926818)]), 'valid_1': OrderedDict([('binary_logloss', 0.07986298733349559)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0763081   valid_1's binary_logloss: 0
.0713515
[40]   training's binary_logloss: 0.0458991   valid_1's binary_logloss: 0
.0533772
[60]   training's binary_logloss: 0.0268995   valid_1's binary_logloss: 0
.0500975
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[80]      training's binary_logloss: 0.0173082      valid_1's binary_logloss: 0
      .0503842
Early stopping, best iteration is:
[69]      training's binary_logloss: 0.0222006      valid_1's binary_logloss: 0
      .0484617
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.022200568816619155)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04846174511668607)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0749          valid_1's binary_logloss: 0
      .0719529
[40]      training's binary_logloss: 0.0455643      valid_1's binary_logloss: 0
      .0505666
[60]      training's binary_logloss: 0.0275289      valid_1's binary_logloss: 0
      .047257
[80]      training's binary_logloss: 0.0178211      valid_1's binary_logloss: 0
      .048333
Early stopping, best iteration is:
[65]      training's binary_logloss: 0.0242396      valid_1's binary_logloss: 0
      .045706
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.024239553793691047)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04570596706297358)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0713354      valid_1's binary_logloss: 0
      .087901
[40]      training's binary_logloss: 0.0407864      valid_1's binary_logloss: 0
      .0695828
[60]      training's binary_logloss: 0.0271825      valid_1's binary_logloss: 0
      .0707321
Early stopping, best iteration is:
[49]      training's binary_logloss: 0.0338745      valid_1's binary_logloss: 0
      .0676976
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03387446410018306)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.06769762266687211)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0741521      valid_1's binary_logloss: 0
      .0814711
[40]      training's binary_logloss: 0.0437405      valid_1's binary_logloss: 0
      .0670428
[I 2021-05-09 16:12:14,354] Trial 25 finished with value: 0.061920362507861
97 and parameters: {'lambda_l1': 0.22644415104153892, 'lambda_l2': 1.201743
2555911966e-08, 'num_leaves': 82, 'feature_fraction': 0.5678229220196189, '
bagging_fraction': 0.5051529789942145, 'bagging_freq': 6, 'min_child_sample
s': 82, 'max_depth': 9}. Best is trial 10 with value: 0.0599211266953847.
[60]      training's binary_logloss: 0.0267948      valid_1's binary_logloss: 0
      .0684536
Early stopping, best iteration is:
[45]      training's binary_logloss: 0.03981          valid_1's binary_logloss: 0
      .0659145
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.039809955545281446)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06591450035820969)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0714388      valid_1's binary_logloss: 0
      .0948827
[40]      training's binary_logloss: 0.0430779      valid_1's binary_logloss: 0
      .0822657
Early stopping, best iteration is:

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[34]      training's binary_logloss: 0.049166      valid_1's binary_logloss: 0
.081822
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04916599117934574)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.0818219773345684)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0588646      valid_1's binary_logloss: 0
.0682079
[40]      training's binary_logloss: 0.0210725      valid_1's binary_logloss: 0
.0541686
[60]      training's binary_logloss: 0.00933461      valid_1's binary_logloss: 0
.0550896
Early stopping, best iteration is:
[40]      training's binary_logloss: 0.0210725      valid_1's binary_logloss: 0
.0541686
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.021072459588071028)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.05416855335247822)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0564639      valid_1's binary_logloss: 0
.0677745
[40]      training's binary_logloss: 0.0206548      valid_1's binary_logloss: 0
.0514719
[60]      training's binary_logloss: 0.00904565      valid_1's binary_logloss: 0
.0516932
Early stopping, best iteration is:
[57]      training's binary_logloss: 0.0103145      valid_1's binary_logloss: 0
.049809
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01031453209159121)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.049809001297248794)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0542196      valid_1's binary_logloss: 0
.0819332
[40]      training's binary_logloss: 0.0203731      valid_1's binary_logloss: 0
.0680791
Early stopping, best iteration is:
[36]      training's binary_logloss: 0.0238562      valid_1's binary_logloss: 0
.0674059
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02385619606094011)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06740593779635556)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0562068      valid_1's binary_logloss: 0
.0776392
[40]      training's binary_logloss: 0.0201411      valid_1's binary_logloss: 0
.0656202
Early stopping, best iteration is:
[36]      training's binary_logloss: 0.0247038      valid_1's binary_logloss: 0
.0651273
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02470381418951265)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06512728879218055)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0565945      valid_1's binary_logloss: 0
.090471
[40]      training's binary_logloss: 0.0213489      valid_1's binary_logloss: 0
.0801334

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[I 2021-05-09 16:12:15,173] Trial 26 finished with value: 0.063328843537262
55 and parameters: {'lambda_l1': 0.001819955410853246, 'lambda_l2': 4.39553
76239621355e-05, 'num_leaves': 34, 'feature_fraction': 0.4448625978054424,
'bagging_fraction': 0.6778143885048068, 'bagging_freq': 4, 'min_child_sampl
es': 28, 'max_depth': 7}. Best is trial 10 with value: 0.0599211266953847.
[60]    training's binary_logloss: 0.00942742    valid_1's binary_logloss: 0
.089006
Early stopping, best iteration is:
[40]    training's binary_logloss: 0.0213489    valid_1's binary_logloss: 0
.0801334
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.021348858984178768)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0801334364480496)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0679504    valid_1's binary_logloss: 0
.069223
[40]    training's binary_logloss: 0.0347232    valid_1's binary_logloss: 0
.0511323
[60]    training's binary_logloss: 0.0197156    valid_1's binary_logloss: 0
.0478032
[80]    training's binary_logloss: 0.0113727    valid_1's binary_logloss: 0
.0520164
Early stopping, best iteration is:
[64]    training's binary_logloss: 0.017728    valid_1's binary_logloss: 0
.0476933
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.017728028414227246)]), 'valid_1': OrderedDict
([('binary_logloss', 0.047693307467182464)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0688488    valid_1's binary_logloss: 0
.069621
[40]    training's binary_logloss: 0.0366389    valid_1's binary_logloss: 0
.0496399
[60]    training's binary_logloss: 0.020202    valid_1's binary_logloss: 0
.0489315
Early stopping, best iteration is:
[48]    training's binary_logloss: 0.0292695    valid_1's binary_logloss: 0
.0474387
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.02926946883951398)]), 'valid_1': OrderedDict
([('binary_logloss', 0.047438705695290184)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0650431    valid_1's binary_logloss: 0
.0844345
[40]    training's binary_logloss: 0.0335749    valid_1's binary_logloss: 0
.0656602
[60]    training's binary_logloss: 0.0189604    valid_1's binary_logloss: 0
.0650537
Early stopping, best iteration is:
[58]    training's binary_logloss: 0.0200964    valid_1's binary_logloss: 0
.0642411
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.020096392317674877)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0642410944607635)]))
Training until validation scores don't improve for 20 rounds
[I 2021-05-09 16:12:15,780] Trial 27 finished with value: 0.060709926970162
71 and parameters: {'lambda_l1': 0.02335561347267632, 'lambda_l2': 5.890095
970215887e-07, 'num_leaves': 45, 'feature_fraction': 0.5083692666594244, 'b
agging_fraction': 0.6005336934162303, 'bagging_freq': 7, 'min_child_sampl
es': 46, 'max_depth': 5}. Best is trial 10 with value: 0.0599211266953847.

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[20]      training's binary_logloss: 0.0658114      valid_1's binary_logloss: 0
.0794842
[40]      training's binary_logloss: 0.034368      valid_1's binary_logloss: 0
.0653947
[60]      training's binary_logloss: 0.0192589      valid_1's binary_logloss: 0
.0685102
Early stopping, best iteration is:
[49]      training's binary_logloss: 0.027079      valid_1's binary_logloss: 0
.065112
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.027078961328219686)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06511196396371018)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0626601      valid_1's binary_logloss: 0
.0933024
[40]      training's binary_logloss: 0.0326806      valid_1's binary_logloss: 0
.0803721
Early stopping, best iteration is:
[37]      training's binary_logloss: 0.0356933      valid_1's binary_logloss: 0
.0790646
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.035693343118000626)]), 'valid_1': OrderedDict
([('binary_logloss', 0.07906456326386721)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0638569      valid_1's binary_logloss: 0
.0665107
[40]      training's binary_logloss: 0.0275938      valid_1's binary_logloss: 0
.0494069
[60]      training's binary_logloss: 0.0139939      valid_1's binary_logloss: 0
.0499388
Early stopping, best iteration is:
[50]      training's binary_logloss: 0.0198242      valid_1's binary_logloss: 0
.0478788
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01982419669740012)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.0478787640955548)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0625881      valid_1's binary_logloss: 0
.0702306
[40]      training's binary_logloss: 0.0264653      valid_1's binary_logloss: 0
.0505117
[60]      training's binary_logloss: 0.0131387      valid_1's binary_logloss: 0
.0499457
Early stopping, best iteration is:
[51]      training's binary_logloss: 0.0177042      valid_1's binary_logloss: 0
.0489288
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.017704229076884837)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04892881340845221)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0577538      valid_1's binary_logloss: 0
.0850555
[40]      training's binary_logloss: 0.0241662      valid_1's binary_logloss: 0
.0677177
[60]      training's binary_logloss: 0.0117395      valid_1's binary_logloss: 0
.0691262
Early stopping, best iteration is:
[41]      training's binary_logloss: 0.0231767      valid_1's binary_logloss: 0
.0670391
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02317667834548334)]), 'valid_1': OrderedDict(

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[('binary_logloss', 0.0670391443349321)))]))
Training until validation scores don't improve for 20 rounds
[I 2021-05-09 16:12:16,482] Trial 28 finished with value: 0.062791118269237
21 and parameters: {'lambda_l1': 0.11420694683427922, 'lambda_l2': 1.253851
9967884296e-06, 'num_leaves': 94, 'feature_fraction': 0.6452824784045639, '
bagging_fraction': 0.9941434398625556, 'bagging_freq': 6, 'min_child_sample
s': 67, 'max_depth': 6}. Best is trial 10 with value: 0.0599211266953847.
[20]    training's binary_logloss: 0.0616444    valid_1's binary_logloss: 0
.0793784
[40]    training's binary_logloss: 0.0254081    valid_1's binary_logloss: 0
.0676959
[60]    training's binary_logloss: 0.0123182    valid_1's binary_logloss: 0
.0689613
Early stopping, best iteration is:
[45]    training's binary_logloss: 0.0204873    valid_1's binary_logloss: 0
.0670265
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.020487289256540784)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06702648095645229)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0582638    valid_1's binary_logloss: 0
.0934601
[40]    training's binary_logloss: 0.0238171    valid_1's binary_logloss: 0
.0835886
[60]    training's binary_logloss: 0.011495     valid_1's binary_logloss: 0
.0868535
Early stopping, best iteration is:
[48]    training's binary_logloss: 0.0183223    valid_1's binary_logloss: 0
.0830824
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.018322337412286168)]), 'valid_1': OrderedDict
([('binary_logloss', 0.08308238855079465)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.075472     valid_1's binary_logloss: 0
.0704768
[40]    training's binary_logloss: 0.0450556    valid_1's binary_logloss: 0
.0538273
[60]    training's binary_logloss: 0.0304916    valid_1's binary_logloss: 0
.0527768
[80]    training's binary_logloss: 0.02337      valid_1's binary_logloss: 0
.0520743
Early stopping, best iteration is:
[73]    training's binary_logloss: 0.0253311    valid_1's binary_logloss: 0
.0514353
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.025331102735578582)]), 'valid_1': OrderedDict
([('binary_logloss', 0.05143531051356884)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0736466    valid_1's binary_logloss: 0
.0718607
[40]    training's binary_logloss: 0.0441476    valid_1's binary_logloss: 0
.0517672
[60]    training's binary_logloss: 0.0297711    valid_1's binary_logloss: 0
.0479204
[80]    training's binary_logloss: 0.0234131    valid_1's binary_logloss: 0
.0483477
Early stopping, best iteration is:
[70]    training's binary_logloss: 0.0262542    valid_1's binary_logloss: 0
.0472034
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde

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redDict([('binary_logloss', 0.026254179902303162)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04720340118614241)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0701817 valid_1's binary_logloss: 0
.0883665
[40] training's binary_logloss: 0.0420888 valid_1's binary_logloss: 0
.0720069
[60] training's binary_logloss: 0.0291791 valid_1's binary_logloss: 0
.0701945
[80] training's binary_logloss: 0.0217363 valid_1's binary_logloss: 0
.0686054
[100] training's binary_logloss: 0.0179677 valid_1's binary_logloss: 0
.0682511
[120] training's binary_logloss: 0.016038 valid_1's binary_logloss: 0
.0683343
Early stopping, best iteration is:
[111] training's binary_logloss: 0.016745 valid_1's binary_logloss: 0
.0680111
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01674500205741277)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.06801108380531463)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0727665 valid_1's binary_logloss: 0
.0809979
[40] training's binary_logloss: 0.0421592 valid_1's binary_logloss: 0
.0654423
[60] training's binary_logloss: 0.0283848 valid_1's binary_logloss: 0
.0641164
Early stopping, best iteration is:
[58] training's binary_logloss: 0.0295807 valid_1's binary_logloss: 0
.0638184
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02958065646796263)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.0638184447587216)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0702263 valid_1's binary_logloss: 0
.0978418
[I 2021-05-09 16:12:17,255] Trial 29 finished with value: 0.061620721919638
8 and parameters: {'lambda_l1': 2.333095886478458, 'lambda_l2': 2.689142029
974687e-06, 'num_leaves': 31, 'feature_fraction': 0.5687677942554944, 'bagg
ing_fraction': 0.7500733801947492, 'bagging_freq': 5, 'min_child_samples':
55, 'max_depth': 9}. Best is trial 10 with value: 0.0599211266953847.
[40] training's binary_logloss: 0.0409389 valid_1's binary_logloss: 0
.083551
[60] training's binary_logloss: 0.0280433 valid_1's binary_logloss: 0
.0783425
[80] training's binary_logloss: 0.0219075 valid_1's binary_logloss: 0
.08085
Early stopping, best iteration is:
[64] training's binary_logloss: 0.0265888 valid_1's binary_logloss: 0
.0776354
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.026588775223981575)]), 'valid_1': OrderedDict
([('binary_logloss', 0.07763536933444647)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0730951 valid_1's binary_logloss: 0
.0705887
[40] training's binary_logloss: 0.0392817 valid_1's binary_logloss: 0
.0543911
[60] training's binary_logloss: 0.0214672 valid_1's binary_logloss: 0

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.0517184
[80]    training's binary_logloss: 0.0116206    valid_1's binary_logloss: 0
.0533982
Early stopping, best iteration is:
[70]    training's binary_logloss: 0.0161514    valid_1's binary_logloss: 0
.0508841
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.01615144943230143)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.05088412755353074)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0709401    valid_1's binary_logloss: 0
.0725102
[40]    training's binary_logloss: 0.0400572    valid_1's binary_logloss: 0
.0527026
[60]    training's binary_logloss: 0.0211517    valid_1's binary_logloss: 0
.0512183
Early stopping, best iteration is:
[47]    training's binary_logloss: 0.0319266    valid_1's binary_logloss: 0
.0504979
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03192662123995792)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.0504979074183525)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0679276    valid_1's binary_logloss: 0
.0880441
[40]    training's binary_logloss: 0.0358345    valid_1's binary_logloss: 0
.0668127
[60]    training's binary_logloss: 0.0194229    valid_1's binary_logloss: 0
.0641914
Early stopping, best iteration is:
[59]    training's binary_logloss: 0.0201324    valid_1's binary_logloss: 0
.0632905
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0201324036702187)]), 'valid_1': OrderedDict([
('binary_logloss', 0.06329054619721919)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.070829    valid_1's binary_logloss: 0
.0787691
[40]    training's binary_logloss: 0.036525    valid_1's binary_logloss: 0
.0657007
[60]    training's binary_logloss: 0.0206696    valid_1's binary_logloss: 0
.0662636
Early stopping, best iteration is:
[49]    training's binary_logloss: 0.0282372    valid_1's binary_logloss: 0
.0650197
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.028237153731926166)]), 'valid_1': OrderedDict
[('binary_logloss', 0.06501970392956594)]))
Training until validation scores don't improve for 20 rounds
[I 2021-05-09 16:12:17,992] Trial 30 finished with value: 0.061696251490535
04 and parameters: {'lambda_l1': 0.00015058808515686412, 'lambda_l2': 4.006
1638751738666e-08, 'num_leaves': 73, 'feature_fraction': 0.4232756785298915
, 'bagging_fraction': 0.6342154892942262, 'bagging_freq': 7, 'min_child_sam
ples': 80, 'max_depth': 8}. Best is trial 10 with value: 0.0599211266953847
.
[20]    training's binary_logloss: 0.0676104    valid_1's binary_logloss: 0
.0949007
[40]    training's binary_logloss: 0.0365763    valid_1's binary_logloss: 0
.0798037
Early stopping, best iteration is:

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[37]    training's binary_logloss: 0.0395936    valid_1's binary_logloss: 0
.078789
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03959358372176318)]), 'valid_1': OrderedDict([
([('binary_logloss', 0.0787889723540068)]))})
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0808304    valid_1's binary_logloss: 0
.0759094
[40]    training's binary_logloss: 0.0520668    valid_1's binary_logloss: 0
.0557203
[60]    training's binary_logloss: 0.0376286    valid_1's binary_logloss: 0
.0518412
[80]    training's binary_logloss: 0.0267898    valid_1's binary_logloss: 0
.0488478
[100]   training's binary_logloss: 0.0204105    valid_1's binary_logloss: 0
.0482454
Early stopping, best iteration is:
[89]    training's binary_logloss: 0.0233821    valid_1's binary_logloss: 0
.0473614
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0233821208135961)]), 'valid_1': OrderedDict([
('binary_logloss', 0.04736137677992221)]))})
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0792944    valid_1's binary_logloss: 0
.0755859
[40]    training's binary_logloss: 0.0535516    valid_1's binary_logloss: 0
.0527192
[60]    training's binary_logloss: 0.0355355    valid_1's binary_logloss: 0
.0489352
[80]    training's binary_logloss: 0.0267018    valid_1's binary_logloss: 0
.0438165
Early stopping, best iteration is:
[79]    training's binary_logloss: 0.027147    valid_1's binary_logloss: 0
.0436294
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02714698037014188)]), 'valid_1': OrderedDict([
('binary_logloss', 0.04362943178660764)]))})
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0758774    valid_1's binary_logloss: 0
.0917754
[40]    training's binary_logloss: 0.0480771    valid_1's binary_logloss: 0
.0722396
[60]    training's binary_logloss: 0.0349902    valid_1's binary_logloss: 0
.0675168
[80]    training's binary_logloss: 0.0265398    valid_1's binary_logloss: 0
.0647307
[100]   training's binary_logloss: 0.0202224    valid_1's binary_logloss: 0
.0652136
Early stopping, best iteration is:
[91]    training's binary_logloss: 0.0221281    valid_1's binary_logloss: 0
.0638734
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.022128085482934406)]), 'valid_1': OrderedDict([
('binary_logloss', 0.06387337073075747)]))})
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0775099    valid_1's binary_logloss: 0
.0816285
[40]    training's binary_logloss: 0.0491184    valid_1's binary_logloss: 0
.0651631

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[I 2021-05-09 16:12:18,929] Trial 31 finished with value: 0.060080304096328
64 and parameters: {'lambda_l1': 1.092469585572488, 'lambda_l2': 9.00188150
6158933e-06, 'num_leaves': 79, 'feature_fraction': 0.53592574567884, 'baggi
ng_fraction': 0.5415419234936101, 'bagging_freq': 7, 'min_child_samples': 1
00, 'max_depth': 8}. Best is trial 10 with value: 0.0599211266953847.
[60]      training's binary_logloss: 0.0343713      valid_1's binary_logloss: 0
.06205
[80]      training's binary_logloss: 0.0253231      valid_1's binary_logloss: 0
.0632062
Early stopping, best iteration is:
[70]      training's binary_logloss: 0.0278376      valid_1's binary_logloss: 0
.0612712
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.027837554475063437)]), 'valid_1': OrderedDict
([('binary_logloss', 0.061271166840824724)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0738613      valid_1's binary_logloss: 0
.097629
[40]      training's binary_logloss: 0.0481721      valid_1's binary_logloss: 0
.0852536
Early stopping, best iteration is:
[37]      training's binary_logloss: 0.0502035      valid_1's binary_logloss: 0
.0842662
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.050203521997926014)]), 'valid_1': OrderedDict
([('binary_logloss', 0.08426617434353115)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0856858      valid_1's binary_logloss: 0
.0796952
[40]      training's binary_logloss: 0.0636138      valid_1's binary_logloss: 0
.0591503
[60]      training's binary_logloss: 0.0546512      valid_1's binary_logloss: 0
.0545808
[80]      training's binary_logloss: 0.0486221      valid_1's binary_logloss: 0
.0521644
[100]     training's binary_logloss: 0.0456389      valid_1's binary_logloss: 0
.0509968
[120]     training's binary_logloss: 0.0411867      valid_1's binary_logloss: 0
.0518561
Early stopping, best iteration is:
[111]     training's binary_logloss: 0.043225      valid_1's binary_logloss: 0
.0509402
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde
redDict([('binary_logloss', 0.04322500909524247)]), 'valid_1': OrderedDict
([('binary_logloss', 0.050940211521881704)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0859633      valid_1's binary_logloss: 0
.0789678
[40]      training's binary_logloss: 0.0631234      valid_1's binary_logloss: 0
.0568469
[60]      training's binary_logloss: 0.0543048      valid_1's binary_logloss: 0
.052162
[80]      training's binary_logloss: 0.0486368      valid_1's binary_logloss: 0
.0500917
[100]     training's binary_logloss: 0.0449046      valid_1's binary_logloss: 0
.0480162
Early stopping, best iteration is:
[95]      training's binary_logloss: 0.0458716      valid_1's binary_logloss: 0
.047691
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': orde

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redDict([('binary_logloss', 0.045871557200050365)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04769101992374869)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.081162 valid_1's binary_logloss: 0
.0946355
[40] training's binary_logloss: 0.0589846 valid_1's binary_logloss: 0
.075905
[60] training's binary_logloss: 0.0507246 valid_1's binary_logloss: 0
.0718191
[80] training's binary_logloss: 0.0453097 valid_1's binary_logloss: 0
.0699159
[100] training's binary_logloss: 0.0420308 valid_1's binary_logloss: 0
.0691802
[120] training's binary_logloss: 0.0392038 valid_1's binary_logloss: 0
.0672355
[140] training's binary_logloss: 0.0376041 valid_1's binary_logloss: 0
.0672603
[160] training's binary_logloss: 0.0370183 valid_1's binary_logloss: 0
.0665714
Early stopping, best iteration is:
[150] training's binary_logloss: 0.0370183 valid_1's binary_logloss: 0
.0665714
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03701825178670031)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.06657135504685154)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0842623 valid_1's binary_logloss: 0
.0859394
[40] training's binary_logloss: 0.0593802 valid_1's binary_logloss: 0
.069521
[60] training's binary_logloss: 0.0501414 valid_1's binary_logloss: 0
.0685204
[80] training's binary_logloss: 0.0458858 valid_1's binary_logloss: 0
.0664692
[I 2021-05-09 16:12:19,553] Trial 32 finished with value: 0.060909364600176
08 and parameters: {'lambda_l1': 4.142780565885865, 'lambda_l2': 4.03738564
91193525e-06, 'num_leaves': 83, 'feature_fraction': 0.4832487118215959, 'ba
gging_fraction': 0.4627152717115891, 'bagging_freq': 6, 'min_child_samples'
: 94, 'max_depth': 7}. Best is trial 10 with value: 0.0599211266953847.
[100] training's binary_logloss: 0.0414321 valid_1's binary_logloss: 0
.0644102
[120] training's binary_logloss: 0.0381551 valid_1's binary_logloss: 0
.0639157
Early stopping, best iteration is:
[113] training's binary_logloss: 0.0391085 valid_1's binary_logloss: 0
.0631009
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.039108537662426786)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06310089013319886)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0794826 valid_1's binary_logloss: 0
.100328
[40] training's binary_logloss: 0.0569945 valid_1's binary_logloss: 0
.0838295
[60] training's binary_logloss: 0.0507017 valid_1's binary_logloss: 0
.0808366
[80] training's binary_logloss: 0.0441973 valid_1's binary_logloss: 0
.0762433
[100] training's binary_logloss: 0.0415118 valid_1's binary_logloss: 0
.0786625

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Early stopping, best iteration is:
[80]   training's binary_logloss: 0.0441973   valid_1's binary_logloss: 0
      .0762433
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0441973087474912)]), 'valid_1': OrderedDict([
('binary_logloss', 0.07624334637519965)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.077827   valid_1's binary_logloss: 0
      .0741931
[40]   training's binary_logloss: 0.047951   valid_1's binary_logloss: 0
      .0565995
[60]   training's binary_logloss: 0.0332962   valid_1's binary_logloss: 0
      .051404
[80]   training's binary_logloss: 0.0222732   valid_1's binary_logloss: 0
      .0508848
Early stopping, best iteration is:
[68]   training's binary_logloss: 0.0282571   valid_1's binary_logloss: 0
      .0496696
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02825707534180471)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.04966964192933415)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0766331   valid_1's binary_logloss: 0
      .0746579
[40]   training's binary_logloss: 0.0496784   valid_1's binary_logloss: 0
      .0529074
[60]   training's binary_logloss: 0.031106   valid_1's binary_logloss: 0
      .0512651
[80]   training's binary_logloss: 0.0205889   valid_1's binary_logloss: 0
      .0482942
Early stopping, best iteration is:
[73]   training's binary_logloss: 0.0235085   valid_1's binary_logloss: 0
      .0473526
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.023508506366122645)]), 'valid_1': OrderedDict
[('binary_logloss', 0.047352603369656646)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0736968   valid_1's binary_logloss: 0
      .0915562
[40]   training's binary_logloss: 0.0443778   valid_1's binary_logloss: 0
      .073734
[60]   training's binary_logloss: 0.0306137   valid_1's binary_logloss: 0
      .0683479
Early stopping, best iteration is:
[58]   training's binary_logloss: 0.0321252   valid_1's binary_logloss: 0
      .0680528
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.032125214821890895)]), 'valid_1': OrderedDict
[('binary_logloss', 0.06805275024528538)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0760147   valid_1's binary_logloss: 0
      .0823632
[I 2021-05-09 16:12:20,579] Trial 33 finished with value: 0.061763437643965
19 and parameters: {'lambda_l1': 0.3362064874439117, 'lambda_l2': 2.3464479
860050388e-05, 'num_leaves': 66, 'feature_fraction': 0.5282171697546285, 'b
agging_fraction': 0.5156598563654935, 'bagging_freq': 7, 'min_child_samples
': 93, 'max_depth': 6}. Best is trial 10 with value: 0.0599211266953847.
[40]   training's binary_logloss: 0.0456161   valid_1's binary_logloss: 0
      .0676632
[60]   training's binary_logloss: 0.0295803   valid_1's binary_logloss: 0

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.0648771
Early stopping, best iteration is:
[57]   training's binary_logloss: 0.0324489   valid_1's binary_logloss: 0
.0643953
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.03244890534593938)]), 'valid_1': OrderedDict([('binary_logloss', 0.06439526831116052)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0717411   valid_1's binary_logloss: 0
.0949882
[40]   training's binary_logloss: 0.0445908   valid_1's binary_logloss: 0
.0817495
[60]   training's binary_logloss: 0.0309565   valid_1's binary_logloss: 0
.0803127
[80]   training's binary_logloss: 0.0205384   valid_1's binary_logloss: 0
.0808643
Early stopping, best iteration is:
[62]   training's binary_logloss: 0.0291626   valid_1's binary_logloss: 0
.0793469
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.029162603273919264)]), 'valid_1': OrderedDict([('binary_logloss', 0.07934692436438927)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.073394   valid_1's binary_logloss: 0
.0704028
[40]   training's binary_logloss: 0.0403751   valid_1's binary_logloss: 0
.0512721
[60]   training's binary_logloss: 0.0232374   valid_1's binary_logloss: 0
.05153
Early stopping, best iteration is:
[54]   training's binary_logloss: 0.0272026   valid_1's binary_logloss: 0
.0501942
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.027202612237647306)]), 'valid_1': OrderedDict([('binary_logloss', 0.05019416293676434)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0715658   valid_1's binary_logloss: 0
.0689201
[40]   training's binary_logloss: 0.0398931   valid_1's binary_logloss: 0
.047753
[60]   training's binary_logloss: 0.0201308   valid_1's binary_logloss: 0
.0463543
[80]   training's binary_logloss: 0.0117013   valid_1's binary_logloss: 0
.047732
Early stopping, best iteration is:
[66]   training's binary_logloss: 0.016534   valid_1's binary_logloss: 0
.0454721
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01653401517675362)]), 'valid_1': OrderedDict([('binary_logloss', 0.04547212922211407)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0691966   valid_1's binary_logloss: 0
.0887709
[40]   training's binary_logloss: 0.036708   valid_1's binary_logloss: 0
.0693374
[60]   training's binary_logloss: 0.0208792   valid_1's binary_logloss: 0
.0732968
Early stopping, best iteration is:
[45]   training's binary_logloss: 0.0321682   valid_1's binary_logloss: 0
.0680552
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.032168205520552055)]), 'valid_1': OrderedDict([('binary_logloss', 0.068055205520552055)]))
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redDict([('binary_logloss', 0.032168234868195686)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0680552306090754)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0712415 valid_1's binary_logloss: 0
.078304
[40] training's binary_logloss: 0.0371597 valid_1's binary_logloss: 0
.0646651
[60] training's binary_logloss: 0.0197564 valid_1's binary_logloss: 0
.0638084
Early stopping, best iteration is:
[53] training's binary_logloss: 0.0245563 valid_1's binary_logloss: 0
.0624281
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.024556270417043943)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06242809604709743)]))
[I 2021-05-09 16:12:21,384] Trial 34 finished with value: 0.060981000513258
42 and parameters: {'lambda_l1': 0.0061090496999569605, 'lambda_l2': 2.4528
31008653104e-07, 'num_leaves': 49, 'feature_fraction': 0.7012956665463115,
'bagging_fraction': 0.5879832282337212, 'bagging_freq': 6, 'min_child_sampl
es': 86, 'max_depth': 8}. Best is trial 10 with value: 0.0599211266953847.
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0696924 valid_1's binary_logloss: 0
.0955121
[40] training's binary_logloss: 0.0387621 valid_1's binary_logloss: 0
.0787554
[60] training's binary_logloss: 0.0220359 valid_1's binary_logloss: 0
.0833873
Early stopping, best iteration is:
[40] training's binary_logloss: 0.0387621 valid_1's binary_logloss: 0
.0787554
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03876212738877981)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.07875538375124085)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.07601 valid_1's binary_logloss: 0
.0718316
[40] training's binary_logloss: 0.0443769 valid_1's binary_logloss: 0
.05167
[60] training's binary_logloss: 0.0273535 valid_1's binary_logloss: 0
.0477597
[80] training's binary_logloss: 0.0153538 valid_1's binary_logloss: 0
.0525011
Early stopping, best iteration is:
[64] training's binary_logloss: 0.024481 valid_1's binary_logloss: 0
.047412
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02448103596722163)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.04741199840137234)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0753107 valid_1's binary_logloss: 0
.0724183
[40] training's binary_logloss: 0.0460055 valid_1's binary_logloss: 0
.0497187
[60] training's binary_logloss: 0.0260986 valid_1's binary_logloss: 0
.0459223
[80] training's binary_logloss: 0.0161036 valid_1's binary_logloss: 0
.0452041
Early stopping, best iteration is:
[75] training's binary_logloss: 0.0179513 valid_1's binary_logloss: 0
.0443698

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best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01795131090687018)]), 'valid_1': OrderedDict([('binary_logloss', 0.04436981655850779)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0715648 valid_1's binary_logloss: 0.0917956
[40] training's binary_logloss: 0.0420298 valid_1's binary_logloss: 0.0693281
[60] training's binary_logloss: 0.0273853 valid_1's binary_logloss: 0.0698056
Early stopping, best iteration is:
[56] training's binary_logloss: 0.0309881 valid_1's binary_logloss: 0.0670125
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.030988142367238646)]), 'valid_1': OrderedDict([('binary_logloss', 0.06701246699413345)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.073568 valid_1's binary_logloss: 0.0794455
[40] training's binary_logloss: 0.0403525 valid_1's binary_logloss: 0.064295
[60] training's binary_logloss: 0.0238099 valid_1's binary_logloss: 0.0590654
Early stopping, best iteration is:
[56] training's binary_logloss: 0.0277637 valid_1's binary_logloss: 0.0578765
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.027763748343333113)]), 'valid_1': OrderedDict([('binary_logloss', 0.05787645846339323)]))
[I 2021-05-09 16:12:22,266] Trial 35 finished with value: 0.05946529087966085 and parameters: {'lambda_l1': 3.1510533256462115e-05, 'lambda_l2': 0.0001827005217028645, 'num_leaves': 79, 'feature_fraction': 0.6046434091911356, 'bagging_fraction': 0.56973565192141, 'bagging_freq': 7, 'min_child_samples': 100, 'max_depth': 7}. Best is trial 35 with value: 0.05946529087966085.

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Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0705231   valid_1's binary_logloss: 0
      .0941902
[40]   training's binary_logloss: 0.0407225   valid_1's binary_logloss: 0
      .0820563
Early stopping, best iteration is:
[35]   training's binary_logloss: 0.0475266   valid_1's binary_logloss: 0
      .0806557
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04752662221264211)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.08065571398089744)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0621837   valid_1's binary_logloss: 0
      .0661765
[40]   training's binary_logloss: 0.0285617   valid_1's binary_logloss: 0
      .0492537
[60]   training's binary_logloss: 0.0147519   valid_1's binary_logloss: 0
      .0490991
Early stopping, best iteration is:
[48]   training's binary_logloss: 0.0218205   valid_1's binary_logloss: 0
      .0474638
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.0218205013886253)]), 'valid_1': OrderedDict([
('binary_logloss', 0.04746379682395622)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0616707   valid_1's binary_logloss: 0
      .0674518
[40]   training's binary_logloss: 0.0293852   valid_1's binary_logloss: 0
      .0479919
[60]   training's binary_logloss: 0.0132896   valid_1's binary_logloss: 0
      .0490952
Early stopping, best iteration is:
[48]   training's binary_logloss: 0.022775    valid_1's binary_logloss: 0
      .0463776
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.022774970941004582)]), 'valid_1': OrderedDict
[('binary_logloss', 0.046377592032935115)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0589454   valid_1's binary_logloss: 0
      .0856527
[40]   training's binary_logloss: 0.0274008   valid_1's binary_logloss: 0
      .0684318
[60]   training's binary_logloss: 0.0158739   valid_1's binary_logloss: 0
      .0702302
Early stopping, best iteration is:
[43]   training's binary_logloss: 0.0251654   valid_1's binary_logloss: 0
      .0680705
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02516540223414297)]), 'valid_1': OrderedDict(
[('binary_logloss', 0.06807054627683967)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.060085    valid_1's binary_logloss: 0
      .0809187
[40]   training's binary_logloss: 0.0252142   valid_1's binary_logloss: 0
      .0671329
[60]   training's binary_logloss: 0.0133458   valid_1's binary_logloss: 0
      .0706061

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[I 2021-05-09 16:12:22,929] Trial 36 finished with value: 0.061856149779853
5 and parameters: {'lambda_l1': 6.71534571731035e-06, 'lambda_l2': 0.001603
5354691326803, 'num_leaves': 76, 'feature_fraction': 0.6758621642787719, 'b
agging_fraction': 0.5614122393458763, 'bagging_freq': 7, 'min_child_samples
': 33, 'max_depth': 6}. Best is trial 35 with value: 0.05946529087966085.
Early stopping, best iteration is:
[42]   training's binary_logloss: 0.0241133   valid_1's binary_logloss: 0
.0659446
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.024113330507127134)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06594458269319625)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0594874   valid_1's binary_logloss: 0
.0909238
[40]   training's binary_logloss: 0.0303086   valid_1's binary_logloss: 0
.0858294
Early stopping, best iteration is:
[33]   training's binary_logloss: 0.0385252   valid_1's binary_logloss: 0
.0814242
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.03852522109696143)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.0814242310723402)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0601825   valid_1's binary_logloss: 0
.0666148
[40]   training's binary_logloss: 0.0236778   valid_1's binary_logloss: 0
.0510632
Early stopping, best iteration is:
[38]   training's binary_logloss: 0.0261641   valid_1's binary_logloss: 0
.0504623
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02616410343510339)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.05046225342727803)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0599484   valid_1's binary_logloss: 0
.0688504
[40]   training's binary_logloss: 0.0254331   valid_1's binary_logloss: 0
.051314
[60]   training's binary_logloss: 0.0094453   valid_1's binary_logloss: 0
.0523356
Early stopping, best iteration is:
[44]   training's binary_logloss: 0.0204585   valid_1's binary_logloss: 0
.0496864
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.020458497333628155)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04968643147767821)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0581524   valid_1's binary_logloss: 0
.0845415
[40]   training's binary_logloss: 0.023352   valid_1's binary_logloss: 0
.0689214
Early stopping, best iteration is:
[38]   training's binary_logloss: 0.0253374   valid_1's binary_logloss: 0
.0676823
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.025337424618471497)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0676823089873304)]))
Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0577753   valid_1's binary_logloss: 0
.0775032
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[40]    training's binary_logloss: 0.0217763    valid_1's binary_logloss: 0
      .0627972
[60]    training's binary_logloss: 0.00835584    valid_1's binary_logloss: 0
      .0627229
Early stopping, best iteration is:
[48]    training's binary_logloss: 0.0146855    valid_1's binary_logloss: 0
      .0612048
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.01468553110673846)]), 'valid_1': OrderedDict([('binary_logloss', 0.06120484728183121)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0574738    valid_1's binary_logloss: 0
      .0928695
[40]    training's binary_logloss: 0.0240975    valid_1's binary_logloss: 0
      .0849052
[60]    training's binary_logloss: 0.0103301    valid_1's binary_logloss: 0
      .0916733
Early stopping, best iteration is:
[42]    training's binary_logloss: 0.0223802    valid_1's binary_logloss: 0
      .0842049
[I 2021-05-09 16:12:23,711] Trial 37 finished with value: 0.062648147695692
74 and parameters: {'lambda_l1': 5.235326379458039e-07, 'lambda_l2': 0.0001
3875452299538977, 'num_leaves': 63, 'feature_fraction': 0.6037401216401825,
'bagging_fraction': 0.7009236836570657, 'bagging_freq': 6, 'min_child_samples': 42, 'max_depth': 9}. Best is trial 35 with value: 0.05946529087966085.

```

```

best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.022380180317628527)]), 'valid_1': OrderedDict
([('binary_logloss', 0.0842048973043459)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0737212    valid_1's binary_logloss: 0
.0710872
[40]    training's binary_logloss: 0.040548    valid_1's binary_logloss: 0
.0561837
[60]    training's binary_logloss: 0.0247719    valid_1's binary_logloss: 0
.0536752
Early stopping, best iteration is:
[58]    training's binary_logloss: 0.02643    valid_1's binary_logloss: 0
.053283
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.026430014992109487)]), 'valid_1': OrderedDict
([('binary_logloss', 0.053283036235823596)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0731123    valid_1's binary_logloss: 0
.0701562
[40]    training's binary_logloss: 0.0436087    valid_1's binary_logloss: 0
.0506228
[60]    training's binary_logloss: 0.0225588    valid_1's binary_logloss: 0
.0483481
[80]    training's binary_logloss: 0.0129959    valid_1's binary_logloss: 0
.0463914
Early stopping, best iteration is:
[76]    training's binary_logloss: 0.014224    valid_1's binary_logloss: 0
.045816
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.014224039062442444)]), 'valid_1': OrderedDict
([('binary_logloss', 0.045816007635690756)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0693349    valid_1's binary_logloss: 0
.0895566
[40]    training's binary_logloss: 0.0382856    valid_1's binary_logloss: 0
.0658838
[60]    training's binary_logloss: 0.0213713    valid_1's binary_logloss: 0
.0636269
Early stopping, best iteration is:
[56]    training's binary_logloss: 0.0255821    valid_1's binary_logloss: 0
.0623092
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.025582096293234505)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06230922280420096)]))
Training until validation scores don't improve for 20 rounds
[20]    training's binary_logloss: 0.0714305    valid_1's binary_logloss: 0
.0792837
[40]    training's binary_logloss: 0.0389951    valid_1's binary_logloss: 0
.0656765
[60]    training's binary_logloss: 0.0223168    valid_1's binary_logloss: 0
.0637163
[I 2021-05-09 16:12:24,497] Trial 38 finished with value: 0.061156794349439
846 and parameters: {'lambda_11': 3.965877298928453e-05, 'lambda_12': 0.006
799554120265558, 'num_leaves': 86, 'feature_fraction': 0.6220468934357378,
'bagging_fraction': 0.6423663740146273, 'bagging_freq': 7, 'min_child_sampl
es': 99, 'max_depth': 11}. Best is trial 35 with value: 0.05946529087966085
.
[80]    training's binary_logloss: 0.0129824    valid_1's binary_logloss: 0
.0648984
Early stopping, best iteration is:

```

```

[62]      training's binary_logloss: 0.0211323      valid_1's binary_logloss: 0
.0629187
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.02113232010454494)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.06291865254052387)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.068851      valid_1's binary_logloss: 0
.094022
[40]      training's binary_logloss: 0.0389022      valid_1's binary_logloss: 0
.0825535
Early stopping, best iteration is:
[37]      training's binary_logloss: 0.0426375      valid_1's binary_logloss: 0
.0814571
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.04263749675401086)]), 'valid_1': OrderedDict(
([('binary_logloss', 0.08145705253096006)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0681243      valid_1's binary_logloss: 0
.0695079
[40]      training's binary_logloss: 0.0316173      valid_1's binary_logloss: 0
.0491232
[60]      training's binary_logloss: 0.0159035      valid_1's binary_logloss: 0
.047242
Early stopping, best iteration is:
[57]      training's binary_logloss: 0.0177572      valid_1's binary_logloss: 0
.0460314
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.017757210103804908)]), 'valid_1': OrderedDict
([('binary_logloss', 0.046031416663078764)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0650208      valid_1's binary_logloss: 0
.067279
[40]      training's binary_logloss: 0.0327133      valid_1's binary_logloss: 0
.0509242
[60]      training's binary_logloss: 0.0143026      valid_1's binary_logloss: 0
.0500578
Early stopping, best iteration is:
[57]      training's binary_logloss: 0.0158532      valid_1's binary_logloss: 0
.0493537
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.015853211657325096)]), 'valid_1': OrderedDict
([('binary_logloss', 0.04935367651149128)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0650459      valid_1's binary_logloss: 0
.0847212
[40]      training's binary_logloss: 0.0311236      valid_1's binary_logloss: 0
.0675835
[60]      training's binary_logloss: 0.0151735      valid_1's binary_logloss: 0
.0662196
[80]      training's binary_logloss: 0.00738491     valid_1's binary_logloss: 0
.0711747
Early stopping, best iteration is:
[62]      training's binary_logloss: 0.0140204      valid_1's binary_logloss: 0
.0657079
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': Orde
redDict([('binary_logloss', 0.014020400284514836)]), 'valid_1': OrderedDict
([('binary_logloss', 0.06570785202755203)]))
Training until validation scores don't improve for 20 rounds
[20]      training's binary_logloss: 0.0637668      valid_1's binary_logloss: 0
.0803983
[40]      training's binary_logloss: 0.0308378      valid_1's binary_logloss: 0

```

```
.0641251
[60] training's binary_logloss: 0.0150385 valid_1's binary_logloss: 0.0676876
Early stopping, best iteration is:
[43] training's binary_logloss: 0.0278417 valid_1's binary_logloss: 0.0636321
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.027841709626802612)]), 'valid_1': OrderedDict([('binary_logloss', 0.06363212648971463)]))
Training until validation scores don't improve for 20 rounds
[20] training's binary_logloss: 0.0636239 valid_1's binary_logloss: 0.0935358

[I 2021-05-09 16:12:25,615] Trial 39 finished with value: 0.06104395870009423 and parameters: {'lambda_l1': 4.5095064299818534e-07, 'lambda_l2': 1.1375762331750034e-05, 'num_leaves': 71, 'feature_fraction': 0.5719077754670745, 'bagging_fraction': 0.587553709975497, 'bagging_freq': 6, 'min_child_samples': 54, 'max_depth': 15}. Best is trial 35 with value: 0.05946529087966085.
[40] training's binary_logloss: 0.0308853 valid_1's binary_logloss: 0.0806512
Early stopping, best iteration is:
[38] training's binary_logloss: 0.0330428 valid_1's binary_logloss: 0.0804947
best_score defaultdict(<class 'collections.OrderedDict'>, {'training': OrderedDict([('binary_logloss', 0.033042801086207885)]), 'valid_1': OrderedDict([('binary_logloss', 0.08049472180863443)]))
```

```
In [11]: print('Best trial: score {}, params {}'.format(study.best_trial.value, study.best_trial.params))
```

```
Best trial: score 0.05946529087966085, params {'lambda_l1': 3.1510533256462115e-05, 'lambda_l2': 0.0001827005217028645, 'num_leaves': 79, 'feature_fraction': 0.6046434091911356, 'bagging_fraction': 0.56973565192141, 'bagging_freq': 7, 'min_child_samples': 100, 'max_depth': 7}
```

```
In [12]: early_stop = 20
verbose_eval = 20
d_train = lgb.Dataset(X_train,y_train)
d_valid = lgb.Dataset(X_valid,y_valid)
watchlist = [d_train, d_valid]
param = {
    'objective': 'binary',
    'metric': 'binary_logloss',
    'verbose': -1,
    'lambda_l1': 7.902601989395657e-07,
    'lambda_l2': 5.648254437122679e-07,
    'num_leaves': 67,
    'feature_fraction': 0.6998029478945647,
    'bagging_fraction': 0.5584550389770908,
    'bagging_freq': 4,
    'min_child_samples': 60,
    'max_depth': 5
}
model1 = lgb.train(param,train_set=d_train,num_boost_round=1500,valid_sets=watchlist,verbose_eval=verbose_eval,early_stopping_rounds=early_stop)
```

```

Training until validation scores don't improve for 20 rounds
[20]   training's binary_logloss: 0.0662859   valid_1's binary_logloss: 0
      .0728906
[40]   training's binary_logloss: 0.0361768   valid_1's binary_logloss: 0
      .0498894
[60]   training's binary_logloss: 0.0210851   valid_1's binary_logloss: 0
      .0474592
Early stopping, best iteration is:
[53]   training's binary_logloss: 0.0254509   valid_1's binary_logloss: 0
      .0470348

```

Now let's test all feature importance ideas!

Drop Column Importance

I choose two metrics to generate feature importance: one is accuracy, another one is log loss.

Accuracy

```
In [13]: model = lgb.LGBMClassifier(**param)
```

```
In [14]: ## Accuracy as metric
         imp = dropcol_importances(model,X_train, y_train, X_valid, y_valid,accuracy)
```

```

Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4

```



```
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
```

will be ignored. Current value: $\lambda_2=5.648254437122679e-07$
[LightGBM] [Warning] λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_1=7.902601989395657e-07$
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignored. Current value: bagging_freq=4
[LightGBM] [Warning] λ_2 is set= $5.648254437122679e-07$, λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_2=5.648254437122679e-07$
[LightGBM] [Warning] λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_1=7.902601989395657e-07$
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignored. Current value: bagging_freq=4
[LightGBM] [Warning] λ_2 is set= $5.648254437122679e-07$, λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_2=5.648254437122679e-07$
[LightGBM] [Warning] λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_1=7.902601989395657e-07$
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignored. Current value: bagging_freq=4
[LightGBM] [Warning] λ_2 is set= $5.648254437122679e-07$, λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_2=5.648254437122679e-07$
[LightGBM] [Warning] λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_1=7.902601989395657e-07$
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignored. Current value: bagging_freq=4
[LightGBM] [Warning] λ_2 is set= $5.648254437122679e-07$, λ_1 is set= $7.902601989395657e-07$, $\alpha=0.0$
will be ignored. Current value: $\lambda_2=5.648254437122679e-07$

```
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
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```

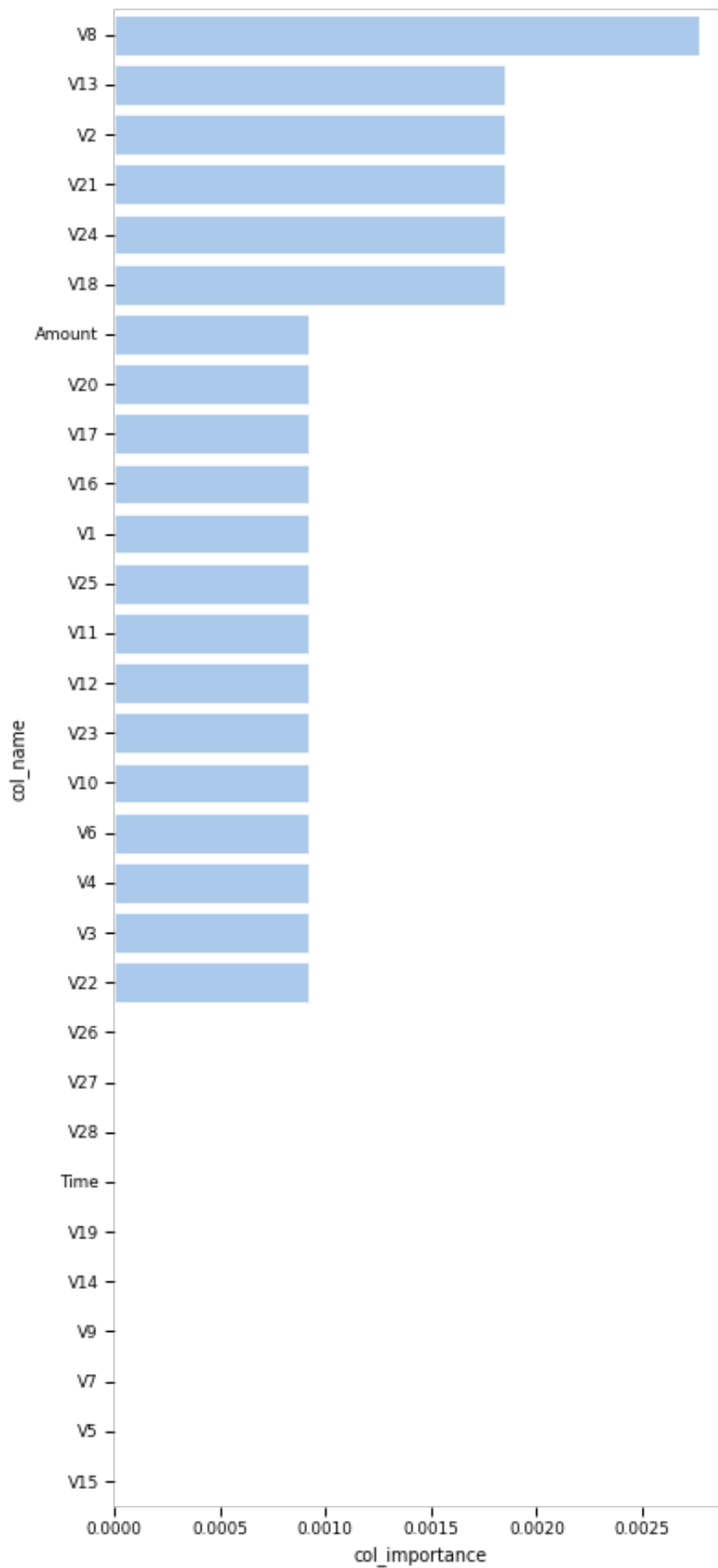
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```

```
In [15]: col_list = list(df.columns)
col_list.remove('Class')
```

```
In [16]: #
imp_result_drop_acc = defaultdict(float)
for i,item in enumerate(col_list):
    imp_result_drop_acc[item] = abs(imp[i])
importance_plot(imp_result_drop_acc)
```



Log loss

In [17]:

```

## log_loss as metric
imp = dropcol_importances(model,X_train, y_train, X_valid, y_valid,log_loss)

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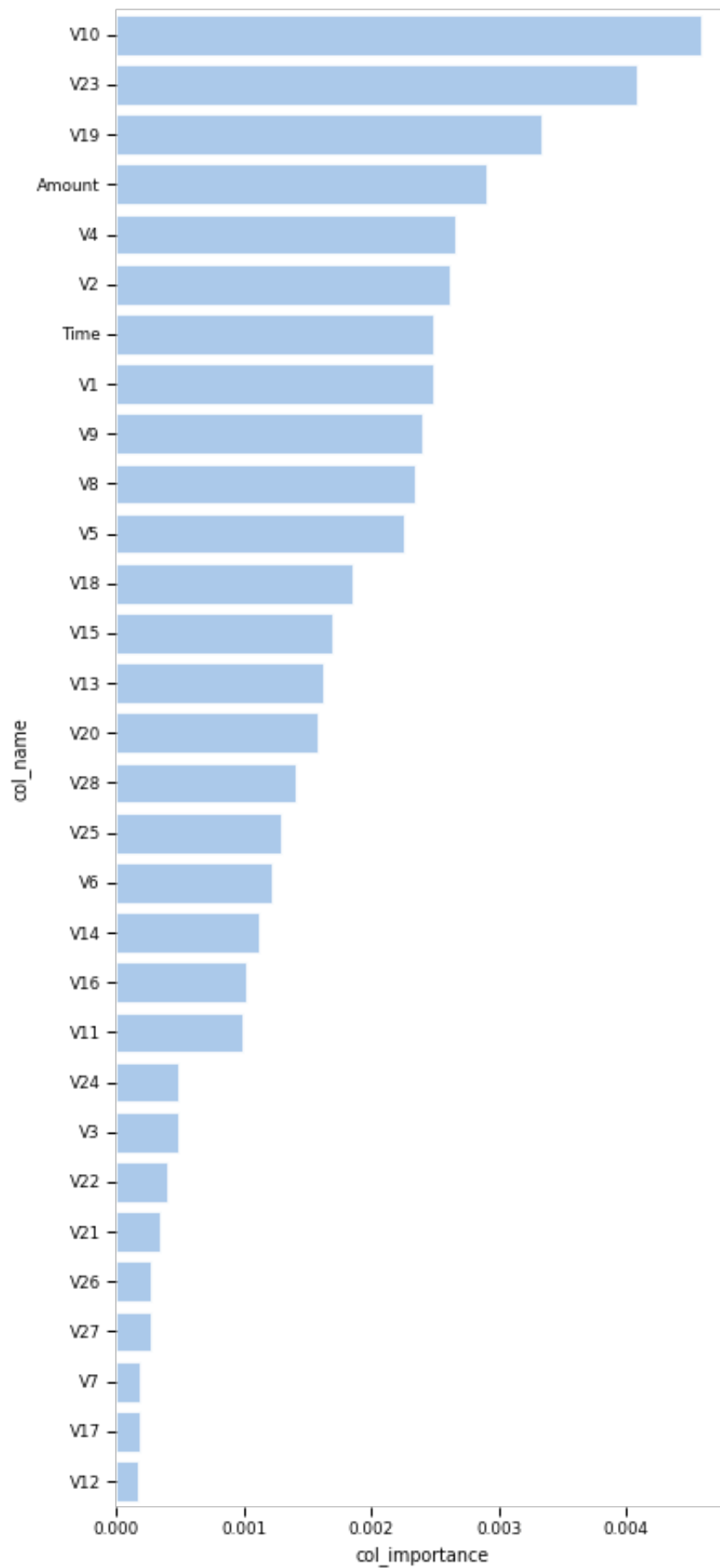
```
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
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[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
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will be ignored. Current value: lambda_l2=5.648254437122679e-07
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will be ignored. Current value: lambda_l1=7.902601989395657e-07
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1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
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will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
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[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
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will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
```

```
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
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[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
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647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
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[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
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[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
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647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
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will be ignored. Current value: lambda_l2=5.648254437122679e-07
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will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
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[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
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Finished loading model, total used 100 iterations
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[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
Finished loading model, total used 100 iterations
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
```

```
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
```

In [18]:

```
#
imp_result_drop_log = defaultdict(float)
for i,item in enumerate(col_list):
    imp_result_drop_log[item] = abs(imp[i])
importance_plot(imp_result_drop_log)
```



Permutation Importance

Accuracy

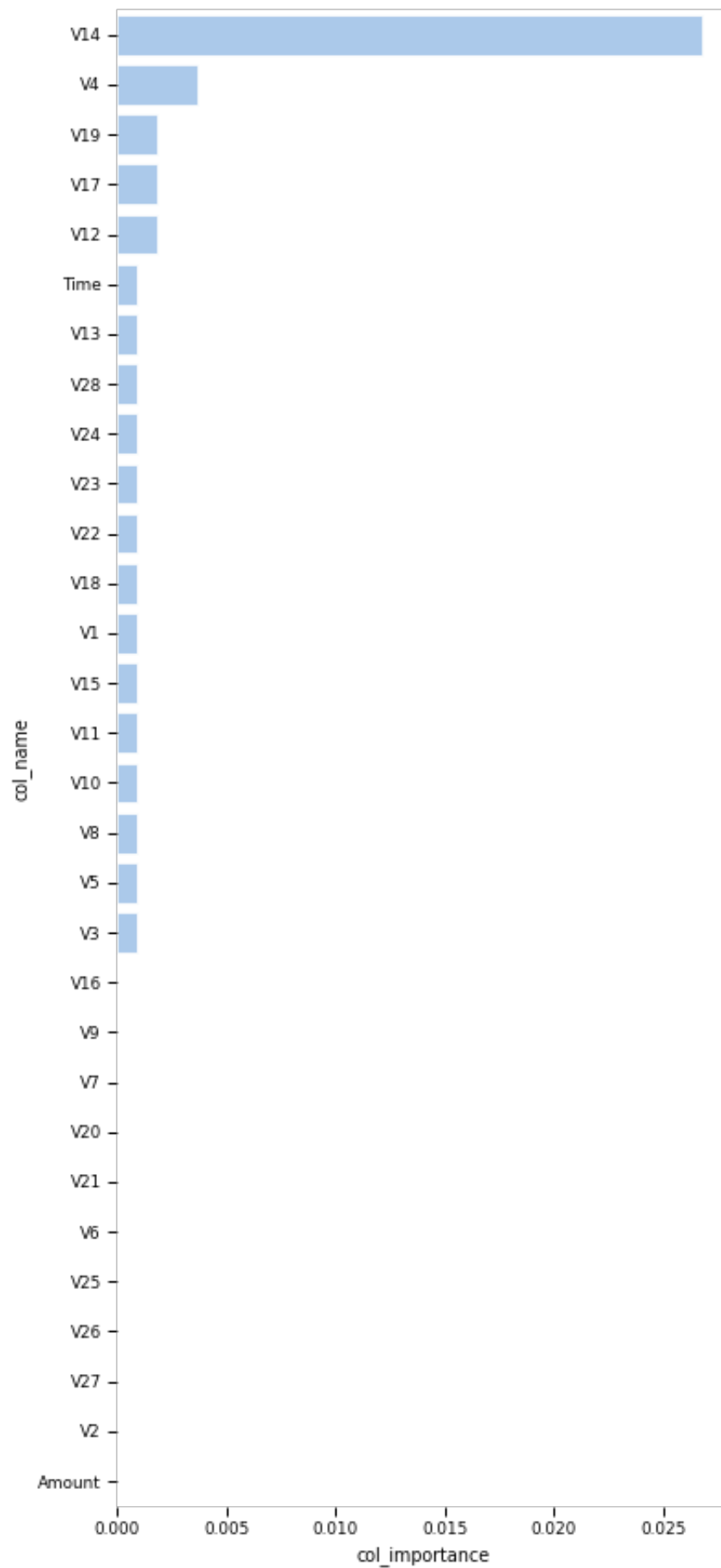
```
In [19]: model = lgb.LGBMClassifier(**param)
         model.fit(X_train,y_train)
```

```
[LightGBM] [Warning] bagging_fraction is set=0.5584550389770908, subsample=
1.0 will be ignored. Current value: bagging_fraction=0.5584550389770908
[LightGBM] [Warning] feature_fraction is set=0.6998029478945647, colsample_
bytree=1.0 will be ignored. Current value: feature_fraction=0.6998029478945
647
[LightGBM] [Warning] bagging_freq is set=4, subsample_freq=0 will be ignore
d. Current value: bagging_freq=4
[LightGBM] [Warning] lambda_l2 is set=5.648254437122679e-07, reg_lambda=0.0
will be ignored. Current value: lambda_l2=5.648254437122679e-07
[LightGBM] [Warning] lambda_l1 is set=7.902601989395657e-07, reg_alpha=0.0
will be ignored. Current value: lambda_l1=7.902601989395657e-07
```

```
Out[19]: LGBMClassifier(bagging_fraction=0.5584550389770908, bagging_freq=4,
                        feature_fraction=0.6998029478945647,
                        lambda_l1=7.902601989395657e-07, lambda_l2=5.648254437122679
e-07,
                        max_depth=5, metric='binary_logloss', min_child_samples=60,
                        num_leaves=67, objective='binary', verbose=-1)
```

```
In [20]: imp = permutation_importances(model, X_valid, y_valid, accuracy_score, proba
```

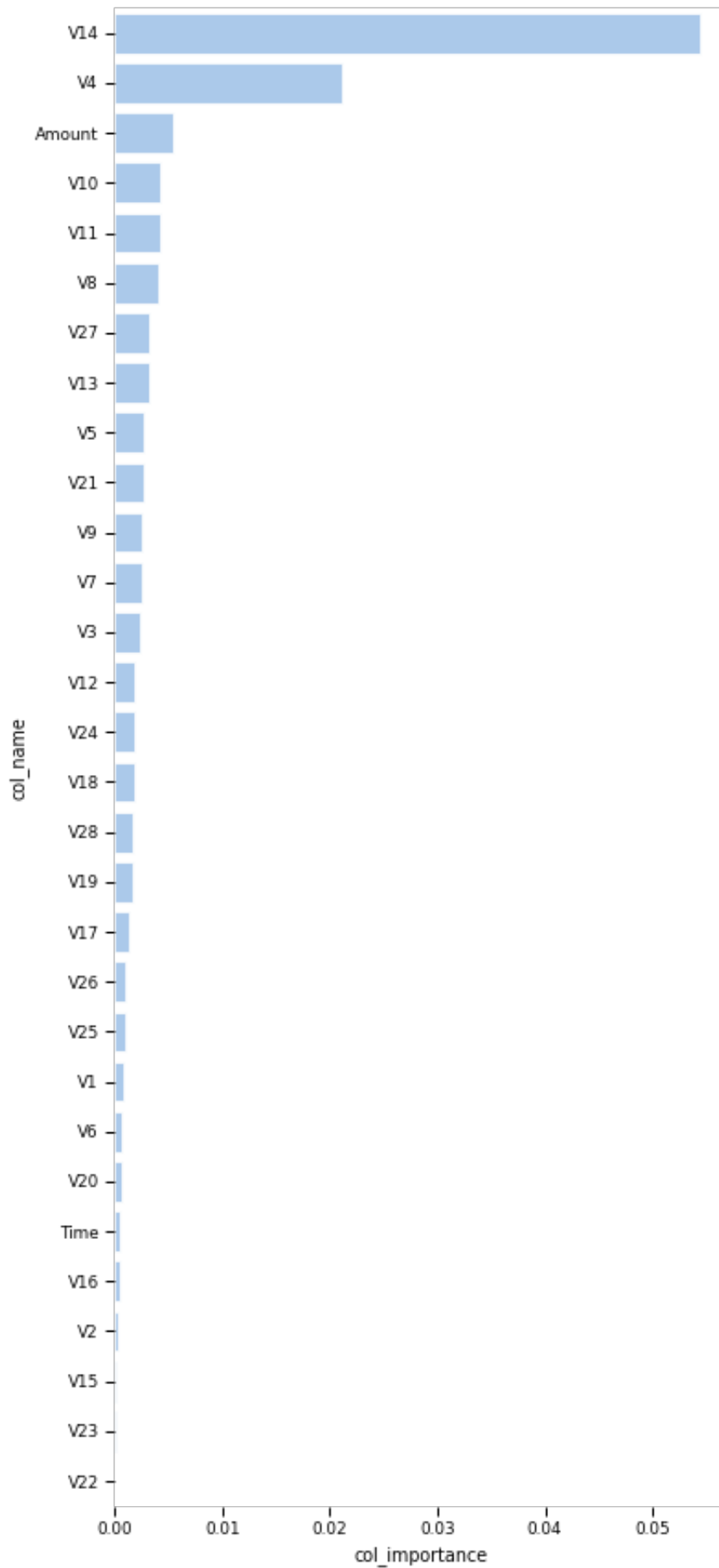
```
In [21]: #
         imp_result_permutation_acc = defaultdict(float)
         for i,item in enumerate(col_list):
             imp_result_permutation_acc[item] = abs(imp[i])
         importance_plot(imp_result_permutation_acc)
```



Log loss

```
In [22]: imp = permutation_importances(model, X_valid, y_valid, log_loss, proba = True)
```

```
In [23]: #
imp_result_permutation_log = defaultdict(float)
for i, item in enumerate(col_list):
    imp_result_permutation_log[item] = abs(imp[i])
importance_plot(imp_result_permutation_log)
```

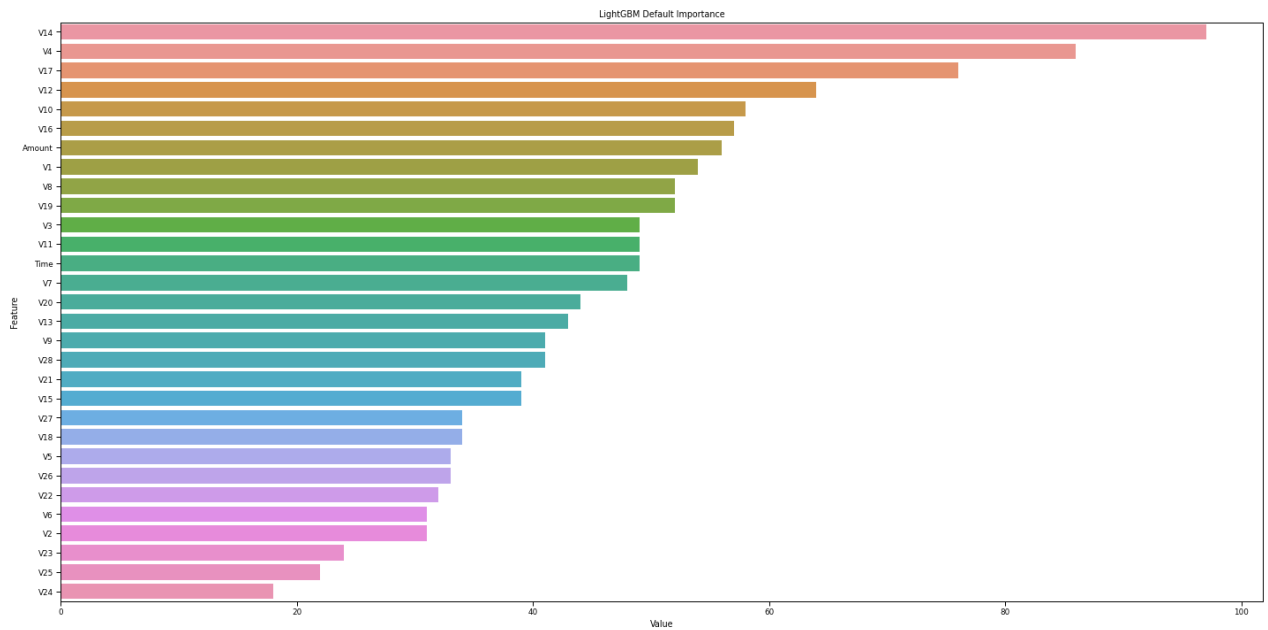


LightGBM Default Feature Importance

I also want to see the performance of LightGBM's default importance result.

In [24]:

```
## LightGBM default feature importance
feature_imp = pd.DataFrame(sorted(zip(model.feature_importances_, X.columns),
plt.figure(figsize=(20, 10))
sns.barplot(x="Value", y="Feature", data=feature_imp.sort_values(by="Value")
plt.title('LightGBM Default Importance')
plt.tight_layout()
plt.show()
```



SHAP

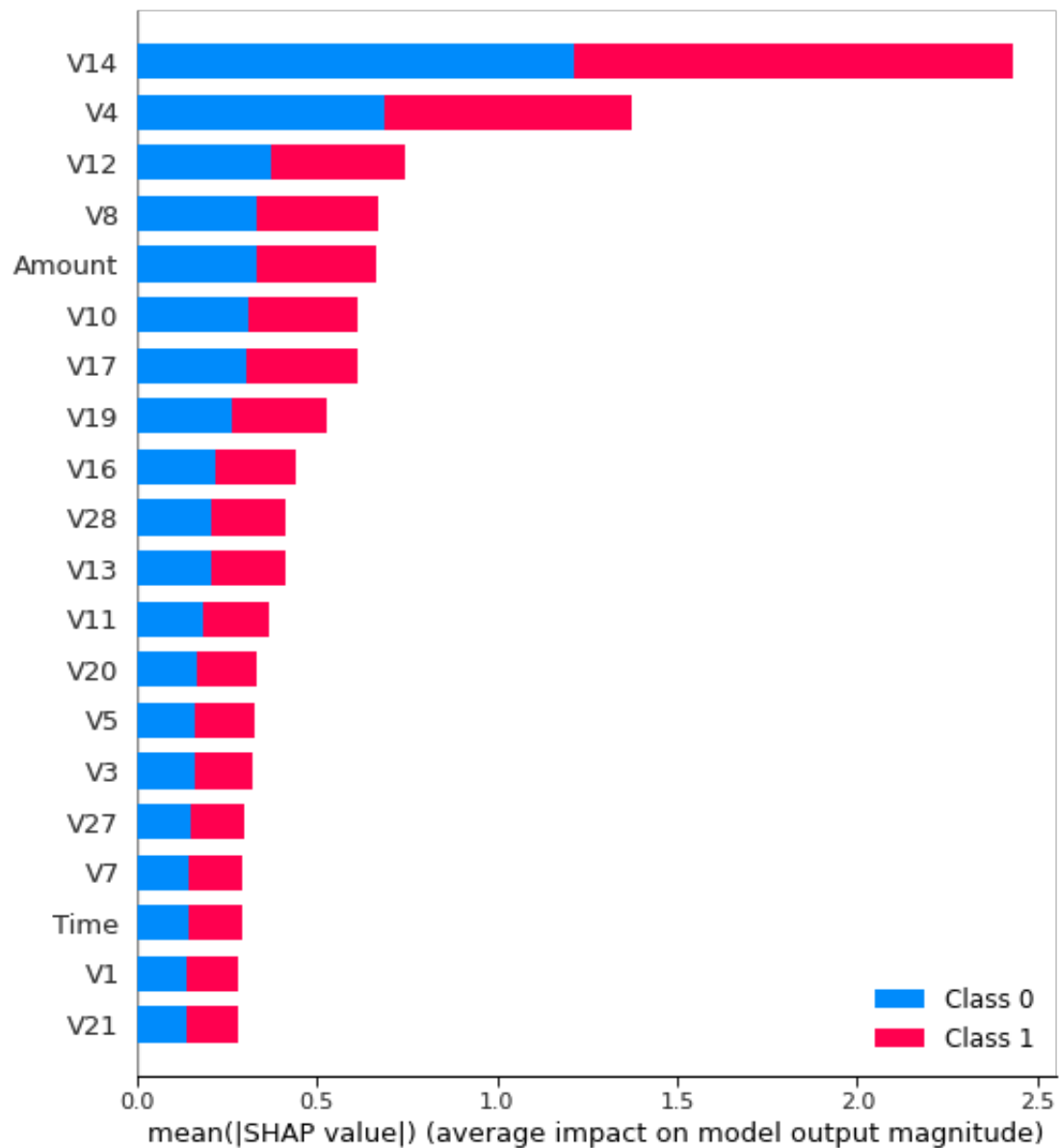
SHAP is the state of the art in Machine Learning explainability. It also has feature importance output.

In [36]:

```
#shap.initjs()
shap_values = shap.TreeExplainer(model).shap_values(X_valid)
```

In [26]:

```
shap.summary_plot(shap_values, X_valid)
```



In [27]:

```
vals= np.abs(shap_values).mean(0)
feature_importance = pd.DataFrame(list(zip(X.columns, sum(vals))), columns=X.columns)
feature_importance.sort_values(by=['feature_importance_vals'], ascending=False)
feature_importance
```

Out[27]:

	col_name	feature_importance_vals
14	V14	1317.113029
4	V4	745.368070
12	V12	402.238080
8	V8	361.554340
29	Amount	360.981563
10	V10	332.565777
17	V17	331.064427
19	V19	284.044797
16	V16	238.635295
28	V28	224.174521
13	V13	223.136677
11	V11	198.595395
20	V20	180.347503
5	V5	177.293663
3	V3	173.222635
27	V27	159.975118
7	V7	158.191329
0	Time	157.790260
1	V1	151.086132
21	V21	150.874725
22	V22	147.721150
2	V2	126.719584
26	V26	118.989537
9	V9	117.791374
25	V25	113.543604
18	V18	98.725839
6	V6	90.444124
24	V24	84.751243
23	V23	66.683705
15	V15	56.510506

Feature Importance Comparison

- Spearman: importance_spearman
- PCA: importance_pca
- mRMR: importance_mRMR
- Drop Column Importance with accuracy: imp_result_drop_acc
- Drop Column Importance with log loss: imp_result_drop_log
- Permutation Importance with accuracy: imp_result_permutation_acc
- Permutation Importance with log loss: imp_result_permutation_log
- LightGBM default: feature_imp
- Shap: feature_importance

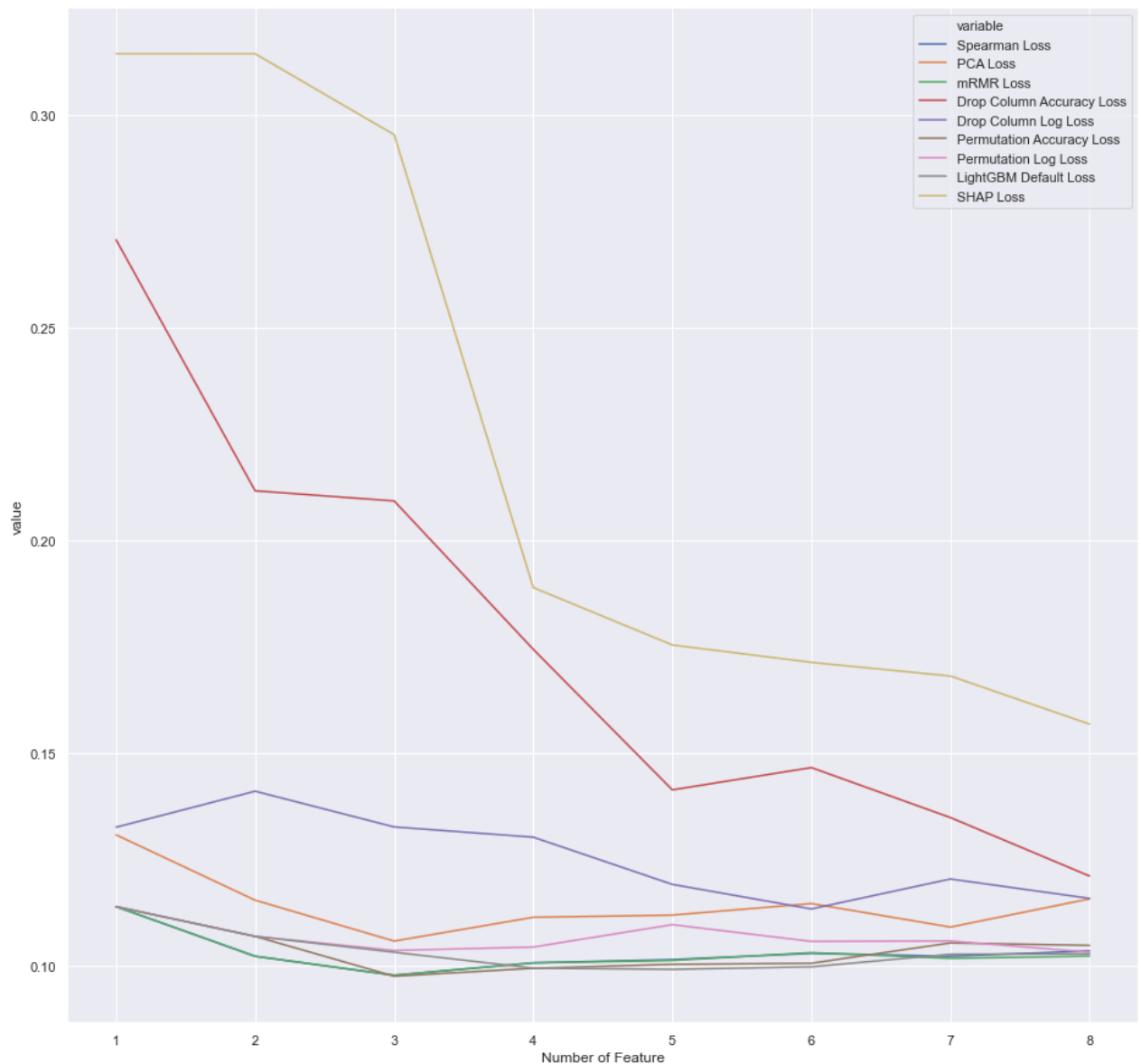
```
In [29]: importance_spearman_order = get_order_from_imp_dict(importance_spearman)
importance_pca_order = get_order_from_imp_dict(importance_pca)
importance_mRMR_order = get_order_from_imp_dict(importance_mRMR)
importance_drop_acc_order = get_order_from_imp_dict(imp_result_drop_acc)
importance_drop_log_order = get_order_from_imp_dict(imp_result_drop_log)
importance_permutation_acc_order = get_order_from_imp_dict(imp_result_permutation_acc)
importance_permutation_log_order = get_order_from_imp_dict(imp_result_permutation_log)
importance_lgbm_default = list(feature_imp.Feature)[::-1]
importance_shap_default = list(feature_imp.Feature)
```

```
In [31]: imp_spearman_loss = loss_feature_lgbm(X_train,y_train,importance_spearman_order)
imp_pca_loss = loss_feature_lgbm(X_train,y_train,importance_pca_order)
imp_mRMR_loss = loss_feature_lgbm(X_train,y_train,importance_mRMR_order)
imp_drop_acc_loss = loss_feature_lgbm(X_train,y_train,importance_drop_acc_order)
imp_drop_log_loss = loss_feature_lgbm(X_train,y_train,importance_drop_log_order)
imp_permutation_acc_loss = loss_feature_lgbm(X_train,y_train,importance_permutation_acc_order)
imp_permutation_log_loss = loss_feature_lgbm(X_train,y_train,importance_permutation_log_order)
imp_lgbm_loss = loss_feature_lgbm(X_train,y_train,importance_lgbm_default)
imp_shap_loss = loss_feature_lgbm(X_train,y_train,importance_shap_default)
```

```
In [32]: num_features = list(range(1,9))
data_preproc = pd.DataFrame({
    'Number of Feature': num_features,
    'Spearman Loss': imp_spearman_loss,
    'PCA Loss': imp_pca_loss,
    'mRMR Loss': imp_mRMR_loss,
    'Drop Column Accuracy Loss': imp_drop_acc_loss,
    'Drop Column Log Loss': imp_drop_log_loss,
    'Permutation Accuracy Loss': imp_permutation_acc_loss,
    'Permutation Log Loss': imp_permutation_log_loss,
    'LightGBM Default Loss': imp_lgbm_loss,
    'SHAP Loss': imp_shap_loss})
```

```
In [33]: sns.set(rc={'figure.figsize':(15.7,15.27)})
sns.lineplot(x='Number of Feature', y='value', hue='variable',
             data=pd.melt(data_preproc, ['Number of Feature']))
```

Out[33]: <matplotlib.axes._subplots.AxesSubplot at 0x15d613070>



This is just a initial attempt to see which feature importance method is good, the comparision is actually sensitive to model's parameter. From plot we notice:

- The best feature importance search methods are **LightGBM default feature importance**, **Permutation with Accuracy as Metric** and **mRMR feature importance**.
- For **Drop Column** and **Permutation** methods, they are sensitive to evaluation metric. For **Drop Column**, log loss performs better than accuracy, **Permutation** with two different metrics have similar results.
- **Permutation** is better than **Drop Column**, maybe because **Drop Column** method's models are not fully tuned.
- **SHAP** is the worst for some reasons.

Automatic Feature Searching

Final choice: importance_mRMR_order

In [62]:

```
out_col, loss_list = automatic_feature_search(X,y,importance_mRMR_order)
print(f'Final columns selected:{out_col}')
print(f'Loss history:{loss_list}')

Final columns selected:Index(['V14', 'V12', 'V4', 'V11', 'V3', 'V10', 'V16',
                              'V17', 'V9', 'V7', 'V2',
                              'V6', 'V1', 'V18', 'V21', 'V5', 'V27', 'V19', 'V8', 'V28', 'V20', 'V
                              24',
                              'V26', 'V13', 'V25'],
                              dtype='object')
Loss history:[0.09856560867844771, 0.09770468524278716, 0.09681408621246848,
              0.09832274538858035]
```

This is an automatic feature searching method built for LightGBM model using log loss. Start from full features then drop the column with lowest importance. If the validation metric becomes worse, stop dropping and output the final result.

LightGBM only discards 4 features.

Conclusion

Feature importance helps us select features, interpret the model. Sometimes business values is inside of the feature importance. When we are dealing with real-world business problems, feature importance should combine with business instinct to guide companies' strategies and actions.

What is best feature importance measurement? It seems do not have a "best" answer. Permutation method, mRMR and LightGBM's default importance have good performance from the experiment results. Whereas they might be the best for this particular dataset (classification). I would say the final **true solution** should always be experimental design (A/B testing).

References

- <https://arxiv.org/pdf/1908.05376.pdf> (mRMR)
- https://en.wikipedia.org/wiki/Spearman%27s_rank_correlation_coefficient
- <https://github.com/slundberg/shap> (SHAP)
- <https://github.com/parr/msds621/blob/master/lectures/feature-importance.pdf>
- <https://github.com/parr/msds689/blob/master/projects/featimp/featimp.md>
- <https://towardsdatascience.com/shap-explained-the-way-i-wish-someone-explained-it-to-me-ab81cc69ef30>