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Факультет «Информатика и системы управления»

Кафедра «Системы обработки информации и управления»

Отчет по лабораторной работе № 2

по дисциплине «Технология машинного обучения»

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Задание:

1. Выбрать набор данных (датасет), содержащий категориальные признаки и пропуски в данных. Для выполнения следующих пунктов можно использовать несколько различных наборов данных (один для обработки пропусков, другой для категориальных признаков и т.д.)
2. Для выбранного датасета (датасетов) на основе материалов лекции решить следующие задачи:
    a. обработку пропусков в данных;
    b. кодирование категориальных признаков;
    c. масштабирование данных.

Текст программы:

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

```
from google.colab import drive

drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

```
data = pd.read_csv('/content/drive/My Drive/datasets/significant earthquakes.csv', sep=",")
```

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

```
(23412, 21)
```

```
# типы колонок
data.dtypes
```

```
Date                        object
Time                        object
Latitude                   float64
Longitude                  float64
Type                        object
Depth                      float64
Depth Error                float64
Depth Seismic Stations     float64
Magnitude                  float64
Magnitude Type              object
Magnitude Error            float64
Magnitude Seismic Stations float64
Azimuthal Gap              float64
Horizontal Distance        float64
Horizontal Error           float64
Root Mean Square           float64
ID                          object
Source                      object
Location Source             object
Magnitude Source            object
Status                      object
dtype: object
```

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

```
Date                           0
Time                           0
Latitude                       0
Longitude                      0
Type                           0
Depth                          0
Depth Error                18951
Depth Seismic Stations     16315
Magnitude                      0
Magnitude Type                 3
Magnitude Error            23085
Magnitude Seismic Stations 20848
Azimuthal Gap              16113
Horizontal Distance        21808
Horizontal Error           22256
Root Mean Square            6060
ID                             0
Source                         0
Location Source                0
Magnitude Source               0
Status                         0
dtype: int64
```

```
data.head()
```

	Date	Time	Latitude	Longitude	Type	Depth	Depth Error	Depth Seismic Stations	Magnitude	Magnitude Type	...	Magnitude Seismic Stations	Azimuthal Gap	Horiz Dis
0	01/02/1965	13:44:18	19.246	145.616	Earthquake	131.6	NaN	NaN	6.0	MW	...	NaN	NaN	
1	01/04/1965	11:29:49	1.863	127.352	Earthquake	80.0	NaN	NaN	5.8	MW	...	NaN	NaN	
2	01/05/1965	18:05:58	-20.579	-173.972	Earthquake	20.0	NaN	NaN	6.2	MW	...	NaN	NaN	
3	01/08/1965	18:49:43	-59.076	-23.557	Earthquake	15.0	NaN	NaN	5.8	MW	...	NaN	NaN	
4	01/09/1965	13:32:50	11.938	126.427	Earthquake	15.0	NaN	NaN	5.8	MW	...	NaN	NaN	

5 rows × 21 columns

Обработка пропусков данных

Удаление

```
# Удаление колонок, содержащих пустые значения
data_clear_columns = data.dropna(axis=1, how='any')
print("Было колонок:", data.shape[1])
print("Осталось колонок:", data_clear_columns.shape[1])
```

```
Было колонок: 21
Осталось колонок: 12
```

```
# Удаление строк, содержащих пустые значения
data_clean_rows = data.dropna(axis=0, how='any')
print("Было строк:", data.shape[0])
print("Осталось строк:", data_clean_rows.shape[0])
```

```
Было строк: 23412
Осталось строк: 14
```

Заполнение 0

```
data.head()
```

	Date	Time	Latitude	Longitude	Type	Depth	Depth Error	Depth Seismic Stations	Magnitude	Magnitude Type	...	Magnitude Seismic Stations	Azimuthal Gap	Horiz Dis
0	01/02/1965	13:44:18	19.246	145.616	Earthquake	131.6	NaN	NaN	6.0	MW	...	NaN	NaN	
1	01/04/1965	11:29:49	1.863	127.352	Earthquake	80.0	NaN	NaN	5.8	MW	...	NaN	NaN	
2	01/05/1965	18:05:58	-20.579	-173.972	Earthquake	20.0	NaN	NaN	6.2	MW	...	NaN	NaN	
3	01/08/1965	18:49:43	-59.076	-23.557	Earthquake	15.0	NaN	NaN	5.8	MW	...	NaN	NaN	
4	01/09/1965	13:32:50	11.938	126.427	Earthquake	15.0	NaN	NaN	5.8	MW	...	NaN	NaN	

5 rows × 21 columns

```
# Заполнение всех пропущенных значений нулями
data_filled_with_zeros = data.fillna(0)
data_filled_with_zeros.head()
```

	Date	Time	Latitude	Longitude	Type	Depth	Depth Error	Depth Seismic Stations	Magnitude	Magnitude Type	...	Magnitude Seismic Stations	Azimuthal Gap	Horiz Dis
0	01/02/1965	13:44:18	19.246	145.616	Earthquake	131.6	0.0	0.0	6.0	MW	...	0.0	0.0	
1	01/04/1965	11:29:49	1.863	127.352	Earthquake	80.0	0.0	0.0	5.8	MW	...	0.0	0.0	
2	01/05/1965	18:05:58	-20.579	-173.972	Earthquake	20.0	0.0	0.0	6.2	MW	...	0.0	0.0	
3	01/08/1965	18:49:43	-59.076	-23.557	Earthquake	15.0	0.0	0.0	5.8	MW	...	0.0	0.0	
4	01/09/1965	13:32:50	11.938	126.427	Earthquake	15.0	0.0	0.0	5.8	MW	...	0.0	0.0	

5 rows × 21 columns

Внедрение значений

Числовые значения

```
import pandas as pd

num_cols = []
total_count = data.shape[0]
missing_data = []

for col in data.columns:
    temp_null_count = data[col].isnull().sum()
    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)
        missing_data.append([col, dt, temp_null_count, temp_perc])

missing_df = pd.DataFrame(missing_data, columns=['Название', 'Тип', 'Количество пропусков', 'Процент пропусков'])

missing_df
```

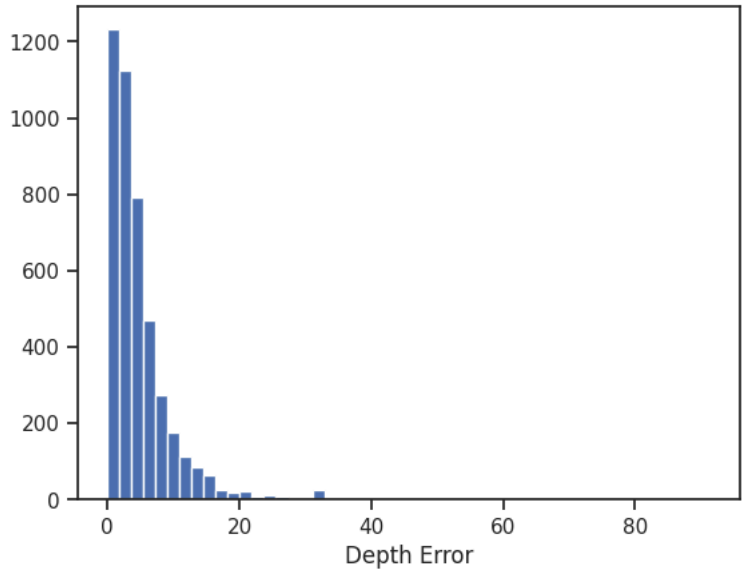
	Название	Тип	Количество пропусков	Процент пропусков
0	Depth Error	float64	18951	80.95
1	Depth Seismic Stations	float64	16315	69.69
2	Magnitude Error	float64	23085	98.60
3	Magnitude Seismic Stations	float64	20848	89.05
4	Azimuthal Gap	float64	16113	68.82
5	Horizontal Distance	float64	21808	93.15
6	Horizontal Error	float64	22256	95.06
7	Root Mean Square	float64	6060	25.88

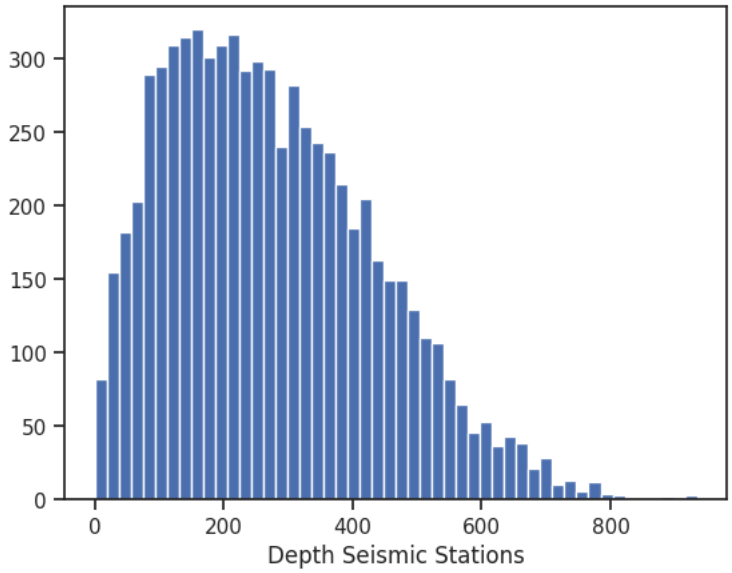
```
# Фильтр по колонкам с пропущенными значениями
data_num = data[num_cols]
data_num
```

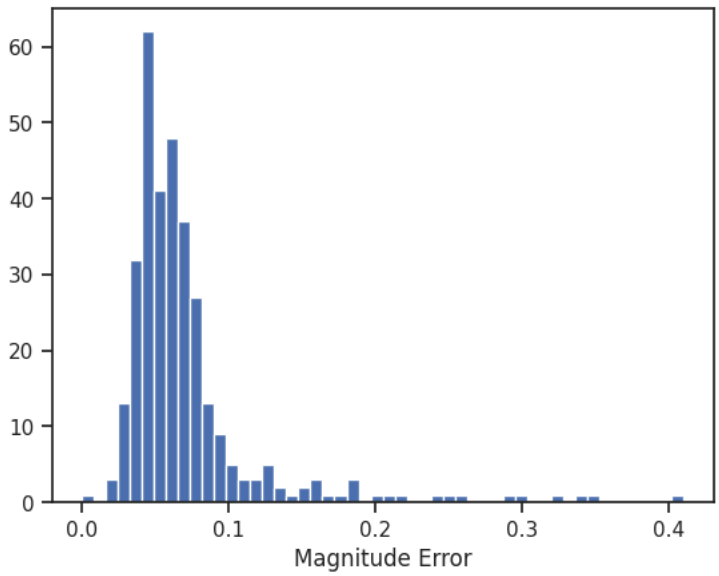
	Depth Error	Depth Seismic Stations	Magnitude Error	Magnitude Seismic Stations	Azimuthal Gap	Horizontal Distance	Horizontal Error	Root Mean Square
0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
3	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
4	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...
23407	1.2	40.0	0.320	18.0	42.47	0.120	NaN	0.1898
23408	2.0	33.0	0.260	18.0	48.58	0.129	NaN	0.2187
23409	1.8	NaN	NaN	NaN	91.00	0.992	4.8	1.5200
23410	1.8	NaN	NaN	NaN	26.00	3.553	6.0	1.4300
23411	2.2	NaN	0.029	428.0	97.00	0.681	4.5	0.9100

23412 rows × 8 columns

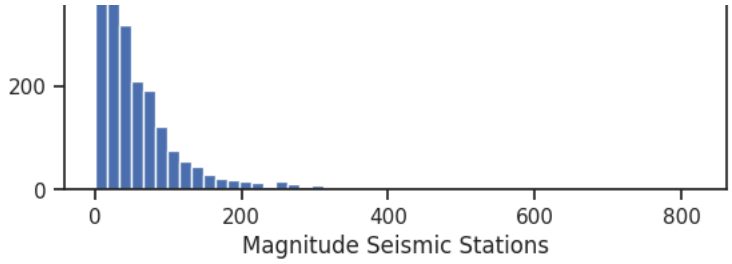
```
# Гистограмма по признакам
for col in data_num:
    plt.hist(data[col], 50)
    plt.xlabel(col)
    plt.show()
```

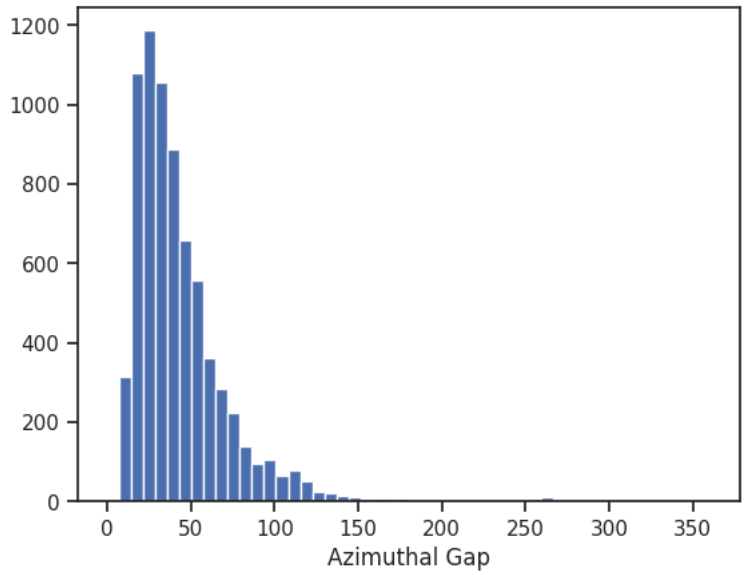

1200
1000
800
600
400
200
0
0
20
40
60
80
Depth Error

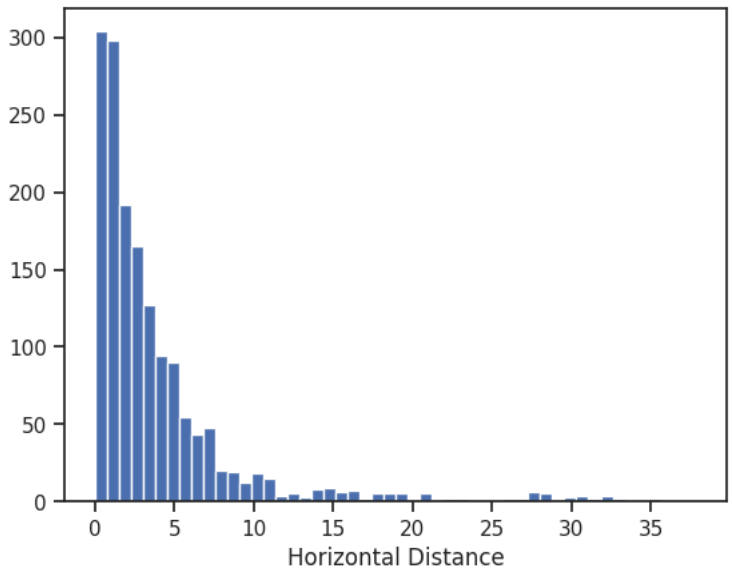

300
250
200
150
100
50
0
0
200
400
600
800
Depth Seismic Stations

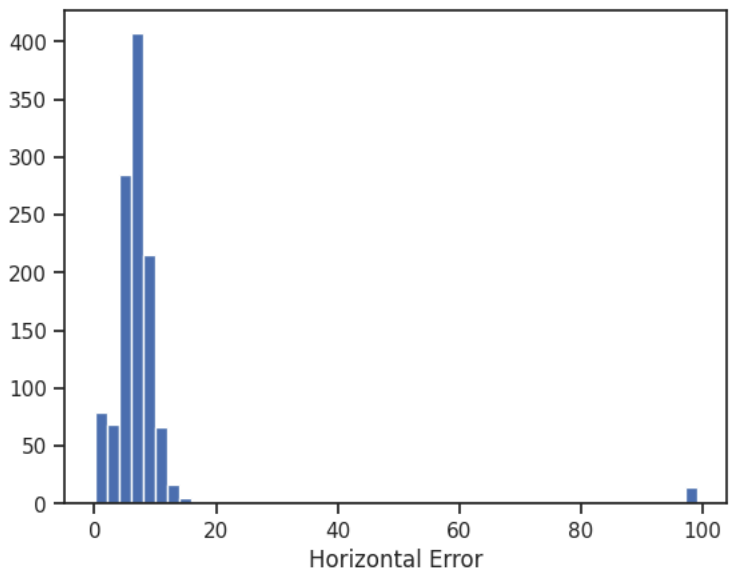

60
50
40
30
20
10
0
0.0
0.1
0.2
0.3
0.4
Magnitude Error


800
600
400

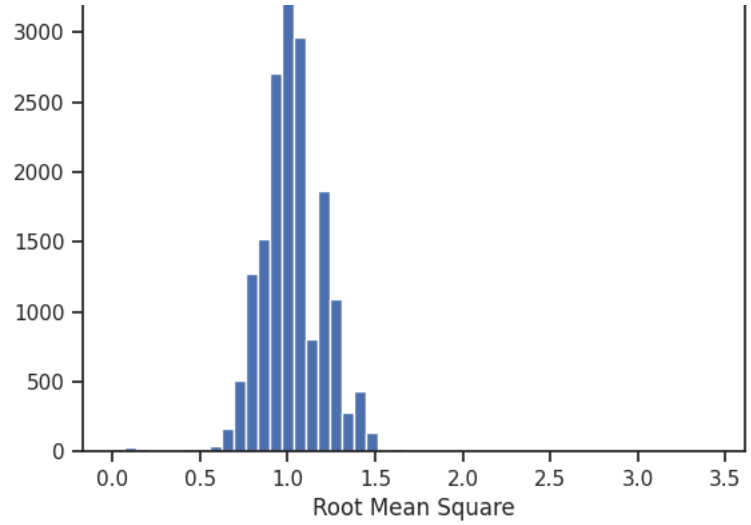

200
0
0
200
400
600
800
Magnitude Seismic Stations


1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
350
Azimuthal Gap


300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
Horizontal Distance


400
350
300
250
200
150
100
50
0
0
20
40
60
80
100
Horizontal Error


3500




```
data_num_DSS = data_num[['Depth Seismic Stations']]
data_num_DSS.head()
```

	Depth Seismic Stations
0	NaN
1	NaN
2	NaN
3	NaN
4	NaN

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


indicator = MissingIndicator()
mask_missing_values_only = indicator.fit_transform(data_num_DSS)
mask_missing_values_only
```

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

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


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


for strategy in strategies:
  print(strategy, test_num_impute(strategy))
```

```
mean [275.36409751 275.36409751 275.36409751 ... 275.36409751 275.36409751
 275.36409751]
median [255. 255. 255. ... 255. 255. 255.]
most_frequent [0. 0. 0. ... 0. 0. 0.]
```

```
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]
```

```
data[['Magnitude Seismic Stations']].describe()
```

	Magnitude Seismic Stations
count	2564.000000
mean	48.944618
std	62.943106
min	0.000000
25%	10.000000
50%	28.000000
75%	66.000000
max	821.000000

```
for strategy in strategies:
  print(test_num_impute_col(data, 'Magnitude Seismic Stations', strategy))
```

```
('Magnitude Seismic Stations', 'mean', 20848, 48.94461778471139, 48.94461778471139)
('Magnitude Seismic Stations', 'median', 20848, 28.0, 28.0)
('Magnitude Seismic Stations', 'most_frequent', 20848, 1.0, 1.0)
```

Категориальные значения

```
import pandas as pd

num_cols = []
total_count = data.shape[0]
missing_data = []

for col in data.columns:
    temp_null_count = data[col].isnull().sum()
    dt = str(data[col].dtype)
    if temp_null_count > 0 and (dt == 'object'):
        num_cols.append(col)
        temp_perc = round((temp_null_count / total_count) * 100.0, 2)
        missing_data.append([col, dt, temp_null_count, temp_perc])

missing_df = pd.DataFrame(missing_data, columns=['Название', 'Тип', 'Количество пропусков', 'Процент пропусков'])

missing_df
```

	Название	Тип	Количество пропусков	Процент пропусков
0	Magnitude Type	object	3	0.01

```
cat_temp_data = data[['Magnitude Type']]
cat_temp_data.head()
```

	Magnitude Type
0	MW
1	MW
2	MW
3	MW
4	MW

```
cat_temp_data['Magnitude Type'].unique()
```

```
array(['MW', 'ML', 'MH', 'MS', 'MB', 'MWC', 'MD', nan, 'MWB', 'MWW',
       'MWR'], dtype=object)
```

```
cat_temp_data[cat_temp_data['Magnitude Type'].isnull()].shape
```

```
(3, 1)
```

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

```
array(['MB', 'MD', 'MH', 'ML', 'MS', 'MW', 'MWB', 'MWC', 'MWR', 'MWW'],
      dtype=object)
```

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

```
array(['MB', 'MD', 'MH', 'ML', 'MS', 'MW', 'MWB', 'MWC', 'MWR', 'MWW',
       'NA'], dtype=object)
```

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

```
3
```

Преобразование категориальный признаков в числовые

```
data.select_dtypes(include='object')
```

	Date	Time	Type	Magnitude Type	ID	Source	Location Source	Magnitude Source	Status
0	01/02/1965	13:44:18	Earthquake	MW	ISCGEM860706	ISCGEM	ISCGEM	ISCGEM	Automatic
1	01/04/1965	11:29:49	Earthquake	MW	ISCGEM860737	ISCGEM	ISCGEM	ISCGEM	Automatic
2	01/05/1965	18:05:58	Earthquake	MW	ISCGEM860762	ISCGEM	ISCGEM	ISCGEM	Automatic
3	01/08/1965	18:49:43	Earthquake	MW	ISCGEM860856	ISCGEM	ISCGEM	ISCGEM	Automatic
4	01/09/1965	13:32:50	Earthquake	MW	ISCGEM860890	ISCGEM	ISCGEM	ISCGEM	Automatic
...	...	...	...	...	...	...	...	...	...
23407	12/28/2016	08:22:12	Earthquake	ML	NN00570710	NN	NN	NN	Reviewed
23408	12/28/2016	09:13:47	Earthquake	ML	NN00570744	NN	NN	NN	Reviewed
23409	12/28/2016	12:38:51	Earthquake	MWW	US10007NAF	US	US	US	Reviewed
23410	12/29/2016	22:30:19	Earthquake	MWW	US10007NL0	US	US	US	Reviewed
23411	12/30/2016	20:08:28	Earthquake	MB	US10007NTD	US	US	US	Reviewed

23412 rows × 9 columns

LabelEcoder

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

	Magnitude Type
0	MW
1	MW
2	MW
3	MW
4	MW
...	...
23407	ML
23408	ML
23409	MWW
23410	MWW
23411	MB

23412 rows × 1 columns

```
cat_enc['Magnitude Type'].unique()
```

```
array(['MW', 'ML', 'MH', 'MS', 'MB', 'MWC', 'MD', 'MWB', 'MWW', 'MWR'],
      dtype=object)
```

```
from sklearn.preprocessing import LabelEncoder


le = LabelEncoder()
cat_enc_le = le.fit_transform(cat_enc['Magnitude Type'])


cat_enc_le
```

```
array([5, 5, 5, ..., 9, 9, 0])
```

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

```
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
# Обратная кодировка
le.inverse_transform([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

```
array(['MB', 'MD', 'MH', 'ML', 'MS', 'MW', 'MWB', 'MWC', 'MWR', 'MWW'],
      dtype=object)
```

OrdinalEcoder

```
from sklearn.preprocessing import OrdinalEncoder


data_oe = data[['Type', 'Status']]
data_oe.head()
```

	Type	Status
0	Earthquake	Automatic
1	Earthquake	Automatic
2	Earthquake	Automatic
3	Earthquake	Automatic
4	Earthquake	Automatic

```
# Импьютация константой
imp4 = SimpleImputer(missing_values=np.nan, strategy='constant', fill_value='NA')
data_oe_filled = imp4.fit_transform(data_oe)
data_oe_filled
```

```
array([['Earthquake', 'Automatic'],
       ['Earthquake', 'Automatic'],
       ['Earthquake', 'Automatic'],
       ...,
       ['Earthquake', 'Reviewed'],
       ['Earthquake', 'Reviewed'],
       ['Earthquake', 'Reviewed']], dtype=object)
```

```
oe = OrdinalEncoder()
cat_enc_oe = oe.fit_transform(data_oe_filled)
cat_enc_oe
```

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

```
# Уникальные значения 1 признака
np.unique(cat_enc_oe[:, 0])
```

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

```
# Уникальные значения 2 признака
np.unique(cat_enc_oe[:, 1])
```

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

```
# Наименования категорий в соответствии с порядковыми номерами
oe.categories_
```

```
[array(['Earthquake', 'Explosion', 'Nuclear Explosion', 'Rock Burst'],
       dtype=object),
 array(['Automatic', 'Reviewed'], dtype=object)]
```

```
# Обратное преобразование
oe.inverse_transform(cat_enc_oe)
```

```
array([['Earthquake', 'Automatic'],
       ['Earthquake', 'Automatic'],
       ['Earthquake', 'Automatic'],
       ...,
       ['Earthquake', 'Reviewed'],
       ['Earthquake', 'Reviewed'],
       ['Earthquake', 'Reviewed']], dtype=object)
```

Кодирование шкал порядка

```
# В датасете нет подходящих данных
```

One-hot encoding

```
from sklearn.preprocessing import OneHotEncoder
```

```
ohe = OneHotEncoder()
cat_enc_ohe = ohe.fit_transform(data[['Type']])
```

```
data[['Type']].shape
```

```
(23412, 1)
```

```
cat_enc_ohe.shape
```

```
(23412, 4)
```

```
cat_enc_ohe
```

```
<23412x4 sparse matrix of type '<class 'numpy.float64'>'
        with 23412 stored elements in Compressed Sparse Row format>
```

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

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

Pandas get_dummies

```
pd.get_dummies(data[["Type"]]).head()
```

	Type_Earthquake	Type_Explosion	Type_Nuclear Explosion	Type_Rock Burst
0	1	0	0	0
1	1	0	0	0
2	1	0	0	0
3	1	0	0	0
4	1	0	0	0

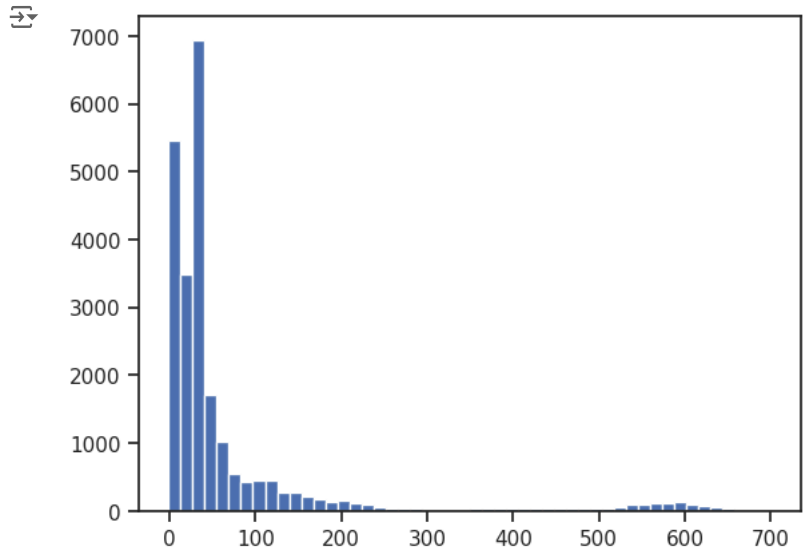
Масштабирование данных

MinMax масштабирование

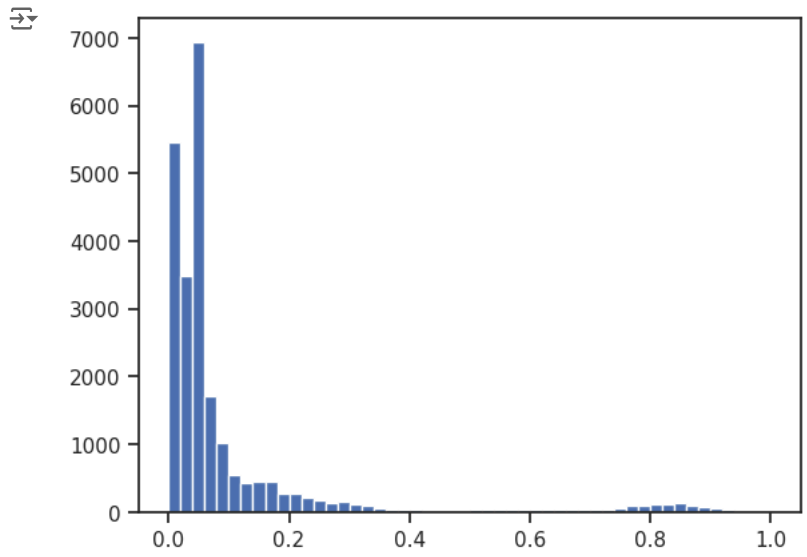
```
from sklearn.preprocessing import MinMaxScaler


sc1 = MinMaxScaler()
sc1_data = sc1.fit_transform(data[['Depth']])


plt.hist(data['Depth'], 50)
plt.show()
```




```
plt.hist(sc1_data, 50)
plt.show()
```

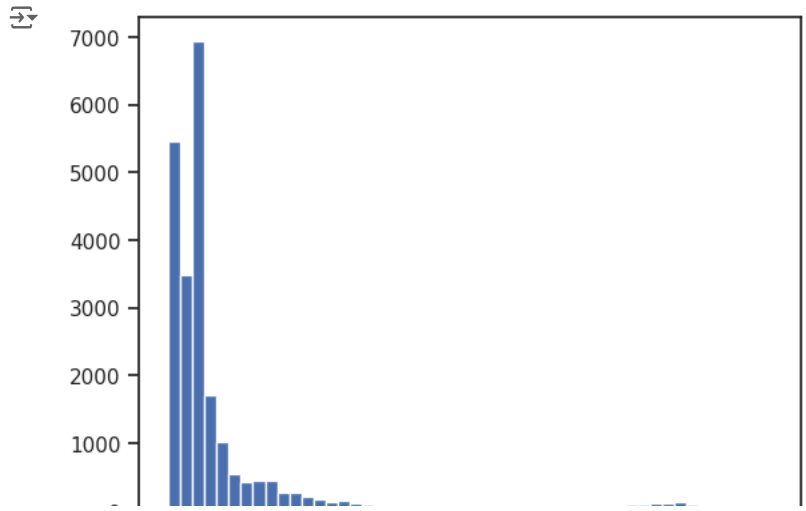


Масштабирование на основе Z-оценки

```
from sklearn.preprocessing import StandardScaler


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


plt.hist(sc2_data, 50)
plt.show()
```


7000
6000
5000
4000
3000
2000
1000