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(МГТУ им. Н.Э. Баумана)

ФАКУЛЬТЕТ _____ИНФОРМАТИКА И СИСТЕМЫ УПРАВЛЕНИЯ_____

КАФЕДРА _____СИСТЕМЫ ОБРАБОТКИ ИНФОРМАЦИИ И УПРАВЛЕНИЯ (ИУ5)____

О Т Ч Е Т

Лабораторная работа №3

по дисциплине: Машинное обучение _____

на тему: Обработка пропусков в данных, кодирование категориальных признаков, масштабирование данных.

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2020 г.

Лабораторная работа №3

Обработка пропусков в данных, кодирование категориальных признаков, масштабирование данных.

Мы научимся обрабатывать пропуски в данных для количественных (числовых) и категориальных признаков и масштабировать данные. Также мы научимся преобразовывать категориальные признаки в числовые.

В чем состоит проблема?

- Если в данных есть пропуски, то большинство алгоритмов машинного обучения не будут с ними работать. Даже корреляционная матрица не будет строиться корректно.
- Большинство алгоритмов машинного обучения требуют явного перекодирования категориальных признаков в числовые. Даже если алгоритм не требует этого явно, такое перекодирование возможно стоит попробовать, чтобы повысить качество модели.
- Большинство алгоритмов показывает лучшее качество на масштабированных признаках, в особенности алгоритмы, использующие методы градиентного спуска.

In [1]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.set(style="ticks")
```

Загрузка и первичный анализ данных

Используем данные информации о содержании веществ в воздухе

In [2]:

```
# Будем использовать только обучающую выборку
data = pd.read_csv('Measurement_summary.csv', sep=",")
```

In [3]:

```
# размер набора данных
data.shape
```

Out[3]:

```
(647511, 11)
```

In [4]:

```
# типы колонок
data.dtypes
```

Out[4]:

```
Measurement date     object
Station code          int64
Address              object
Latitude            float64
Longitude           float64
SO2                 float64
NO2                 float64
O3                  float64
CO                  float64
PM10                float64
PM2.5               float64
dtype: object
```

In [5]:

```
# проверим есть ли пропущенные значения
data.isnull().sum()
```

Out[5]:

```
Measurement date      0
Station code          0
Address               0
Latitude              0
Longitude             0
SO2                   0
NO2                   0
O3                    0
CO                    0
PM10                329
PM2.5                 0
dtype: int64
```

In [6]:

```
# Первые 5 строк датасета
data.head()
```

Out[6]:

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO	PM10	I
0	2017-01-01 00:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.059	0.002	1.2	73.0	
1	2017-01-01 01:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.058	0.002	1.2	71.0	
2	2017-01-01 02:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
3	2017-01-01 03:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
4	2017-01-01 04:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.003	0.051	0.002	1.2	69.0	

In [7]:

```
total_count = data.shape[0]
print('Всего строк: {}'.format(total_count))
```

```
Всего строк: 647511
```

1. Обработка пропусков в данных

1.1. Простые стратегии - удаление или заполнение нулями

In [8]:

```
# Удаление колонок, содержащих пустые значения
data_new_1 = data.dropna(axis=1, how='any')
(data.shape, data_new_1.shape)
```

Out[8]:

```
((647511, 11), (647511, 10))
```

In [9]:

```
data_new_1.head()
```

Out[9]:

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO	PM2.5
0	2017-01-01 00:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.059	0.002	1.2	57.0
1	2017-01-01 01:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.058	0.002	1.2	59.0
2	2017-01-01 02:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	59.0
3	2017-01-01 03:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	58.0
4	2017-01-01 04:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.003	0.051	0.002	1.2	61.0

In [10]:

```
# Удаление строк, содержащих пустые значения
data_new_2 = data.dropna(axis=0, how='any')
(data.shape, data_new_2.shape)
```

Out[10]:

```
((647511, 11), (647182, 11))
```

In [11]:

```
data_new_2.head()
```

Out[11]:

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO	PM10	I
0	2017-01-01 00:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.059	0.002	1.2	73.0	
1	2017-01-01 01:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.058	0.002	1.2	71.0	
2	2017-01-01 02:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
3	2017-01-01 03:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
4	2017-01-01 04:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.003	0.051	0.002	1.2	69.0	

In [12]:

```
# Заполнение всех пропущенных значений нулями
# В данном случае это некорректно, так как нулями заполняются в том числе катего
риальные колонки
data_new_3 = data.fillna(0)
data_new_3.head()
```

Out[12]:

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO	PM10	I
0	2017-01-01 00:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.059	0.002	1.2	73.0	
1	2017-01-01 01:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.058	0.002	1.2	71.0	
2	2017-01-01 02:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
3	2017-01-01 03:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
4	2017-01-01 04:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.003	0.051	0.002	1.2	69.0	

1.2. "Внедрение значений" - импьютация (imputation)

1.2.1. Обработка пропусков в числовых данных

In [13]:

```
# Выберем числовые колонки с пропущенными значениями
# Цикл по колонкам датасета
num_cols = []
for col in data.columns:
    # Количество пустых значений
    temp_null_count = data[data[col].isnull()].shape[0]
    dt = str(data[col].dtype)
    if temp_null_count>0 and (dt=='float64' or dt=='int64'):
        num_cols.append(col)
        temp_perc = round((temp_null_count / total_count) * 100.0, 2)
        print('Колонка {}. Тип данных {}. Количество пустых значений {}, {}%.'.f
ormat(col, dt, temp_null_count, temp_perc))
```

```
Колонка PM10. Тип данных float64. Количество пустых значений 329, 0.
05%.
```

In [14]:

```
# Фильтр по колонкам с пропущенными значениями
data_num = data[num_cols]
data_num
```

Out[14]:

	PM10
0	73.0
1	71.0
2	70.0
3	70.0
4	69.0
5	70.0
6	66.0
7	71.0
8	72.0
9	74.0
10	76.0
11	83.0
12	93.0
13	94.0
14	93.0
15	87.0
16	87.0
17	91.0
18	91.0
19	92.0
20	94.0
21	93.0
22	89.0
23	91.0
24	93.0
25	92.0
26	90.0
27	92.0
28	92.0
29	92.0
...	...
647481	54.0
647482	47.0
647483	40.0
647484	35.0
647485	28.0
647486	30.0

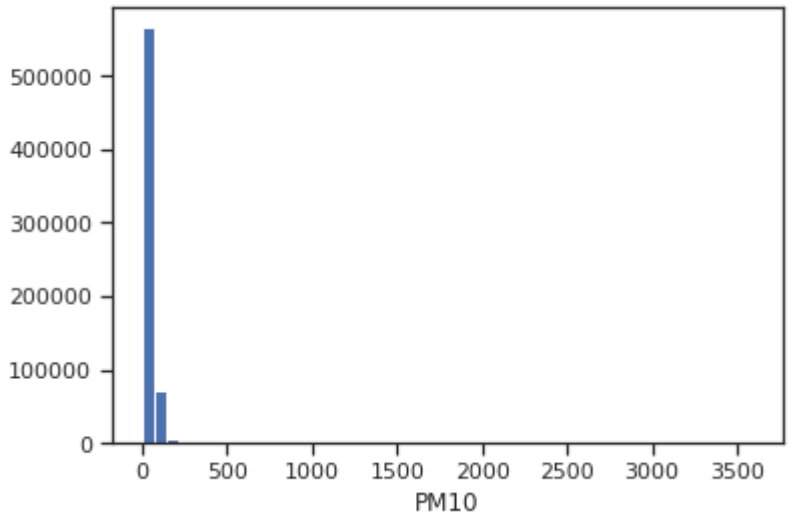
	PM10
647487	43.0
647488	36.0
647489	38.0
647490	43.0
647491	42.0
647492	31.0
647493	28.0
647494	25.0
647495	25.0
647496	20.0
647497	20.0
647498	18.0
647499	19.0
647500	22.0
647501	23.0
647502	24.0
647503	27.0
647504	27.0
647505	24.0
647506	23.0
647507	25.0
647508	24.0
647509	25.0
647510	27.0

647511 rows × 1 columns

In [15]:

```
# Гистограмма по признакам
for col in data_num:
    plt.hist(data[col], 50)
    plt.xlabel(col)
    plt.show()
```

```
/home/mark/.local/lib/python3.7/site-packages/numpy/lib/histograms.p
y:824: RuntimeWarning: invalid value encountered in greater_equal
  keep = (tmp_a >= first_edge)
/home/mark/.local/lib/python3.7/site-packages/numpy/lib/histograms.p
y:825: RuntimeWarning: invalid value encountered in less_equal
  keep &= (tmp_a <= last_edge)
```



In [16]:

```
# Фильтр по пустым значениям поля MasVnrArea
data[data['PM10'].isnull()]
```

Out[16]:

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33421	2017-11-10 04:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.057	0.002	0.8
33422	2017-11-10 05:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.059	0.002	0.8
33423	2017-11-10 06:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.065	0.002	1.0
33424	2017-11-10 07:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.065	0.002	0.9
33425	2017-11-10 08:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.006	0.070	0.003	1.2
33426	2017-11-10 09:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.006	0.071	0.002	1.2
33427	2017-11-10 10:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.006	0.073	0.004	1.0
33428	2017-11-10 11:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.045	0.017	0.7
33429	2017-11-10 12:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.039	0.022	0.6
33430	2017-11-10 13:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.028	0.5
33431	2017-11-10 14:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.027	0.4

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33432	2017-11-10 15:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.030	0.021	0.5
33433	2017-11-10 16:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.026	0.020	0.6
33434	2017-11-10 17:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.019	0.025	0.5
33435	2017-11-10 18:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.022	0.023	0.5
33436	2017-11-10 19:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.030	0.016	0.5
33437	2017-11-10 20:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.023	0.020	0.4
33438	2017-11-10 21:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.014	0.027	0.3
33439	2017-11-10 22:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.015	0.024	0.3
33440	2017-11-10 23:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.014	0.024	0.3
33441	2017-11-11 00:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.014	0.024	0.3
33442	2017-11-11 01:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.012	0.024	0.3
33443	2017-11-11 02:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.010	0.025	0.3

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33444	2017-11-11 03:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.011	0.023	0.3
33445	2017-11-11 04:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.010	0.022	0.3
33446	2017-11-11 05:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.013	0.019	0.3
33447	2017-11-11 06:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.017	0.015	0.3
33448	2017-11-11 07:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.002	0.023	0.010	0.3
33449	2017-11-11 08:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.002	0.020	0.013	0.4
33450	2017-11-11 09:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.002	0.014	0.019	0.3
...	...	...	...	...	...	...	...	...	...
33720	2017-11-22 15:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.029	0.029	0.7
33721	2017-11-22 16:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.028	0.024	0.5
33722	2017-11-22 17:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.018	0.5
33723	2017-11-22 18:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.023	0.020	0.4

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33724	2017-11-22 19:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.017	0.023	0.3
33725	2017-11-22 20:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.019	0.021	0.4
33726	2017-11-22 21:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.019	0.020	0.4
33727	2017-11-22 22:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.019	0.020	0.4
33728	2017-11-22 23:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.018	0.020	0.4
33729	2017-11-23 00:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.017	0.021	0.4
33730	2017-11-23 01:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.015	0.022	0.4
33731	2017-11-23 02:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.012	0.025	0.4
33732	2017-11-23 03:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.012	0.024	0.4
33733	2017-11-23 04:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.013	0.023	0.4
33734	2017-11-23 05:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.008	0.5
33735	2017-11-23 06:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.038	0.002	0.5

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33736	2017-11-23 07:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.041	0.002	0.7
33737	2017-11-23 08:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.040	0.003	0.6
33738	2017-11-23 09:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.040	0.004	0.7
33739	2017-11-23 10:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.040	0.005	0.6
33740	2017-11-23 11:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.016	0.023	0.3
33741	2017-11-23 12:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.009	0.030	0.3
33742	2017-11-23 13:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.009	0.029	0.3
33743	2017-11-23 14:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.011	0.028	0.3
33744	2017-11-23 15:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.013	0.026	0.3
33745	2017-11-23 16:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.016	0.022	0.3
33746	2017-11-23 17:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.027	0.013	0.3
33747	2017-11-23 18:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.031	0.009	0.4

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33748	2017-11-23 19:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.033	0.007	0.4
33749	2017-11-23 20:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.034	0.006	0.4

329 rows × 11 columns

In [17]:

```
# Запоминаем индексы строк с пустыми значениями
flt_index = data[data['PM10'].isnull()].index
flt_index
```

Out[17]:

```
Int64Index([33421, 33422, 33423, 33424, 33425, 33426, 33427, 33428,
33429,
            33430,
            ...
            33740, 33741, 33742, 33743, 33744, 33745, 33746, 33747,
33748,
            33749],
           dtype='int64', length=329)
```

In [18]:

```
# Проверяем что выводятся нужные строки
data[data.index.isin(flt_index)]
```

Out[18]:

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33421	2017-11-10 04:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.057	0.002	0.8
33422	2017-11-10 05:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.059	0.002	0.8
33423	2017-11-10 06:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.065	0.002	1.0
33424	2017-11-10 07:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.065	0.002	0.9
33425	2017-11-10 08:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.006	0.070	0.003	1.2
33426	2017-11-10 09:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.006	0.071	0.002	1.2
33427	2017-11-10 10:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.006	0.073	0.004	1.0
33428	2017-11-10 11:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.045	0.017	0.7
33429	2017-11-10 12:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.039	0.022	0.6
33430	2017-11-10 13:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.028	0.5
33431	2017-11-10 14:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.027	0.4

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33432	2017-11-10 15:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.030	0.021	0.5
33433	2017-11-10 16:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.026	0.020	0.6
33434	2017-11-10 17:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.019	0.025	0.5
33435	2017-11-10 18:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.022	0.023	0.5
33436	2017-11-10 19:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.030	0.016	0.5
33437	2017-11-10 20:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.023	0.020	0.4
33438	2017-11-10 21:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.014	0.027	0.3
33439	2017-11-10 22:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.015	0.024	0.3
33440	2017-11-10 23:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.014	0.024	0.3
33441	2017-11-11 00:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.014	0.024	0.3
33442	2017-11-11 01:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.012	0.024	0.3
33443	2017-11-11 02:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.010	0.025	0.3

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33444	2017-11-11 03:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.011	0.023	0.3
33445	2017-11-11 04:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.010	0.022	0.3
33446	2017-11-11 05:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.013	0.019	0.3
33447	2017-11-11 06:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.017	0.015	0.3
33448	2017-11-11 07:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.002	0.023	0.010	0.3
33449	2017-11-11 08:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.002	0.020	0.013	0.4
33450	2017-11-11 09:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.002	0.014	0.019	0.3
...	...	...	...	...	...	...	...	...	...
33720	2017-11-22 15:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.029	0.029	0.7
33721	2017-11-22 16:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.005	0.028	0.024	0.5
33722	2017-11-22 17:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.018	0.5
33723	2017-11-22 18:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.023	0.020	0.4

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33724	2017-11-22 19:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.017	0.023	0.3
33725	2017-11-22 20:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.019	0.021	0.4
33726	2017-11-22 21:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.019	0.020	0.4
33727	2017-11-22 22:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.019	0.020	0.4
33728	2017-11-22 23:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.018	0.020	0.4
33729	2017-11-23 00:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.017	0.021	0.4
33730	2017-11-23 01:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.015	0.022	0.4
33731	2017-11-23 02:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.012	0.025	0.4
33732	2017-11-23 03:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.012	0.024	0.4
33733	2017-11-23 04:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.013	0.023	0.4
33734	2017-11-23 05:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.029	0.008	0.5
33735	2017-11-23 06:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.038	0.002	0.5

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33736	2017-11-23 07:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.041	0.002	0.7
33737	2017-11-23 08:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.040	0.003	0.6
33738	2017-11-23 09:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.040	0.004	0.7
33739	2017-11-23 10:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.040	0.005	0.6
33740	2017-11-23 11:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.016	0.023	0.3
33741	2017-11-23 12:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.004	0.009	0.030	0.3
33742	2017-11-23 13:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.009	0.029	0.3
33743	2017-11-23 14:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.011	0.028	0.3
33744	2017-11-23 15:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.013	0.026	0.3
33745	2017-11-23 16:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.016	0.022	0.3
33746	2017-11-23 17:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.027	0.013	0.3
33747	2017-11-23 18:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.031	0.009	0.4

	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO
33748	2017-11-23 19:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.033	0.007	0.4
33749	2017-11-23 20:00	102	15, Deoksugung-gil, Jung-gu, Seoul, Republic o...	37.564263	126.974676	0.003	0.034	0.006	0.4

329 rows × 11 columns

In [19]:

```
# фильтр по колонке
data_num[data_num.index.isin(flt_index)]['PM10']
```

Out[19]:

```
33421   NaN
33422   NaN
33423   NaN
33424   NaN
33425   NaN
33426   NaN
33427   NaN
33428   NaN
33429   NaN
33430   NaN
33431   NaN
33432   NaN
33433   NaN
33434   NaN
33435   NaN
33436   NaN
33437   NaN
33438   NaN
33439   NaN
33440   NaN
33441   NaN
33442   NaN
33443   NaN
33444   NaN
33445   NaN
33446   NaN
33447   NaN
33448   NaN
33449   NaN
33450   NaN
         ..
33720   NaN
33721   NaN
33722   NaN
33723   NaN
33724   NaN
33725   NaN
33726   NaN
33727   NaN
33728   NaN
33729   NaN
33730   NaN
33731   NaN
33732   NaN
33733   NaN
33734   NaN
33735   NaN
33736   NaN
33737   NaN
33738   NaN
33739   NaN
33740   NaN
33741   NaN
33742   NaN
33743   NaN
33744   NaN
33745   NaN
33746   NaN
33747   NaN
```

```
33748   NaN
33749   NaN
Name: PM10, Length: 329, dtype: float64
```

Будем использовать встроенные средства импьютации библиотеки scikit-learn - https://scikit-learn.org/stable/modules/impute.html#impute (https://scikit-learn.org/stable/modules/impute.html#impute)

In [20]:

```
data_num_PM10 = data_num[['PM10']]
data_num_PM10.head()
```

Out[20]:

	PM10
0	73.0
1	71.0
2	70.0
3	70.0
4	69.0

In [21]:

```
from sklearn.impute import SimpleImputer
from sklearn.impute import MissingIndicator
```

In [22]:

```
# Фильтр для проверки заполнения пустых значений
indicator = MissingIndicator()
mask_missing_values_only = indicator.fit_transform(data_num_PM10)
mask_missing_values_only
```

Out[22]:

```
array([[False],
       [False],
       [False],
       ...,
       [False],
       [False],
       [False]])
```

С помощью класса SimpleImputer (https://scikit-learn.org/stable/modules/generated/sklearn.impute.SimpleImputer.html#sklearn.impute.SimpleImputer) можно проводить импьютацию различными показателями центра распределения (https://ru.wikipedia.org/wiki/%D0%9F%D0%BE%D0%BA%D0%B0%D0%B7%D0%B0%D1%82%D0%B5%D0

In [23]:

```
strategies=['mean', 'median','most_frequent']
```

In [24]:

```
def test_num_impute(strategy_param):
    imp_num = SimpleImputer(strategy=strategy_param)
    data_num_imp = imp_num.fit_transform(data_num_PM10)
    return data_num_imp[mask_missing_values_only]
```

In [25]:

```
strategies[0], test_num_impute(strategies[0])
```

Out[25]:

```
('mean',
 array([43.71126206, 43.71126206, 43.71126206, 43.71126206, 43.71126
206,
        43.71126206, 43.71126206, 43.71126206, 43.71126206, 43.71126
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          43.71126206, 43.71126206, 43.71126206, 43.71126206, 43.71126
   206,
          43.71126206, 43.71126206, 43.71126206, 43.71126206, 43.71126
   206,
          43.71126206, 43.71126206, 43.71126206, 43.71126206]))
```

In [26]:

```
strategies[1], test_num_impute(strategies[1])
```

Out[26]:

```
('median',
 array([35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
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        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35., 35.,
35.,
        35., 35., 35., 35.]))
```

In [27]:

```
strategies[2], test_num_impute(strategies[2])
```

Out[27]:

```
('most_frequent',
 array([27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27., 27.,
27.,
        27., 27., 27., 27.]))
```

In [28]:

```
# Более сложная функция, которая позволяет задавать колонку и вид импьютации
def test_num_impute_col(dataset, column, strategy_param):
    temp_data = dataset[[column]]

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

    imp_num = SimpleImputer(strategy=strategy_param)
    data_num_imp = imp_num.fit_transform(temp_data)

    filled_data = data_num_imp[mask_missing_values_only]

    return column, strategy_param, filled_data.size, filled_data[0], filled_data
[filled_data.size-1]
```

In [29]:

```
data[['PM10']].describe()
```

Out[29]:

	PM10
count	647182.000000
mean	43.711262
std	71.153913
min	-1.000000
25%	22.000000
50%	35.000000
75%	53.000000
max	3586.000000

In [30]:

```
test_num_impute_col(data, 'PM10', strategies[0])
```

Out[30]:

```
('PM10', 'mean', 329, 43.711262056114045, 43.711262056114045)
```

In [31]:

```
test_num_impute_col(data, 'PM10', strategies[1])
```

Out[31]:

```
('PM10', 'median', 329, 35.0, 35.0)
```

In [32]:

```
test_num_impute_col(data, 'PM10', strategies[2])
```

Out[32]:

```
('PM10', 'most_frequent', 329, 27.0, 27.0)
```

1.2.2. Обработка пропусков в категориальных данных

In [35]:

```
# Будем использовать только обучающую выборку
data = pd.read_csv('battles.csv', sep=",")
```

In [60]:

```
data.head()
```

Out[60]:

	name	year	battle_number	attacker_king	defender_king	attacker_1	attacker_2	d
0	Battle of the Golden Tooth	298	1	Joffrey/Tommen Baratheon	Robb Stark	Lannister	NaN	
1	Battle at the Mummer's Ford	298	2	Joffrey/Tommen Baratheon	Robb Stark	Lannister	NaN	
2	Battle of Riverrun	298	3	Joffrey/Tommen Baratheon	Robb Stark	Lannister	NaN	
3	Battle of the Green Fork	298	4	Robb Stark	Joffrey/Tommen Baratheon	Stark	NaN	
4	Battle of the Whispering Wood	298	5	Robb Stark	Joffrey/Tommen Baratheon	Stark	Tully	

In [36]:

```
# Выберем категориальные колонки с пропущенными значениями
# Цикл по колонкам датасета
cat_cols = []
for col in data.columns:
    # Количество пустых значений
    temp_null_count = data[data[col].isnull()].shape[0]
    dt = str(data[col].dtype)
    if temp_null_count>0 and (dt=='object'):
        cat_cols.append(col)
        temp_perc = round((temp_null_count / total_count) * 100.0, 2)
        print('Колонка {}. Тип данных {}. Количество пустых значений {}, {}%.'.f
ormat(col, dt, temp_null_count, temp_perc))
```

```
Колонка attacker_king. Тип данных object. Количество пустых значений
2, 0.0%.
Колонка defender_king. Тип данных object. Количество пустых значений
3, 0.0%.
Колонка attacker_2. Тип данных object. Количество пустых значений 2
8, 0.0%.
Колонка defender_1. Тип данных object. Количество пустых значений 1,
0.0%.
Колонка battle_type. Тип данных object. Количество пустых значений 1
8, 0.0%.
Колонка attacker_commander. Тип данных object. Количество пустых зна
чений 1, 0.0%.
Колонка location. Тип данных object. Количество пустых значений 1,
0.0%.
```

Какие из этих колонок Вы бы выбрали или не выбрали для построения модели?

In [37]:

```
cat_temp_data = data[['battle_type']]
cat_temp_data.head()
```

Out[37]:

	battle_type
0	pitched battle
1	ambush
2	pitched battle
3	pitched battle
4	ambush

In [38]:

```
cat_temp_data['battle_type'].unique()
```

Out[38]:

```
array(['pitched battle', 'ambush', 'siege', nan, 'razing'], dtype=ob
ject)
```

In [39]:

```
cat_temp_data[cat_temp_data['battle_type'].isnull()].shape
```

Out[39]:

```
(18, 1)
```

In [40]:

```
# Импьютация наиболее частыми значениями
imp2 = SimpleImputer(missing_values=np.nan, strategy='most_frequent')
data_imp2 = imp2.fit_transform(cat_temp_data)
data_imp2
```

Out[40]:

```
array([['pitched battle'],
       ['ambush'],
       ['pitched battle'],
       ['pitched battle'],
       ['ambush'],
       ['ambush'],
       ['pitched battle'],
       ['pitched battle'],
       ['siege'],
       ['ambush'],
       ['pitched battle'],
       ['ambush'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
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       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['pitched battle'],
       ['razing'],
       ['siege'],
       ['siege'],
       ['siege'],
       ['siege']], dtype=object)
```

In [41]:

```
# Пустые значения отсутствуют
np.unique(data_imp2)
```

Out[41]:

```
array(['ambush', 'pitched battle', 'razing', 'siege'], dtype=object)
```

In [42]:

```
# Импьютация константой
imp3 = SimpleImputer(missing_values=np.nan, strategy='constant', fill_value=
'!!!!')
data_imp3 = imp3.fit_transform(cat_temp_data)
data_imp3
```

Out[42]:

```
array([['pitched battle'],
       ['ambush'],
       ['pitched battle'],
       ['pitched battle'],
       ['ambush'],
       ['ambush'],
       ['pitched battle'],
       ['pitched battle'],
       ['siege'],
       ['ambush'],
       ['pitched battle'],
       ['ambush'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['!!!!'],
       ['pitched battle'],
       ['pitched battle'],
       ['razing'],
       ['siege'],
       ['siege'],
       ['siege'],
       ['siege']], dtype=object)
```

In [43]:

```
np.unique(data_imp3)
```

Out[43]:

```
array(['!!!', 'ambush', 'pitched battle', 'razing', 'siege'], dtype=
object)
```

In [44]:

```
data_imp3[data_imp3=='!!!'].size
```

Out[44]:

18

2. Преобразование категориальных признаков в числовые

In [45]:

```
cat_enc = pd.DataFrame({'c1':data_imp2.T[0]})
cat_enc
```

Out[45]:

	c1
0	pitched battle
1	ambush
2	pitched battle
3	pitched battle
4	ambush
5	ambush
6	pitched battle
7	pitched battle
8	siege
9	ambush
10	pitched battle
11	ambush
12	pitched battle
13	pitched battle
14	pitched battle
15	pitched battle
16	pitched battle
17	pitched battle
18	pitched battle
19	pitched battle
20	pitched battle
21	pitched battle
22	pitched battle
23	pitched battle
24	pitched battle
25	pitched battle
26	pitched battle
27	pitched battle
28	pitched battle
29	pitched battle
30	pitched battle
31	pitched battle
32	razing
33	siege
34	siege
35	siege
36	siege

2.1. Кодирование категорий целочисленными значениями - label encoding (https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.LabelE

In [46]:

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
```

In [47]:

```
le = LabelEncoder()
cat_enc_le = le.fit_transform(cat_enc['c1'])
```

In [48]:

```
cat_enc['c1'].unique()
```

Out[48]:

```
array(['pitched battle', 'ambush', 'siege', 'razing'], dtype=object)
```

In [49]:

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

Out[49]:

```
array([0, 1, 2, 3])
```

In [50]:

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

Out[50]:

```
array(['ambush', 'pitched battle', 'razing', 'siege'], dtype=object)
```

2.2. Кодирование категорий наборами бинарных значений - one-hot encoding (https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.OneHo

In [51]:

```
ohe = OneHotEncoder()
cat_enc_ohe = ohe.fit_transform(cat_enc[['c1']])
```

In [52]:

```
cat_enc.shape
```

Out[52]:

```
(37, 1)
```

In [53]:

```
cat_enc_ohe.shape
```

Out[53]:

```
(37, 4)
```

In [54]:

```
cat_enc_ohe
```

Out[54]:

```
<37x4 sparse matrix of type '<class 'numpy.float64'>'
        with 37 stored elements in Compressed Sparse Row format>
```

In [55]:

```
cat_enc_ohe.todense()[0:10]
```

Out[55]:

```
matrix([[0., 1., 0., 0.],
        [1., 0., 0., 0.],
        [0., 1., 0., 0.],
        [0., 1., 0., 0.],
        [1., 0., 0., 0.],
        [1., 0., 0., 0.],
        [0., 1., 0., 0.],
        [0., 1., 0., 0.],
        [0., 0., 0., 1.],
        [1., 0., 0., 0.]])
```

In [56]:

```
cat_enc.head(10)
```

Out[56]:

	c1
0	pitched battle
1	ambush
2	pitched battle
3	pitched battle
4	ambush
5	ambush
6	pitched battle
7	pitched battle
8	siege
9	ambush

2.3. Pandas get_dummies (https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.get_dummies.html) - быстрый вариант one-hot кодирования

In [57]:

```
pd.get_dummies(cat_enc).head()
```

Out[57]:

	c1_ambush	c1_pitched battle	c1_razing	c1_siege
0	0	1	0	0
1	1	0	0	0
2	0	1	0	0
3	0	1	0	0
4	1	0	0	0

In [58]:

```
pd.get_dummies(cat_temp_data, dummy_na=True).head()
```

Out[58]:

	battle_type_ambush	battle_type_pitched battle	battle_type_razing	battle_type_siege	battle_type_
0	0	1	0	0	
1	1	0	0	0	
2	0	1	0	0	
3	0	1	0	0	
4	1	0	0	0	

In [ ]:

```

```

3. Масштабирование данных

Термины "масштабирование" и "нормализация" часто используются как синонимы. Масштабирование предполагает изменение диапазона измерения величины, а нормализация - изменение распределения этой величины.

Если признаки лежат в различных диапазонах, то необходимо их нормализовать. Как правило, применяют два подхода:

- MinMax масштабирование:

$$x_{\text{новый}} = \frac{x_{\text{старый}} - min(X)}{max(X) - min(X)}$$

В этом случае значения лежат в диапазоне от 0 до 1.

- Масштабирование данных на основе Z-оценки (https://ru.wikipedia.org/wiki/Z-%D0%BE%D1%86%D0%B5%D0%BD%D0%BA%D0%B0):

$$x_{\text{новый}} = \frac{x_{\text{старый}} - AVG(X)}{\sigma(X)}$$

В этом случае большинство значений попадает в диапазон от -3 до 3.

где X - матрица объект-признак, $AVG(X)$ - среднее значение, σ - среднеквадратичное отклонение.

In [59]:

```
from sklearn.preprocessing import MinMaxScaler, StandardScaler, Normalizer
```

3.1. MinMax масштабирование (https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.MinMa

In [67]:

```
data = pd.read_csv('Measurement_summary.csv', sep=",")
data.head()
```

Out[67]:

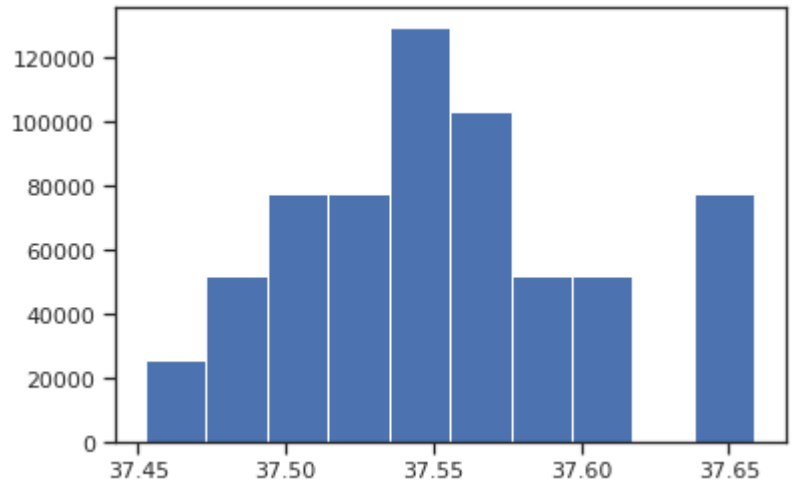
	Measurement date	Station code	Address	Latitude	Longitude	SO2	NO2	O3	CO	PM10	I
0	2017-01-01 00:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.059	0.002	1.2	73.0	
1	2017-01-01 01:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.058	0.002	1.2	71.0	
2	2017-01-01 02:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
3	2017-01-01 03:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.004	0.056	0.002	1.2	70.0	
4	2017-01-01 04:00	101	19, Jong-ro 35ga-gil, Jongno-gu, Seoul, Republ...	37.572016	127.005007	0.003	0.051	0.002	1.2	69.0	

In [68]:

```
sc1 = MinMaxScaler()
sc1_data = sc1.fit_transform(data[['PM2.5']])
```

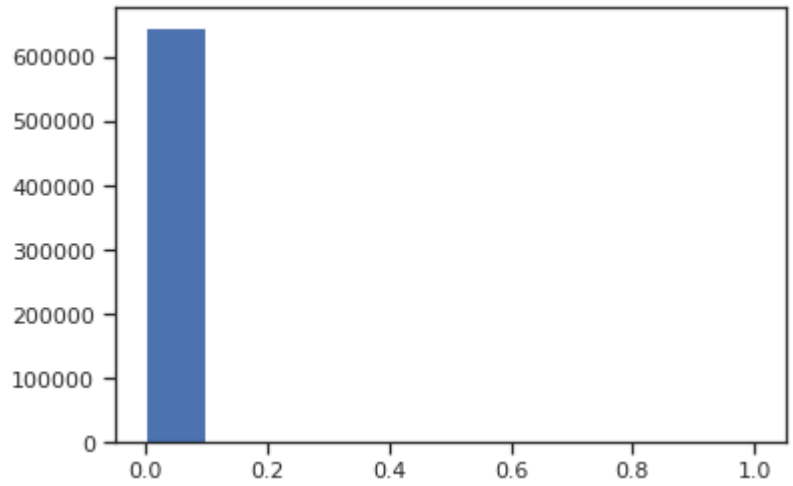
In [76]:

```
plt.hist(data['Latitude'], 10)
plt.show()
```



In [77]:

```
plt.hist(sc1_data, 10)
plt.show()
```



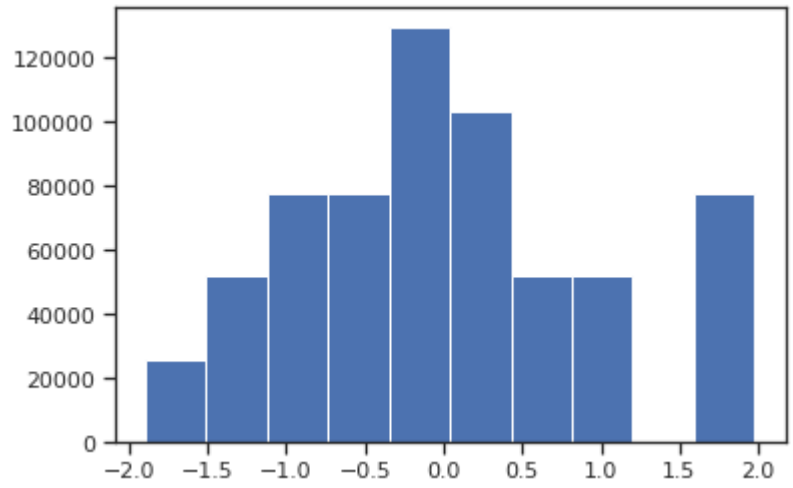
3.2. Масштабирование данных на основе Z-оценки (https://ru.wikipedia.org/wiki/Z-%D0%BE%D1%86%D0%B5%D0%BD%D0%BA%D0%B0) - StandardScaler (https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.Standa

In [81]:

```
sc2 = StandardScaler()
sc2_data = sc2.fit_transform(data[['Latitude']])
```

In [82]:

```
plt.hist(sc2_data, 10)
plt.show()
```



3.3. Нормализация данных (https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.Norma

In [83]:

```
sc3 = Normalizer()
sc3_data = sc3.fit_transform(data[['Latitude']])
```

In [84]:

```
plt.hist(sc3_data, 10)
plt.show()
```