МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ
им. Н.Э. Баумана

Факультет «Информатика и системы управления»
Кафедра «Систем обработки информации и управления»

ОТЧЕТ

Лабораторная работа №__2__
по дисциплине «Методы машинного обучения»

Тема: «Обработка признаков (часть 1).»

ИСПОЛНИТЕЛЬ: ____Кожуро Б.Е.____
ФИО
группа _____ИУ5-21М_____
_____
подпись
"__"___ __ ___2024 г.

ПРЕПОДАВАТЕЛЬ: ___Гапанюк Ю.Е.___
ФИО
_____
подпись
"__"_____2024 г.

Москва - 2024

Задание

1. Выбрать набор данных (датасет), содержащий категориальные и числовые признаки и пропуски в данных. Для выполнения следующих пунктов можно использовать несколько различных наборов данных (один для обработки пропусков, другой для категориальных признаков и т.д.) Просьба не использовать датасет, на котором данная задача решалась в лекции.
2. Для выбранного датасета (датасетов) на основе материалов лекций решить следующие задачи:
    a. устранение пропусков в данных;
    b. кодирование категориальных признаков;
    c. нормализация числовых признаков.
3. Сформировать отчет и разместить его в своем репозитории на github.

Выполнение

Лабораторная работа 2

Кожуро Б.Е.

датасет 1 https://www.kaggle.com/datasets/lava18/google-play-store-apps

датасет 2 https://www.kaggle.com/datasets/kumarajarshi/life-expectancy-who

датасет 3 https://www.kaggle.com/datasets/muthuj7/weather-dataset

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.set(style="ticks")
from sklearn.impute import SimpleImputer
from sklearn.impute import MissingIndicator
import scipy.stats as stats

data = pd.read_csv(r'C:\Users\ksarb\Documents\MMO_2024\Datasets\
googleplaystore.csv', sep=",")

data.isnull().sum()
```

```
App                  0
Category             0
Rating            1474
Reviews              0
Size                 0
Installs             0
Type                 1
Price                0
Content Rating       1
Genres               0
Last Updated         0
Current Ver          8
Android Ver          3
dtype: int64
```

```
data.shape
```

```
(10841, 13)
```

```
data.head()
```

```
                                                 App        Category
Rating  \
0     Photo Editor & Candy Camera & Grid & ScrapBook  ART_AND_DESIGN
```

```
4.1
1                                Coloring book moana  ART_AND_DESIGN
3.9
2  U Launcher Lite – FREE Live Cool Themes, Hide ...  ART_AND_DESIGN
4.7
3                                Sketch - Draw & Paint  ART_AND_DESIGN
4.5
4               Pixel Draw - Number Art Coloring Book  ART_AND_DESIGN
4.3

  Reviews  Size     Installs  Type Price Content Rating  \
0     159   19M      10,000+  Free     0       Everyone
1     967   14M     500,000+  Free     0       Everyone
2   87510  8.7M   5,000,000+  Free     0       Everyone
3  215644   25M  50,000,000+  Free     0           Teen
4     967  2.8M     100,000+  Free     0       Everyone

                      Genres      Last Updated         Current Ver  \
0               Art & Design   January 7, 2018               1.0.0
1  Art & Design;Pretend Play  January 15, 2018               2.0.0
2               Art & Design    August 1, 2018               1.2.4
3               Art & Design      June 8, 2018  Varies with device
4    Art & Design;Creativity     June 20, 2018                 1.1

    Android Ver
0  4.0.3 and up
1  4.0.3 and up
2  4.0.3 and up
3    4.2 and up
4    4.4 and up
```

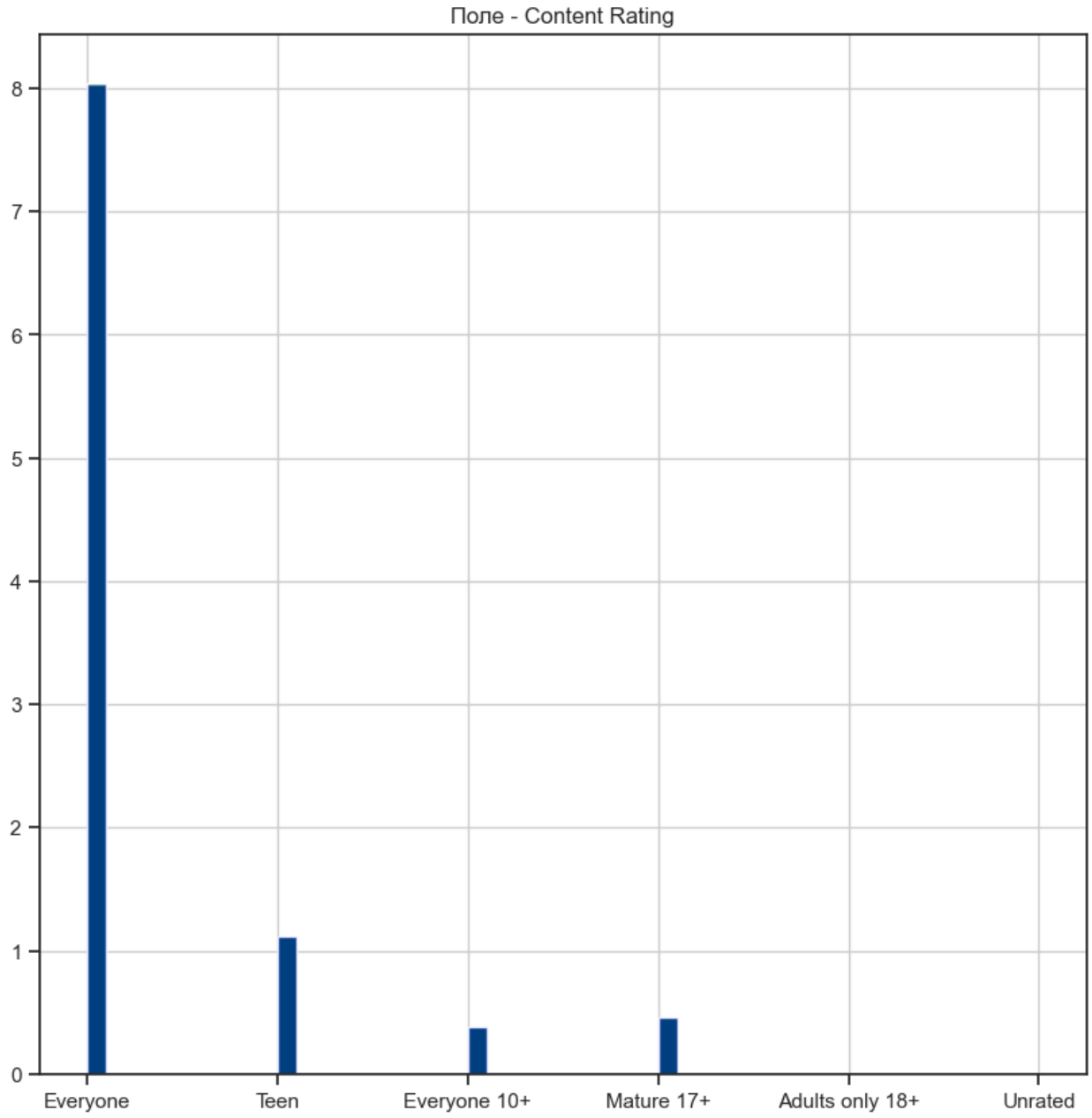
Пропуски в данных в столбцах type, content_rating и ver (оба) можно обработать удалением - это единичные значения.

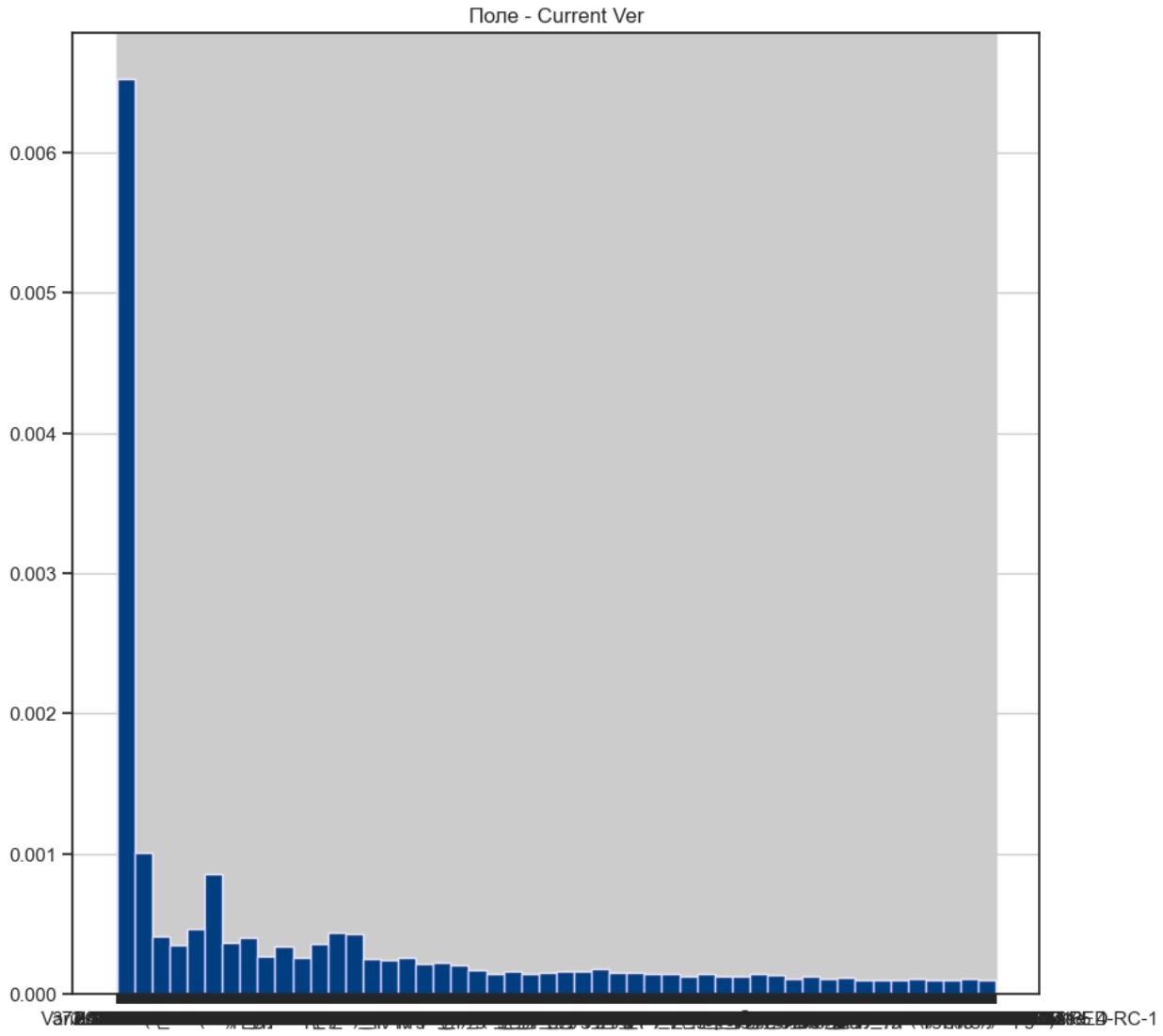
```
colsForDel = ['Type', 'Content Rating', 'Current Ver', 'Android Ver']
data_drop_na = data[colsForDel].dropna()
data_drop_na.shape
```

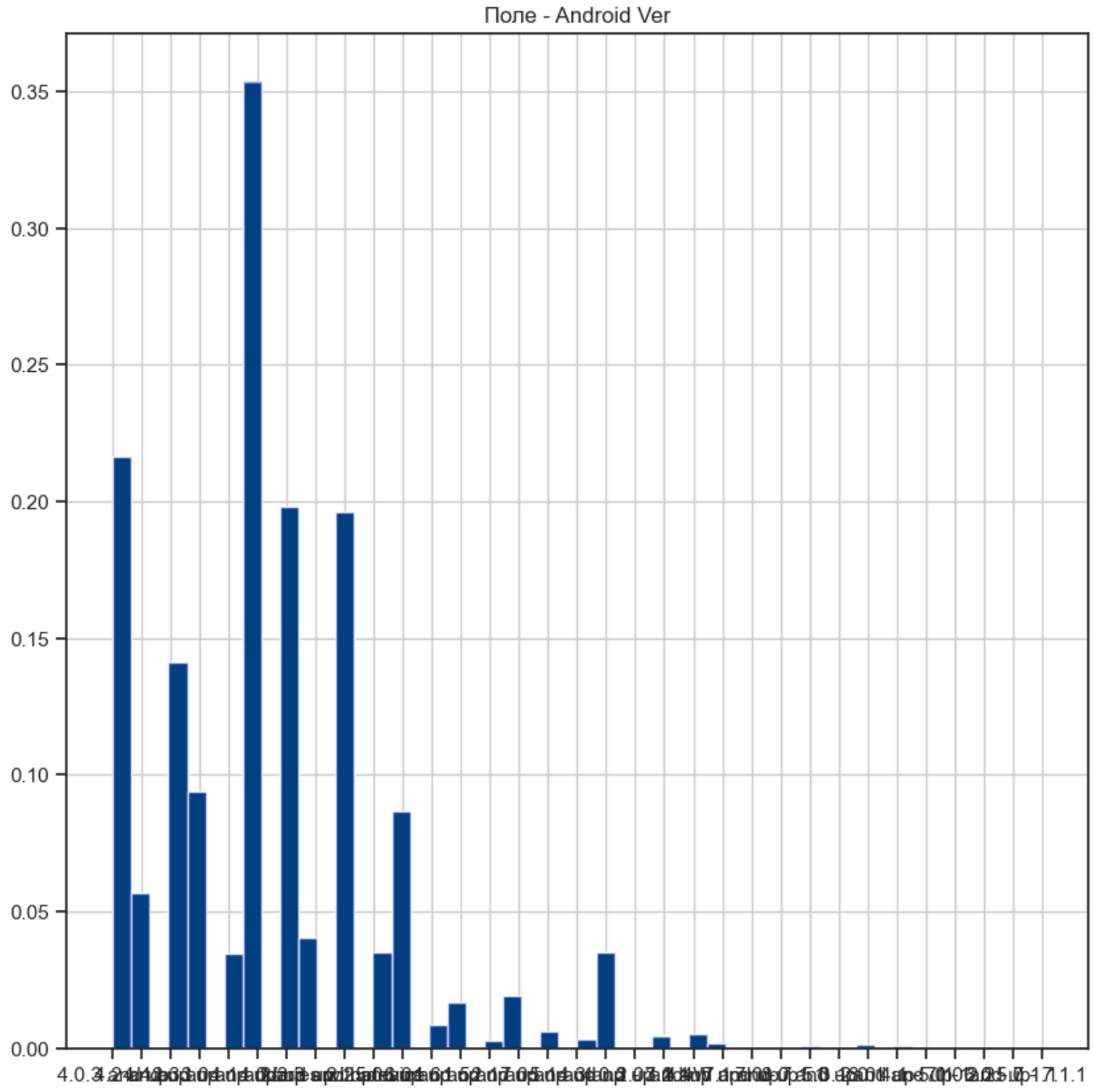
```
(10829, 4)
```

```
def plot_hist_diff(old_ds, new_ds, cols):
    """
    Разница между распределениями до и после устранения пропусков
    """
    for c in cols:
        fig, ax = plt.subplots(figsize=(10,10))
        ax.title.set_text('Поле - ' + str(c))
        old_ds[c].hist(bins=50, ax=ax, density=True, color='green')
        new_ds[c].hist(bins=50, ax=ax, color='blue', density=True,
```

```
alpha=0.5)
        plt.show()

plot_hist_diff(data, data_drop_na, ['Content Rating', 'Current Ver',
'Android Ver'])
```




Поле - Current Ver
0.006
0.005
0.004
0.003
0.002
0.001
0.000
RC-1




```
data.dtypes
```

```
App                object
Category           object
Rating            float64
Reviews            object
Size               object
Installs           object
Type               object
Price              object
Content Rating     object
Genres             object
```

```
Last Updated       object
Current Ver        object
Android Ver        object
dtype: object
```

```
data = data.dropna(subset=colsForDel)
data.shape
```

```
(10829, 13)
```

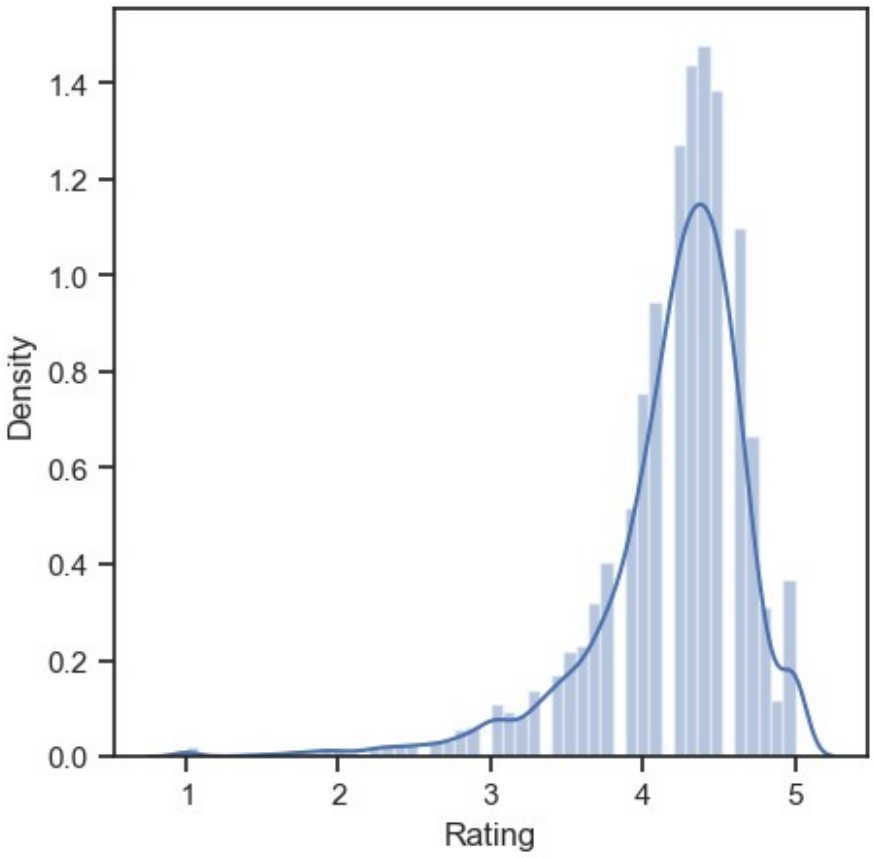
```
data.isnull().sum()
```

```
App                   0
Category              0
Rating             1469
Reviews               0
Size                  0
Installs              0
Type                  0
Price                 0
Content Rating        0
Genres                0
Last Updated          0
Current Ver           0
Android Ver           0
dtype: int64
```

```
fig, ax = plt.subplots(figsize=(5,5))
sns.distplot(data['Rating'])
```

```
C:\Users\ksarb\AppData\Local\Temp\ipykernel_3944\195523562.py:2:
UserWarning:

`distplot` is a deprecated function and will be removed in seaborn
v0.14.0.

Please adapt your code to use either `displot` (a figure-level
function with
similar flexibility) or `histplot` (an axes-level function for
histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(data['Rating'])
```

```
<Axes: xlabel='Rating', ylabel='Density'>
```



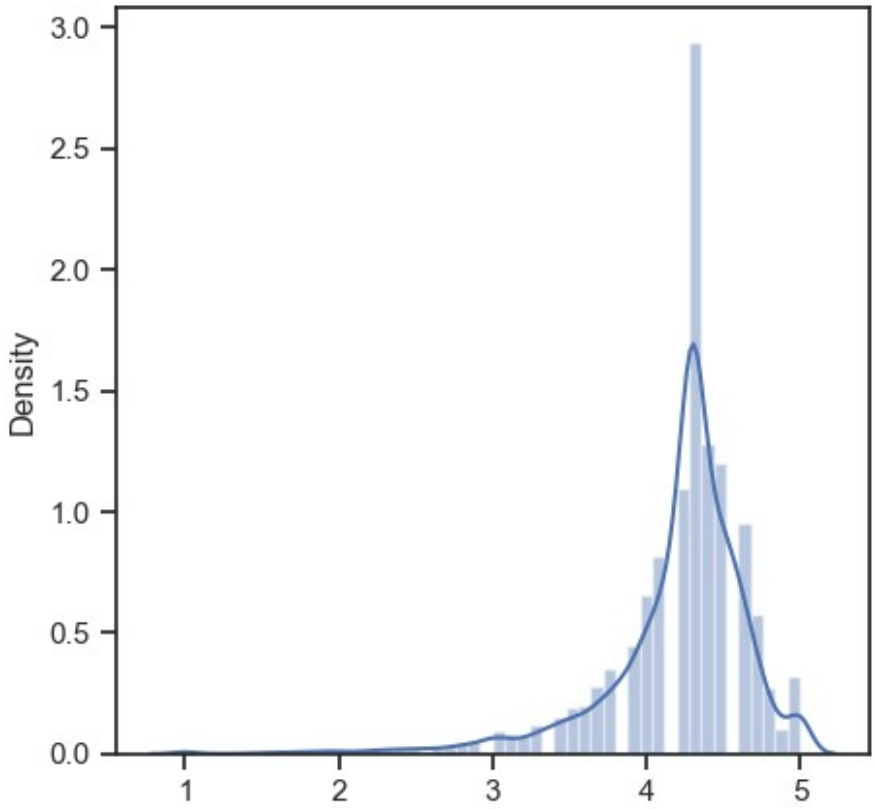
Заполним rating

```
def impute_column(dataset, column, strategy_param,
fill_value_param=None):
    """
    Заполнение пропусков в одном признаке
    """
    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

filled_data, _, _ = impute_column(data, 'Rating', 'median')
```

```
fig, ax = plt.subplots(figsize=(5,5))
sns.distplot(filled_data)
```

```
C:\Users\ksarb\AppData\Local\Temp\ipykernel_3944\2113822577.py:2:
UserWarning:

`distplot` is a deprecated function and will be removed in seaborn
v0.14.0.

Please adapt your code to use either `displot` (a figure-level
function with
similar flexibility) or `histplot` (an axes-level function for
histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(filled_data)
```

```
<Axes: ylabel='Density'>
```




```
filled_data
```

```
array([4.1, 3.9, 4.7, ..., 4.3, 4.5, 4.5])
```

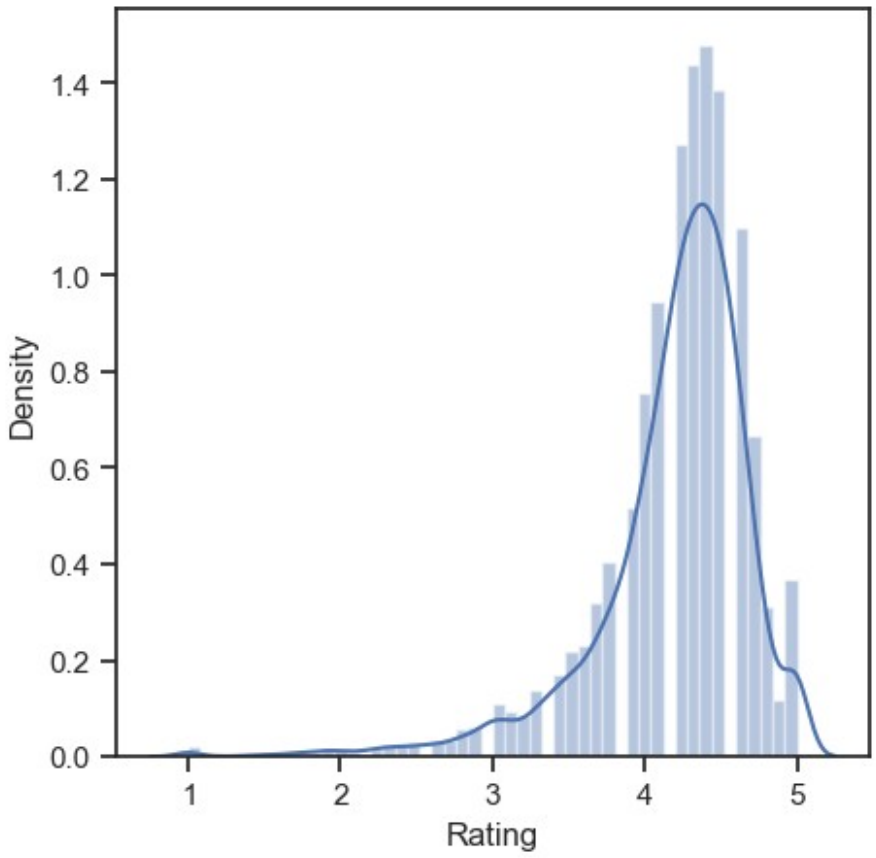
```
knnimpute_hdata = data[['Reviews', 'Rating']].copy()
knnimpute_hdata.head()
from sklearn.impute import KNNImputer
knnimputer = KNNImputer(
    n_neighbors=5,
    weights='distance',
    metric='nan_euclidean',
    add_indicator=False,
)
knnimpute_hdata_imputed_temp =
knnimputer.fit_transform(knnimpute_hdata)
knnimpute_hdata_imputed = pd.DataFrame(knnimpute_hdata_imputed_temp,
columns=knnimpute_hdata.columns)
knnimpute_hdata_imputed.head()
```

```
    Reviews  Rating
0     159.0     4.1
1     967.0     3.9
2   87510.0     4.7
3  215644.0     4.5
4     967.0     4.3
```

```
fig, ax = plt.subplots(figsize=(5,5))
sns.distplot(knnimpute_hdata['Rating'])
```

```
C:\Users\ksarb\AppData\Local\Temp\ipykernel_3944\274606484.py:2:
UserWarning:

`distplot` is a deprecated function and will be removed in seaborn
v0.14.0.

Please adapt your code to use either `displot` (a figure-level
function with
similar flexibility) or `histplot` (an axes-level function for
histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(knnimpute_hdata['Rating'])
```

```
<Axes: xlabel='Rating', ylabel='Density'>
```



С помощью импьютации сохранили форму распределения, не создав пиков.

кодирование признаков

категориальные

```
data1 = pd.read_csv(r'C:\Users\ksarb\Documents\MMO_2024\Datasets\
Life.csv', sep=",")

from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()

data1.head()
```

```
       Country  Year      Status  Life expectancy   Adult Mortality  \
0  Afghanistan  2015  Developing              65.0            263.0
1  Afghanistan  2014  Developing              59.9            271.0
2  Afghanistan  2013  Developing              59.9            268.0
3  Afghanistan  2012  Developing              59.5            272.0
4  Afghanistan  2011  Developing              59.2            275.0

   infant deaths  Alcohol  percentage expenditure  Hepatitis B
Measles   ...  \
0             62     0.01               71.279624         65.0
```

```
1154  ...
1              64     0.01               73.523582          62.0
492  ...
2              66     0.01               73.219243          64.0
430  ...
3              69     0.01               78.184215          67.0
2787  ...
4              71     0.01                7.097109          68.0
3013  ...

   Polio  Total expenditure  Diphtheria    HIV/AIDS         GDP
Population  \
0    6.0               8.16         65.0        0.1  584.259210
33736494.0
1   58.0               8.18         62.0        0.1  612.696514
327582.0
2   62.0               8.13         64.0        0.1  631.744976
31731688.0
3   67.0               8.52         67.0        0.1  669.959000
3696958.0
4   68.0               7.87         68.0        0.1   63.537231
2978599.0

    thinness  1-19 years   thinness 5-9 years  \
0                   17.2                 17.3
1                   17.5                 17.5
2                   17.7                 17.7
3                   17.9                 18.0
4                   18.2                 18.2

   Income composition of resources  Schooling
0                            0.479       10.1
1                            0.476       10.0
2                            0.470        9.9
3                            0.463        9.8
4                            0.454        9.5

[5 rows x 22 columns]
```

```
data1['Country'].unique()
```

```
array(['Afghanistan', 'Albania', 'Algeria', 'Angola',
       'Antigua and Barbuda', 'Argentina', 'Armenia', 'Australia',
       'Austria', 'Azerbaijan', 'Bahamas', 'Bahrain', 'Bangladesh',
       'Barbados', 'Belarus', 'Belgium', 'Belize', 'Benin', 'Bhutan',
       'Bolivia (Plurinational State of)', 'Bosnia and Herzegovina',
       'Botswana', 'Brazil', 'Brunei Darussalam', 'Bulgaria',
       'Burkina Faso', 'Burundi', "Côte d'Ivoire", 'Cabo Verde',
       'Cambodia', 'Cameroon', 'Canada', 'Central African Republic',
       'Chad', 'Chile', 'China', 'Colombia', 'Comoros', 'Congo',
```

```
       'Cook Islands', 'Costa Rica', 'Croatia', 'Cuba', 'Cyprus',
       'Czechia', "Democratic People's Republic of Korea",
       'Democratic Republic of the Congo', 'Denmark', 'Djibouti',
       'Dominica', 'Dominican Republic', 'Ecuador', 'Egypt',
       'El Salvador', 'Equatorial Guinea', 'Eritrea', 'Estonia',
       'Ethiopia', 'Fiji', 'Finland', 'France', 'Gabon', 'Gambia',
       'Georgia', 'Germany', 'Ghana', 'Greece', 'Grenada',
'Guatemala',
       'Guinea', 'Guinea-Bissau', 'Guyana', 'Haiti', 'Honduras',
       'Hungary', 'Iceland', 'India', 'Indonesia',
       'Iran (Islamic Republic of)', 'Iraq', 'Ireland', 'Israel',
'Italy',
       'Jamaica', 'Japan', 'Jordan', 'Kazakhstan', 'Kenya',
'Kiribati',
       'Kuwait', 'Kyrgyzstan', "Lao People's Democratic Republic",
       'Latvia', 'Lebanon', 'Lesotho', 'Liberia', 'Libya',
'Lithuania',
       'Luxembourg', 'Madagascar', 'Malawi', 'Malaysia', 'Maldives',
       'Mali', 'Malta', 'Marshall Islands', 'Mauritania', 'Mauritius',
       'Mexico', 'Micronesia (Federated States of)', 'Monaco',
'Mongolia',
       'Montenegro', 'Morocco', 'Mozambique', 'Myanmar', 'Namibia',
       'Nauru', 'Nepal', 'Netherlands', 'New Zealand', 'Nicaragua',
       'Niger', 'Nigeria', 'Niue', 'Norway', 'Oman', 'Pakistan',
'Palau',
       'Panama', 'Papua New Guinea', 'Paraguay', 'Peru',
'Philippines',
       'Poland', 'Portugal', 'Qatar', 'Republic of Korea',
       'Republic of Moldova', 'Romania', 'Russian Federation',
'Rwanda',
       'Saint Kitts and Nevis', 'Saint Lucia',
       'Saint Vincent and the Grenadines', 'Samoa', 'San Marino',
       'Sao Tome and Principe', 'Saudi Arabia', 'Senegal', 'Serbia',
       'Seychelles', 'Sierra Leone', 'Singapore', 'Slovakia',
'Slovenia',
       'Solomon Islands', 'Somalia', 'South Africa', 'South Sudan',
       'Spain', 'Sri Lanka', 'Sudan', 'Suriname', 'Swaziland',
'Sweden',
       'Switzerland', 'Syrian Arab Republic', 'Tajikistan',
'Thailand',
       'The former Yugoslav republic of Macedonia', 'Timor-Leste',
'Togo',
       'Tonga', 'Trinidad and Tobago', 'Tunisia', 'Turkey',
       'Turkmenistan', 'Tuvalu', 'Uganda', 'Ukraine',
       'United Arab Emirates',
       'United Kingdom of Great Britain and Northern Ireland',
       'United Republic of Tanzania', 'United States of America',
       'Uruguay', 'Uzbekistan', 'Vanuatu',
```

```
       'Venezuela (Bolivarian Republic of)', 'Viet Nam', 'Yemen',
       'Zambia', 'Zimbabwe'], dtype=object)
```

```
cat_enc_le = le.fit_transform(data1['Country'])
```

```
np.unique(cat_enc_le)
```

```
array([  0,   1,   2,   3,   4,   5,   6,   7,   8,   9,  10,  11,
12,
        13,  14,  15,  16,  17,  18,  19,  20,  21,  22,  23,  24,
25,
        26,  27,  28,  29,  30,  31,  32,  33,  34,  35,  36,  37,
38,
        39,  40,  41,  42,  43,  44,  45,  46,  47,  48,  49,  50,
51,
        52,  53,  54,  55,  56,  57,  58,  59,  60,  61,  62,  63,
64,
        65,  66,  67,  68,  69,  70,  71,  72,  73,  74,  75,  76,
77,
        78,  79,  80,  81,  82,  83,  84,  85,  86,  87,  88,  89,
90,
        91,  92,  93,  94,  95,  96,  97,  98,  99, 100, 101, 102,
103,
       104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115,
116,
       117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128,
129,
       130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141,
142,
       143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154,
155,
       156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167,
168,
       169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180,
181,
       182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192])
```

```
le.inverse_transform([0, 1, 2, 3])
```

```
array(['Afghanistan', 'Albania', 'Algeria', 'Angola'], dtype=object)
```

```
pd.get_dummies(data1[['Country']]).head()
```

```
   Country_Afghanistan  Country_Albania  Country_Algeria
Country_Angola  \
0                 True            False            False
False
1                 True            False            False
False
2                 True            False            False
False
```

```
3                  True             False             False
False
4                  True             False             False
False

   Country_Antigua and Barbuda  Country_Argentina  Country_Armenia  \
0                         False              False            False
1                         False              False            False
2                         False              False            False
3                         False              False            False
4                         False              False            False

   Country_Australia  Country_Austria  Country_Azerbaijan  ...  \
0              False            False               False  ...
1              False            False               False  ...
2              False            False               False  ...
3              False            False               False  ...
4              False            False               False  ...

   Country_United Republic of Tanzania  Country_United States of
America  \
0                                False
False
1                                False
False
2                                False
False
3                                False
False
4                                False
False

   Country_Uruguay  Country_Uzbekistan  Country_Vanuatu  \
0            False               False            False
1            False               False            False
2            False               False            False
3            False               False            False
4            False               False            False

   Country_Venezuela (Bolivarian Republic of)  Country_Viet Nam  \
0                                       False             False
1                                       False             False
2                                       False             False
3                                       False             False
4                                       False             False

   Country_Yemen  Country_Zambia  Country_Zimbabwe
0          False           False             False
1          False           False             False
2          False           False             False
```

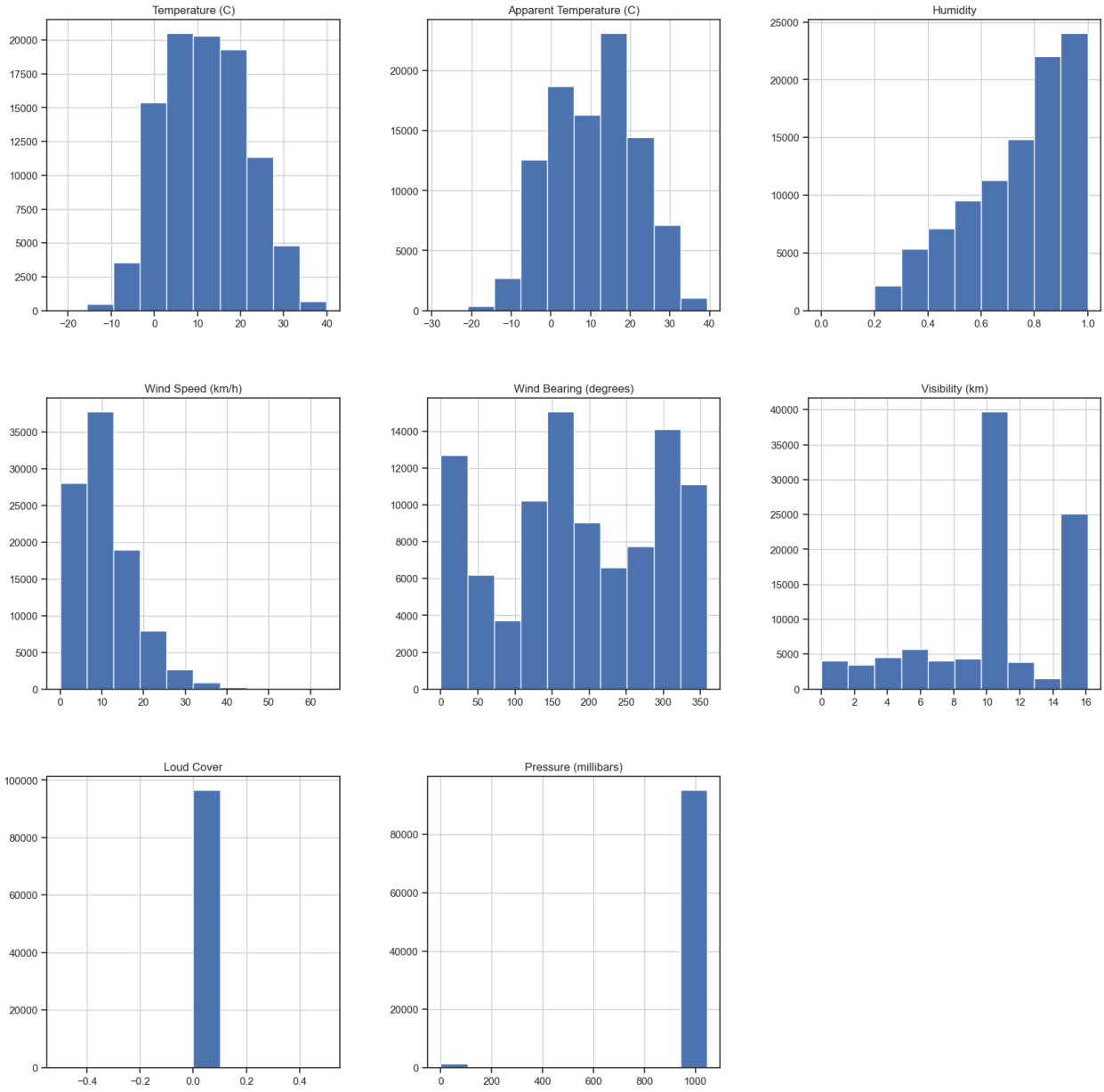
```
3          False           False             False
4          False           False             False

[5 rows x 193 columns]
```

числовые

```
data2 = pd.read_csv(r'C:\Users\ksarb\Documents\MMO_2024\Datasets\
weatherHistory.csv', sep=",")
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()

data2.dtypes
```

```
Formatted Date               object
Summary                      object
Precip Type                  object
Temperature (C)             float64
Apparent Temperature (C)    float64
Humidity                    float64
Wind Speed (km/h)           float64
Wind Bearing (degrees)      float64
Visibility (km)             float64
Loud Cover                  float64
Pressure (millibars)        float64
Daily Summary                object
dtype: object
```

```
data2.hist(figsize=(20,20))
plt.show()
```




```
from sklearn.preprocessing import MinMaxScaler
# Обучаем StandardScaler на всей выборке и масштабируем
cs31 = MinMaxScaler()
data_cs31_scaled_temp = cs31.fit_transform(data2[['Apparent
Temperature (C)']])
# формируем DataFrame на основе массива
data_scaled =pd.DataFrame(data_cs31_scaled_temp, columns=['Apparent
Temperature (C)'])
data_scaled.describe()
```

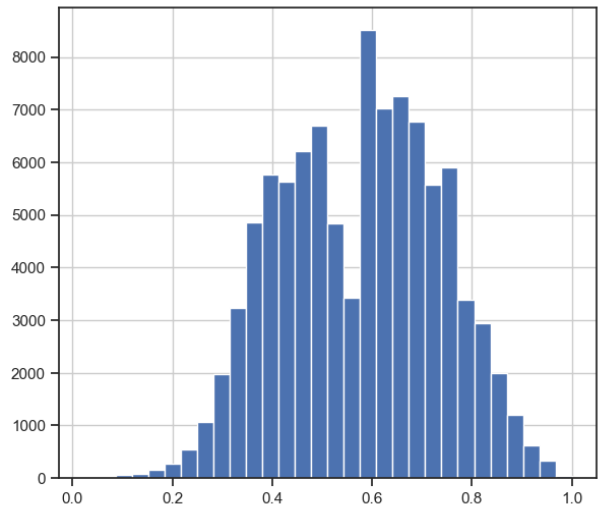
```
       Apparent Temperature (C)
count              96453.000000
mean                   0.575172
```

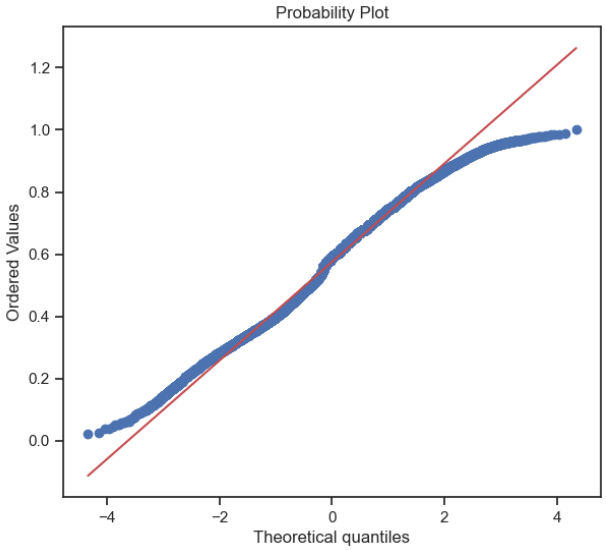
```
std                         0.159509
min                         0.000000
25%                         0.447767
50%                         0.592246
75%                         0.694226
max                         1.000000
```

```
data_scaled.loc[data_scaled['Apparent Temperature (C)']==0]
```

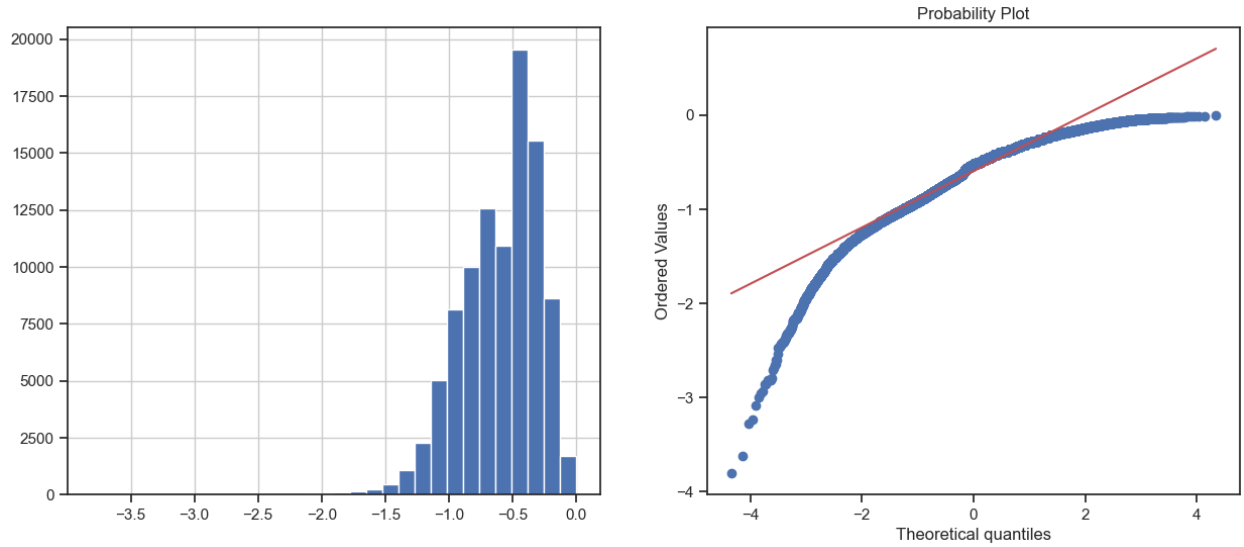
```
       Apparent Temperature (C)
54864                       0.0
```

```
data_scaled = data_scaled.loc[data_scaled['Apparent Temperature (C)']!
=0]

diagnostic_plots(data_scaled, 'Apparent Temperature (C)')
```

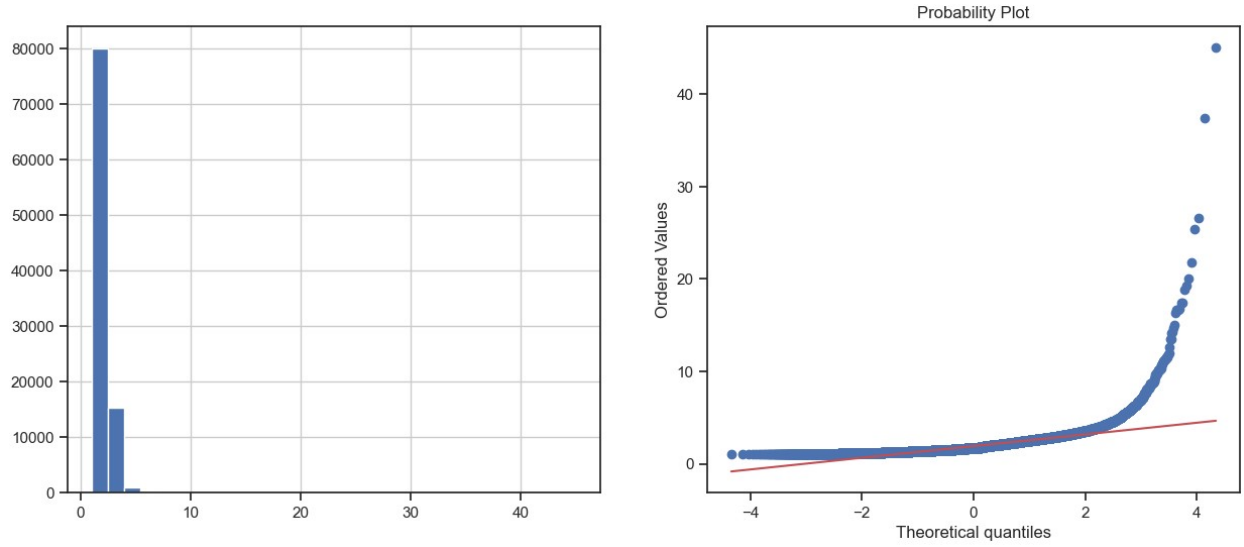




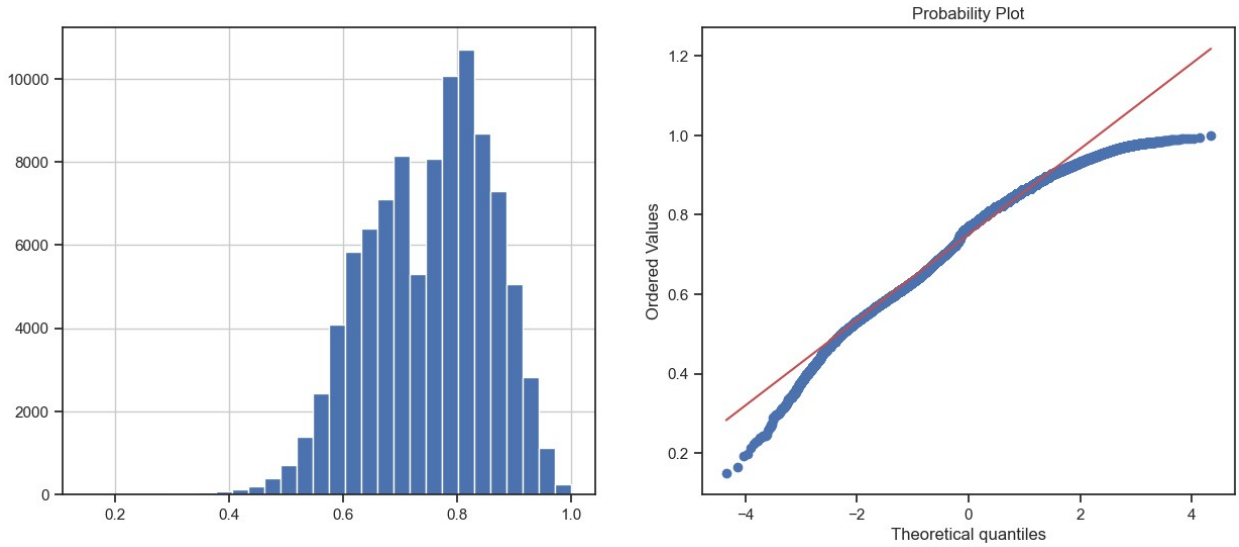

```
# логарифмическое
data_scaled['norm_log'] = np.log(data_scaled['Apparent Temperature
(C)'])
diagnostic_plots(data_scaled, 'norm_log')
```



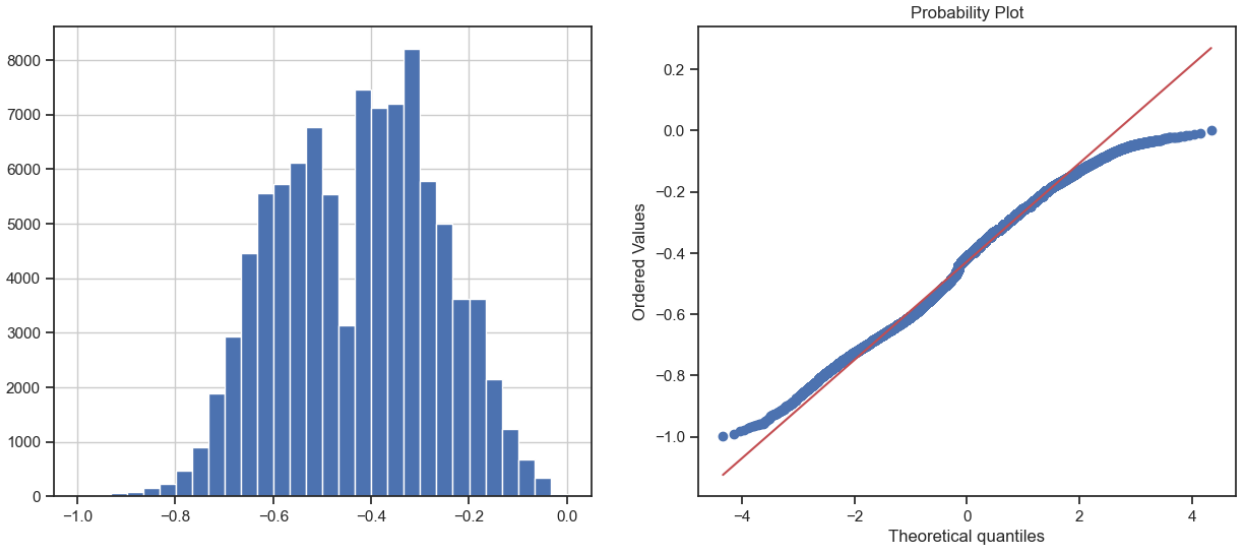

```
# обратное
data_scaled['norm_reciprocal'] = 1 / (data_scaled['Apparent
Temperature (C)'])
diagnostic_plots(data_scaled, 'norm_reciprocal')
```



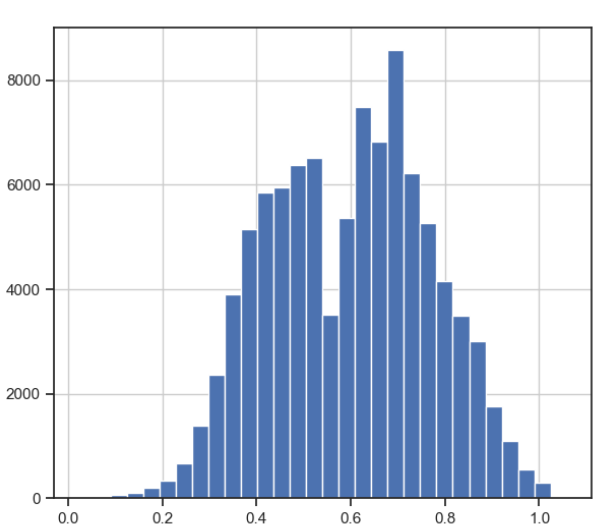

```
# root
data_scaled['norm_sqr'] = data_scaled['Apparent Temperature
(C)']**(1/2)
diagnostic_plots(data_scaled, 'norm_sqr')
```

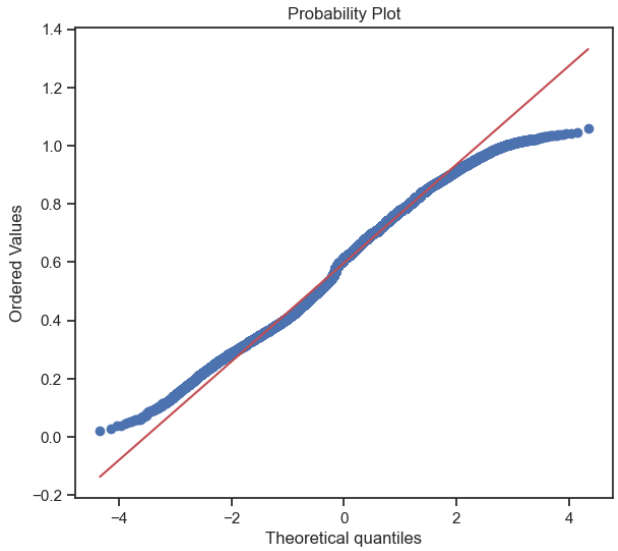



```
# Бокса-Кокса
data_scaled['norm_boxcox'], param = stats.boxcox(data_scaled['Apparent
Temperature (C)'])
print('Оптимальное значение λ = {}'.format(param))
diagnostic_plots(data_scaled, 'norm_boxcox')

Оптимальное значение λ = 0.9778834045020082
```




```
# Преобразование Йео-Джонсона
data_scaled['norm_yeojohnson'], param =
stats.yeojohnson(data_scaled['Apparent Temperature (C)'])
print('Оптимальное значение λ = {}'.format(param))
diagnostic_plots(data_scaled, 'norm_yeojohnson')

Оптимальное значение λ = 1.1461032413095196
```


8000
6000
4000
2000
0
0.0
0.2
0.4
0.6
0.8
1.0


Probability Plot
Ordered Values
Theoretical quantiles
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−4
−2
0
2
4

Вывод:

Датасет необходимо подготавливать перед проведением любой работы по машинному обучению. В ЛР мы выполнили следующие стратеги работы с пропусками:

- Удаление строк с пропусками, где их количество менее 1% - они не являлись значимыми.
- Заполнение пропусков в rating – они составляют 10% от датасета. Были испробованы заполнение медианой – создало пик и нарушило распределение и импутация knn – сохранила распределение.

Категориальные признаки мы закодировали – чтобы была возможность сопоставить их в вычислениях с другими числовыми признаками, вычислить корреляцию.

Также была опробована нормализация – лучший результат дало преобразование Бокса-Кокса, однако оно потребовало предварительного масштабирования minmax до промежутка [0;1] с удалением 0 – чтобы стало (0;1]