```
# Импортируем все необходимые библиотеки

import pandas as pd
import numpy as np
from sqlalchemy import create_engine

# from dotenv import load_dotenv
from catboost import CatBoostClassifier
import os
import gc

# Загружаем переменные окружения из .env файла
load_dotenv()

# Создаем URL для SQLAlchemy
SQLALCHEMY_DATABASE_URL = (
    f"postgresql://"
    f"{os.getenv('POSTGRES_USER')}:{os.getenv('POSTGRES_PASSWORD')}@"
    f"{os.getenv('POSTGRES_HOST')}:{os.getenv('POSTGRES_PORT')}/"
    f"{os.getenv('POSTGRES_DATABASE')}"
)
engine = create_engine(SQLALCHEMY_DATABASE_URL)

### Данные по пользователям с нашими признаками

user_info = pd.read_sql(
    """SELECT * FROM users_info_features_ruslan_prashchurovich""",
con=engine
)

user_info.head()

   user_id  gender country                city  exp_group       os
source  \
0      200       1  Russia           Degtyarsk          3  Android
ads
1      201       0  Russia              Abakan          0  Android
ads
2      202       1  Russia            Smolensk          4  Android
ads
3      203       0  Russia              Moscow          1      iOS
ads
4      204       0  Russia  Anzhero-Sudzhensk          3  Android
ads

  age_category  user_total_views  user_total_likes  user_ctr
favorite_topic  \
0        young               315                43  0.120112
entertainment
1  middle_aged               632                58  0.084058
tech
```

```
2        child                541                  87  0.138535
politics
3        young                258                  61  0.191223
sport
4  middle_aged                115                  23  0.166667
tech

   favorite_hour  mean_length_view  mean_length_number_view
mean_length_like  \
0              8       1798.600000                 8.133333
1439.400000
1             22       1636.866667                 3.800000
1984.266667
2             22        449.266667                 3.133333
1095.600000
3             16       1053.800000                 2.933333
1898.333333
4             15       1441.266667                 4.333333
1104.066667

   mean_length_number_like
0                 5.200000
1                 3.666667
2                 3.600000
3                 4.800000
4                 4.600000

### Посты и топики с нашими признаками

posts_info = pd.read_sql(
    """SELECT * FROM posts_info_features_ruslan_prashchurovich""",
con=engine
)

posts_info.head()

   post_id                                               text
topic  \
0        1  UK economy facing major risks\n\nThe UK manufa...
business
1        2  Aids and climate top Davos agenda\n\nClimate c...
business
2        3  Asian quake hits European shares\n\nShares in ...
business
3        4  India power shares jump on debut\n\nShares in ...
business
4        5  Lacroix label bought by US firm\n\nLuxury good...
business

   numbers_count  text_length  word_count  TotalTfIdf  MaxTfIdf
```

```
MeanTfIdf  \
0             13         1967          327    8.134297  0.511790
0.000541
1             20         2701          449   11.356141  0.254945
0.000756
2             47         3408          571   10.911138  0.410319
0.000726
3              6         1026          178    6.754817  0.372043
0.000450
4              3          889          155    5.946105  0.526337
0.000396

   TextCluster  ...  DistanceTo19thCluster  DistanceTo20thCluster  \
0            8  ...               0.611784               0.581796
1           22  ...               0.587971               0.557299
2            8  ...               0.668490               0.658415
3            8  ...               0.716179               0.683872
4           22  ...               0.554863               0.506563

   DistanceTo21thCluster  DistanceTo22thCluster  DistanceTo23thCluster
\
0               0.584506               0.587526               0.540042

1               0.577983               0.579828               0.512105

2               0.700094               0.685362               0.642903

3               0.682313               0.680886               0.633085

4               0.484730               0.524628               0.448073


   DistanceTo24thCluster  DistanceTo25thCluster  total_views_post  \
0               0.624294               0.702854              7414
1               0.646764               0.703910              6851
2               0.629109               0.773713              7263
3               0.789145               0.804049              6964
4               0.686375               0.635861              7400

   total_likes_post  post_ctr
0              1057  0.142568
1               636  0.092833
2              1116  0.153656
3              1165  0.167289
4              1141  0.154189

[5 rows x 38 columns]

### Попробуем обучить, скажем, на 5 миллионах строк (таблица слишком
большая: более 70 млн строк)
```

```
feed_data = pd.read_sql(
    """SELECT * FROM feed_data WHERE action = 'view' LIMIT 5000000""",
con=engine
)

feed_data.head()

            timestamp  user_id  post_id action  target
0 2021-12-10 14:55:08    84681     1338   view       1
1 2021-12-10 14:57:33    84681     6282   view       0
2 2021-12-10 14:58:52    84681     4553   view       0
3 2021-12-10 15:01:41    84681     3214   view       0
4 2021-12-10 15:03:50    84681     4360   view       0

### Воспроизведем датафрейм со всеми новыми фичами
df = pd.merge(feed_data, posts_info, on="post_id", how="left")
df = pd.merge(df, user_info, on="user_id", how="left")

df.head()

            timestamp  user_id  post_id action  target  \
0 2021-12-10 14:55:08    84681     1338   view       1
1 2021-12-10 14:57:33    84681     6282   view       0
2 2021-12-10 14:58:52    84681     4553   view       0
3 2021-12-10 15:01:41    84681     3214   view       0
4 2021-12-10 15:03:50    84681     4360   view       0

                                                text     topic
numbers_count  \
0  Iraq advice claim sparks new row\n\nThe Tories...  politics
14
1  Little Dieter Needs To Fly is another in the r...     movie
4
2  There is only one film I can think of that mig...     movie
0
3  #goodnotes   this brings home that there are s...     covid
4
4  If this is the authors and directors idea of a...     movie
0

   text_length  word_count  ...  age_category  user_total_views  \
0         3600         609  ...         young               396
1         2428         445  ...         young               396
2         1086         205  ...         young               396
3          140          23  ...         young               396
4          869         149  ...         young               396

   user_total_likes  user_ctr  favorite_topic  favorite_hour  \
0                65  0.140998           sport             11
1                65  0.140998           sport             11
```

```
2                 65  0.140998          sport             11
3                 65  0.140998          sport             11
4                 65  0.140998          sport             11

   mean_length_view  mean_length_number_view  mean_length_like  \
0        912.466667                 3.066667       1725.466667
1        912.466667                 3.066667       1725.466667
2        912.466667                 3.066667       1725.466667
3        912.466667                 3.066667       1725.466667
4        912.466667                 3.066667       1725.466667

   mean_length_number_like
0                 5.866667
1                 5.866667
2                 5.866667
3                 5.866667
4                 5.866667

[5 rows x 58 columns]

### А еще научимся выделять признаки из даты
df["hour"] = pd.to_datetime(df["timestamp"]).apply(lambda x: x.hour)
df["month"] = pd.to_datetime(df["timestamp"]).apply(lambda x: x.month)

# Циклическое кодирование
df["hour_sin"] = np.sin(2 * np.pi * df["hour"] / 24)
df["hour_cos"] = np.cos(2 * np.pi * df["hour"] / 24)
df["month_sin"] = np.sin(2 * np.pi * df["month"] / 12)
df["month_cos"] = np.cos(2 * np.pi * df["month"] / 12)

df.head()

            timestamp  user_id  post_id action  target  \
0 2021-12-10 14:55:08    84681     1338   view       1
1 2021-12-10 14:57:33    84681     6282   view       0
2 2021-12-10 14:58:52    84681     4553   view       0
3 2021-12-10 15:01:41    84681     3214   view       0
4 2021-12-10 15:03:50    84681     4360   view       0

                                                text     topic
numbers_count  \
0  Iraq advice claim sparks new row\n\nThe Tories...  politics
14
1  Little Dieter Needs To Fly is another in the r...     movie
4
2  There is only one film I can think of that mig...     movie
0
3  #goodnotes   this brings home that there are s...     covid
4
4  If this is the authors and directors idea of a...     movie
```

```
0

   text_length  word_count  ...  mean_length_view
mean_length_number_view  \
0         3600         609  ...        912.466667
3.066667
1         2428         445  ...        912.466667
3.066667
2         1086         205  ...        912.466667
3.066667
3          140          23  ...        912.466667
3.066667
4          869         149  ...        912.466667
3.066667

   mean_length_like  mean_length_number_like  hour  month  hour_sin
hour_cos  \
0       1725.466667                 5.866667    14     12 -0.500000 -
0.866025
1       1725.466667                 5.866667    14     12 -0.500000 -
0.866025
2       1725.466667                 5.866667    14     12 -0.500000 -
0.866025
3       1725.466667                 5.866667    15     12 -0.707107 -
0.707107
4       1725.466667                 5.866667    15     12 -0.707107 -
0.707107

      month_sin  month_cos
0 -2.449294e-16        1.0
1 -2.449294e-16        1.0
2 -2.449294e-16        1.0
3 -2.449294e-16        1.0
4 -2.449294e-16        1.0

[5 rows x 64 columns]

### Уберем все ненужные колонки

df = df.drop(
    columns=[
        #    'timestamp',  ### timestamp пока оставим
        "action",
        "text",
    ],
    axis=1,
)

# Почистим переменные
```

```
del user_info
del posts_info
del feed_data

gc.collect()
```

```
0
```

```
### За отсечку возьмем 2021-12-10

X_train = df[df.timestamp < "2021-12-10"].drop(
    columns=["timestamp", "target", "user_id", "post_id"], axis=1
)
X_test = df[df.timestamp >= "2021-12-10"].drop(
    columns=["timestamp", "target", "user_id", "post_id"], axis=1
)

y_train = df[df.timestamp < "2021-12-10"]["target"]
y_test = df[df.timestamp >= "2021-12-10"]["target"]

y_train.shape, y_test.shape
```

```
((3875355,), (1124645,))
```

```
object_cols = [
    "topic",
    "TextCluster",
    "gender",
    "country",
    "city",
    "exp_group",
    "hour",
    "month",
    "favorite_topic",
    "os",
    "source",
    "age_category",
    "favorite_hour",
]

### Теперь обучим катбуст!

seed = 104773
catboost = CatBoostClassifier(
    iterations=150,
    learning_rate=1,
    depth=5,
    cat_features=object_cols,
    verbose=0,
    random_state=seed,
)
```

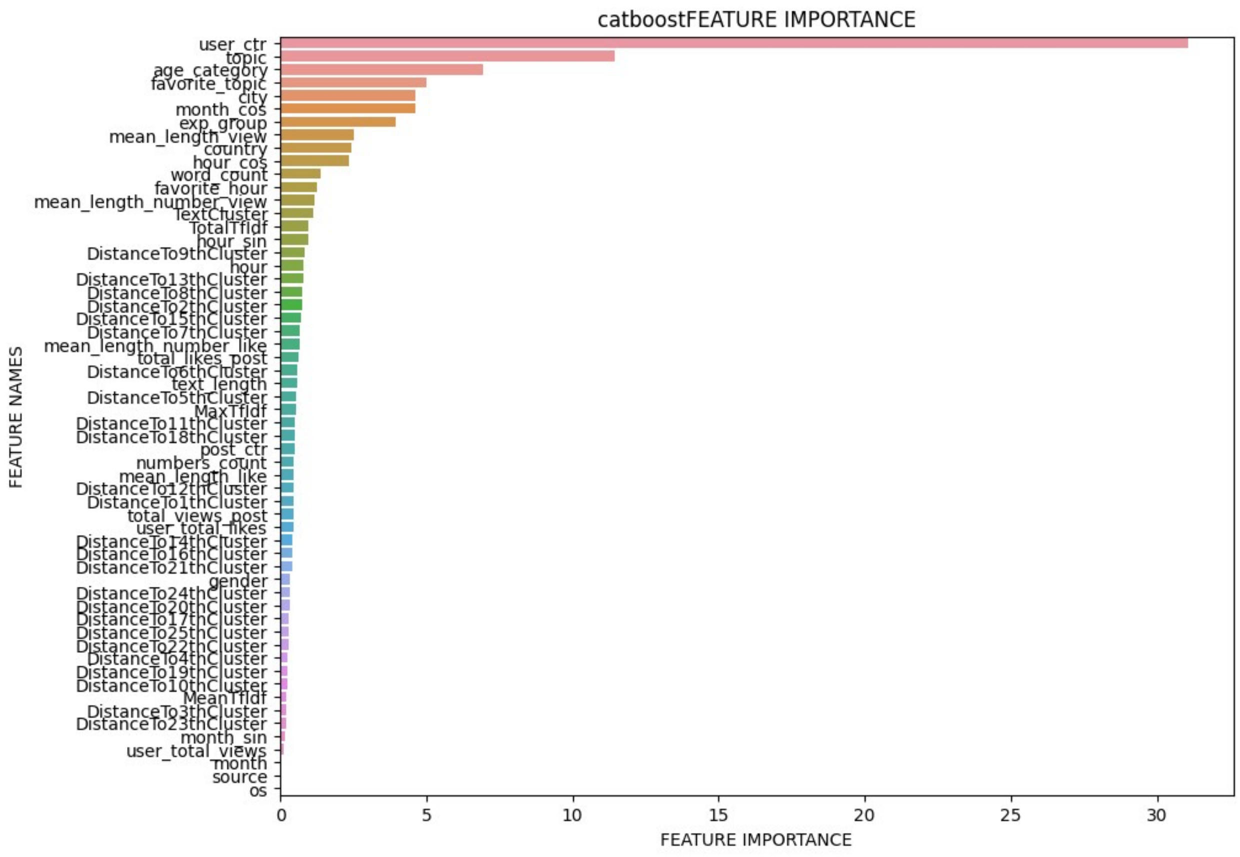
```
catboost.fit(X_train, y_train, eval_set=(X_test, y_test), verbose=25)
```

```
0:    learn: 0.3480067 test: 0.3930940  best: 0.3930940 (0)   total:
2.23s remaining: 5m 31s
25:   learn: 0.3372880 test: 0.3823317  best: 0.3823317 (25)  total:
49.1s remaining: 3m 54s
50:   learn: 0.3359490 test: 0.3806361  best: 0.3806361 (50)  total: 1m
35s   remaining: 3m 5s
75:   learn: 0.3352086 test: 0.3803387  best: 0.3803387 (75)  total: 2m
21s   remaining: 2m 18s
100:  learn: 0.3345435 test: 0.3795612  best: 0.3795612 (100) total: 3m
7s    remaining: 1m 31s
125:  learn: 0.3339486 test: 0.3791217  best: 0.3791173 (121) total: 3m
55s   remaining: 44.8s
149:  learn: 0.3335277 test: 0.3790315  best: 0.3789989 (147) total: 4m
40s   remaining: 0us

bestTest = 0.3789989306
bestIteration = 147

Shrink model to first 148 iterations.

<catboost.core.CatBoostClassifier at 0x7dfd349c0810>
```

```
### Замерим качество работы такой модели
### Возьмем ROC-AUC
from sklearn.metrics import roc_auc_score

print(
    f"Качество на трейне: {roc_auc_score(y_train,
catboost.predict_proba(X_train)[:, 1])}"
)
print(
    f"Качество на тесте: {roc_auc_score(y_test,
catboost.predict_proba(X_test)[:, 1])}"
)
```

```
Качество на трейне: 0.6874009321752084
Качество на тесте: 0.6657179614328319
```

```
### Из любопытства посмотрим на feature_importance

import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt


def plot_feature_importance(importance, names, model_type):

    # Создадим массивы важности и названий признаков
    feature_importance = np.array(importance)
    feature_names = np.array(names)

    # Создадим датафрейм из словаря
    data = {"feature_names": feature_names, "feature_importance":
feature_importance}
    fi_df = pd.DataFrame(data)

    # Отсортируем по важности
    fi_df.sort_values(by=["feature_importance"], ascending=False,
inplace=True)

    # Определим размер графика
    plt.figure(figsize=(10, 8))
    # Нарисуем
    sns.barplot(x=fi_df["feature_importance"],
y=fi_df["feature_names"])
    # Добавим подписи
    plt.title(model_type + "FEATURE IMPORTANCE")
    plt.xlabel("FEATURE IMPORTANCE")
    plt.ylabel("FEATURE NAMES")


plot_feature_importance(catboost.feature_importances_,
X_train.columns, "catboost")
```



По графику видно, что наиболее важные для модели признаки, полученные в результате feature-engineering, что безусловно, очень круто! Также, стоит отдельно отметить важность признака `age_category`, а значит, решение оставить его было правильным.

```
### Сохраним модель
catboost.save_model("catboost_model", format="cbm")
```