Министерство науки и высшего образования Российской Федерации
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ФАКУЛЬТЕТ ____Информатика, искусственный интеллект и системы управления ___

КАФЕДРА _____Системы обработки информации и управления_____

ОТЧЁТ
К ЛАБОРАТОРНОЙ РАБОТЕ №3

НА ТЕМУ:
Обработка признаков. Часть 2

Студент: Громоздов Д.Р.
Группа: ИУ5-23М

Преподаватель: Гапанюк Ю.Е.

2022 г.

Цель лабораторной работы: изучение продвинутых способов предварительной обработки данных для дальнейшего формирования моделей.

Задание:

1. Выбрать один или несколько наборов данных (датасетов) для решения следующих задач. Каждая задача может быть решена на отдельном датасете, или несколько задач могут быть решены на одном датасете. Просьба не использовать датасет, на котором данная задача решалась в лекции.
2. Для выбранного датасета (датасетов) на основе материалов лекций решить следующие задачи:
   I. масштабирование признаков (не менее чем тремя способами);
   II. обработку выбросов для числовых признаков (по одному способу для удаления выбросов и для замены выбросов);
   III. обработку по крайней мере одного нестандартного признака (который не является числовым или категориальным);
   IV. отбор признаков:
      - один метод из группы методов фильтрации (filter methods);
      - один метод из группы методов обертывания (wrapper methods);
      - один метод из группы методов вложений (embedded methods).

Лабораторная работа №3. "Обработка признаков (часть 2)"

Выполнил: Громоздов Д.Р.; группа ИУ5-23М

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Задание: Выбрать один или несколько наборов данных (датасетов) для решения следующих задач. Каждая задача может быть решена на отдельном датасете, или несколько задач могут быть решены на одном датасете. Просьба не использовать датасет, на котором данная задача решалась в лекции. Для выбранного датасета (датасетов) на основе материалов лекций решить следующие задачи: масштабирование признаков (не менее чем тремя способами); обработку выбросов для числовых признаков (по одному способу для удаления выбросов и для замены выбросов); обработку по крайней мере одного нестандартного признака (который не является числовым или категориальным); отбор признаков: один метод из группы методов фильтрации (filter methods); один метод из группы методов обертывания (wrapper methods); один метод из группы методов вложений (embedded methods).

Масштабирование признаков

In [29]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import scipy.stats as stats
import datetime
from sklearn.preprocessing import RobustScaler
from sklearn.preprocessing import MaxAbsScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.feature_selection import SelectFromModel
from sklearn.linear_model import LogisticRegression
from sklearn.feature_selection import VarianceThreshold
from mlxtend.feature_selection import SequentialFeatureSelector as SFS
from category_encoders.one_hot import OneHotEncoder as ce_OneHotEncoder
```

In [2]:
```
data_load = pd.read_csv('data/prices_tunisia.csv', sep=",")
data_load.head()
```

Out[2]:

	category	room_count	bathroom_count	size	type	price	city	region	log_price
0	Terrains et Fermes	-1.0	-1.0	-1.0	À Vendre	100000.0	Ariana	Raoued	5.000000
1	Terrains et Fermes	-1.0	-1.0	-1.0	À Vendre	316000.0	Ariana	Autres villes	5.499687
2	Appartements	2.0	1.0	80.0	À Louer	380.0	Ariana	Autres villes	2.579784
3	Locations de vacances	1.0	1.0	90.0	À Louer	70.0	Ariana	Autres villes	1.845098
4	Appartements	2.0	2.0	113.0	À Vendre	170000.0	Ariana	Ariana Ville	5.230449

In [3]:
```
data_load.describe()
```

Out[3]:

	room_count	bathroom_count	size	price	log_price
count	12748.000000	12748.000000	12748.000000	1.274800e+04	12748.000000
mean	1.759649	0.759884	130.896219	1.601575e+07	4.374245
std	2.171468	1.264812	184.074990	1.016644e+09	1.389788
min	-1.000000	-1.000000	-1.000000	1.000000e+01	1.000000
25%	-1.000000	-1.000000	-1.000000	8.500000e+02	2.929419
50%	2.000000	1.000000	95.000000	8.975000e+04	4.953033
75%	3.000000	1.000000	150.000000	2.600000e+05	5.414973
max	20.000000	10.000000	2000.000000	1.000000e+11	11.000000

In [4]:
```
data = data_load[["room_count", "bathroom_count", "size", "log_price"]]
```

In [5]:
```
def arr_to_df(arr_scaled):
    res = pd.DataFrame(arr_scaled, columns=data.columns)
    return res
```

a) Масштабируем нормализацией по средним. Mean Normalization.

In [6]:
```
class MeanNormalisation:

    def fit(self, param_df):
        self.means = param_df.mean(axis=0)
        maxs = param_df.max(axis=0)
        mins = param_df.min(axis=0)
        self.ranges = maxs - mins

    def transform(self, param_df):
        param_df_scaled = (param_df - self.means) / self.ranges
```

```
        return param_df_scaled

    def fit_transform(self, param_df):
        self.fit(param_df)
        return self.transform(param_df)
```

In [7]:
```
data_mn_scale = MeanNormalisation().fit_transform(data)
data_mn_scale.head()
```

Out[7]:

	room_count	bathroom_count	size	log_price
0	-0.131412	-0.159989	-0.065915	0.062575
1	-0.131412	-0.159989	-0.065915	0.112544
2	0.011445	0.021829	-0.025435	-0.179446
3	-0.036174	0.021829	-0.020438	-0.252915
4	0.011445	0.112738	-0.008944	0.085620

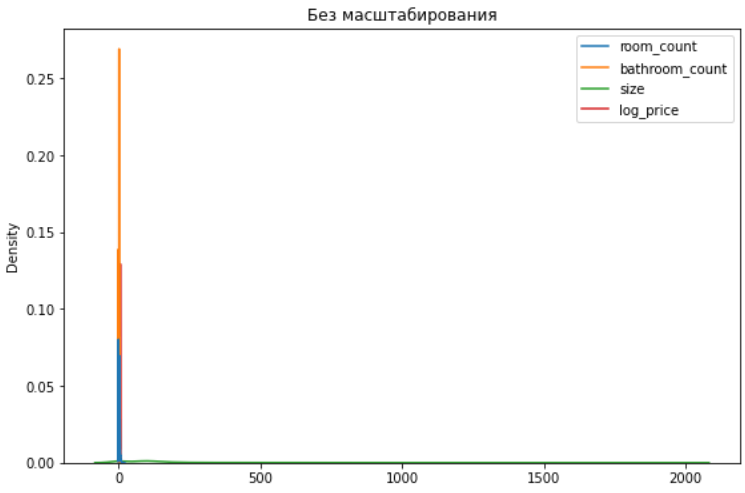
In [8]:
```
data_mn_scale.describe()
```

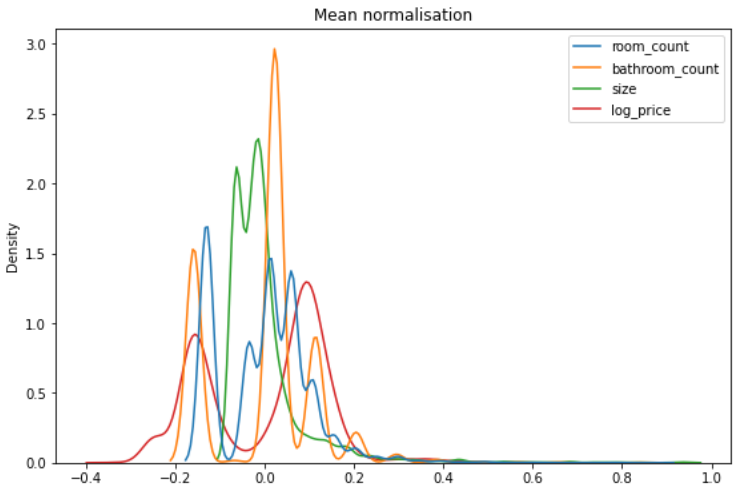
Out[8]:

	room_count	bathroom_count	size	log_price
count	1.274800e+04	1.274800e+04	1.274800e+04	1.274800e+04
mean	6.131134e-18	-3.344255e-18	2.786879e-18	-6.026626e-17
std	1.034032e-01	1.149829e-01	9.199150e-02	1.389788e-01
min	-1.314118e-01	-1.599894e-01	-6.591515e-02	-3.374245e-01
25%	-1.314118e-01	-1.599894e-01	-6.591515e-02	-1.444826e-01
50%	1.144531e-02	2.182874e-02	-1.793914e-02	5.787875e-02
75%	5.906435e-02	2.182874e-02	9.547117e-03	1.040728e-01
max	8.685882e-01	8.400106e-01	9.340848e-01	6.625755e-01

In [10]:
```
def draw_graph(col_list, data1, data2, label1, label2):
    fig, (ax1, ax2) = plt.subplots(ncols = 2, figsize=(20,6))
    ax1.set_title(label1)
    sns.kdeplot(data=data1[col_list], ax=ax1)
    ax2.set_title(label2)
    sns.kdeplot(data=data2[col_list], ax=ax2)
    plt.show()
```

In [11]:
```
draw_graph(['room_count', 'bathroom_count','size','log_price'], data, data_mn_scale,'Без масштабирования', 'Mean normalisation')
```





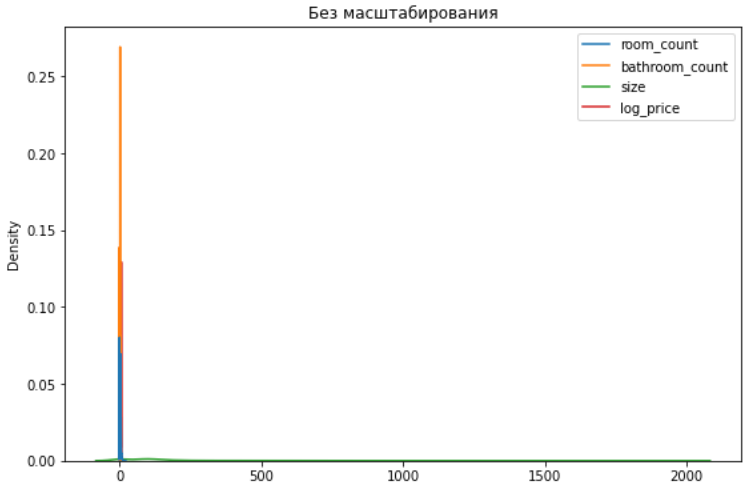
b) Масштабирование по медиане

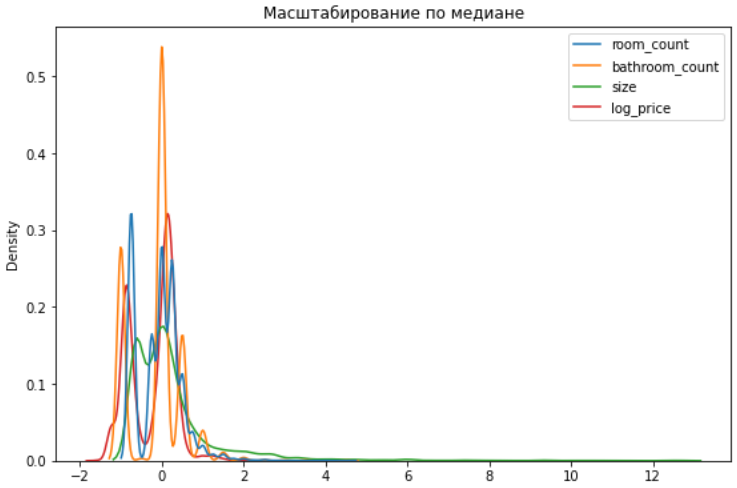
In [12]:
```
rs = RobustScaler()
data_median_scale_arr = rs.fit_transform(data)
data_median_scale = arr_to_df(data_median_scale_arr)
data_median_scale.describe()
```

Out[12]:

	room_count	bathroom_count	size	log_price
count	12748.000000	12748.000000	12748.000000	1.274800e+04
mean	-0.060088	-0.120058	0.237723	-2.328605e-01
std	0.542867	0.632406	1.219040	5.591462e-01
min	-0.750000	-1.000000	-0.635762	-1.590403e+00
25%	-0.750000	-1.000000	-0.635762	-8.141499e-01
50%	0.000000	0.000000	0.000000	1.786765e-16
75%	0.250000	0.000000	0.364238	1.858501e-01
max	4.500000	4.500000	12.615894	2.432844e+00

In [13]:
```
draw_graph(['room_count', 'bathroom_count','size','log_price'], data, data_median_scale,'Без масштабирования', 'Масштабирование по медиане')
```





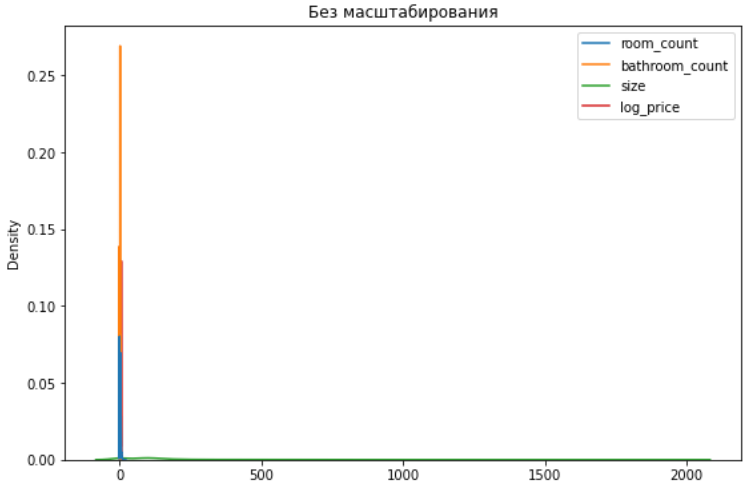
c) Масштабирование по максимальному значению

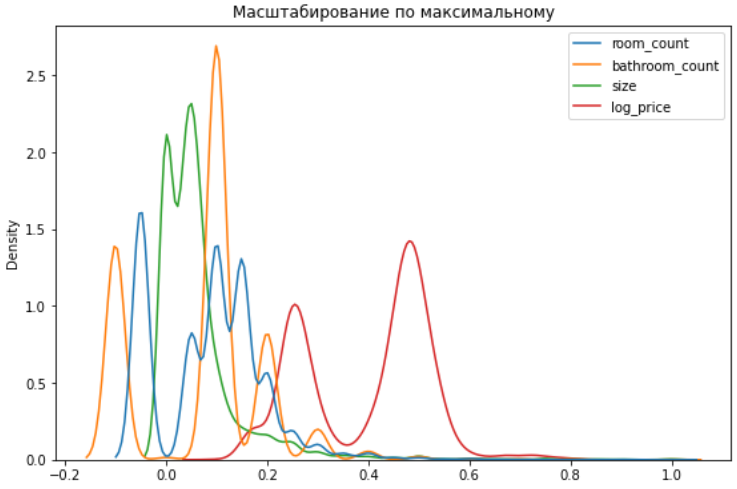
In [14]:
```
mas = MaxAbsScaler()
data_max_scale_arr = mas.fit_transform(data)
data_max_scale = arr_to_df(data_max_scale_arr)
data_max_scale.describe()
```

Out[14]:

	room_count	bathroom_count	size	log_price
count	12748.000000	12748.000000	12748.000000	12748.000000
mean	0.087982	0.075988	0.065448	0.397659
std	0.108573	0.126481	0.092037	0.126344
min	-0.050000	-0.100000	-0.000500	0.090909
25%	-0.050000	-0.100000	-0.000500	0.266311
50%	0.100000	0.100000	0.047500	0.450276
75%	0.150000	0.100000	0.075000	0.492270
max	1.000000	1.000000	1.000000	1.000000

In [15]:
```
draw_graph(['room_count', 'bathroom_count','size','log_price'], data, data_max_scale,'Без масштабирования', 'Масштабирование по максимальном
```



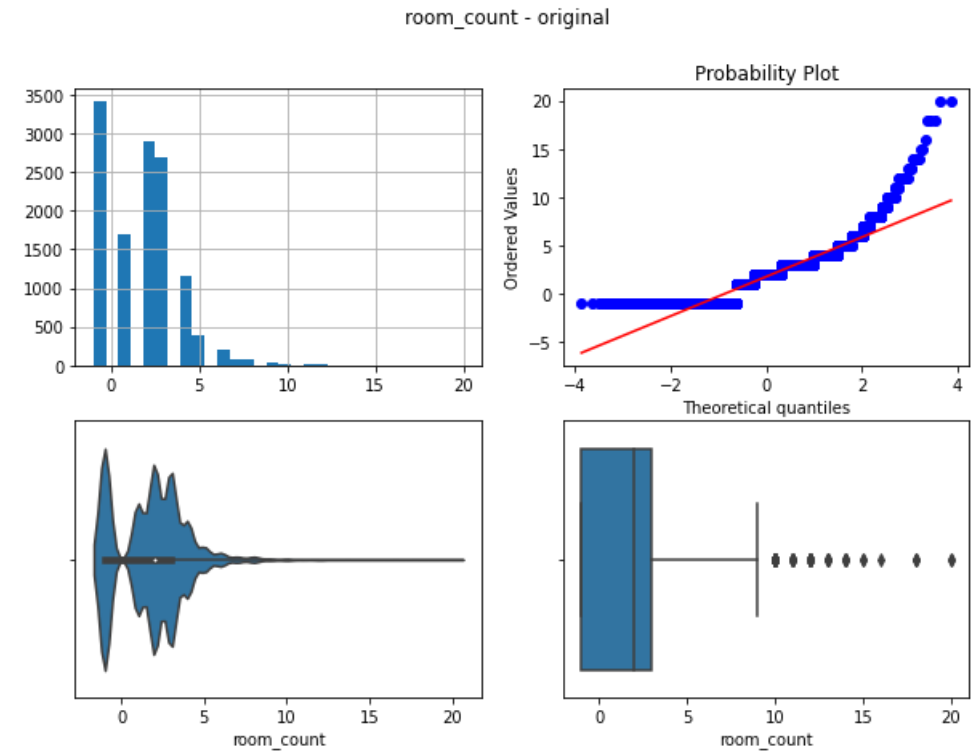


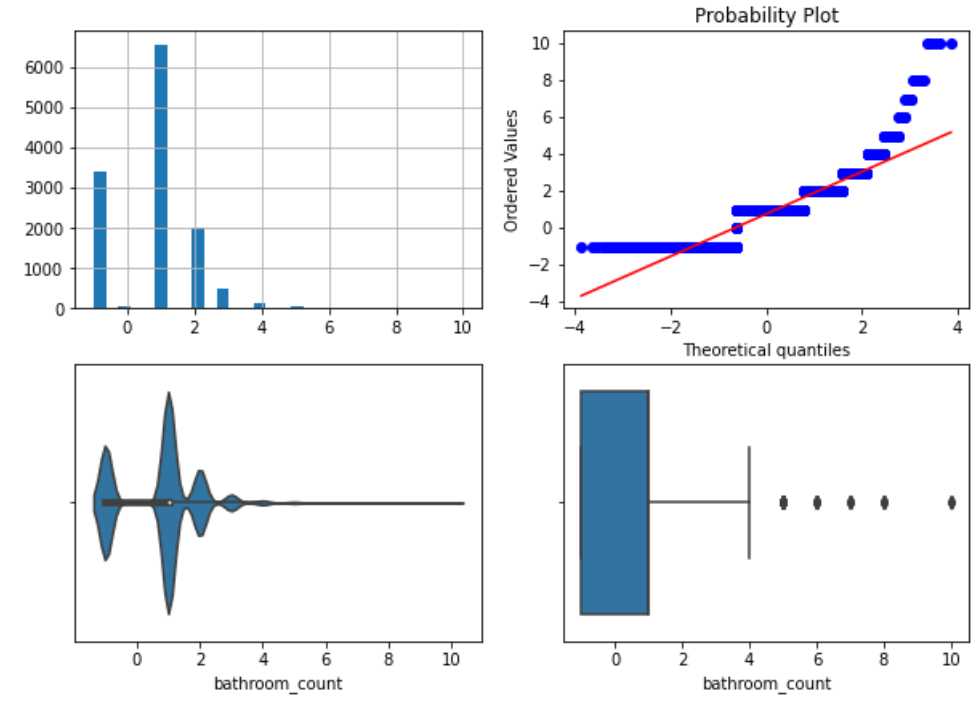
Обработка выбросов(числовые признаки)

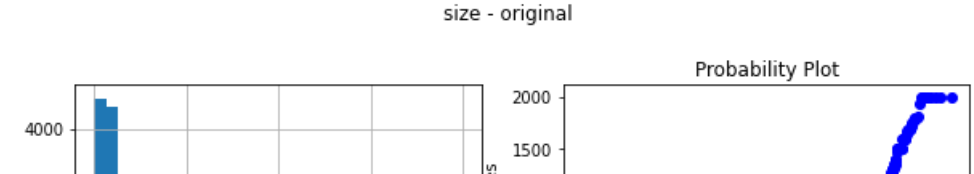
In [16]:
```
col_list = ['room_count', 'bathroom_count','size','log_price']
```

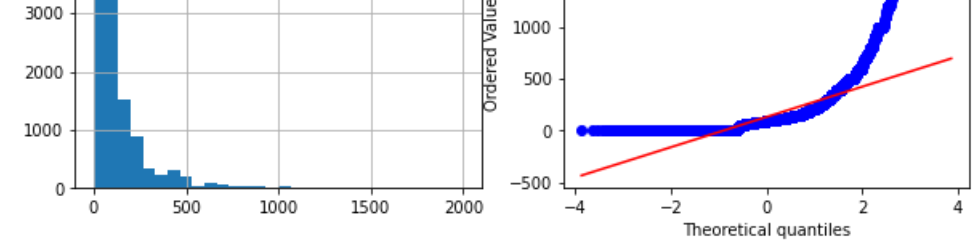
```
def diagnostic_plots(df, variable, title):
    fig, ax = plt.subplots(figsize=(10,7))
    # гистограмма
    plt.subplot(2, 2, 1)
    df[variable].hist(bins=30)
    ## Q-Q plot
    plt.subplot(2, 2, 2)
    stats.probplot(df[variable], dist="norm", plot=plt)
    # ящик с усами
    plt.subplot(2, 2, 3)
    sns.violinplot(x=df[variable])
    # ящик с усами
    plt.subplot(2, 2, 4)
    sns.boxplot(x=df[variable])
    fig.suptitle(title)
    plt.show()
```

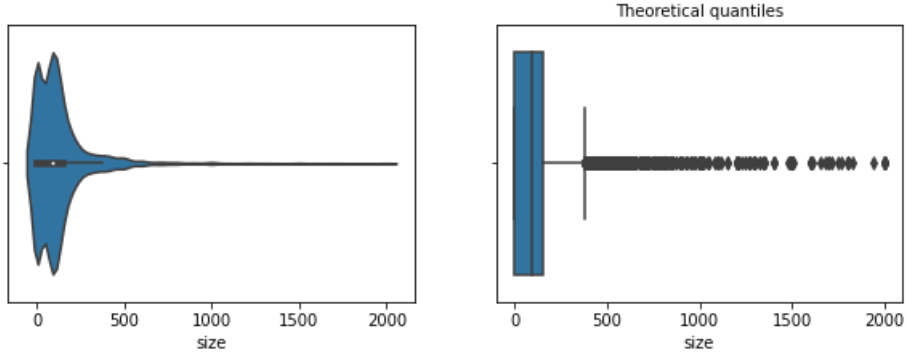
In [17]:
```
for col in col_list:
    diagnostic_plots(data, col, '{} - original'.format(col))
```



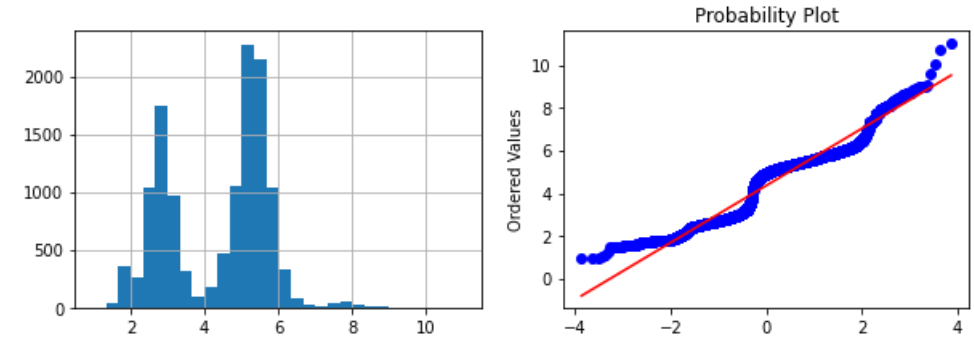


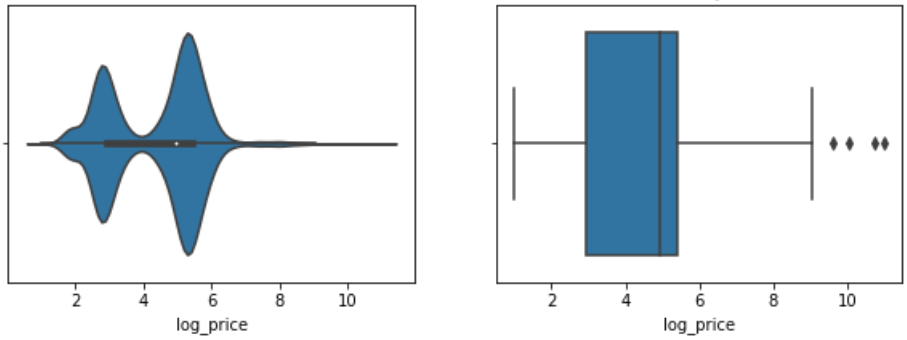






log_price - original

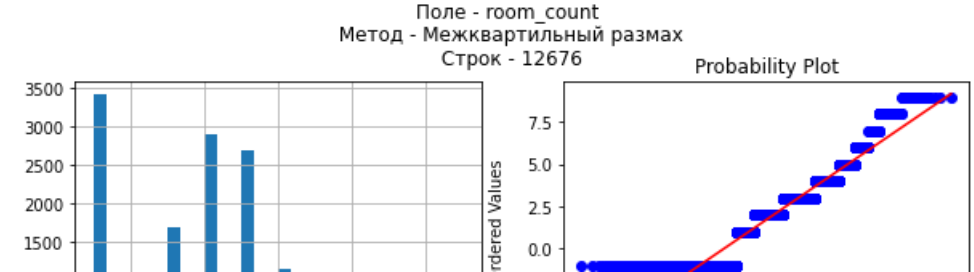


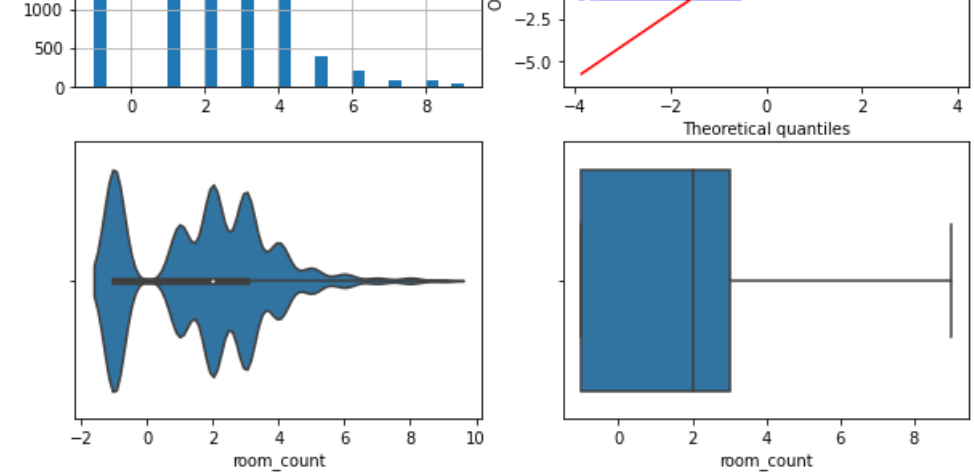


Удаление методом межквартильного размаха.

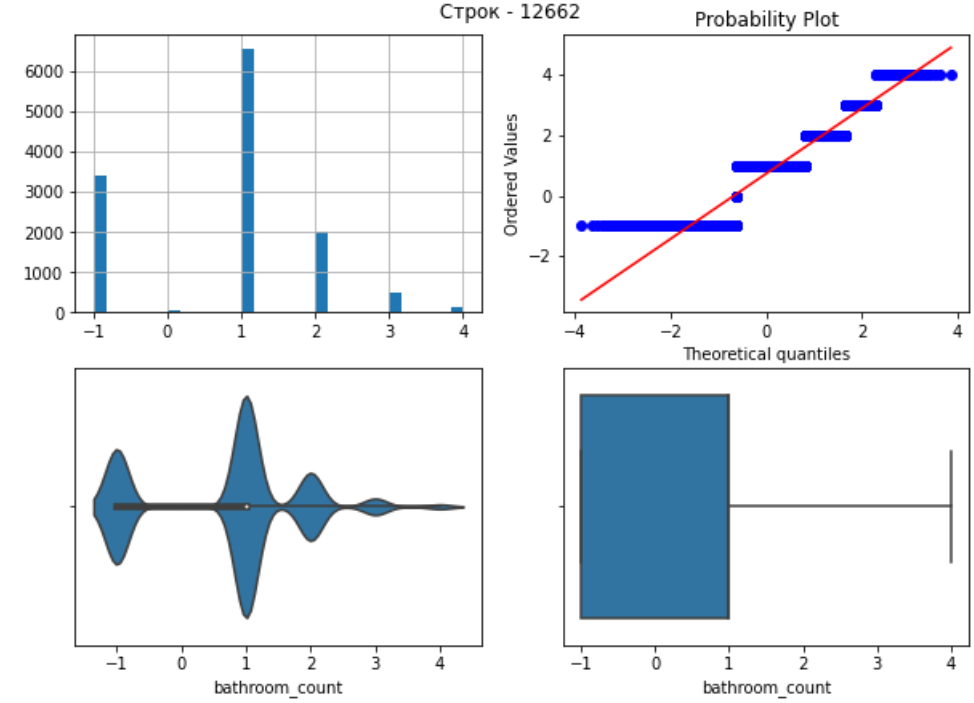
In [18]:
```
#создадим функцию обнаружения выбросов только для метода межквартильного размаха
def get_outlier_boundaries(df, col):
    K2 = 1.5
    IQR = df[col].quantile(0.75) - df[col].quantile(0.25)
    lower_boundary = df[col].quantile(0.25) - (K2 * IQR)
    upper_boundary = df[col].quantile(0.75) + (K2 * IQR)
    return lower_boundary, upper_boundary
```

In [19]:
```
obt = 'Межквартильный размах'
for col in col_list:
    # Вычисление верхней и нижней границы
    lower_boundary, upper_boundary = get_outlier_boundaries(data, col)
    # Флаги для удаления выбросов
    outliers_temp = np.where(data[col] > upper_boundary, True,
                             np.where(data[col] < lower_boundary, True, False))
    # Удаление данных на основе флага
    data_trimmed = data.loc[~(outliers_temp), ]
    title = 'Поле - {}\n Метод - {}\n Строк - {}'.format(col, obt, data_trimmed.shape[0])
    diagnostic_plots(data_trimmed, col, title)
```

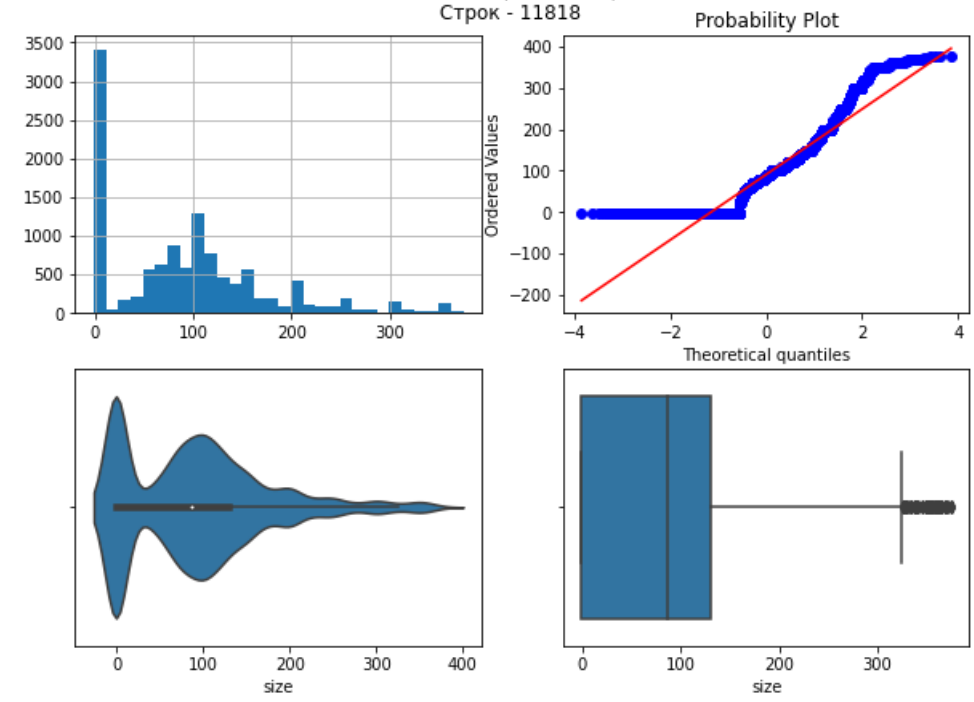




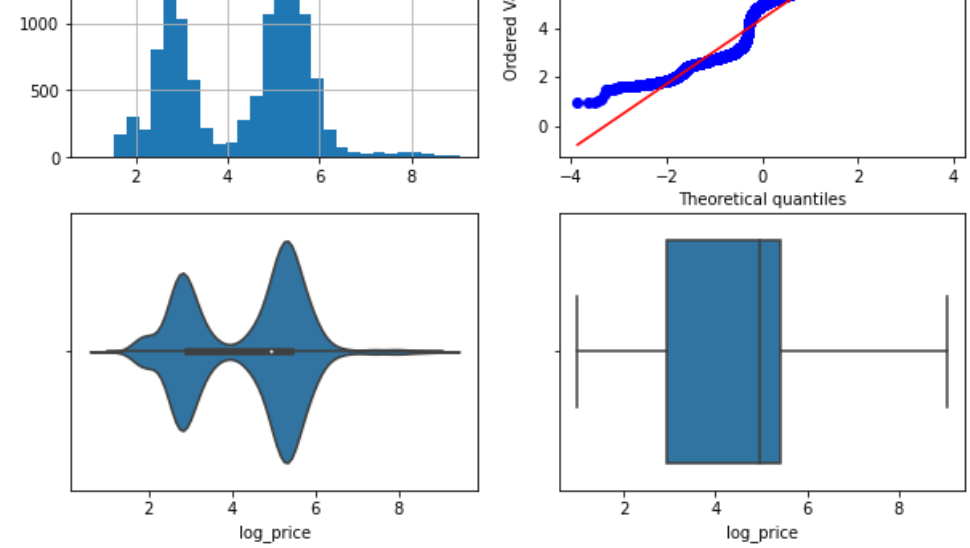
Поле - bathroom_count
Метод - Межквартильный размах
Строк - 12662



Поле - size
Метод - Межквартильный размах
Строк - 11818



Поле - log_price
Метод - Межквартильный размах
Строк - 12744



Замена выбросов методом трёх сигм

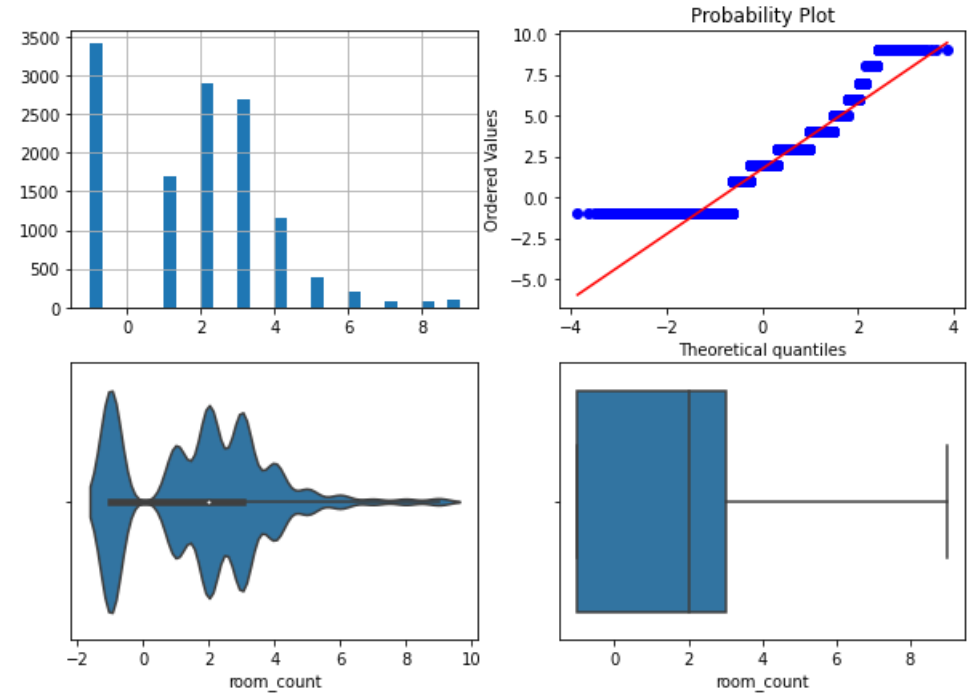
In [20]:
```
def get_outlier_boundaries_sigm(df, col):
    K1 = 3
    lower_boundary = df[col].mean() - (K1 * df[col].std())
    upper_boundary = df[col].mean() + (K1 * df[col].std())
    return lower_boundary, upper_boundary
```

In [21]:
```
obt2 = 'Три сигмы'
for col in col_list:
    # Вычисление верхней и нижней границы
    lower_boundary, upper_boundary = get_outlier_boundaries(data, col)
    # Изменение данных
    data[col] = np.where(data[col] > upper_boundary, upper_boundary,
                         np.where(data[col] < lower_boundary, lower_boundary, data[col]))
    title = 'Поле-{}, метод-{}'.format(col, obt2)
    diagnostic_plots(data, col, title)
```

C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\2915231609.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data[col] = np.where(data[col] > upper_boundary, upper_boundary,

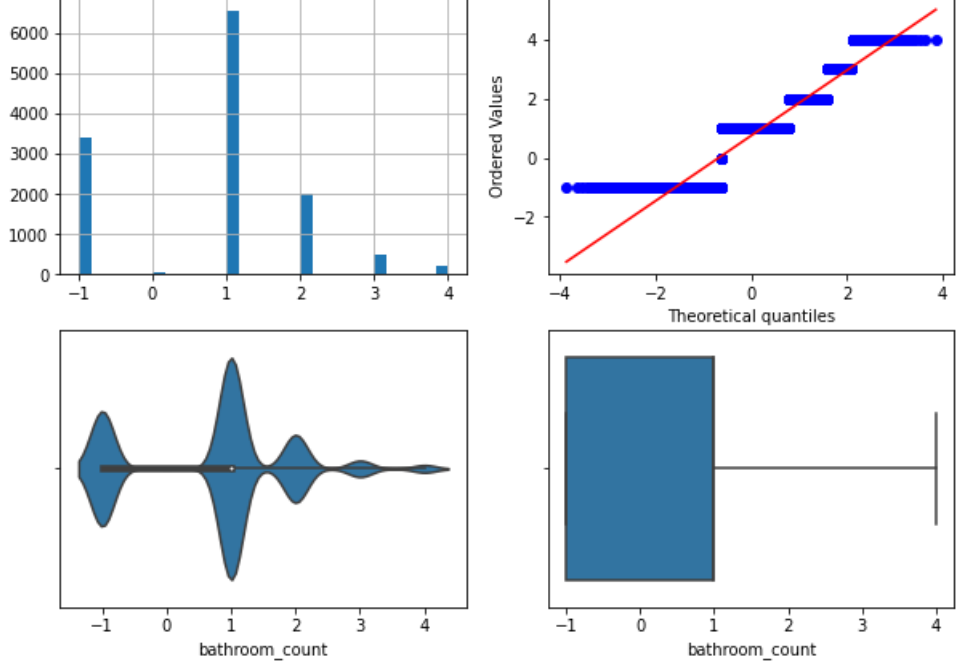
Поле-room_count, метод-Три сигмы



C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\2915231609.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data[col] = np.where(data[col] > upper_boundary, upper_boundary,

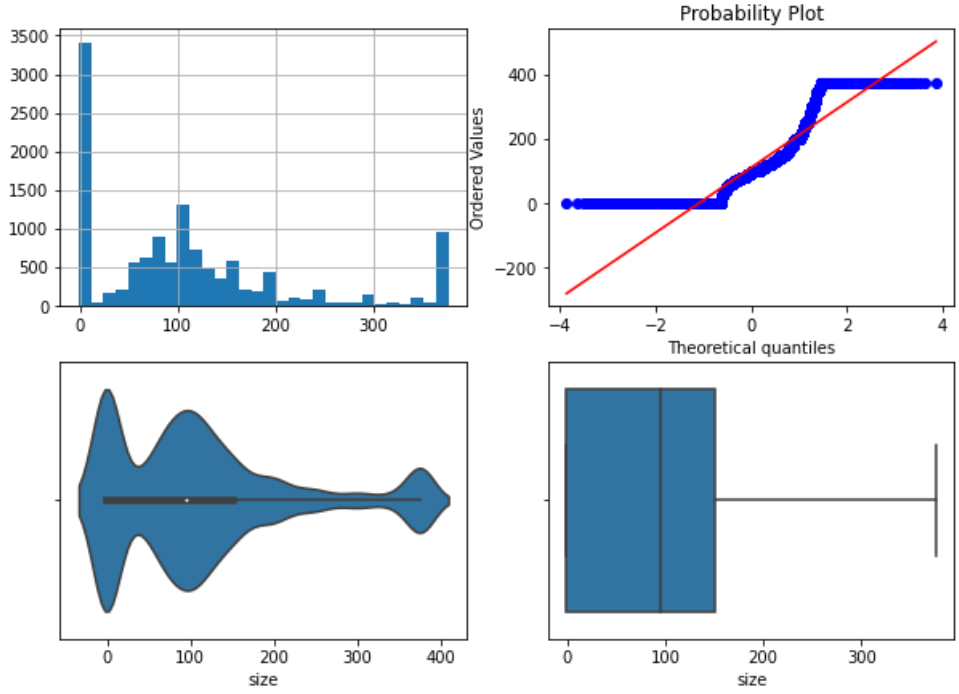
Поле-bathroom_count, метод-Три сигмы



C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\2915231609.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data[col] = np.where(data[col] > upper_boundary, upper_boundary,

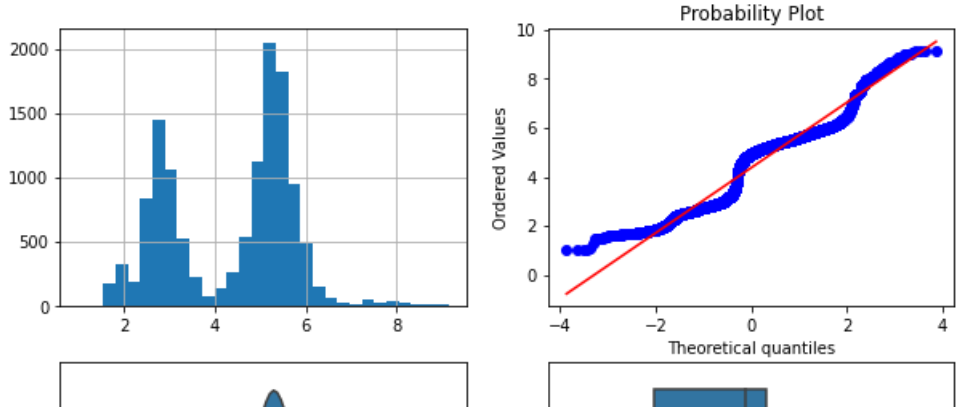
Поле-size, метод-Три сигмы

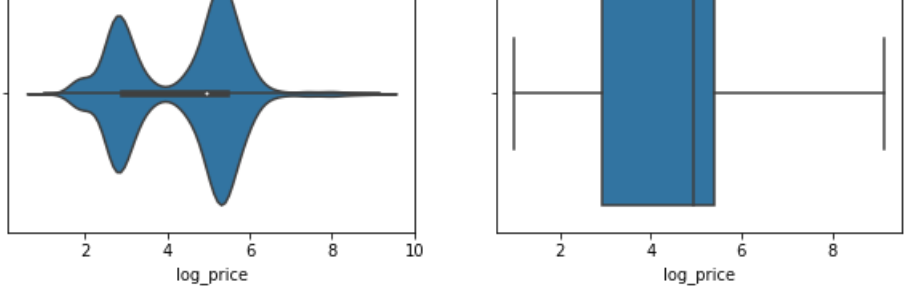


C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\2915231609.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data[col] = np.where(data[col] > upper_boundary, upper_boundary,

Поле-log_price, метод-Три сигмы





Обработка нестандартных признаков

In [22]:
```
data_in = pd.read_csv('data/news.csv', sep = ',')
```

In [23]:
```
data_input = data_in.iloc[0:2000, :]
```

In [24]:
```
data_input
```

Out[24]:

	datetime	title	content	category	url
0	2010-01-01 00:49:00	Enige Litouwse kerncentrale dicht	De enige kerncentrale van Litouwen is oudjaars...	Buitenland	https://nos.nl/artikel/126231-enige-litouwse-k...
1	2010-01-01 02:08:00	Spanje eerste EU-voorzitter onder nieuw verdrag	Spanje is met ingang van vandaag voorzitter va...	Buitenland	https://nos.nl/artikel/126230-spanje-eerste-eu...
2	2010-01-01 02:09:00	Fout justitie in Blackwater-zaak	Vijf werknemers van het omstreden Amerikaanse ...	Buitenland	https://nos.nl/artikel/126233-fout-justitie-in...
3	2010-01-01 05:14:00	Museumplein vol, minder druk in Rotterdam	Het Oud en Nieuwfeest op het Museumplein in Am...	Binnenland	https://nos.nl/artikel/126232-museumplein-vol-...
4	2010-01-01 05:30:00	Obama krijgt rapporten over aanslag	President Obama heeft de eerste rapporten gekr...	Buitenland	https://nos.nl/artikel/126236-obama-krijgt-rap...
...	...	...	...	...	...
1995	2010-02-24 11:59:00	Hoge boetes voor aspergeteelster	Een aspergeteelster uit Someren in Noord-Braba...	Binnenland	https://nos.nl/artikel/139429-hoge-boetes-voor...
1996	2010-02-24 12:46:00	'Dit zijn de angstscenario's van een coach'	Het ging goed mis gisteravond op de tien kilom...	Buitenland	https://nos.nl/artikel/139433-dit-zijn-de-angs...
1997	2010-02-24 13:00:00	Tragedie op Terpstra's laatste Spelen	Door Martijn Bink en Mattijs van de Wiel "Vand...	Buitenland	https://nos.nl/artikel/139551-tragedie-op-terp...
1998	2010-02-24 14:06:00	Relletjes bij staking Griekenland	In Athene zijn vechtpartijen tussen betogers e...	Buitenland	https://nos.nl/artikel/139452-relletjes-bij-st...
1999	2010-02-24 14:10:00	Militaire eer voor Britse speurhond	Een Britse speurhond krijgt een militaire onde...	Buitenland	https://nos.nl/artikel/139441-militaire-eer-vo...

2000 rows × 5 columns

In [25]:
```
#def substr_in_url(substr):
    #lsubstr = substr.lower()
    #return data_load.apply(lambda x: 1 if lsubstr in x['url'].lower() else 0, axis=1)
```

In [26]:
```
#data_load['is_get'] = substr_in_url('GET')
#data_load['is_php'] = substr_in_url('PHP')
#data_load['is_js'] = substr_in_url('JS')
#data_load['is_woff'] = substr_in_url('WOFF')
#url_features = ['is_get', 'is_php', 'is_js', 'is_woff']
```

Обработаем признак даты и времени.

In [27]:
```
#приводим колонку с датой и временем к форме, понятной Datetime
data_input['datetime'] = data_input.apply(lambda x: pd.to_datetime(x['datetime'], format='%Y-%m-%d %H:%M:%S'), axis=1)
```

```
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1421213694.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['datetime'] = data_input.apply(lambda x: pd.to_datetime(x['datetime'], format='%Y-%m-%d %H:%M:%S'), axis=1)
```

In [28]:
```
# День
data_input['day'] = data_input['datetime'].dt.day
# Месяц
data_input['month'] = data_input['datetime'].dt.month
# Год
data_input['year'] = data_input['datetime'].dt.year
# Часы
data_input['hour'] = data_input['datetime'].dt.hour
#Минуты
data_input['minute'] = data_input['datetime'].dt.minute
#Секунды
data_input['second'] = data_input['datetime'].dt.second
#Неделя года
data_input['week'] = data_input['datetime'].dt.isocalendar().week
```

```
    #Квартал
    data_input['quarter'] = data_input['datetime'].dt.quarter
    #День недели
    data_input['dayofweek'] = data_input['datetime'].dt.dayofweek
    #Выходной день
    data_input['day_name'] = data_input['datetime'].dt.day_name()
    #data_load['is_holiday'] = data.apply(lambda x: 1 if x['dt'].dayofweek in [5,6] else 0, axis=1)
```

```
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['day'] = data_input['datetime'].dt.day
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['month'] = data_input['datetime'].dt.month
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['year'] = data_input['datetime'].dt.year
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:8: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['hour'] = data_input['datetime'].dt.hour
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:10: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['minute'] = data_input['datetime'].dt.minute
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['second'] = data_input['datetime'].dt.second
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:14: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['week'] = data_input['datetime'].dt.isocalendar().week
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:16: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['quarter'] = data_input['datetime'].dt.quarter
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:18: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['dayofweek'] = data_input['datetime'].dt.dayofweek
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\377714258.py:20: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input['day_name'] = data_input['datetime'].dt.day_name()
```

In [29]:
```
    # Создадим масштабируемые признаки для дальнейших экспериментов
    dt_features = ['year', 'day', 'month', 'hour', 'minute', 'second', 'week', 'quarter', 'dayofweek']
    dt_features_scaled = []
    for f in dt_features:
        f_new = str(f + '_scaled')
        dt_features_scaled.append(f_new)
        data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
    dt_features_scaled
```

```
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_27640\1824856256.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_input[f_new] = MinMaxScaler().fit_transform(data_input[[f]])
```

Out[29]:

```
['year_scaled',
 'day_scaled',
 'month_scaled',
 'hour_scaled',
 'minute_scaled',
 'second_scaled',
 'week_scaled',
 'quarter_scaled',
 'dayofweek_scaled']
```

In [30]:

```
#функция кодировки значения синусом или косинусом
def round_code(v, T, cos_flag = True):
    x = 2*np.pi*v/T
    if cos_flag:
        return np.cos(x)
    else:
        return np.sin(x)
```

In [31]:

```
# Опеределим периоды для признаков
for f in dt_features:
    print(f, data_input[f].min(), data_input[f].max())
```

```
year 2010 2010
day 1 31
month 1 2
hour 0 23
minute 0 59
second 0 0
week 1 53
quarter 1 1
dayofweek 0 6
```

In [37]:
```python
dt_features_periods = [0, 31, 12, 24, 60, 60, 52, 4, 7]
```

In [33]:
```python
#Датафрейм большой и при его фрагментации нам попались только значения из 2010 года, поэтому колонку года не кодируем
# объявлем dt_features_round пустым, чтобы инициировать массив для дальнейшей работы с ним
dt_features_round = []
```

In [34]:
```python
%%time
# Построим отображение признаков на круг, год пропускаем
for f,p in zip(dt_features[1:], dt_features_periods[1:]):
    f_cos = str(f + '_cos')
    f_sin = str(f + '_sin')
    data_input[f_cos] = data_input.apply(lambda x: round_code(x[f], p), axis=1)
    data_input[f_sin] = data_input.apply(lambda x: round_code(x[f], p, False), axis=1)
    dt_features_round.append(f_cos)
    dt_features_round.append(f_sin)
dt_features_round
```

```
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
CPU times: total: 953 ms
Wall time: 954 ms
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
<timed exec>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
Out[34]:['day_cos',
'day_sin',
'month_cos',
'month_sin',
'hour_cos',
'hour_sin',
'minute_cos',
'minute_sin',
'second_cos',
'second_sin',
'week_cos',
'week_sin',
'quarter_cos',
'quarter_sin',
'dayofweek_cos',
'dayofweek_sin']

In [36]:
```
data_input
```

Out[36]:

	datetime	title	content	category	url	day	month	year	hour	minute	...	minute_cos	minute_sin
0	2010-01-01 00:49:00	Enige Litouwse kerncentrale dicht	De enige kerncentrale van Litouwen is oudjaars...	Buitenland	https://nos.nl/artikel/126231-enige-litouwse-k...	1	1	2010	0	49	...	0.406737	-9.135455e-01
1	2010-01-01 02:08:00	Spanje eerste EU-voorzitter onder nieuw verdrag	Spanje is met ingang van vandaag voorzitter va...	Buitenland	https://nos.nl/artikel/126230-spanje-eerste-eu...	1	1	2010	2	8	...	0.669131	7.431448e-01
2	2010-01-01 02:09:00	Fout justitie in Blackwater-zaak	Vijf werknemers van het omstreden Amerikaanse ...	Buitenland	https://nos.nl/artikel/126233-fout-justitie-in...	1	1	2010	2	9	...	0.587785	8.090170e-01
3	2010-01-01 05:14:00	Museumplein vol, minder druk in Rotterdam	Het Oud en Nieuwfeest op het Museumplein in Am...	Binnenland	https://nos.nl/artikel/126232-museumplein-vol-...	1	1	2010	5	14	...	0.104528	9.945219e-01
4	2010-01-01 05:30:00	Obama krijgt rapporten over aanslag	President Obama heeft de eerste rapporten gekr...	Buitenland	https://nos.nl/artikel/126236-obama-krijgt-rap...	1	1	2010	5	30	...	-1.000000	5.665539e-16
...	...	...	...	...	...	...	...	...	...	...	...	...	...
1995	2010-02-24 11:59:00	Hoge boetes voor aspergeteelster	Een aspergeteelster uit Someren in Noord-Braba...	Binnenland	https://nos.nl/artikel/139429-hoge-boetes-voor...	24	2	2010	11	59	...	0.994522	-1.045285e-01
1996	2010-02-24 12:46:00	'Dit zijn de angstscenario's van een coach'	Het ging goed mis gisteravond op de tien kilom...	Buitenland	https://nos.nl/artikel/139433-dit-zijn-de-angs...	24	2	2010	12	46	...	0.104528	-9.945219e-01
1997	2010-02-24 13:00:00	Tragedie op Terpstra's laatste Spelen	Door Martijn Bink en Mattijs van de Wiel "Vand...	Buitenland	https://nos.nl/artikel/139551-tragedie-op-terp...	24	2	2010	13	0	...	1.000000	0.000000e+00
1998	2010-02-24 14:06:00	Relletjes bij staking Griekenland	In Athene zijn vechtpartijen tussen betogers e...	Buitenland	https://nos.nl/artikel/139452-relletjes-bij-st...	24	2	2010	14	6	...	0.809017	5.877853e-01
1999	2010-02-24 14:10:00	Militaire eer voor Britse speurhond	Een Britse speurhond krijgt een militaire onde...	Buitenland	https://nos.nl/artikel/139441-militaire-eer-vo...	24	2	2010	14	10	...	0.500000	8.660254e-01

2000 rows × 40 columns

Отбор признаков

In [91]:
```
data_class = pd.read_csv('data/glass.csv', sep=",")
#data_data = data_class.iloc[:, 2:23] #data_data = data_class.iloc[:, 1:22]
#data_targ = data_class[['class']]
#data_data
data_class.shape
```

Out[91]:(214, 10)

In [92]:
```
data_class.head()
```

Out[92]:

	RI	Na	Mg	Al	Si	K	Ca	Ba	Fe	Type
0	1.52101	13.64	4.49	1.10	71.78	0.06	8.75	0.0	0.0	1
1	1.51761	13.89	3.60	1.36	72.73	0.48	7.83	0.0	0.0	1
2	1.51618	13.53	3.55	1.54	72.99	0.39	7.78	0.0	0.0	1
3	1.51766	13.21	3.69	1.29	72.61	0.57	8.22	0.0	0.0	1
4	1.51742	13.27	3.62	1.24	73.08	0.55	8.07	0.0	0.0	1

In [93]:
```
data_data = data_class.iloc[:, 0:9] #data_data = data_class.iloc[:, 1:22]
data_targ = data_class[['Type']]
data_data
```

Out[93]:

	RI	Na	Mg	Al	Si	K	Ca	Ba	Fe
0	1.52101	13.64	4.49	1.10	71.78	0.06	8.75	0.00	0.0
1	1.51761	13.89	3.60	1.36	72.73	0.48	7.83	0.00	0.0
2	1.51618	13.53	3.55	1.54	72.99	0.39	7.78	0.00	0.0
3	1.51766	13.21	3.69	1.29	72.61	0.57	8.22	0.00	0.0
4	1.51742	13.27	3.62	1.24	73.08	0.55	8.07	0.00	0.0
...	...	...	...	...	...	...	...	...	...
209	1.51623	14.14	0.00	2.88	72.61	0.08	9.18	1.06	0.0
210	1.51685	14.92	0.00	1.99	73.06	0.00	8.40	1.59	0.0
211	1.52065	14.36	0.00	2.02	73.42	0.00	8.44	1.64	0.0
212	1.51651	14.38	0.00	1.94	73.61	0.00	8.48	1.57	0.0
213	1.51711	14.23	0.00	2.08	73.36	0.00	8.62	1.67	0.0

214 rows × 9 columns

Filter method

In [94]:
```
data_class['Fe'].unique()
```

Out[94]:
```
array([0.  , 0.26, 0.11, 0.24, 0.17, 0.07, 0.19, 0.14, 0.22, 0.06, 0.3 ,
       0.16, 0.1 , 0.09, 0.31, 0.03, 0.12, 0.32, 0.15, 0.2 , 0.34, 0.28,
       0.08, 0.29, 0.21, 0.18, 0.25, 0.35, 0.37, 0.51, 0.05, 0.01])
```

In [95]:
```
data_class['RI'].unique()
```

Out[95]:
```
array([1.52101, 1.51761, 1.51618, 1.51766, 1.51742, 1.51596, 1.51743,
       1.51756, 1.51918, 1.51755, 1.51571, 1.51763, 1.51589, 1.51748,
       1.51784, 1.52196, 1.51911, 1.51735, 1.5175 , 1.51966, 1.51736,
       1.51751, 1.5172 , 1.51764, 1.51793, 1.51721, 1.51768, 1.51747,
       1.51775, 1.51753, 1.51783, 1.51567, 1.51909, 1.51797, 1.52213,
       1.51779, 1.5221 , 1.51786, 1.519  , 1.51869, 1.52667, 1.52223,
       1.51898, 1.5232 , 1.51926, 1.51808, 1.51837, 1.51778, 1.51769,
       1.51215, 1.51824, 1.51754, 1.51905, 1.51977, 1.52172, 1.52227,
       1.52099, 1.52152, 1.523  , 1.51574, 1.51848, 1.51593, 1.51631,
       1.5159 , 1.51645, 1.51627, 1.51613, 1.51592, 1.51646, 1.51594,
       1.51409, 1.51625, 1.51569, 1.5164 , 1.51841, 1.51605, 1.51588,
       1.51629, 1.5186 , 1.51689, 1.51811, 1.51655, 1.5173 , 1.5182 ,
       1.52725, 1.5241 , 1.52475, 1.53125, 1.53393, 1.52222, 1.51818,
       1.52664, 1.52739, 1.52777, 1.51892, 1.51847, 1.51846, 1.51829,
       1.51708, 1.51673, 1.51652, 1.51844, 1.51663, 1.51687, 1.51707,
       1.52177, 1.51872, 1.51667, 1.52081, 1.52068, 1.5202 , 1.52614,
       1.51813, 1.518  , 1.51789, 1.51806, 1.51711, 1.51674, 1.5169 ,
       1.51851, 1.51662, 1.51709, 1.5166 , 1.51839, 1.5161 , 1.5167 ,
       1.51643, 1.51665, 1.52127, 1.51694, 1.52121, 1.51776, 1.51796,
       1.51832, 1.51934, 1.52211, 1.51514, 1.51915, 1.52171, 1.52151,
       1.51969, 1.51666, 1.51994, 1.52369, 1.51316, 1.51321, 1.52043,
       1.52058, 1.52119, 1.51937, 1.51852, 1.51299, 1.51888, 1.51916,
       1.51115, 1.51131, 1.51838, 1.52315, 1.52247, 1.52365, 1.51602,
       1.51623, 1.51719, 1.51683, 1.51545, 1.51556, 1.51727, 1.51531,
       1.51609, 1.51508, 1.51653, 1.51658, 1.51617, 1.51732, 1.51831,
       1.51685, 1.52065, 1.51651])
```

In [99]:
```
data_copy = data_data.iloc[:, 3:8]
```

In [100]:
```
# удаление константных и псевдоконстантных признаков
selector_fm = VarianceThreshold(threshold = 0.15)
selector_fm.fit(data_copy)
selector_fm.variances_
```

Out[100]:
```
array([0.24810537, 0.59711782, 0.42336657, 2.01590152, 0.24607173])
```

In [101]:
```
selector_fm.transform(data_copy)
```

Out[101]:
```
array([[1.100e+00, 7.178e+01, 6.000e-02, 8.750e+00, 0.000e+00],
       [1.360e+00, 7.273e+01, 4.800e-01, 7.830e+00, 0.000e+00],
       [1.540e+00, 7.299e+01, 3.900e-01, 7.780e+00, 0.000e+00],
       ...,
       [2.020e+00, 7.342e+01, 0.000e+00, 8.440e+00, 1.640e+00],
       [1.940e+00, 7.361e+01, 0.000e+00, 8.480e+00, 1.570e+00],
       [2.080e+00, 7.336e+01, 0.000e+00, 8.620e+00, 1.670e+00]])
```

Была удалена колонка содержания железа.

Wrapper method

In [112]:
```
#Sequential Forward Selection


X = data_data
targ_y = data_targ
```

```
y = np.ravel(targ_y)
feature_names = ('Refractive index', 'Sodium', 'Magnesium', 'Aluminium', 'Silica', 'Potassium', 'Calcium', 'Barium', 'Iron')

knn = KNeighborsClassifier(n_neighbors=4)

sfs1 = SFS(knn,
           k_features=8,
           forward=True,
           floating=False,
           verbose=2,
           scoring='accuracy',
           cv=0)

sfs1 = sfs1.fit(X, y, custom_feature_names=feature_names)
sfs1.subsets_
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   9 out of   9 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 1/8 -- score: 0.6822429906542056[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   8 out of   8 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 2/8 -- score: 0.7476635514018691[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   7 out of   7 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 3/8 -- score: 0.7710280373831776[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   6 out of   6 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 4/8 -- score: 0.8177570093457944[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 5/8 -- score: 0.8177570093457944[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   4 out of   4 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 6/8 -- score: 0.8177570093457944[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   3 out of   3 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 7/8 -- score: 0.8271028037383178[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   2 out of   2 | elapsed:    0.0s finished

[2022-04-06 00:46:44] Features: 8/8 -- score: 0.8364485981308412
```

```
Out[112]:{1: {'feature_idx': (3,),
              'cv_scores': array([0.68224299]),
              'avg_score': 0.6822429906542056,
              'feature_names': ('Aluminium',)},
             2: {'feature_idx': (2, 3),
              'cv_scores': array([0.74766355]),
              'avg_score': 0.7476635514018691,
              'feature_names': ('Magnesium', 'Aluminium')},
             3: {'feature_idx': (2, 3, 6),
              'cv_scores': array([0.77102804]),
              'avg_score': 0.7710280373831776,
              'feature_names': ('Magnesium', 'Aluminium', 'Calcium')},
             4: {'feature_idx': (2, 3, 5, 6),
              'cv_scores': array([0.81775701]),
              'avg_score': 0.8177570093457944,
              'feature_names': ('Magnesium', 'Aluminium', 'Potassium', 'Calcium')},
             5: {'feature_idx': (0, 2, 3, 5, 6),
              'cv_scores': array([0.81775701]),
              'avg_score': 0.8177570093457944,
              'feature_names': ('Refractive index',
               'Magnesium',
               'Aluminium',
               'Potassium',
               'Calcium')},
             6: {'feature_idx': (0, 1, 2, 3, 5, 6),
              'cv_scores': array([0.81775701]),
              'avg_score': 0.8177570093457944,
              'feature_names': ('Refractive index',
               'Sodium',
               'Magnesium',
               'Aluminium',
               'Potassium',
               'Calcium')},
             7: {'feature_idx': (0, 1, 2, 3, 5, 6, 8),
```

```
 'cv_scores': array([0.8271028]),
 'avg_score': 0.8271028037383178,
 'feature_names': ('Refractive index',
  'Sodium',
  'Magnesium',
  'Aluminium',
  'Potassium',
  'Calcium',
  'Iron')},
8: {'feature_idx': (0, 1, 2, 3, 5, 6, 7, 8),
 'cv_scores': array([0.8364486]),
 'avg_score': 0.8364485981308412,
 'feature_names': ('Refractive index',
  'Sodium',
  'Magnesium',
  'Aluminium',
  'Potassium',
  'Calcium',
  'Barium',
  'Iron')}}
```

In [113]:
```
print('Best subset (corresponding names): ', sfs1.k_feature_names_)
```

```
Best subset (corresponding names):  ('Refractive index', 'Sodium', 'Magnesium', 'Aluminium', 'Potassium', 'Calcium', 'Barium', 'Iron')
```

Признак содержания кремния не вошёл в лучшие результаты для модели

Embedded method

Воспользуемся моделью логистической регрессии, поскольку имеем задачу классификации:

In [114]:
```
x_val = X.values.tolist()
```

In [115]:
```
e_lr1 = LogisticRegression(C= 1000, solver='sag', penalty='l2', max_iter = 5300)
e_lr1.fit(x_val, y)
e_lr1.coef_
```

Out[115]:
```
array([[-8.86388536e-02, -1.09019926e+00,  2.09116409e+00,
        -3.76078373e+00,  1.53850398e-01,  2.85248776e-03,
         4.61957399e-01,  7.67171503e-01, -6.96559946e-01],
       [ 1.71548520e-01, -3.15750082e-01,  5.26470743e-01,
        -1.46356660e-01, -7.76262033e-03,  1.39110916e+00,
         5.51582432e-01,  1.17023994e+00,  2.16672392e+00],
       [-2.49241501e-02,  3.53495278e-02,  1.77604756e+00,
        -1.63895777e+00, -1.01393377e-01, -6.54039755e-01,
         5.46529031e-01, -3.44259488e-01,  1.09686489e-01],
       [ 6.61382435e-02, -1.07075727e+00, -9.57281499e-01,
         4.40335077e+00,  6.71671650e-02,  1.92603855e+00,
         3.94878664e-01, -2.42919786e-01, -4.45621283e-01],
       [-1.30922761e-01,  1.69772128e+00, -1.13727199e+00,
         1.70121556e-01, -1.71564241e-01, -3.73898251e+00,
        -7.27391927e-01, -2.56983928e+00, -7.69888213e-01],
       [ 6.79900094e-03,  7.43635810e-01, -2.29912891e+00,
         9.72625843e-01,  5.97026744e-02,  1.07302207e+00,
        -1.22755560e+00,  1.21960711e+00, -3.64340967e-01]])
```

In [117]:
```
#только четыре признака из восьми оказались хорошими!
sel_e_lr1 = SelectFromModel(e_lr1)
sel_e_lr1.fit(x_val, y)
list(zip(feature_names, sel_e_lr1.get_support()))
```

Out[117]:
```
[('Refractive index', False),
 ('Sodium', False),
 ('Magnesium', True),
 ('Aluminium', True),
 ('Silica', False),
 ('Potassium', True),
 ('Calcium', False),
 ('Barium', True),
 ('Iron', False)]
```

Оказались хорошими для модели признаки содержания в стекле магния, алюминия, калия, бария.