

Московский государственный технический университет им. Н.Э. Баумана
Факультет «Информатика и системы управления»
Кафедра «Системы обработки информации и управления»



Лабораторная работа №6
По курсу «Методы машинного обучения»

«Решение задачи обучения с учителем»

ИСПОЛНИТЕЛЬ:

Чичикин Тимофей Дмитриевич
Группа ИУ5-25М

ПРОВЕРИЛ:

Гапанюк Ю.Е.

Задание:

1. Поиск и выбор набора данных для построения модели машинного обучения. На основе выбранного набора данных строится модель машинного обучения для решения или задачи классификации, или задачи регрессии.
2. Для выбранного датасета (датасетов) на основе материалов лекций, в целях улучшения выборки, решить следующие задачи (если это необходимо в данном датасете):
 - устранение пропусков в данных;
 - кодирование категориальных признаков;
 - нормализацию числовых признаков;
 - масштабирование признаков;
 - обработку выбросов для числовых признаков;
 - обработку нестандартных признаков (которые не являются числовым или категориальным);
 - отбор признаков, наиболее подходящих для построения модели;
 - устранение дисбаланса классов в случае решения задачи классификации на дисбалансированной выборке.
3. Обучить модель и оценить метрики качества для двух выборок :
 - исходная выборка, которая содержит только минимальную предобработку данных, необходимую для построения модели (например, кодирование категориальных признаков).
 - улучшенная выборка, полученная в результате полной предобработки данных в пункте 2.
4. Построить модель с использованием произвольной библиотеки AutoML.
5. Сравнить метрики для трех полученных моделей.

Вывод:

Была проделана работа по решению задачи обучения с учителем.

```
!pip install numpy pandas scikit-surprise sklearn seaborn matplotlib automl mljar-supervis
```

```
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: pluggy<0.8,>=0.5 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: atomicwrites>=1.0 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: more-itertools>=4.0.0 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: llvmlite<0.35,>=0.34.0.dev0 in /usr/local/lib/python3.7/dist-packages
Collecting python-editor>=0.3
```

```
Downloading https://files.pythonhosted.org/packages/c6/d3/201fc3abe391bbae6606e6
```

```
Collecting Mako
```

```
Downloading https://files.pythonhosted.org/packages/f3/54/dbc07fbb20865d3b78fdb7
```

```
|████████████████████████████████████████████████████████████████████████████████| 81kB 8.8MB/s
```

```
Requirement already satisfied: PrettyTable>=0.7.2 in /usr/local/lib/python3.7/dist-packages
```

```
Collecting stevedore>=2.0.1
```

```
Downloading https://files.pythonhosted.org/packages/d4/49/b602307aeac3df3384ff1f
```

```
|████████████████████████████████████████████████████████████████████████████████| 51kB 5.4MB/s
```

```
Requirement already satisfied: PyYAML>=3.12 in /usr/local/lib/python3.7/dist-packages
```

```
Collecting pbr!=2.1.0,>=2.0.0
```

```
Downloading https://files.pythonhosted.org/packages/18/e0/1d4702dd81121d04a477c2
```

```
|████████████████████████████████████████████████████████████████████████████████| 112kB 45.7MB/s
```

```
Collecting cmd2>=1.0.0
```

```
Downloading https://files.pythonhosted.org/packages/15/8b/15061b32332bb35ea2a2f6
```

```
|████████████████████████████████████████████████████████████████████████████████| 143kB 32.5MB/s
```

```
Requirement already satisfied: greenlet!=0.4.17; python_version >= "3" in /usr/local/lib/python3.7/dist-packages
```

```
Requirement already satisfied: typing-extensions>=3.6.4; python_version < "3.8" in /usr/local/lib/python3.7/dist-packages
```

```
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages
```

```
Requirement already satisfied: MarkupSafe>=0.9.2 in /usr/local/lib/python3.7/dist-packages
```

```
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages
```

```
Collecting colorama>=0.3.7
```

```
Downloading https://files.pythonhosted.org/packages/44/98/5b86278fbbf250d239ae0e
```

```
Collecting pyperclip>=1.6
```

```
Downloading https://files.pythonhosted.org/packages/a7/2c/4c64579f847bd5d539803c
```

```
Building wheels for collected packages: mljar-supervised, dtreeviz, shap, pyperclip
```

```
Building wheel for mljar-supervised (setup.py) ... done
```

```
Created wheel for mljar-supervised: filename=mljar_supervised-0.10.4-cp37-none-any.whl size=1111111111
```

```
Stored in directory: /root/.cache/pip/wheels/a3/ea/35/583dcb9528d9a561e490f431ab
```

```
Building wheel for dtreeviz (setup.py) ... done
```

```
Created wheel for dtreeviz: filename=dtreeviz-1.3-cp37-none-any.whl size=66642 size=66642
```

```
Stored in directory: /root/.cache/pip/wheels/60/36/b1/188ee35c677e48463f6482d580
```

```
Building wheel for shap (setup.py) ... done
```

```
Created wheel for shap: filename=shap-0.36.0-cp37-cp37m-linux_x86_64.whl size=4545454545
```

```
Stored in directory: /root/.cache/pip/wheels/fb/15/e1/8f61106790da27e0765aaa6e66
```

```
Building wheel for pyperclip (setup.py) ... done
```

```
Created wheel for pyperclip: filename=pyperclip-1.8.2-cp37-none-any.whl size=1111111111
```

```
Stored in directory: /root/.cache/pip/wheels/25/af/b8/3407109267803f4015e1ee2ff2
```

```
Successfully built mljar-supervised dtreeviz shap pyperclip
```

```
ERROR: mljar-supervised 0.10.4 has requirement lightgbm==3.0.0, but you'll have li
```

```
ERROR: mljar-supervised 0.10.4 has requirement numpy>=1.20.0, but you'll have nump
```

```
ERROR: mljar-supervised 0.10.4 has requirement pandas==1.2.0, but you'll have pand
```

```
ERROR: mljar-supervised 0.10.4 has requirement scikit-learn==0.24.2, but you'll ha
```

```
ERROR: mljar-supervised 0.10.4 has requirement scipy==1.6.1, but you'll have scip
```

```
ERROR: mljar-supervised 0.10.4 has requirement tabulate==0.8.7, but you'll have ta
```

```
Installing collected packages: xgboost, catboost, colour, dtreeviz, slicer, shap,
```

```
Found existing installation: xgboost 0.90
```

```
Uninstalling xgboost-0.90:
```

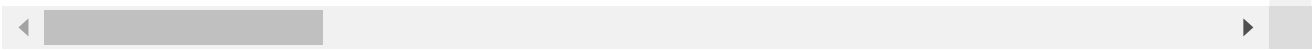
```
Successfully uninstalled xgboost-0.90
```

```
Found existing installation: wordcloud 1.5.0
```

```
Uninstalling wordcloud-1.5.0:
```

```
Successfully uninstalled wordcloud-1.5.0
```

```
Successfully installed Mako-1.1.4 alembic-1.6.5 catboost-0.24.4 category-encoders-
```



```
!pip install --upgrade numpy
!pip install --upgrade pandas
!pip install --upgrade lightgbm
!pip install --upgrade scikit-learn
!pip install --upgrade scipy
!pip install --upgrade tabulate
```

```
!pip install mljar-supervised
```

RESTART RUNTIME

```
from sklearn.model_selection import train_test_split
from supervised.automl import AutoML
```

pandas.util.testing is deprecated. Use the functions in the public API at pandas.test

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import RobustScaler
from sklearn.preprocessing import MaxAbsScaler
from sklearn.impute import SimpleImputer
from sklearn.impute import MissingIndicator
from sklearn.impute import KNNImputer
import scipy.stats as stats
```

```
import scipy.stats as stats
import sklearn
from sklearn.svm import SVR
from sklearn.svm import LinearSVC
from sklearn.feature_selection import SelectFromModel
from sklearn.linear_model import Lasso
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.neighbors import KNeighborsRegressor
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split
from sklearn.feature_selection import VarianceThreshold
from sklearn.feature_selection import mutual_info_classif, mutual_info_regression
from sklearn.feature_selection import SelectKBest, SelectPercentile
from sklearn.linear_model import LinearRegression
from sklearn.neighbors import KNeighborsRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split
from IPython.display import Image
%matplotlib inline
sns.set(style="ticks")
```

```
def draw_kde(col_list, df1, df2, label1, label2):
    fig, (ax1, ax2) = plt.subplots(
        ncols=2, figsize=(12, 5))
    # первый график
    ax1.set_title(label1)
    sns.kdeplot(data=df1[col_list], ax=ax1)
    # второй график
    ax2.set_title(label2)
    sns.kdeplot(data=df2[col_list], ax=ax2)
    plt.show()
```

```
def impute_column(dataset, column, strategy_param, fill_value_param=None):

    temp_data = dataset[[column]].values
    size = temp_data.shape[0]

    indicator = MissingIndicator()
    mask_missing_values_only = indicator.fit_transform(temp_data)

    imputer = SimpleImputer(strategy=strategy_param,
                            fill_value=fill_value_param)
    all_data = imputer.fit_transform(temp_data)
```



```
missed_data = temp_data[mask_missing_values_only]
filled_data = all_data[mask_missing_values_only]

return all_data.reshape((size,)), filled_data, missed_data
```

```
def diagnostic_plots(df, variable):
    plt.figure(figsize=(15,6))
    # гистограмма
    plt.subplot(1, 2, 1)
    df[variable].hist(bins=30)
    ## Q-Q plot
    plt.subplot(1, 2, 2)
    stats.probplot(df[variable], dist="norm", plot=plt)
    plt.show()
```

```
from google.colab import drive
drive.mount('/content/gdrive')
```

Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive



```
df = pd.read_csv('/content/gdrive/My Drive/MMO/stars.csv')
df.head(15)
```

	Temperature	Otnosit_yarkost	Otnosit_radius	Abs_Velichina	Color	Spectr_class
0	3068	NaN	0.170	16.120	Red	M
1	3042	0.00050	NaN	16.600	Red	M
2	2600	0.00030	0.102	NaN	Red	M
3	2800	0.00020	NaN	16.650	Red	M
4	1939	NaN	0.103	20.060	NaN	M
5	2840	0.00065	0.110	16.980	Red	M
6	2637	0.00073	0.127	17.220	Red	M
7	2600	0.00040	NaN	17.400	Red	M
8	2650	0.00069	0.110	17.450	Red	M
9	2700	0.00018	NaN	16.050	Red	M
10	3600	0.00290	NaN	10.690	NaN	M
11	3129	0.01220	NaN	11.790	Red	M
12	3134	0.00040	0.196	13.210	Red	M
13	3628	0.00550	NaN	10.480	Red	M
14	2650	0.00060	0.140	11.782	NaN	M

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 240 entries, 0 to 239
Data columns (total 7 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Temperature            240 non-null   int64
1   Otnosit_yarkost        237 non-null   float64
2   Otnosit_radius         228 non-null   float64
3   Abs_Velichina          237 non-null   float64
4   Color                  233 non-null   object
5   Spectr_class           240 non-null   object
6   Type                   240 non-null   int64
dtypes: float64(3), int64(2), object(2)
memory usage: 13.2+ KB
```

➤ Устранение пропусков

Методы заполнения медианой и заполнения наиболее распространенным значением категории

Устранение пропусков с использованием метода заполнения медианой

```
median_oy = df['Otnosit_yarkost'].median()
median_or = df['Otnosit_radius'].median()
median_av = df['Abs_Velichina'].median()

df['Otnosit_yarkost'] = df['Otnosit_yarkost'].fillna(median_oy)
df['Otnosit_radius'] = df['Otnosit_radius'].fillna(median_or)
df['Abs_Velichina'] = df['Abs_Velichina'].fillna(median_av)
```

Устранение пропусков с использованием метода заполнения наиболее распространенным значением категории

```
Color_new, __, _ = impute_column(df, 'Color', 'most_frequent')
df['Color'] = Color_new

df.head(15)
```

	Temperature	Otnosit_yarkost	Otnosit_radius	Abs_Velichina	Color	Spectr_class
0	3068	0.15300	0.170	16.120	Red	M
1	3042	0.00050	0.945	16.600	Red	M
2	2600	0.00030	0.102	6.228	Red	M
3	2800	0.00020	0.945	16.650	Red	M
4	1939	0.15300	0.103	20.060	Red	M
5	2840	0.00065	0.110	16.980	Red	M
6	2637	0.00073	0.127	17.220	Red	M

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 240 entries, 0 to 239
Data columns (total 7 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Temperature            240 non-null    int64
1   Otnosit_yarkost         240 non-null    float64
2   Otnosit_radius          240 non-null    float64
3   Abs_Velichina           240 non-null    float64
4   Color                   240 non-null    object
5   Spectr_class            240 non-null    object
6   Type                    240 non-null    int64
dtypes: float64(3), int64(2), object(2)
memory usage: 13.2+ KB
```

➤ Кодирование категориальных признаков

```
df['Spectr_class'].unique()
```

```
array(['M', 'B', 'A', 'F', 'O', 'K', 'G'], dtype=object)
```

```
df.loc[df['Spectr_class'] == 'M', 'Spectr_class'] = 1
df.loc[df['Spectr_class'] == 'B', 'Spectr_class'] = 2
df.loc[df['Spectr_class'] == 'A', 'Spectr_class'] = 3
df.loc[df['Spectr_class'] == 'F', 'Spectr_class'] = 4
df.loc[df['Spectr_class'] == 'O', 'Spectr_class'] = 5
df.loc[df['Spectr_class'] == 'K', 'Spectr_class'] = 6
df.loc[df['Spectr_class'] == 'G', 'Spectr_class'] = 7
df['Spectr_class'] = pd.to_numeric(df['Spectr_class'])
```

```
df['Spectr_class'].unique()
```

```
array([1, 2, 3, 4, 5, 6, 7])
```

```
df['Color'].unique()
```

```
array(['Red', 'Blue White', 'White', 'Yellowish White',
      'Pale yellow orange', 'Blue', 'Blue-white', 'yellow-white',
      'Whitish', 'Orange', 'White-Yellow', 'white', 'yellowish',
      'Yellowish', 'Orange-Red', 'Blue white', 'Blue-White'],
      dtype=object)
```

```
df['Color'] = df['Color'].replace(['Blue-white', 'Blue white', 'Blue-White'], 'Blue White')
df['Color'] = df['Color'].replace(['Yellowish White', 'yellow-white', 'White-Yellow'], 'Yellow White')
df['Color'] = df['Color'].replace(['white', 'Whitish'], 'White')
df['Color'] = df['Color'].replace(['yellowish'], 'Yellowish')
df['Color'] = df['Color'].replace(['Pale yellow orange', 'Orange', 'Orange-Red'], 'Yellow Red')
```

```
df['Color'].unique()
```

```
array(['Red', 'Blue White', 'White', 'Yellow White', 'Yellow Red', 'Blue',
      'Yellowish'], dtype=object)
```

```
df.loc[df['Color'] == 'Red', 'Color'] = 1
df.loc[df['Color'] == 'Blue White', 'Color'] = 2
df.loc[df['Color'] == 'White', 'Color'] = 3
df.loc[df['Color'] == 'Yellow White', 'Color'] = 4
df.loc[df['Color'] == 'Yellow Red', 'Color'] = 5
df.loc[df['Color'] == 'Blue', 'Color'] = 6
df.loc[df['Color'] == 'Yellowish', 'Color'] = 7
df['Color'] = pd.to_numeric(df['Color'])
```

```
df['Color'].unique()
```

```
array([1, 2, 3, 4, 5, 6, 7])
```

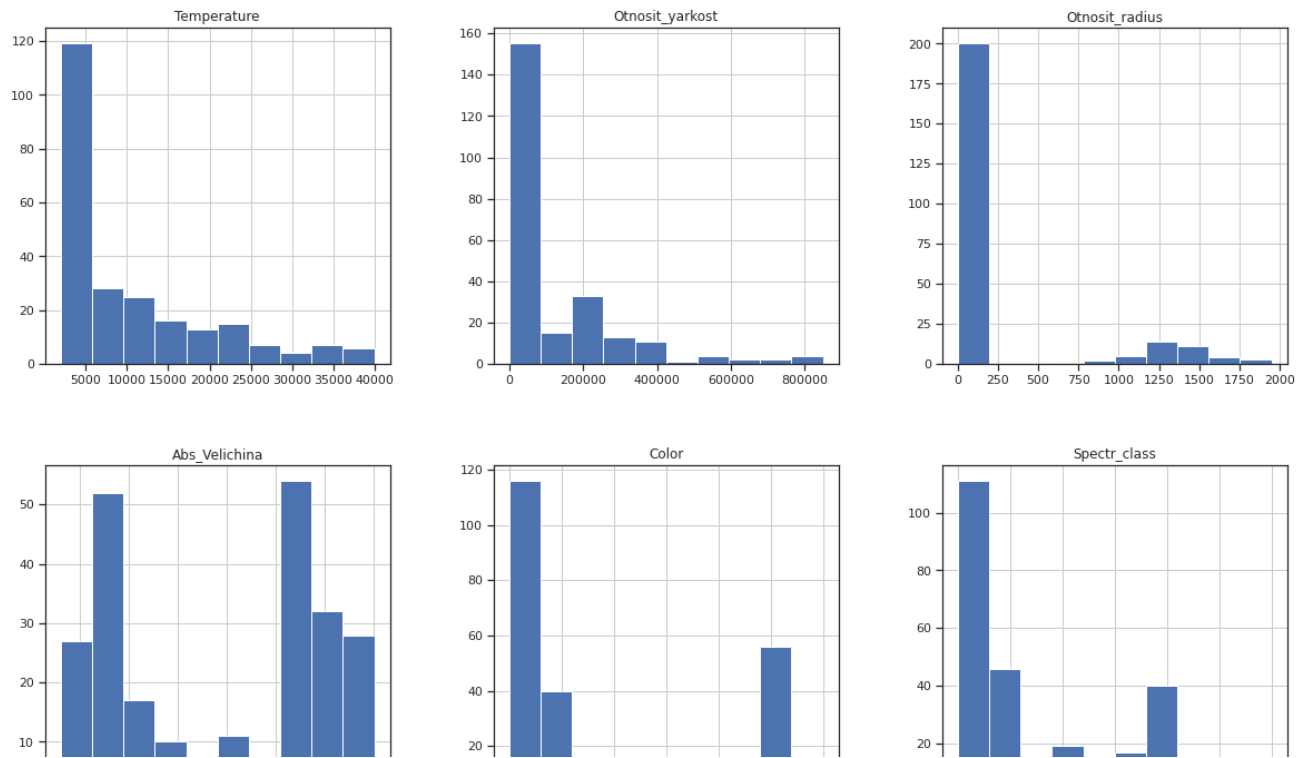
```
df.head(15)
```

	Temperature	Otnosit_yarkost	Otnosit_radius	Abs_Velichina	Color	Spectr_class
0	3068	0.15300	0.170	16.120	1	1
1	3042	0.00050	0.945	16.600	1	1

▼ Нормализация числовых признаков

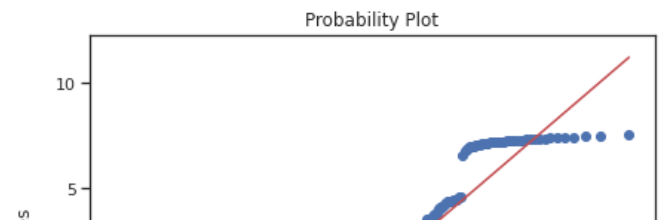
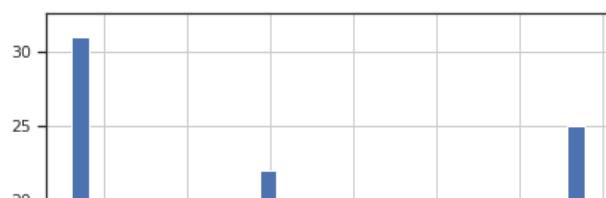
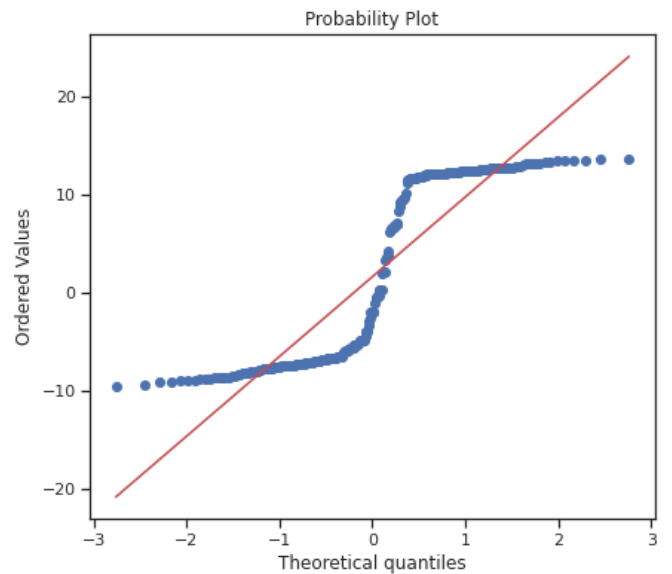
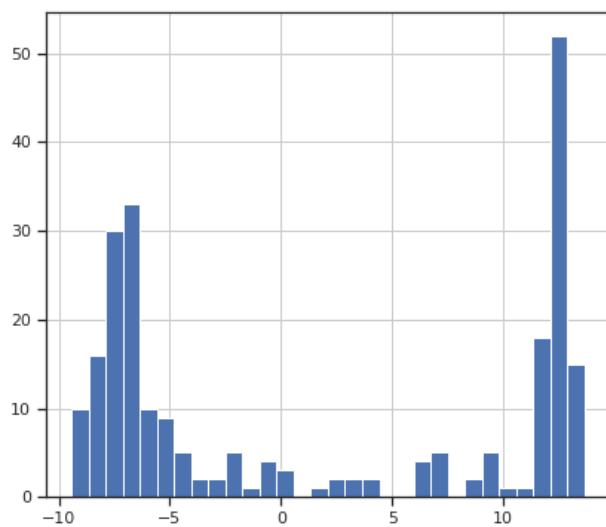
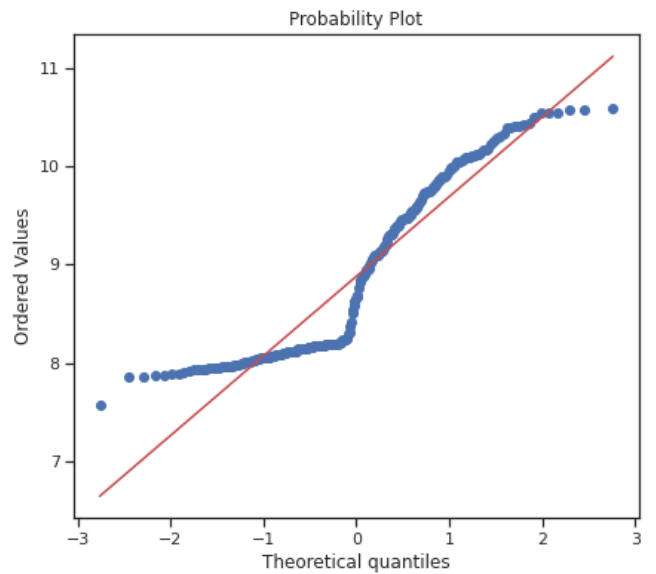
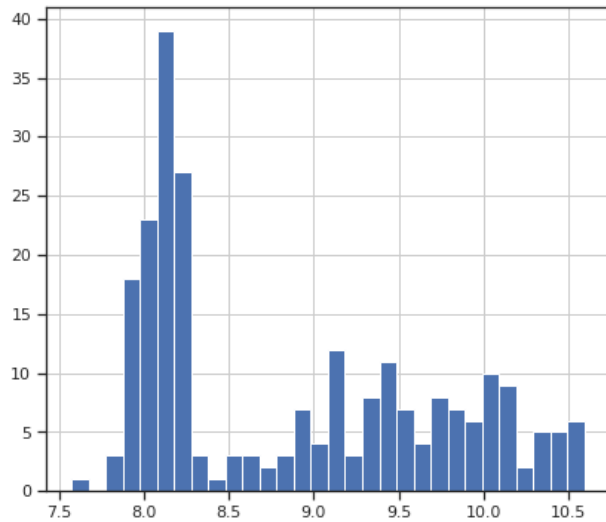
4	1939	0.15300	0.103	20.060	1	1
---	------	---------	-------	--------	---	---

```
df_new = df.copy()
df_new.hist(figsize=(20,20))
plt.show()
```



```
df_new['Temperature'] = np.log(df_new['Temperature'])
df_new['Otnosit_yarkost'] = np.log(df_new['Otnosit_yarkost'])
df_new['Otnosit_radius'] = np.log(df_new['Otnosit_radius'])
```

```
diagnostic_plots(df_new, 'Temperature')
diagnostic_plots(df_new, 'Otnosit_yarkost')
diagnostic_plots(df_new, 'Otnosit_radius')
```



▼ Масштабирование признаков



Нужно ли масштабирование
df_new.describe()

	Temperature	Otnosit_yarkost	Otnosit_radius	Abs_Velichina	Color	Spect
count	240.000000	240.000000	240.000000	240.000000	240.000000	24
mean	8.880989	1.684978	0.790533	4.272204	2.700000	

DataFrame не содержащий целевой признак. Здесь введём и далее будем использовать новую в
для дальнейшего сравнения обучения моделей

```
df_ne_cel = df_new.drop('Type', axis=1)
```

25%	8.114098	1.7038446	0.7207275	6.232500	1.000000
------------	----------	-----------	-----------	----------	----------

Функция для восстановления датафрейма на основе масштабированных данных

```
def arr_to_df(arr_scaled):
```

```
    res = pd.DataFrame(arr_scaled, columns=df_ne_cel.columns)
```

```
    return res
```

Деление выборки на обучающую и тестовую

```
X_train, X_test, y_train, y_test = train_test_split(
    df_ne_cel, df_new['Type'], test_size= 0.2, random_state= 1)
```

Размер обучающей выборки

```
X_train.shape, y_train.shape
```

```
((192, 6), (192,))
```

Размер тестовой выборки

```
X_test.shape, y_test.shape
```

```
((48, 6), (48,))
```

Преобразуем массивы в DataFrame

```
X_train_df = arr_to_df(X_train)
```

```
X_test_df = arr_to_df(X_test)
```

```
X_train_df.shape, X_test_df.shape
```

```
((192, 6), (48, 6))
```

Min-Max Масштабирование

Обучаем StandardScaler на всей выборке и масштабируем

```
cs31 = MinMaxScaler()
```

```
data_cs31_scaled_temp = cs31.fit_transform(df_ne_cel)
```

формируем DataFrame на основе массива

```
data_cs31_scaled = arr_to_df(data_cs31_scaled_temp)
```

```
data_cs31_scaled.describe()
```

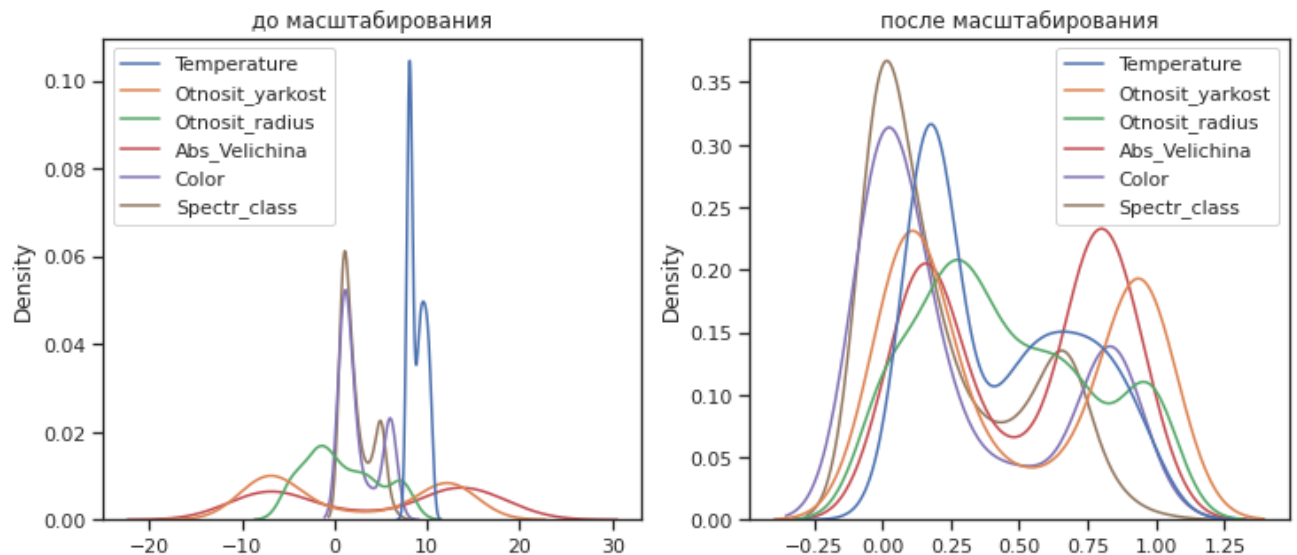

	Temperature	Otnosit_yarkost	Otnosit_radius	Abs_Velichina	Color	Spectr
count	240.000000	240.000000	240.000000	240.000000	240.000000	24
mean	0.433164	0.481615	0.450858	0.506323	0.283333	
std	0.283180	0.393693	0.315052	0.327130	0.351394	
min	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	0.180087	0.103745	0.208206	0.177846	0.000000	

```

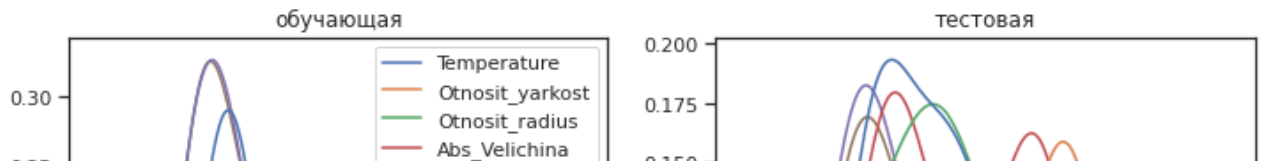
cs32 = MinMaxScaler()
cs32.fit(X_train)
data_cs32_scaled_train_temp = cs32.transform(X_train)
data_cs32_scaled_test_temp = cs32.transform(X_test)
# формируем DataFrame на основе массива
data_cs32_scaled_train = arr_to_df(data_cs32_scaled_train_temp)
data_cs32_scaled_test = arr_to_df(data_cs32_scaled_test_temp)

```

```
draw_kde(['Temperature', 'Otnosit_yarkost', 'Otnosit_radius', 'Abs_Velichina', 'Color', 'S
```



```
draw_kde(['Temperature', 'Otnosit_yarkost', 'Otnosit_radius', 'Abs_Velichina', 'Color', 'S
```

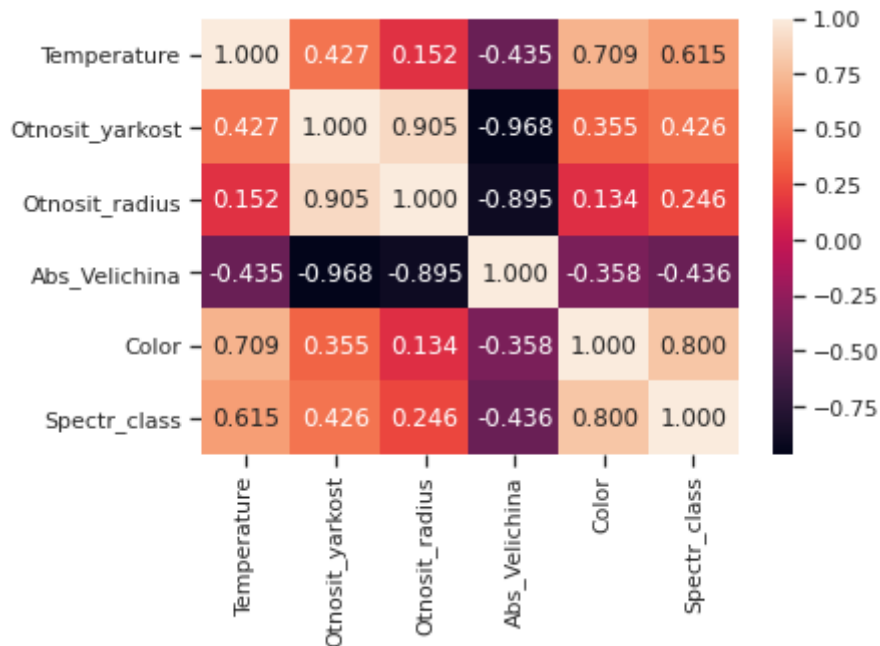


Отбор признаков

Filter methods

```
sns.heatmap(df_ne_cel.corr(), annot=True, fmt='.3f')
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f4c12d6eb50>



```
def make_corr_df(df):
    cr = df.corr()
    cr = cr.abs().unstack()
    cr = cr.sort_values(ascending=False)
    cr = cr[cr >= 0.5]
    cr = cr[cr < 1]
    cr = pd.DataFrame(cr).reset_index()
    cr.columns = ['f1', 'f2', 'corr']
    return cr
```

```
make_corr_df(df_ne_cel)
```

		f1	f2	corr
0	Otnosit_yarkost	Abs_Velichina		0.968208
1	Abs_Velichina	Otnosit_yarkost		0.968208
2	Otnosit_yarkost	Otnosit_radius		0.905371
3	Otnosit_radius	Otnosit_yarkost		0.905371
4	Otnosit_radius	Abs_Velichina		0.894831
5	Abs_Velichina	Otnosit_radius		0.894831

➤ Обнаружение групп коррелирующих признаков

```
0      temperature      color      0.705379
```

```
def corr_groups(cr):
    grouped_feature_list = []
    correlated_groups = []

    for feature in cr['f1'].unique():
        if feature not in grouped_feature_list:
            # находим коррелирующие признаки
            correlated_block = cr[cr['f1'] == feature]
            cur_dups = list(correlated_block['f2'].unique()) + [feature]
            grouped_feature_list = grouped_feature_list + cur_dups
            correlated_groups.append(cur_dups)
    return correlated_groups

# Группы коррелирующих признаков
corr_groups(make_corr_df(df_ne_cel))

[['Abs_Velichina', 'Otnosit_radius', 'Otnosit_yarkost'],
 ['Color', 'Temperature', 'Spectr_class']]
```

➤ Обучение модели и оценка метрики

Для исходной выборки

```
# Разделим выборку на обучающую и тестовую
X_train_basic, X_test_basic, y_train_basic, y_test_basic = train_test_split(
    df_new, df_new['Type'], test_size=0.2, random_state=1)

# Преобразуем массивы в DataFrame
X_train_basic_df = arr_to_df(X_train_basic)
X_test_basic_df = arr_to_df(X_test_basic)

X_train_basic_df.shape, X_test_basic_df.shape
```

```
((192, 6), (48, 6))
```

Для улучшенной выборки

```
# Разделим выборку на обучающую и тестовую
X_train_upgrade, X_test_upgrade, y_train_upgrade, y_test_upgrade = train_test_split(
    df_ne_cel, df_new['Type'], test_size=0.2, random_state=1)

# Преобразуем массивы в DataFrame
X_train_upgrade_df_new = arr_to_df(X_train_upgrade)
X_test_upgrade_df_new = arr_to_df(X_test_upgrade)

X_train_upgrade_df_new.shape, X_test_upgrade_df_new.shape

((192, 6), (48, 6))

class MetricLogger:

    def __init__(self):
        self.df = pd.DataFrame(
            {'metric': pd.Series([], dtype='str'),
             'alg': pd.Series([], dtype='str'),
             'value': pd.Series([], dtype='float')})

    def add(self, metric, alg, value):
        """
        Добавление значения
        """
        # Удаление значения если оно уже было ранее добавлено
        self.df.drop(self.df[(self.df['metric']==metric)&(self.df['alg']==alg)].index, inplace=True)
        # Добавление нового значения
        temp = [{'metric':metric, 'alg':alg, 'value':value}]
        self.df = self.df.append(temp, ignore_index=True)

    def get_data_for_metric(self, metric, ascending=True):
        """
        Формирование данных с фильтром по метрике
        """
        temp_data = self.df[self.df['metric']==metric]
        temp_data_2 = temp_data.sort_values(by='value', ascending=ascending)
        return temp_data_2['alg'].values, temp_data_2['value'].values

    def plot(self, str_header, metric, ascending=True, figsize=(5, 5)):
        """
        Вывод графика
        """
        array_labels, array_metric = self.get_data_for_metric(metric, ascending)
        fig, ax1 = plt.subplots(figsize=figsize)
        pos = np.arange(len(array_metric))
        rects = ax1.barh(pos, array_metric,
                        align='center',
                        height=0.5,
                        tick_label=array_labels)
        ax1.set title(str_header)
```

```

for a,b in zip(pos, array_metric):
    plt.text(0.5, a-0.05, str(round(b,3)), color='white')
plt.xscale('log')
plt.show()

```

```

clas_models_dict = {'LinR': LogisticRegression(),
                    'KNN_5': KNeighborsClassifier(n_neighbors=5),
                    'Tree': DecisionTreeClassifier(random_state=1),
                    'GB': GradientBoostingClassifier(random_state=1),
                    'RF': RandomForestClassifier(n_estimators=20, random_state=1)}

```

```

X_data_dict = {'Basic': (X_train_basic_df, X_test_basic_df),
               'Upgrade': (X_train_upgrade_df_new, X_test_upgrade_df_new)}

```

```

from sklearn.metrics import f1_score, recall_score
def test_models(clas_models_dict, X_data_dict, y_train, y_test):

```

```

    logger = MetricLogger()

```

```

    for model_name, model in clas_models_dict.items():

```

```

        for data_name, data_tuple in X_data_dict.items():

```

```

            X_train, X_test = data_tuple

```

```

            model.fit(X_train, y_train)

```

```

            y_pred = model.predict(X_test)

```

```

            # mse = mean_squared_error(y_test, y_pred)/

```

```

            f1_res = f1_score(y_test, y_pred, average='weighted')

```

```

            print(model, f1_res)

```

```

            logger.add(model_name, data_name, f1_res)

```

```

    return logger

```

```

%%time

```

```

logger = test_models(clas_models_dict, X_data_dict, y_train_basic, y_test_basic)

```

```

/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:765: Converge

```

```

lbfgs failed to converge (status=1):

```

```

STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

```

Increase the number of iterations (max_iter) or scale the data as shown in:

<https://scikit-learn.org/stable/modules/preprocessing.html>

Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression

```

/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:765: Converge

```

```

lbfgs failed to converge (status=1):

```

```

STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

```

Increase the number of iterations (max_iter) or scale the data as shown in:

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Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression

```
LogisticRegression() 1.0
LogisticRegression() 1.0
KNeighborsClassifier() 0.9396739130434782
KNeighborsClassifier() 0.9396739130434782
DecisionTreeClassifier(random_state=1) 1.0
DecisionTreeClassifier(random_state=1) 1.0
GradientBoostingClassifier(random_state=1) 1.0
GradientBoostingClassifier(random_state=1) 1.0
RandomForestClassifier(n_estimators=20, random_state=1) 1.0
RandomForestClassifier(n_estimators=20, random_state=1) 1.0
CPU times: user 1.32 s, sys: 2.77 ms, total: 1.32 s
Wall time: 1.33 s
```

Построим графики метрик качества модели

```
for model in clas_models_dict:
    logger.plot('Модель: ' + model, model, figsize=(7, 4))
```