In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import statsmodels.api as sm
import seaborn as sns
from tqdm import tqdm_notebook
import warnings
from statsmodels.tsa.stattools import kpss
from statsmodels.stats.multitest import multipletests
from statsmodels.tsa.holtwinters import ExponentialSmoothing
from sklearn.preprocessing import StandardScaler

from xgboost import XGBClassifier
import lightgbm as lgb
from sklearn.model_selection import StratifiedKFold, KFold
from sklearn.metrics import mean_absolute_error
import time
from catboost import CatBoostRegressor, CatBoostClassifier

import lightgbm as lgb
from sklearn.model_selection import train_test_split
from sklearn.metrics import f1_score

import gc

from feature_engineering import reduce_mem_usage, add_rolling_features
from feature_engineering import exponential_smoothing, signal_shifts
from feature_engineering import batch_stats2, add_minus_signal
from feature_engineering import delete_objects_after_rolling
from feature_engineering import add_quantiles, add_target_encoding

from bayes_opt import BayesianOptimization

warnings.filterwarnings('ignore')
sns.set_style('whitegrid')
```

In [2]:
```
def pred_proc(pred):
    pred = np.round(np.clip(pred, 0, 10))
    return pred.astype(int)

def MacroF1Metric(preds, dtrain):
    labels = dtrain.get_label()
    preds = np.round(np.clip(preds, 0, 10)).astype(int)
    score = f1_score(labels, preds, average = 'macro')
    return ('MacroF1Metric', score, True)

def prepare_df(df, window_sizes, alphas, shifts, batch_sizes):
    df = reduce_mem_usage(df)
    df = add_rolling_features(df, window_sizes)
    df = reduce_mem_usage(df)
    df = exponential_smoothing(df, alphas)
    df = reduce_mem_usage(df)
    df = signal_shifts(df, shifts)
    df = reduce_mem_usage(df)
    df = batch_stats2(df, batch_sizes)
    df = reduce_mem_usage(df)
    df = add_minus_signal(df)
    df = reduce_mem_usage(df)

    if 'open_channels' in df.columns:
        y = df['open_channels']
        df = df.drop(columns=['time'])
        return df, y
    else:
        df = df.drop(columns=['time'])
        return df
```

0. Загрузка данных

In [2]:
```
train = pd.read_csv('data/train.csv')
test = pd.read_csv('data/test.csv')

print(train.shape)
print(test.shape)
print(train.head())
```

```
(5000000, 3)
(2000000, 2)
     time  signal  open_channels
0  0.0001 -2.7600              0
1  0.0002 -2.8557              0
2  0.0003 -2.4074              0
3  0.0004 -3.1404              0
4  0.0005 -3.1525              0
```

1. Подготовка датасета

In [3]:
```
from feature_engineering import reduce_mem_usage, add_rolling_features, expo
```

In [4]:
```
def prepare_df(df, window_sizes, alphas, shifts):
    df = reduce_mem_usage(df)
    df = add_rolling_features(df, window_sizes)
    df = reduce_mem_usage(df)
    df = exponential_smoothing(df, alphas)
    df = reduce_mem_usage(df)
    df = signal_shifts(df, shifts)
    df = reduce_mem_usage(df)

    if 'open_channels' in df.columns:
        y = df['open_channels']
        df = df.drop(columns=['time', 'open_channels'])
        return df, y
    else:
        df = df.drop(columns=['time'])
        return df
```

In [5]:
```
window_sizes = [5, 100, 5000]
alphas = [0.5, 0.1]
shifts = [1,2,-1,-2]

X_train, y_train = prepare_df(train, window_sizes, alphas, shifts)
X_test = prepare_df(test, window_sizes, alphas, shifts)
```

```
Mem. usage decreased to 23.84 Mb (79.2% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 286.10 Mb (74.6% reduction)
Mem. usage decreased to 305.18 Mb (15.8% reduction)
Mem. usage decreased to 343.32 Mb (16.3% reduction)
Mem. usage decreased to  7.63 Mb (75.0% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 112.53 Mb (74.1% reduction)
Mem. usage decreased to 120.16 Mb (16.0% reduction)
Mem. usage decreased to 135.42 Mb (9.0% reduction)
```

2. Первая наивная попытка: LGBMRegressor

Попробуем обучить LGBMRegressor, разбивая данные на 5 фолдов, обучаясь как в кросс-валидации, при этом для каждого разбиения считать прогноз лучшей итерации на тесте.

In [6]:
```
X_train = np.array(X_train)
y_train = np.array(y_train)
X_test = np.array(X_test)

scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

In [4]:
```
params = {'num_leaves': 128,
          'min_data_in_leaf': 64,
          'objective': 'huber',
          'max_depth': -1,
          'learning_rate': 0.005,
          "boosting": "gbdt",
          "bagging_freq": 5,
          "bagging_fraction": 0.8,
          "bagging_seed": 11,
          "metric": 'mae',
          "verbosity": -1,
          'reg_alpha': 0.1,
          'reg_lambda': 0.3}
```

In [5]:
```
n_fold = 5
folds = KFold(n_splits=n_fold, shuffle=True, random_state=42)
```

In [10]:
```
oof = np.zeros(len(X_train))
prediction = np.zeros(len(X_test))
scores = []

for fold_n, (train_index, valid_index) in tqdm_notebook(enumerate(folds.spli
    print('Fold', fold_n, 'started at', time.ctime())
    X_train_, X_valid = X_train[train_index], X_train[valid_index]
    y_train_, y_valid = y_train[train_index], y_train[valid_index]

    model = lgb.LGBMRegressor(**params, n_estimators = 5000, n_jobs = -1)
    model.fit(X_train, y_train,
            eval_set=[(X_train_, y_train_), (X_valid, y_valid)], eval_metric
            verbose=500, early_stopping_rounds=200)

    y_pred_valid = model.predict(X_valid)
    y_pred = model.predict(X_test, num_iteration=model.best_iteration_)

    oof[valid_index] = y_pred_valid.reshape(-1,)
    scores.append(mean_absolute_error(y_valid, y_pred_valid))

    prediction += y_pred

prediction /= n_fold
```

...

In [11]:
```
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})

sample_df['open_channels'] = np.round(prediction).astype(np.int)
sample_df.to_csv("submission.csv", index=False, float_format='%.4f')
```

Результат: 0.71 на public LB

3. Возьмем другой датасет

In [3]:
```
def prepare_df(df, window_sizes, alphas, shifts, batch_sizes):
    df = reduce_mem_usage(df)
    df = add_rolling_features(df, window_sizes)
    df = reduce_mem_usage(df)
    df = exponential_smoothing(df, alphas)
    df = reduce_mem_usage(df)
    df = signal_shifts(df, shifts)
    df = reduce_mem_usage(df)
    df = batch_stats2(df, batch_sizes)
    df = reduce_mem_usage(df)
    df = add_minus_signal(df)
    df = reduce_mem_usage(df)

    if 'open_channels' in df.columns:
        y = df['open_channels']
        df = df.drop(columns=['time', 'open_channels'])
        return df, y
    else:
        df = df.drop(columns=['time'])
        return df
```

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

window_sizes = [5, 100, 1000]
alphas = [0.5, 0.1]
shifts = [1,-1]
batch_sizes = [25000, 2500]


X_train, y_train = prepare_df(train, window_sizes, alphas, shifts, batch_siz
X_test = prepare_df(test, window_sizes, alphas, shifts, batch_sizes)
```

```
Mem. usage decreased to 23.84 Mb (79.2% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 286.10 Mb (74.6% reduction)
Mem. usage decreased to 305.18 Mb (15.8% reduction)
Mem. usage decreased to 324.25 Mb (17.1% reduction)
Mem. usage decreased to 562.67 Mb (51.6% reduction)
Mem. usage decreased to 1096.73 Mb (0.0% reduction)
Mem. usage decreased to  7.63 Mb (75.0% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 112.53 Mb (74.1% reduction)
Mem. usage decreased to 120.16 Mb (16.0% reduction)
Mem. usage decreased to 127.79 Mb (9.5% reduction)
Mem. usage decreased to 211.72 Mb (54.3% reduction)
Mem. usage decreased to 413.89 Mb (0.0% reduction)
```

In [5]:
```
X_train.head()
```

Out[5]:

	signal	batch	rolling_mean_5	rolling_std_5	rolling_var_5	rolling_min_5	rolling_max_5	rolli
0	-2.759766	0	0.000000	0.000000	0.000000	0.000000	0.000000	
1	-2.855469	0	0.000000	0.000000	0.000000	0.000000	0.000000	
2	-2.408203	0	0.000000	0.000000	0.000000	0.000000	0.000000	
3	-3.140625	0	0.000000	0.000000	0.000000	0.000000	0.000000	
4	-3.152344	0	-2.863281	0.307617	0.094604	-3.152344	-2.408203	

5 rows × 108 columns

In [6]:
```
X_train = np.array(X_train)
y_train = np.array(y_train)
X_test = np.array(X_test)
```

4. Макро F1-метрика

Подсчет макро f1, которую будем выводить сразу же при обучении lgbm.

Подсмотрено в этом ноутбуке: https://www.kaggle.com/vbmokin/ion-switching-advanced-fe-lgb-xgb-confmatrix/notebook (https://www.kaggle.com/vbmokin/ion-switching-advanced-fe-lgb-xgb-confmatrix/notebook)

In [3]:
```
def MacroF1Metric(preds, dtrain):
    labels = dtrain.get_label()
    preds = np.round(np.clip(preds, 0, 10)).astype(int)
    score = f1_score(labels, preds, average = 'macro')
    return ('MacroF1Metric', score, True)
```

5. Обучение lgbm

Параметры подбираем пока что чисто интуитивно.

In [10]:
```
num_iterations = 3000
X_train_, X_valid, y_train_, y_valid = train_test_split(X_train, y_train, te
params = {'learning_rate': 0.05,
          'max_depth': -1,
          'num_leaves': 200,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
          'sample_fraction':0.33}
model = lgb.train(params, lgb.Dataset(X_train_, y_train_),
                  num_iterations,
                  lgb.Dataset(X_valid, y_valid),
                  verbose_eval=100,
                  early_stopping_rounds=200,
                  feval=MacroF1Metric)
model.save_model('model5.txt', num_iteration=model.best_iteration)
```

```
Training until validation scores don't improve for 200 rounds
[100]   valid_0's MacroF1Metric: 0.931818
[200]   valid_0's MacroF1Metric: 0.934456
[300]   valid_0's MacroF1Metric: 0.935061
[400]   valid_0's MacroF1Metric: 0.935205
[500]   valid_0's MacroF1Metric: 0.935294
[600]   valid_0's MacroF1Metric: 0.935436
[700]   valid_0's MacroF1Metric: 0.935445
[800]   valid_0's MacroF1Metric: 0.935532
[900]   valid_0's MacroF1Metric: 0.935671
[1000]  valid_0's MacroF1Metric: 0.935628
[1100]  valid_0's MacroF1Metric: 0.935719
[1200]  valid_0's MacroF1Metric: 0.935687
[1300]  valid_0's MacroF1Metric: 0.935751
[1400]  valid_0's MacroF1Metric: 0.935708
Early stopping, best iteration is:
[1287]  valid_0's MacroF1Metric: 0.935771
```

Out[10]:
```
132
```

In [12]:
```
num_iterations = 2000
model = lgb.train(params, lgb.Dataset(X_train, y_train),
                  num_iterations,
                  verbose_eval=100,
                  feval=MacroF1Metric)
```

In [14]:
```
%%time

y_lgb_pred = model.predict(X_test)
```

```
Wall time: 1min 6s
```

In [15]:
```
def pred_proc(pred):
    pred = np.round(np.clip(pred, 0, 10))
    return pred.astype(int)
```

In [16]:
```
y_lgb_pred = pred_proc(y_lgb_pred)
```

In [24]:
```
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})

sample_df['open_channels'] = y_lgb_pred
sample_df.to_csv("model5.csv", index=False, float_format='%.4f')
```

Результат: 0.932 на public lb

6. LGBM с бОльшим кол-вом фичей

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

window_sizes = [5, 100, 1000, 5000]
alphas = [0.5, 0.2, 0.05]
shifts = [1,-1,2,-2]
batch_sizes = [50000, 25000, 2500]


X_train, y_train = prepare_df(train, window_sizes, alphas, shifts, batch_siz
X_test = prepare_df(test, window_sizes, alphas, shifts, batch_sizes)

# X_train = np.array(X_train)
y_train = np.array(y_train)
# X_test = np.array(X_test)
```

```
Mem. usage decreased to 23.84 Mb (79.2% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 371.93 Mb (74.7% reduction)
Mem. usage decreased to 400.54 Mb (17.6% reduction)
Mem. usage decreased to 438.69 Mb (13.2% reduction)
Mem. usage decreased to 782.01 Mb (53.9% reduction)
Mem. usage decreased to 1535.42 Mb (0.0% reduction)
Mem. usage decreased to  7.63 Mb (75.0% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 146.87 Mb (74.3% reduction)
Mem. usage decreased to 158.31 Mb (17.8% reduction)
Mem. usage decreased to 173.57 Mb (7.1% reduction)
Mem. usage decreased to 299.45 Mb (55.8% reduction)
Mem. usage decreased to 589.37 Mb (0.0% reduction)
```

In [28]:
```
%%time

num_iterations = 3000
X_train_, X_valid, y_train_, y_valid = train_test_split(X_train, y_train, te
params = {'learning_rate': 0.05,
          'max_depth': -1,
          'num_leaves': 200,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
          'sample_fraction':0.33}
model = lgb.train(params, lgb.Dataset(X_train_, y_train_),
                  num_iterations,
                  lgb.Dataset(X_valid, y_valid),
                  verbose_eval=100,
                  early_stopping_rounds=200,
                  feval=MacroF1Metric)
model.save_model('model6.txt', num_iteration=model.best_iteration)
```

```
Training until validation scores don't improve for 200 rounds
[100]   valid_0's MacroF1Metric: 0.933017
[200]   valid_0's MacroF1Metric: 0.935251
[300]   valid_0's MacroF1Metric: 0.935518
[400]   valid_0's MacroF1Metric: 0.935647
[500]   valid_0's MacroF1Metric: 0.935838
[600]   valid_0's MacroF1Metric: 0.93596
[700]   valid_0's MacroF1Metric: 0.936037
[800]   valid_0's MacroF1Metric: 0.936087
[900]   valid_0's MacroF1Metric: 0.936211
[1000]  valid_0's MacroF1Metric: 0.936281
[1100]  valid_0's MacroF1Metric: 0.936396
[1200]  valid_0's MacroF1Metric: 0.936453
[1300]  valid_0's MacroF1Metric: 0.936567
[1400]  valid_0's MacroF1Metric: 0.936519
[1500]  valid_0's MacroF1Metric: 0.936491
Early stopping, best iteration is:
[1369]  valid_0's MacroF1Metric: 0.936582
Wall time: 40min 54s
```

Out[28]:
```
<lightgbm.basic.Booster at 0x27b90bcee48>
```

In [29]:
```
%%time

num_iterations = 2000
model = lgb.train(params, lgb.Dataset(X_train, y_train),
                  num_iterations,
                  verbose_eval=100,
                  feval=MacroF1Metric)

y_lgb_pred = model.predict(X_test)
```

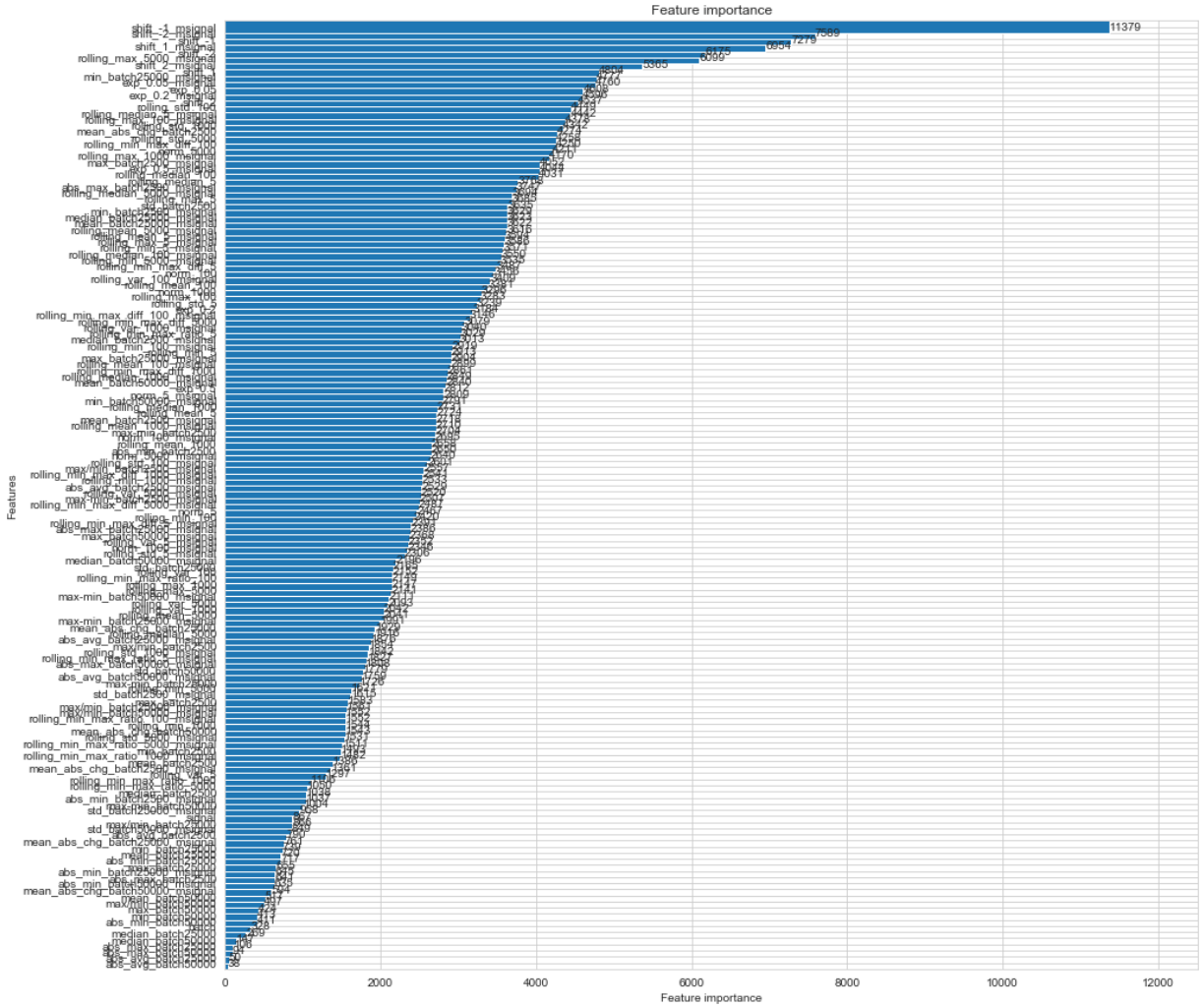
```
Wall time: 21min 15s
```

In [30]:
```
%%time
y_lgb_pred = pred_proc(y_lgb_pred)
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})
sample_df['open_channels'] = y_lgb_pred
sample_df.to_csv("model6.csv", index=False, float_format='%.4f')
```

```
Wall time: 4.39 s
```

Результат: 0.936 на public LB

In [33]:
```
fig =  plt.figure(figsize = (15,15))
axes = fig.add_subplot(111)
lgb.plot_importance(model,ax = axes,height = 2.)
plt.show()
```



Как видим, здорово себя показывают эксп. сглаживания, сдвиги и роллинги. Сделаем упор на них в следующей модели.

7. Еще больше фичей

In [5]:
```
train = pd.read_csv('data/train.csv')
test = pd.read_csv('data/test.csv')

window_sizes = [5, 100, 1000, 5000, 10000]
alphas = [0.5, 0.2, 0.05, 0.7]
shifts = [1,-1,2,-2,3,-3]
batch_sizes = [50000, 25000, 2500]


X_train, y_train = prepare_df(train, window_sizes, alphas, shifts, batch_siz
X_test = prepare_df(test, window_sizes, alphas, shifts, batch_sizes)

# X_train = np.array(X_train)
y_train = np.array(y_train)
# X_test = np.array(X_test)
```

```
Mem. usage decreased to 23.84 Mb (79.2% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 457.76 Mb (74.7% reduction)
Mem. usage decreased to 495.91 Mb (18.7% reduction)
Mem. usage decreased to 553.13 Mb (10.8% reduction)
Mem. usage decreased to 896.45 Mb (50.5% reduction)
Mem. usage decreased to 1764.30 Mb (0.0% reduction)
Mem. usage decreased to  7.63 Mb (75.0% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 181.20 Mb (74.5% reduction)
Mem. usage decreased to 196.46 Mb (18.9% reduction)
Mem. usage decreased to 219.35 Mb (5.7% reduction)
Mem. usage decreased to 345.23 Mb (52.2% reduction)
Mem. usage decreased to 680.92 Mb (0.0% reduction)
```

In [15]:
```
X_train = delete_objects_after_rolling(X_train, 10000)
add_quantiles(X_train, X_test, n_bins=7)
```

In [16]:
```
tmp = []
for i, y in enumerate(y_train):
    if i % 500000 < 10000:
        continue
    else:
        tmp.append(y)
```

In [17]:
```
y_train = np.array(tmp)
```

In [18]:

```
%%time

num_iterations = 3000
X_train_, X_valid, y_train_, y_valid = train_test_split(X_train, y_train, te
params = {'learning_rate': 0.05,
          'max_depth': -1,
          'num_leaves': 200,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
          'sample_fraction':0.33}
model = lgb.train(params, lgb.Dataset(X_train_, y_train_),
                  num_iterations,
                  lgb.Dataset(X_valid, y_valid),
                  verbose_eval=100,
                  early_stopping_rounds=200,
                  feval=MacroF1Metric)
model.save_model('model7.txt', num_iteration=model.best_iteration)
```

```
Training until validation scores don't improve for 200 rounds
[100]   valid_0's MacroF1Metric: 0.93366
[200]   valid_0's MacroF1Metric: 0.935862
[300]   valid_0's MacroF1Metric: 0.936162
[400]   valid_0's MacroF1Metric: 0.936317
[500]   valid_0's MacroF1Metric: 0.936515
[600]   valid_0's MacroF1Metric: 0.936509
[700]   valid_0's MacroF1Metric: 0.936523
[800]   valid_0's MacroF1Metric: 0.936641
[900]   valid_0's MacroF1Metric: 0.936617
[1000]  valid_0's MacroF1Metric: 0.936656
[1100]  valid_0's MacroF1Metric: 0.936691
[1200]  valid_0's MacroF1Metric: 0.936778
[1300]  valid_0's MacroF1Metric: 0.936782
[1400]  valid_0's MacroF1Metric: 0.936859
[1500]  valid_0's MacroF1Metric: 0.936927
[1600]  valid_0's MacroF1Metric: 0.936938
[1700]  valid_0's MacroF1Metric: 0.936913
[1800]  valid_0's MacroF1Metric: 0.936934
[1900]  valid_0's MacroF1Metric: 0.936877
[2000]  valid_0's MacroF1Metric: 0.936855
Early stopping, best iteration is:
[1841]  valid_0's MacroF1Metric: 0.936951
Wall time: 2h 30min 13s
```

Out[18]:

```
<lightgbm.basic.Booster at 0x2c90007a9c8>
```

In [19]:
```
%%time

num_iterations = 2000
model = lgb.train(params, lgb.Dataset(X_train, y_train),
                  num_iterations,
                  verbose_eval=100,
                  feval=MacroF1Metric)

y_lgb_pred = model.predict(X_test)
```

```
Wall time: 24min 10s
```

In [23]:
```
%%time
y_lgb_pred = pred_proc(y_lgb_pred)
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})
sample_df['open_channels'] = y_lgb_pred
sample_df.to_csv("model7.csv", index=False, float_format='%.4f')
```

```
Wall time: 4.2 s
```

Результат: 0.935 на public LB.

9. Обучим такой же lgbm, но на данных без дрифта

Датасет без дрифта взят отсюда: [https://www.kaggle.com/c/liverpool-ion-switching/discussion/135480 (https://www.kaggle.com/c/liverpool-ion-switching/discussion/135480)](https://www.kaggle.com/c/liverpool-ion-switching/discussion/135480)

In [3]:
```
train = pd.read_csv('data/train_clean.csv')
test = pd.read_csv('data/test_clean.csv')

window_sizes = [5, 100, 1000, 5000]
alphas = [0.5, 0.2, 0.05]
shifts = [1,-1,2,-2]
batch_sizes = [50000, 25000, 2500]


X_train, y_train = prepare_df(train, window_sizes, alphas, shifts, batch_siz
X_test = prepare_df(test, window_sizes, alphas, shifts, batch_sizes)

# X_train = np.array(X_train)
y_train = np.array(y_train)
# X_test = np.array(X_test)

# X_train = delete_objects_after_rolling(X_train, 10000)
# add_quantiles(X_train, X_test, n_bins=7)
```

...

In [8]:
```
%%time

num_iterations = 3000
X_train_, X_valid, y_train_, y_valid = train_test_split(X_train, y_train, te
params = {'learning_rate': 0.05,
          'max_depth': -1,
          'num_leaves': 200,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
          'sample_fraction':0.33}
model = lgb.train(params, lgb.Dataset(X_train_, y_train_),
                  num_iterations,
                  lgb.Dataset(X_valid, y_valid),
                  verbose_eval=100,
                  early_stopping_rounds=200,
                  feval=MacroF1Metric)
model.save_model('model9.txt', num_iteration=model.best_iteration)
```

```
Training until validation scores don't improve for 200 rounds
[100]   valid_0's MacroF1Metric: 0.937193
[200]   valid_0's MacroF1Metric: 0.937541
[300]   valid_0's MacroF1Metric: 0.937565
[400]   valid_0's MacroF1Metric: 0.937608
[500]   valid_0's MacroF1Metric: 0.93763
[600]   valid_0's MacroF1Metric: 0.937583
[700]   valid_0's MacroF1Metric: 0.937556
Early stopping, best iteration is:
[514]   valid_0's MacroF1Metric: 0.937659
Wall time: 23min 19s
```

Out[8]:
```
<lightgbm.basic.Booster at 0x2538008a8c8>
```

In [10]:
```
%%time

num_iterations = 600
model = lgb.train(params, lgb.Dataset(X_train, y_train),
                  num_iterations)

y_lgb_pred = model.predict(X_test)
```

```
Wall time: 8min 18s
```

In [11]:
```
y_lgb_pred = pred_proc(y_lgb_pred)
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})
sample_df['open_channels'] = y_lgb_pred
sample_df.to_csv("model9.csv", index=False, float_format='%.4f')
```

Результат: 0.939 на public lb

10. Добавим фичи с таргет енкодингом

In [33]:

```
train = pd.read_csv('data/train_clean.csv')
test = pd.read_csv('data/test_clean.csv')

window_sizes = [5, 100, 1000, 5000]
alphas = [0.5, 0.2, 0.05]
shifts = [1,-1,2,-2]
batch_sizes = [50000, 25000, 2500]


X_train, y_train = prepare_df(train, window_sizes, alphas, shifts, batch_siz
X_test = prepare_df(test, window_sizes, alphas, shifts, batch_sizes)

y_train = np.array(y_train)

add_quantiles(X_train, X_test, [3, 7, 15])
add_target_encoding(X_train, X_test, [3, 7, 15])

X_train = reduce_mem_usage(X_train)
X_test = reduce_mem_usage(X_test)

X_train = X_train.drop(columns=['open_channels'])

gc.collect()
```

```
Mem. usage decreased to 23.84 Mb (79.2% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 381.47 Mb (74.0% reduction)
Mem. usage decreased to 410.08 Mb (17.3% reduction)
Mem. usage decreased to 448.23 Mb (13.0% reduction)
Mem. usage decreased to 762.94 Mb (55.3% reduction)
Mem. usage decreased to 1497.27 Mb (0.0% reduction)
Mem. usage decreased to  7.63 Mb (75.0% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 154.50 Mb (73.0% reduction)
Mem. usage decreased to 165.94 Mb (17.1% reduction)
Mem. usage decreased to 181.20 Mb (6.9% reduction)
Mem. usage decreased to 307.08 Mb (55.2% reduction)
Mem. usage decreased to 604.63 Mb (0.0% reduction)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in

the notebook. You may be able to create the widget by running the appropriate cells.

```
Mem. usage decreased to 1587.87 Mb (15.9% reduction)
Mem. usage decreased to 640.87 Mb (15.8% reduction)
```

Out[33]: 6

In [4]:

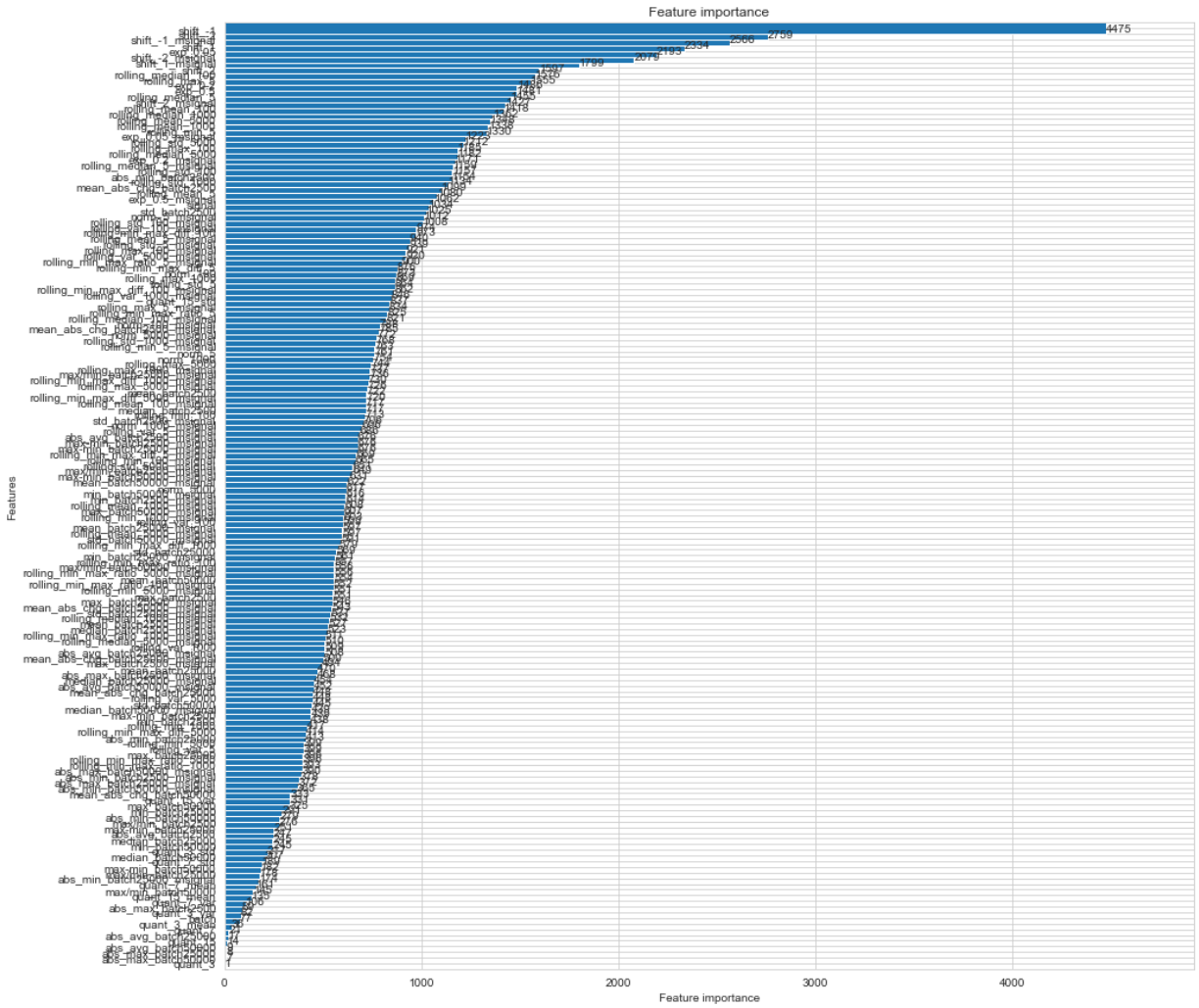
```
%%time
gc.collect()
num_iterations = 3000
X_train_, X_valid, y_train_, y_valid = train_test_split(X_train, y_train, te
params = {'learning_rate': 0.05,
          'max_depth': -1,
          'num_leaves': 200,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
          'sample_fraction':0.33}

del X_train, y_train

train_set = lgb.Dataset(X_train_, y_train_)
val_set = lgb.Dataset(X_valid, y_valid)

del X_train_, X_valid, y_train_, y_valid

gc.collect()

model = lgb.train(params, train_set,
                  num_iterations,
                  val_set,
                  verbose_eval=100,
                  early_stopping_rounds=200,
                  feval=MacroF1Metric)
model.save_model('model10.txt', num_iteration=model.best_iteration)
```

```
Training until validation scores don't improve for 200 rounds
[100]   valid_0's MacroF1Metric: 0.937142
[200]   valid_0's MacroF1Metric: 0.937563
[300]   valid_0's MacroF1Metric: 0.937675
[400]   valid_0's MacroF1Metric: 0.937667
[500]   valid_0's MacroF1Metric: 0.93772
[600]   valid_0's MacroF1Metric: 0.937751
[700]   valid_0's MacroF1Metric: 0.937672
[800]   valid_0's MacroF1Metric: 0.937705
Early stopping, best iteration is:
[609]   valid_0's MacroF1Metric: 0.937757
Wall time: 20min 12s
```

Out[4]: <lightgbm.basic.Booster at 0x263b56c1a48>

In [5]:

```
fig =  plt.figure(figsize = (15,15))
axes = fig.add_subplot(111)
lgb.plot_importance(model,ax = axes,height = 2.)
plt.show()
```



In [6]:

```
del train_set, val_set
gc.collect()
```

Out[6]: 40

In [10]:

```
%%time

train_set = lgb.Dataset(X_train, y_train)

del X_train, y_train

gc.collect()

num_iterations = 600
model = lgb.train(params, train_set,
                  num_iterations)

y_lgb_pred = model.predict(X_test)

np.save('model10_test_preds.npy', y_lgb_pred)
```

```
Wall time: 8min 14s
```

In [11]:

```
y_lgb_pred = pred_proc(y_lgb_pred)
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})
sample_df['open_channels'] = y_lgb_pred
sample_df.to_csv("model10.csv", index=False, float_format='%.4f')
```

Результат: 0.939 на public lb

11. cv-loop

In [36]:

```
def lgb_cv_loop(X_train, y_train, X_test):
    n_fold = 5
    folds = KFold(n_splits=n_fold, shuffle=True, random_state=17)

    num_iterations = 900

    oof = np.zeros(len(X_train))
    prediction = np.zeros(len(X_test))
    scores = []

    for training_index, validation_index in tqdm_notebook(folds.split(X_trai
        gc.collect()

        # разбиение на трэйн и валидацию
        X_train_ = X_train.iloc[training_index]
        y_train_ = y_train[training_index]
        X_valid = X_train.iloc[validation_index]
        y_valid = y_train[validation_index]

        train_set = lgb.Dataset(X_train_, y_train_)

        del X_train_, y_train_

        gc.collect()

        # обучение модели
        model = lgb.train(params, train_set, num_iterations)

        # скор на валидации
        preds = model.predict(X_valid)
        oof[validation_index] = preds.reshape(-1,)
        preds = np.round(np.clip(preds, 0, 10)).astype(int)
        score = f1_score(y_valid, preds, average = 'macro')
        scores.append(score)

        # предсказание на тесте
        preds = model.predict(X_test)
        prediction += preds

        print(f'score: {score}')

    prediction /= n_fold
    prediction = np.round(np.clip(prediction, 0, 10)).astype(int)

    return scores, oof, prediction
```

In [22]:

```
params = {'learning_rate': 0.05,
          'max_depth': -1,
          'num_leaves': 200,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
          'sample_fraction':0.33}
```

In [23]:
```
%%time
scores, oof, prediction = lgb_cv_loop(X_train, y_train, X_test)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
score: 0.9377723991122747
score: 0.9377418056780993
score: 0.9374989672286218
score: 0.9393080850181423
score: 0.9385557886223648

Wall time: 34min 57s
```

In [24]:
```
np.mean(scores)
```

Out[24]:
```
0.9381754091319007
```

In [25]:
```
np.save('model10_oof_preds.npy', oof)
```

12. Bayesian optimization

In [16]:

```python
def bayesion_opt_lgbm(X, y, init_iter=3, n_iters=7, random_state=11, seed=10
    dtrain = lgb.Dataset(data=X, label=y)

    def hyp_lgbm(num_leaves, feature_fraction, bagging_fraction,
                 max_depth, min_split_gain, min_child_weight, num_iterations

        params = {'application': 'regression',
                  'learning_rate': 0.05,
                  'early_stopping_round': 100,
                  'metric': 'MacroF1Metric',
                  'n_jobs': -1}
                  #параметры для gpu (убрать при использовании cpu)
                  #'device': 'gpu',
                  #'gpu_platform_id': 0,
                  #'gpu_device_id': 0}

        params["num_iterations"] = int(round(num_iterations))
        params["num_leaves"] = int(round(num_leaves))
        params['feature_fraction'] = max(min(feature_fraction, 1), 0)
        params['bagging_fraction'] = max(min(bagging_fraction, 1), 0)
        params['max_depth'] = int(round(max_depth))
        params['min_split_gain'] = min_split_gain
        params['min_child_weight'] = min_child_weight
        cv_results = lgb.cv(params, dtrain, nfold=5, seed=seed,
                            categorical_feature=[], stratified=False,
                            verbose_eval=None, feval=MacroF1Metric)

        return np.max(cv_results['MacroF1Metric-mean'])

    pds = {'num_leaves': (80, 220),
           'feature_fraction': (0.1, 0.9),
           'bagging_fraction': (0.8, 1),
           'max_depth': (15, 30),
           'min_split_gain': (0.001, 0.1),
           'min_child_weight': (10, 25),
           'num_iterations': (100, 1000)
          }

    optimizer = BayesianOptimization(hyp_lgbm, pds, random_state=random_stat

    optimizer.maximize(init_points=init_iter, n_iter=n_iters)

    return optimizer
```

In [17]:

```
def lgbm_train(dtrain, best_params, num_iterations=200):

    params = {'application': 'regression', 'num_iterations': num_iterations,
                    'learning_rate': 0.05,
                    'metric': 'MacroF1Metric',
                    'n_jobs': -1}

    params["num_leaves"] = int(round(best_params['num_leaves']))
    params['feature_fraction'] = max(min(best_params['feature_fraction'], 1)
    params['bagging_fraction'] = max(min(best_params['bagging_fraction'], 1)
    params['max_depth'] = int(round(best_params['max_depth']))
    params['min_split_gain'] = best_params['min_split_gain']
    params['min_child_weight'] = best_params['min_child_weight']

    model = lgb.train(params, dtrain, 200, verbose_eval=100,
                      feval=MacroF1Metric)

    return model
```

In [18]:

```
op = bayesion_opt_lgbm(X_train, y_train, init_iter=5, n_iters=20,
                   random_state=17, seed = 17)
```

```
|   iter    |  target   | baggin... | featur... | max_depth | min_ch... | min
_sp... | num_it... | num_le... |
-------------------------------------------------------------------------
---------------------------------
| 1         |  0.9381   |  0.8589   |  0.5245   |  17.87    |  11.02    |  0.
07891  |  690.7    |  169.3    |
| 2         |  0.9383   |  0.9151   |  0.1313   |  20.37    |  24.19    |  0.
006944 |  877.6    |  202.8    |
| 3         |  0.9379   |  0.8102   |  0.6219   |  23.28    |  18.96    |  0.
04887  |  354.7    |  121.7    |
| 4         |  0.9377   |  0.9123   |  0.4168   |  26.83    |  16.28    |  0.
01525  |  235.8    |  87.73    |
| 5         |  0.938    |  0.9436   |  0.3339   |  17.98    |  22.47    |  0.
05723  |  174.1    |  156.3    |
| 6         |  0.938    |  0.9638   |  0.13     |  29.77    |  18.75    |  0.
05716  |  993.1    |  82.91    |
| 7         |  0.9383   |  0.8483   |  0.4234   |  15.07    |  21.99    |  0.
02238  |  873.9    |  201.8    |
| 8         |  0.9377   |  0.8511   |  0.7458   |  18.2     |  15.4     |  0.
```

13. Модель на результатах bayesian opt

In [32]:

```
%%time

params = {'learning_rate': 0.02,
          'bagging_fraction': 0.88,
          'feature_fraction': 0.53,
          'min_child_weight': 12.4,
          'min_split_gain': 0.06,
          'max_depth': 27,
          'num_leaves': 218,
          'metric': 'logloss',
          'random_state': 17,
          'n_jobs':-1,
         #'sample_fraction':0.33
         }

gc.collect()
num_iterations = 3000
X_train_, X_valid, y_train_, y_valid = train_test_split(X_train, y_train, te

del X_train, y_train

train_set = lgb.Dataset(X_train_, y_train_)
val_set = lgb.Dataset(X_valid, y_valid)

del X_train_, X_valid, y_train_, y_valid

gc.collect()

model = lgb.train(params, train_set,
                  num_iterations,
                  val_set,
                  verbose_eval=100,
                  early_stopping_rounds=200,
                  feval=MacroF1Metric)
model.save_model('lgb13.txt', num_iteration=model.best_iteration)
```

```
Training until validation scores don't improve for 200 rounds
[100]   valid_0's MacroF1Metric: 0.614335
[200]   valid_0's MacroF1Metric: 0.936323
[300]   valid_0's MacroF1Metric: 0.937467
[400]   valid_0's MacroF1Metric: 0.937577
[500]   valid_0's MacroF1Metric: 0.937678
[600]   valid_0's MacroF1Metric: 0.937667
[700]   valid_0's MacroF1Metric: 0.937722
[800]   valid_0's MacroF1Metric: 0.937742
[900]   valid_0's MacroF1Metric: 0.937774
[1000]  valid_0's MacroF1Metric: 0.937717
Early stopping, best iteration is:
[869]   valid_0's MacroF1Metric: 0.937803
Wall time: 24min 52s
```

Out[32]:

```
<lightgbm.basic.Booster at 0x26383974e08>
```

In [37]:
```
%%time
scores, oof, prediction = lgb_cv_loop(X_train, y_train, X_test)
```

A Jupyter widget could not be displayed because the widget state could not be found. This could happen if the kernel storing the widget is no longer available, or if the widget state was not saved in the notebook. You may be able to create the widget by running the appropriate cells.

```
score: 0.9378635292772155
score: 0.9380152351255461
score: 0.9375839819218609
score: 0.9393842052037662
score: 0.9384854338633025

Wall time: 40min 46s
```

In [38]:
```
np.mean(scores)
```

Out[38]:
```
0.9382664770783382
```

In [39]:
```
np.save('lgb13_oof_preds.npy', oof)
```

In [40]:
```
%%time

train_set = lgb.Dataset(X_train, y_train)

del X_train, y_train

gc.collect()

num_iterations = 900
model = lgb.train(params, train_set,
                  num_iterations)

y_lgb_pred = model.predict(X_test)

np.save('lgb13_test_preds.npy', y_lgb_pred)
```

```
Wall time: 9min 41s
```

In [41]:
```
y_lgb_pred = pred_proc(y_lgb_pred)
sample_df = pd.read_csv("data/sample_submission.csv", dtype={'time':str})
sample_df['open_channels'] = y_lgb_pred
sample_df.to_csv("lgb13.csv", index=False, float_format='%.4f')
```

Результат: 0.94 на public lb