Федеральное государственное бюджетное образовательное учреждение
высшего профессионального образования
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Лабораторные работы №2-3
по курсу «Методы машинного обучения»

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XXXX

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1. Задание

1. Выбрать набор данных (датасет), содержащий категориальные и числовые признаки и пропуски в данных. Для выполнения следующих пунктов можно использовать несколько различных наборов данных (один для обработки пропусков, другой для категориальных признаков и т.д.)

2. Для выбранного датасета (датасетов) на основе материалов лекций решить следующие задачи:

   (a) устранение пропусков в данных

   (b) кодирование категориальных признаков

   (c) нормализация числовых признаков

   (d) масштабирование признаков (не менее чем тремя способами)

   (e) обработку выбросов для числовых признаков (по одному способу для удаления выбросов и для замены выбросов)

   (f) обработку по крайней мере одного нестандартного признака (который не является числовым или категориальным)

   (g) отбор признаков:

      i. один метод из группы методов фильтрации (filter methods)

      ii. один метод из группы методов обертывания (wrapper methods)

      iii. один метод из группы методов вложений (embedded methods)

Загрузка и первичный анализ данных

In [1]:
```python
# Загрузка данных
import pandas as pd
data = pd.read_csv("melbourne_housing.csv.zst")
```

In [2]:
```python
data.shape
```

Out[2]:
```
(34857, 21)
```

In [3]:
```python
data.dtypes
```

Out[3]:
```
Suburb            object
Address           object
Rooms              int64
Type              object
Price            float64
Method            object
SellerG           object
Date              object
Distance         float64
Postcode         float64
Bedroom2         float64
Bathroom         float64
Car              float64
Landsize         float64
BuildingArea     float64
YearBuilt        float64
CouncilArea       object
Lattitude        float64
Longtitude       float64
Regionname        object
Propertycount    float64
dtype: object
```

In [4]:
```python
data.isnull().sum()
```

Out[4]:
```
Suburb               0
Address              0
Rooms                0
Type                 0
Price             7610
Method               0
SellerG              0
Date                 0
Distance             1
Postcode             1
Bedroom2          8217
Bathroom          8226
Car               8728
Landsize         11810
BuildingArea     21115
YearBuilt        19306
CouncilArea          3
Lattitude         7976
Longtitude        7976
Regionname           3
Propertycount        3
dtype: int64
```

In [5]:
```
# Первые 5 строк датасета
data.head()
```

Out[5]:

	Suburb	Address	Rooms	Type	Price	Method	SellerG	Date	Distance	Po
0	Abbotsford	68 Studley St	2	h	NaN	SS	Jellis	3/09/2016	2.5	
1	Abbotsford	85 Turner St	2	h	1480000.0	S	Biggin	3/12/2016	2.5	
2	Abbotsford	25 Bloomburg St	2	h	1035000.0	S	Biggin	4/02/2016	2.5	
3	Abbotsford	18/659 Victoria St	3	u	NaN	VB	Rounds	4/02/2016	2.5	
4	Abbotsford	5 Charles St	3	h	1465000.0	SP	Biggin	4/03/2017	2.5	

5 rows × 21 columns

Обработка пропусков в данных

Простые стратегии - удаление или заполнение нулями

In [6]:
```
# Удаление колонок, содержащих пустые значения
(data.shape, data.dropna(axis=1, how='any').shape)
```

Out[6]: ((34857, 21), (34857, 7))

In [7]:
```
# Удаление строк, содержащих пустые значения
(data.shape, data.dropna(axis=0, how='any').shape)
```

Out[7]: ((34857, 21), (8887, 21))

In [8]:
```
# Заполнение всех пропущенных значений нулями
# В данном случае это некорректно, так как нулями заполняются в том числе
display(data.head(), data.fillna(0).head())
```

	Suburb	Address	Rooms	Type	Price	Method	SellerG	Date	Distance	Po
0	Abbotsford	68 Studley St	2	h	NaN	SS	Jellis	3/09/2016	2.5	
1	Abbotsford	85 Turner St	2	h	1480000.0	S	Biggin	3/12/2016	2.5	
2	Abbotsford	25 Bloomburg St	2	h	1035000.0	S	Biggin	4/02/2016	2.5	
3	Abbotsford	18/659 Victoria St	3	u	NaN	VB	Rounds	4/02/2016	2.5	
4	Abbotsford	5 Charles St	3	h	1465000.0	SP	Biggin	4/03/2017	2.5	

5 rows × 21 columns

	Suburb	Address	Rooms	Type	Price	Method	SellerG	Date	Distance	Po
0	Abbotsford	68 Studley St	2	h	0.0	SS	Jellis	3/09/2016	2.5	
1	Abbotsford	85 Turner St	2	h	1480000.0	S	Biggin	3/12/2016	2.5	
2	Abbotsford	25 Bloomburg St	2	h	1035000.0	S	Biggin	4/02/2016	2.5	
3	Abbotsford	18/659 Victoria St	3	u	0.0	VB	Rounds	4/02/2016	2.5	
4	Abbotsford	5 Charles St	3	h	1465000.0	SP	Biggin	4/03/2017	2.5	

5 rows × 21 columns

"Внедрение значений" - импьютация (imputation)

In [9]:
```
# Выберем числовые колонки с пропущенными значениями
# Цикл по колонкам датасета
num_cols = []
lines = data.shape[0]
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' or dt == '
    num_cols.append(col)
    temp_perc = round((temp_null_count / lines) * 100.0, 2)
    print('Колонка {}. Тип данных {}. Количество пустых значений {}, {}%.
```

```
Колонка Price. Тип данных float64. Количество пустых значений 7610, 21.8
3%.
Колонка Distance. Тип данных float64. Количество пустых значений 1, 0.0%.
Колонка Postcode. Тип данных float64. Количество пустых значений 1, 0.0%.
Колонка Bedroom2. Тип данных float64. Количество пустых значений 8217, 2
3.57%.
Колонка Bathroom. Тип данных float64. Количество пустых значений 8226, 2
3.6%.
Колонка Car. Тип данных float64. Количество пустых значений 8728, 25.04%.
Колонка Landsize. Тип данных float64. Количество пустых значений 11810, 3
3.88%.
Колонка BuildingArea. Тип данных float64. Количество пустых значений 2111
5, 60.58%.
Колонка YearBuilt. Тип данных float64. Количество пустых значений 19306,
55.39%.
Колонка CouncilArea. Тип данных object. Количество пустых значений 3, 0.0
1%.
Колонка Lattitude. Тип данных float64. Количество пустых значений 7976, 2
2.88%.
Колонка Longtitude. Тип данных float64. Количество пустых значений 7976,
22.88%.
Колонка Regionname. Тип данных object. Количество пустых значений 3, 0.0
1%.
Колонка Propertycount. Тип данных float64. Количество пустых значений 3,
0.01%.
```

In [10]:
```
# Фильтр по колонкам с пропущенными значениями
data_num = data[num_cols]
data_num
```

Out[10]:

	Price	Distance	Postcode	Bedroom2	Bathroom	Car	Landsize	BuildingArea
0	NaN	2.5	3067.0	2.0	1.0	1.0	126.0	NaN
1	1480000.0	2.5	3067.0	2.0	1.0	1.0	202.0	NaN
2	1035000.0	2.5	3067.0	2.0	1.0	0.0	156.0	79.0
3	NaN	2.5	3067.0	3.0	2.0	1.0	0.0	NaN
4	1465000.0	2.5	3067.0	3.0	2.0	0.0	134.0	150.0
...	...	...	...	...	...	...	...	...
34852	1480000.0	6.3	3013.0	4.0	1.0	3.0	593.0	NaN
34853	888000.0	6.3	3013.0	2.0	2.0	1.0	98.0	104.0
34854	705000.0	6.3	3013.0	2.0	1.0	2.0	220.0	120.0
34855	1140000.0	6.3	3013.0	NaN	NaN	NaN	NaN	NaN
34856	1020000.0	6.3	3013.0	2.0	1.0	0.0	250.0	103.0

34857 rows × 14 columns

In [11]:
```python
from sklearn.impute import SimpleImputer
from sklearn.impute import MissingIndicator

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_
```

In [12]:
```python
display(data[['Price']].describe())
display(test_num_impute_col(data, 'Price', 'mean'))
display(test_num_impute_col(data, 'Price', 'median'))
```

	Price
count	2.724700e+04
mean	1.050173e+06
std	6.414671e+05
min	8.500000e+04
25%	6.350000e+05
50%	8.700000e+05
75%	1.295000e+06
max	1.120000e+07

```
('Price', 'mean', 7610, 1050173.344955408, 1050173.344955408)
('Price', 'median', 7610, 870000.0, 870000.0)
```

In [13]:
```python
display(data[['Distance']].describe())
display(test_num_impute_col(data, 'Distance', 'mean'))
display(test_num_impute_col(data, 'Distance', 'median'))
```

	Distance
count	34856.000000
mean	11.184929
std	6.788892
min	0.000000
25%	6.400000
50%	10.300000
75%	14.000000
max	48.100000

```
('Distance', 'mean', 1, 11.18492942391554, 11.18492942391554)
('Distance', 'median', 1, 10.3, 10.3)
```

Обработка пропусков в категориальных данных

In [14]:
```
# Выберем категориальные колонки с пропущенными значениями
# Цикл по колонкам датасета
cat_cols = []
lines = data.shape[0]
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 / lines) * 100.0, 2)
    print('Колонка {}. Тип данных {}. Количество пустых значений {}, {}%.
```

```
Колонка CouncilArea. Тип данных object. Количество пустых значений 3, 0.0
1%.
Колонка Regionname. Тип данных object. Количество пустых значений 3, 0.0
1%.
```

In [15]:
```
# Удаление строк, содержащих пустые значения
(data.shape, data.dropna(axis=0, how='any', subset=['CouncilArea', 'Regio
```

Out[15]:
```
((34857, 21), (34854, 21))
```

In [16]:
```
data['CouncilArea'].unique()
```

Out[16]:
```
array(['Yarra City Council', 'Moonee Valley City Council',
       'Port Phillip City Council', 'Darebin City Council',
       'Hobsons Bay City Council', 'Stonnington City Council',
       'Boroondara City Council', 'Monash City Council',
       'Glen Eira City Council', 'Whitehorse City Council',
       'Maribyrnong City Council', 'Bayside City Council',
       'Moreland City Council', 'Manningham City Council',
       'Melbourne City Council', 'Banyule City Council',
       'Brimbank City Council', 'Kingston City Council',
       'Hume City Council', 'Knox City Council', 'Maroondah City Council
',
       'Casey City Council', 'Melton City Council',
       'Greater Dandenong City Council', 'Nillumbik Shire Council',
       'Cardinia Shire Council', 'Whittlesea City Council',
       'Frankston City Council', 'Macedon Ranges Shire Council',
       'Yarra Ranges Shire Council', 'Wyndham City Council',
       'Moorabool Shire Council', 'Mitchell Shire Council', nan],
      dtype=object)
```

In [17]:
```
import numpy as np

# Импьютация наиболее частыми значениями
most_frequent_imputed = SimpleImputer(
  missing_values=np.nan,
  strategy='most_frequent'
).fit_transform(data[['CouncilArea']])

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

```
Out[17]: array(['Banyule City Council', 'Bayside City Council',
       'Boroondara City Council', 'Brimbank City Council',
       'Cardinia Shire Council', 'Casey City Council',
       'Darebin City Council', 'Frankston City Council',
       'Glen Eira City Council', 'Greater Dandenong City Council',
       'Hobsons Bay City Council', 'Hume City Council',
       'Kingston City Council', 'Knox City Council',
       'Macedon Ranges Shire Council', 'Manningham City Council',
       'Maribyrnong City Council', 'Maroondah City Council',
       'Melbourne City Council', 'Melton City Council',
       'Mitchell Shire Council', 'Monash City Council',
       'Moonee Valley City Council', 'Moorabool Shire Council',
       'Moreland City Council', 'Nillumbik Shire Council',
       'Port Phillip City Council', 'Stonnington City Council',
       'Whitehorse City Council', 'Whittlesea City Council',
       'Wyndham City Council', 'Yarra City Council',
       'Yarra Ranges Shire Council'], dtype=object)
```

```
In [18]: # Импьютация константой
const_imputed = SimpleImputer(
  missing_values=np.nan,
  strategy='constant',
  fill_value='NA'
).fit_transform(data[['CouncilArea']])

display(np.unique(const_imputed), const_imputed[const_imputed == 'NA'].si
```

```
array(['Banyule City Council', 'Bayside City Council',
       'Boroondara City Council', 'Brimbank City Council',
       'Cardinia Shire Council', 'Casey City Council',
       'Darebin City Council', 'Frankston City Council',
       'Glen Eira City Council', 'Greater Dandenong City Council',
       'Hobsons Bay City Council', 'Hume City Council',
       'Kingston City Council', 'Knox City Council',
       'Macedon Ranges Shire Council', 'Manningham City Council',
       'Maribyrnong City Council', 'Maroondah City Council',
       'Melbourne City Council', 'Melton City Council',
       'Mitchell Shire Council', 'Monash City Council',
       'Moonee Valley City Council', 'Moorabool Shire Council',
       'Moreland City Council', 'NA', 'Nillumbik Shire Council',
       'Port Phillip City Council', 'Stonnington City Council',
       'Whitehorse City Council', 'Whittlesea City Council',
       'Wyndham City Council', 'Yarra City Council',
       'Yarra Ranges Shire Council'], dtype=object)
3
```

Преобразование категориальных признаков в числовые

```
In [19]: cat_enc = pd.DataFrame({'c1': most_frequent_imputed.T[0]})
cat_enc
```

Out[19]:

	c1
0	Yarra City Council
1	Yarra City Council
2	Yarra City Council
3	Yarra City Council
4	Yarra City Council
...	...
34852	Maribyrnong City Council
34853	Maribyrnong City Council
34854	Maribyrnong City Council
34855	Maribyrnong City Council
34856	Maribyrnong City Council

34857 rows × 1 columns

Кодирование категорий целочисленными значениями - label encoding

In [20]:
```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder

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

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

Out[20]:
```
array(['Yarra City Council', 'Moonee Valley City Council',
       'Port Phillip City Council', 'Darebin City Council',
       'Hobsons Bay City Council', 'Stonnington City Council',
       'Boroondara City Council', 'Monash City Council',
       'Glen Eira City Council', 'Whitehorse City Council',
       'Maribyrnong City Council', 'Bayside City Council',
       'Moreland City Council', 'Manningham City Council',
       'Melbourne City Council', 'Banyule City Council',
       'Brimbank City Council', 'Kingston City Council',
       'Hume City Council', 'Knox City Council', 'Maroondah City Council
',
       'Casey City Council', 'Melton City Council',
       'Greater Dandenong City Council', 'Nillumbik Shire Council',
       'Cardinia Shire Council', 'Whittlesea City Council',
       'Frankston City Council', 'Macedon Ranges Shire Council',
       'Yarra Ranges Shire Council', 'Wyndham City Council',
       'Moorabool Shire Council', 'Mitchell Shire Council'], dtype=objec
t)
```

In [21]:
```
np.unique(cat_enc_le)
```

Out[21]:
```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 1
6,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32])
```

In [22]:
```
le.inverse_transform([0, 1, 2, 3])
```

Out[22]:
```
array(['Banyule City Council', 'Bayside City Council',
       'Boroondara City Council', 'Brimbank City Council'], dtype=object)
```

Кодирование категорий наборами бинарных значений - one-hot encoding

In [23]:
```
ohe = OneHotEncoder()
cat_enc_ohe = ohe.fit_transform(cat_enc[['c1']])

cat_enc.shape
```

Out[23]:
```
(34857, 1)
```

In [24]:
```
cat_enc_ohe.shape
```

Out[24]:
```
(34857, 33)
```

In [25]:
```
cat_enc_ohe
```

Out[25]:
```
<34857x33 sparse matrix of type '<class 'numpy.float64'>'
	with 34857 stored elements in Compressed Sparse Row format>
```

In [26]:
```
for x in cat_enc_ohe.todense()[0:100]:
  print(x)
```

```
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 1. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 0. 0.]]
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[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0.
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  0. 0. 0. 0. 0. 0. 0. 0. 0.]]
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  0. 0. 0. 0. 0. 0. 0. 0. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0.
  0. 0. 0. 0. 0. 0. 0. 0. 0.]]
```

Pandas get_dummies - быстрый вариант one-hot кодирования

In [27]:
```
pd.get_dummies(cat_enc)[0:200]
```

Out[27]:

	c1_Banyule City Council	c1_Bayside City Council	c1_Boroondara City Council	c1_Brimbank City Council	c1_Cardinia Shire Council	c1_Casey City Council	c1_Darel C Cour
0	0	0	0	0	0	0	
1	0	0	0	0	0	0	
2	0	0	0	0	0	0	
3	0	0	0	0	0	0	
4	0	0	0	0	0	0	
...	...	...	...	...	...	...	
195	0	0	0	0	0	0	
196	0	0	0	0	0	0	
197	0	0	0	0	0	0	
198	0	0	0	0	0	0	
199	0	0	0	0	0	0	

200 rows × 33 columns

In [28]:
```
pd.get_dummies(data['CouncilArea'].unique(), dummy_na = True).head()
```

Out[28]:

	Banyule City Council	Bayside City Council	Boroondara City Council	Brimbank City Council	Cardinia Shire Council	Casey City Council	Darebin City Council	Frankston City Council	Glen Eira City Council
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0
4	0	0	0	0	0	0	0	0	0

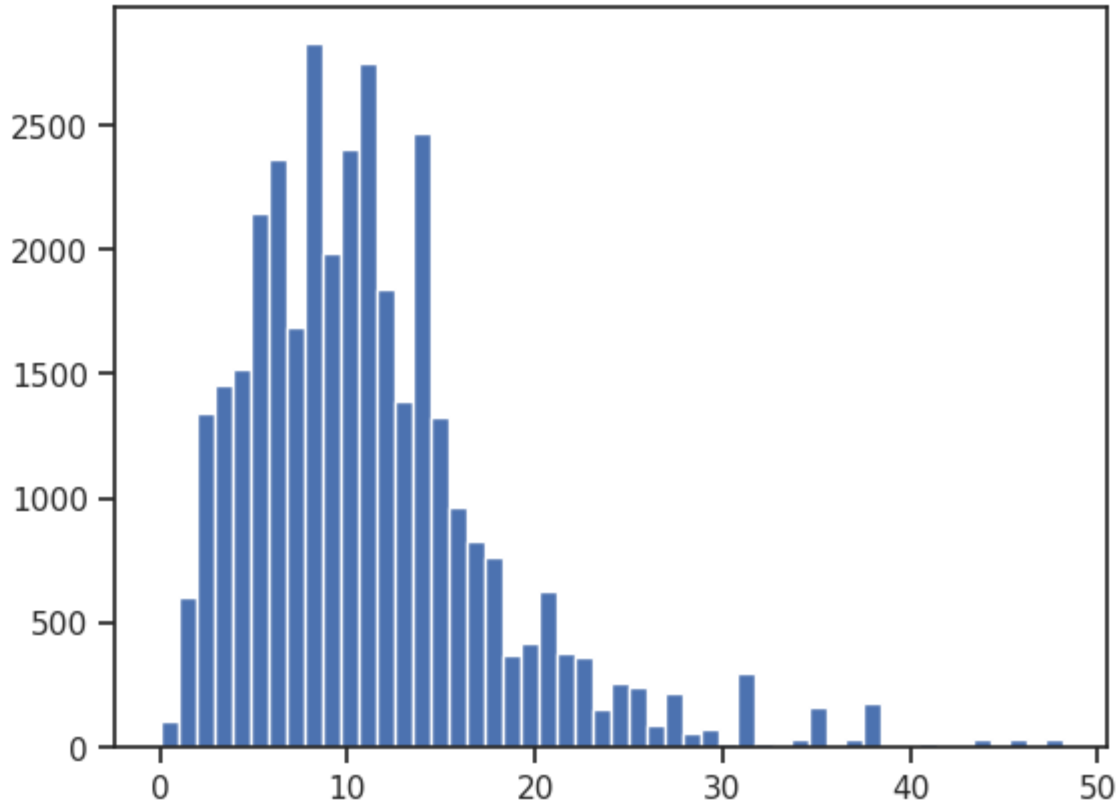
5 rows × 34 columns

Масштабирование данных

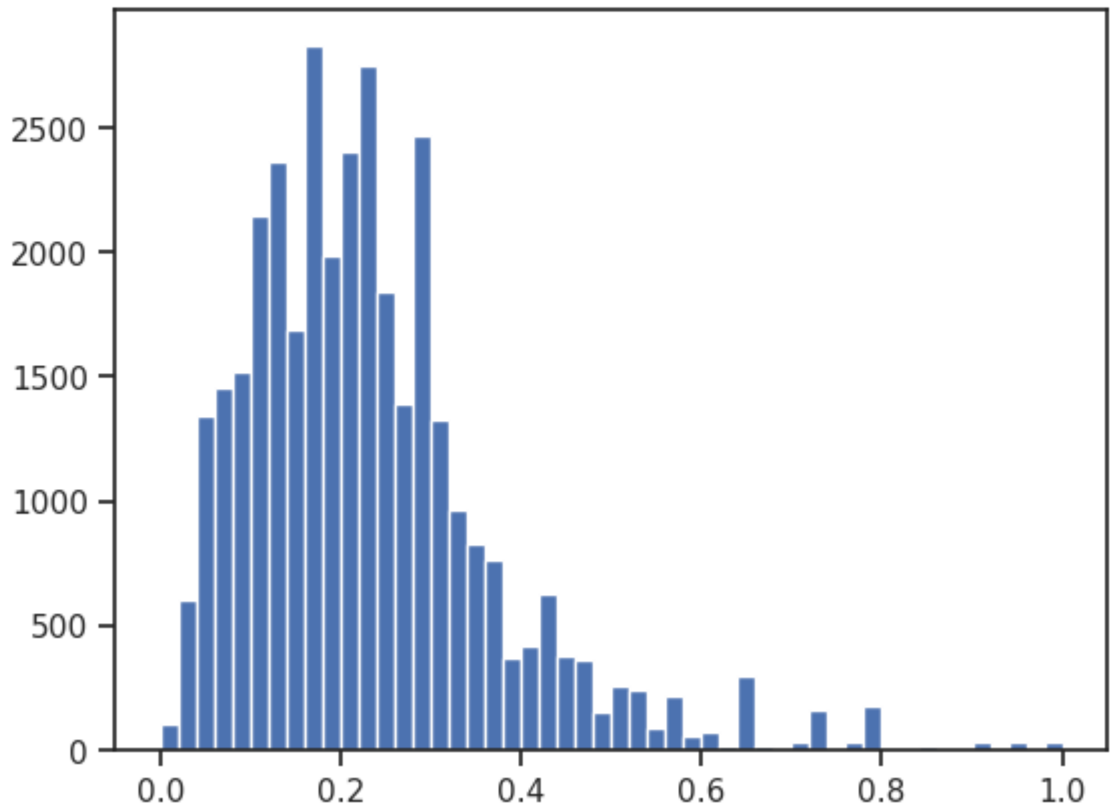
In [29]:
```
from sklearn.preprocessing import MinMaxScaler, StandardScaler, MaxAbsSca
```

MinMax масштабирование

In [30]:
```
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
sns.set(style="ticks")

input = data[['Distance']]
output = MinMaxScaler().fit_transform(input)

plt.hist(input, 50)
plt.show()

plt.hist(output, 50)
plt.show()

display(pd.DataFrame(input).describe())
display(pd.DataFrame(output).describe())
```



0
500
1000
1500
2000
2500
0
10
20
30
40
50



0
500
1000
1500
2000
2500
0.0
0.2
0.4
0.6
0.8
1.0

	Distance
count	34856.000000
mean	11.184929
std	6.788892
min	0.000000
25%	6.400000
50%	10.300000
75%	14.000000
max	48.100000

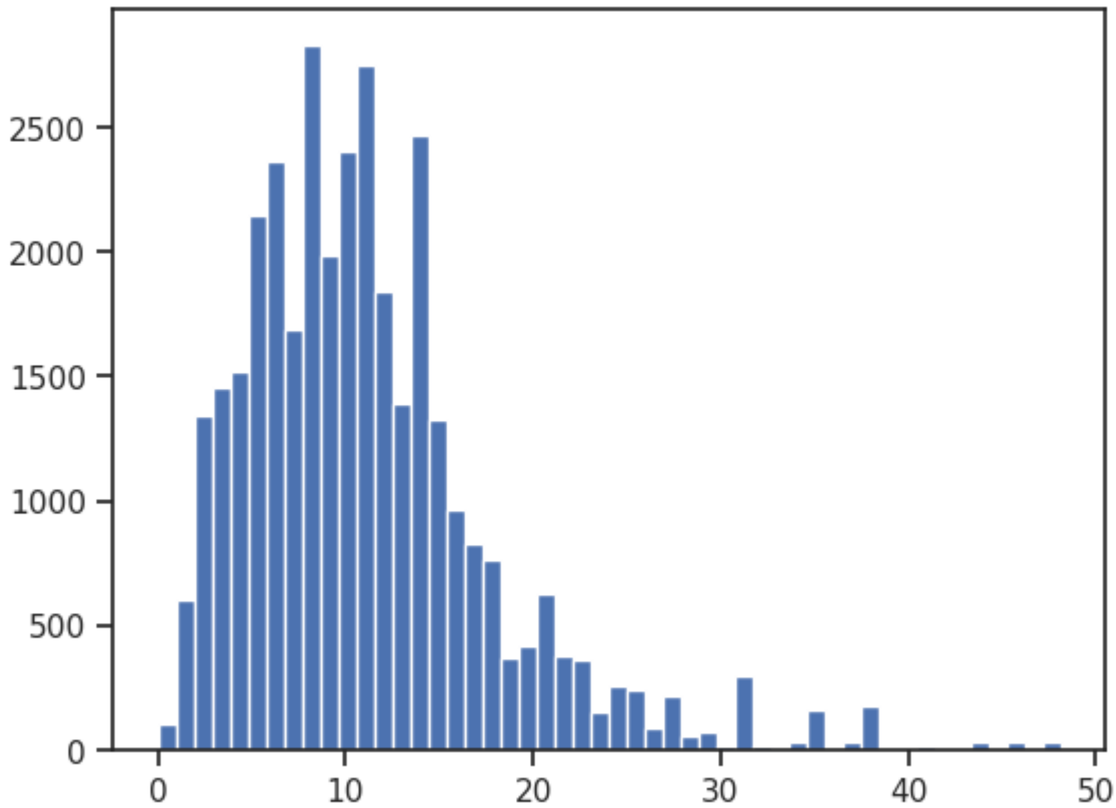
	0
count	34856.000000
mean	0.232535
std	0.141141
min	0.000000
25%	0.133056
50%	0.214137
75%	0.291060
max	1.000000

Особенности метода:

- Среднее значение может варьироваться.
- Среднеквадратичное отклонение может варьироваться.
- Форма исходного распределения может изменяться.
- Максимальные и минимальные значения в диапазоне [0;1].
- Выбросы сохраняются.

Масштабирование данных на основе Z-оценки - StandardScaler

In [31]:
```
input = data[['Distance']]
output = StandardScaler().fit_transform(input)

plt.hist(input, 50)
plt.show()

plt.hist(output, 50)
plt.show()

display(pd.DataFrame(input).describe())
display(pd.DataFrame(output).describe())
```


0
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2000
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0
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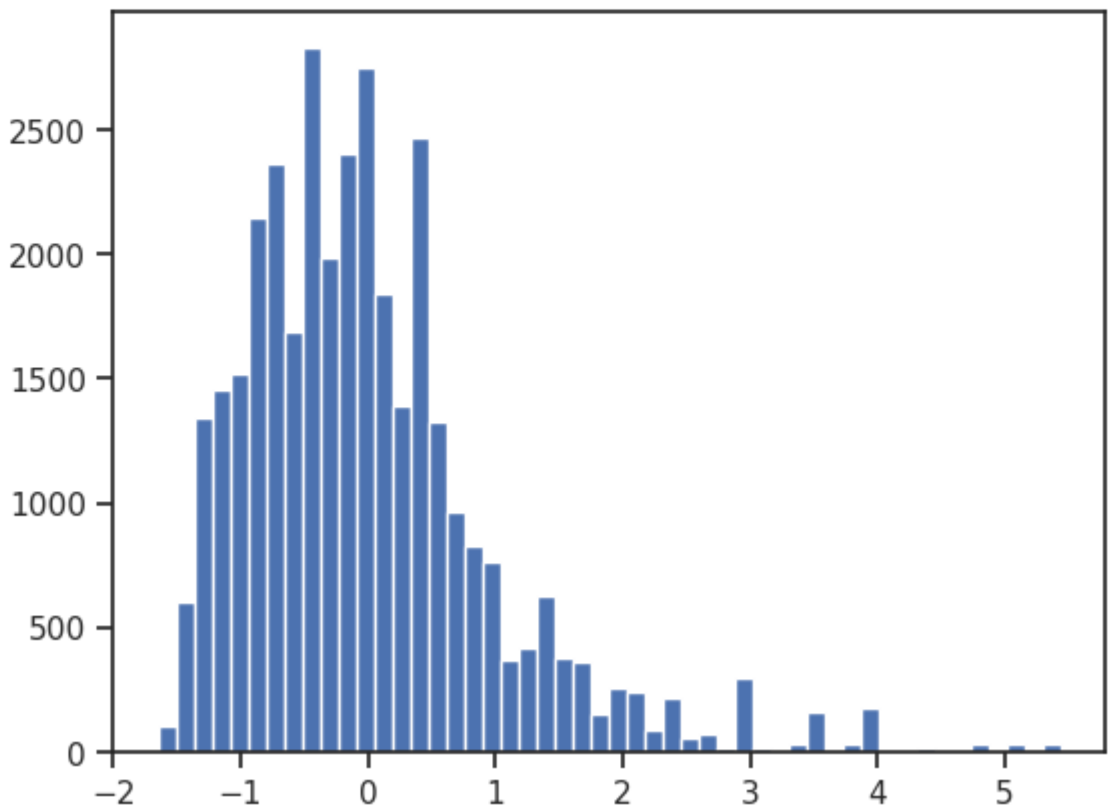
20
30
40
50


0
500
1000
1500
2000
2500
−2
−1
0
1
2
3
4
5

	Distance
count	34856.000000
mean	11.184929
std	6.788892
min	0.000000
25%	6.400000
50%	10.300000
75%	14.000000
max	48.100000

	0
count	3.485600e+04
mean	-1.761272e-16
std	1.000014e+00
min	-1.647557e+00
25%	-7.048275e-01
50%	-1.303515e-01
75%	4.146642e-01
max	5.437647e+00

Особенности метода:

- Среднее значение приводится к 0.
- Среднеквадратичное отклонение приводится к 1.
- Форма исходного распределения сохраняется.
- Максимальные и минимальные значения могут варьироваться.
- Выбросы сохраняются.

Масштабирование по максимальному значению

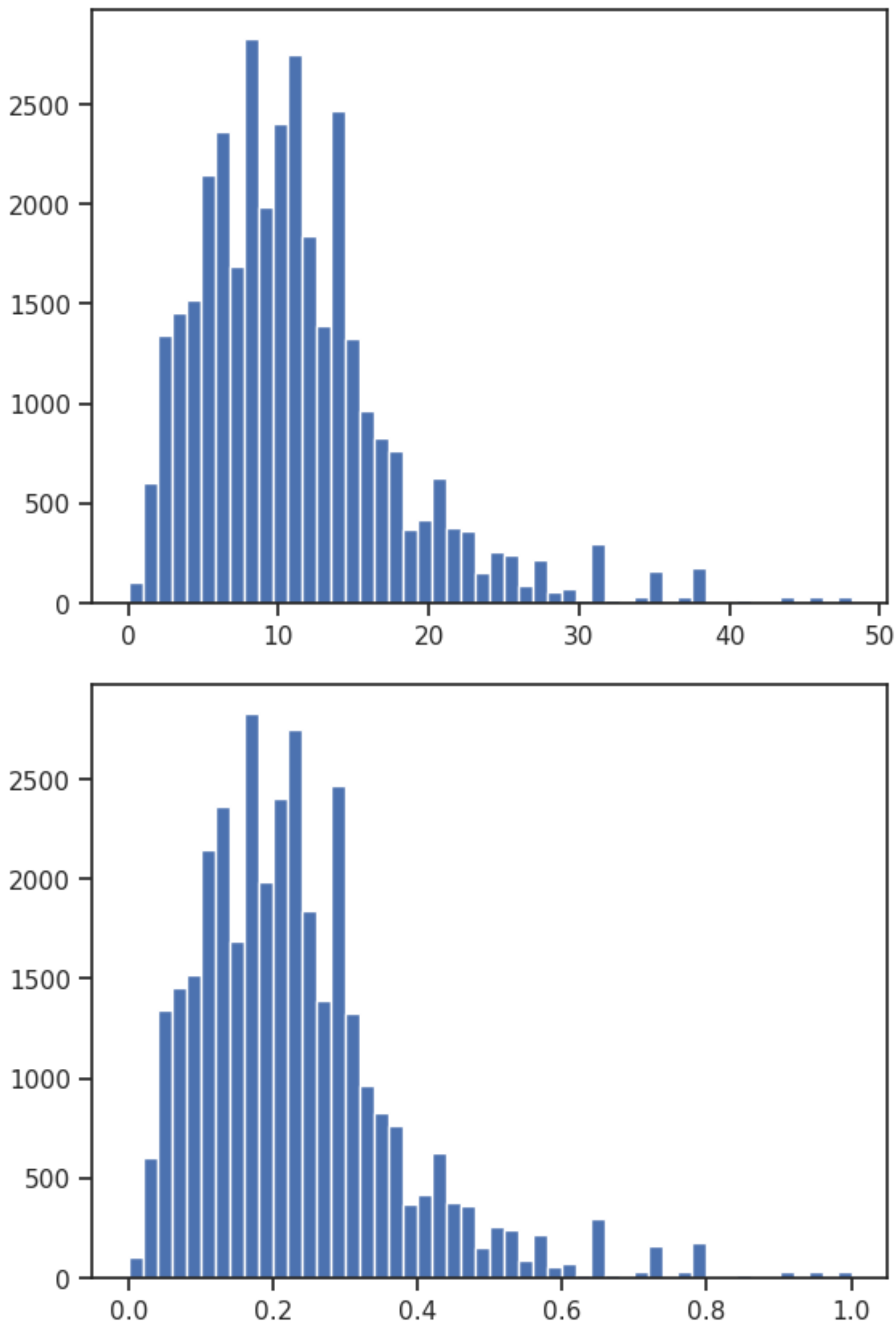
In [32]:

```
input = data[['Distance']]
output = MaxAbsScaler().fit_transform(input)

plt.hist(input, 50)
plt.show()

plt.hist(output, 50)
plt.show()

display(pd.DataFrame(input).describe())
display(pd.DataFrame(output).describe())
```



0
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1000
1500
2000
2500
0
10
20
30
40
50
0
500
1000
1500
2000
2500
0.0
0.2
0.4
0.6
0.8
1.0

	Distance
count	34856.000000
mean	11.184929
std	6.788892
min	0.000000
25%	6.400000
50%	10.300000
75%	14.000000
max	48.100000

	0
count	34856.000000
mean	0.232535
std	0.141141
min	0.000000
25%	0.133056
50%	0.214137
75%	0.291060
max	1.000000

Особенности метода:

- Среднеквадратичное отклонение не масштабируется.
- Форма исходного распределения может изменяться.
- Максимальные и минимальные значения в диапазоне [-1;1].

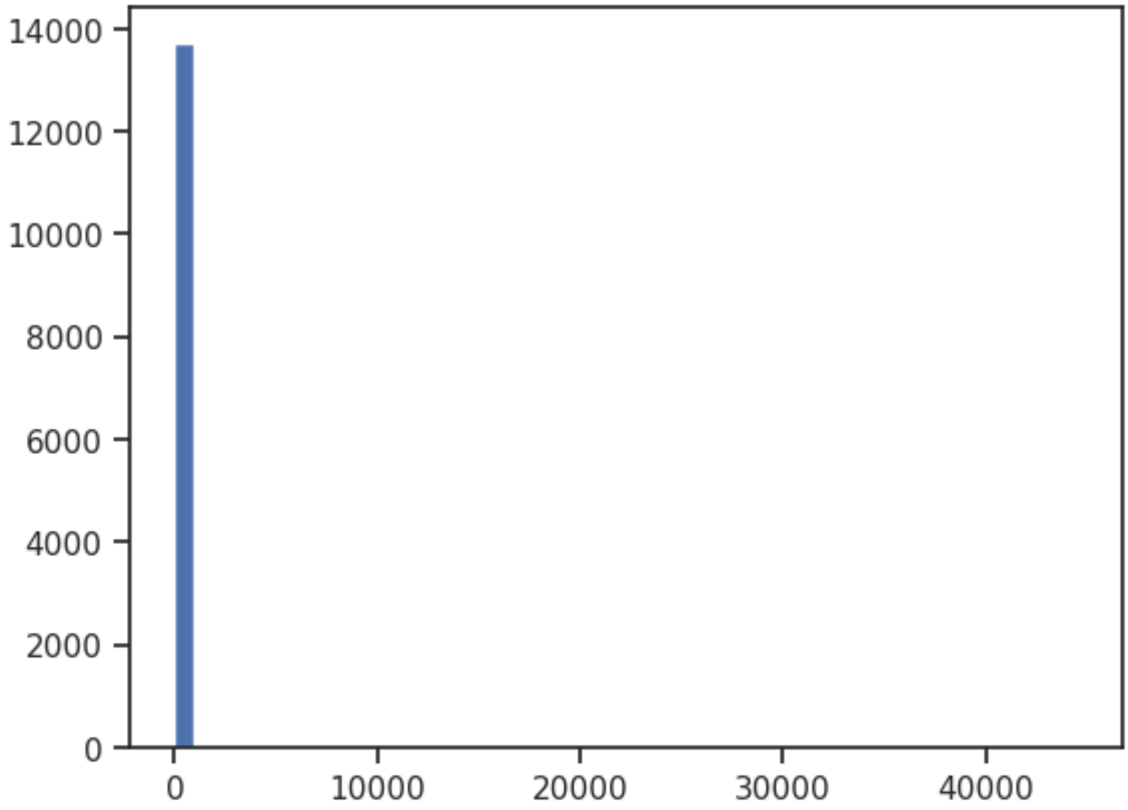
Обработка выбросов

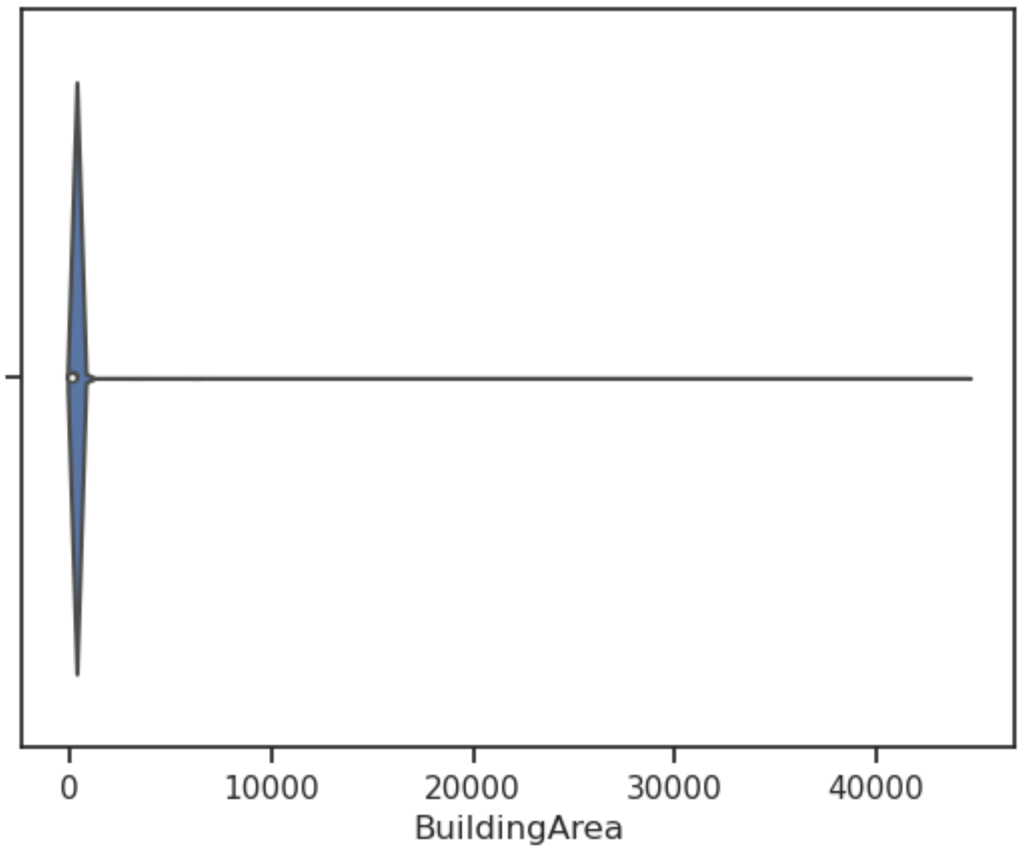
In [33]:
```
display(data[["BuildingArea"]].describe())

plt.hist(data[["BuildingArea"]], 50)
plt.show()

sns.violinplot(x=data["BuildingArea"]);
```

	BuildingArea
count	13742.00000
mean	160.25640
std	401.26706
min	0.00000
25%	102.00000
50%	136.00000
75%	188.00000
max	44515.00000



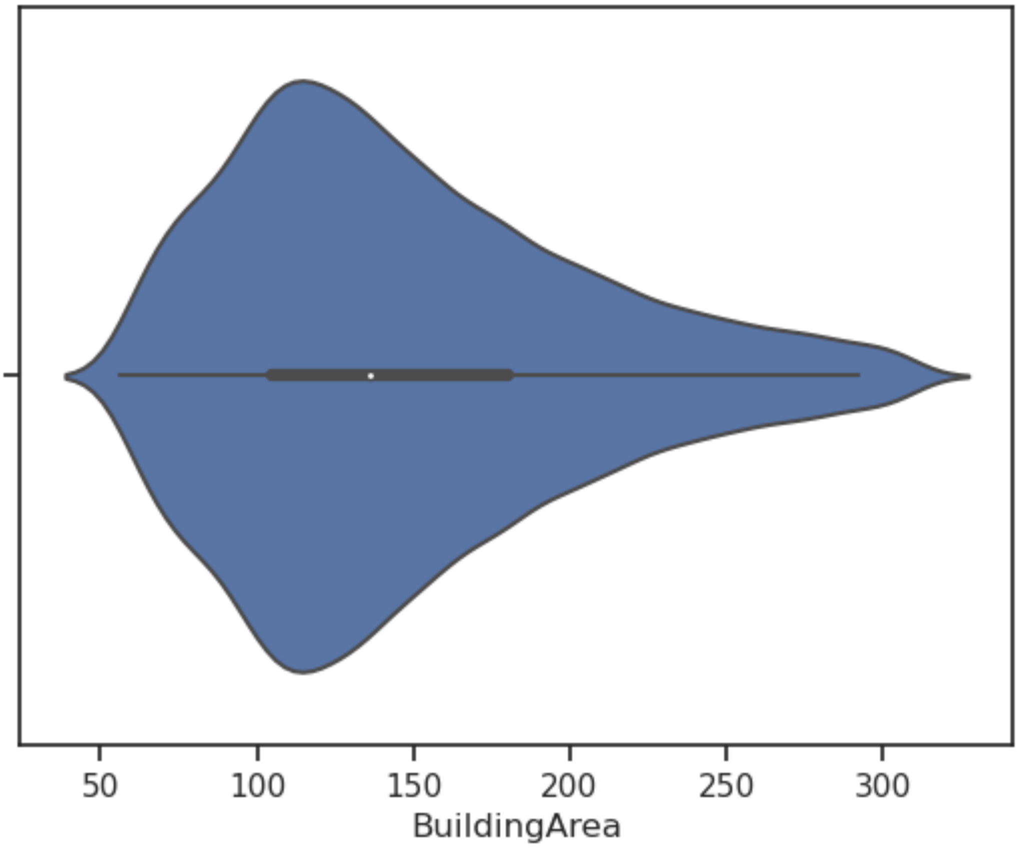

0
10000
20000
30000
40000
BuildingArea

In [34]:
```python
from enum import Enum
class OutlierBoundaryType(Enum):
  SIGMA = 1
  QUANTILE = 2
  IRQ = 3

# Функция вычисления верхней и нижней границы выбросов
def get_outlier_boundaries(df, col, outlier_boundary_type: OutlierBoundar
  if outlier_boundary_type == OutlierBoundaryType.SIGMA:
    K1 = 3
    lower_boundary = df[col].mean() - (K1 * df[col].std())
    upper_boundary = df[col].mean() + (K1 * df[col].std())
  elif outlier_boundary_type == OutlierBoundaryType.QUANTILE:
    lower_boundary = df[col].quantile(0.05)
    upper_boundary = df[col].quantile(0.95)
  elif outlier_boundary_type == OutlierBoundaryType.IRQ:
    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)
  else:
    raise NameError('Unknown Outlier Boundary Type')

  return lower_boundary, upper_boundary

lower_boundary, upper_boundary = get_outlier_boundaries(data, "BuildingAr
outliers_temp = np.where(
  data["BuildingArea"] > upper_boundary,
  True,
  np.where(
    data["BuildingArea"] < lower_boundary,
    True,
    False
  )
)
data_trimmed = data.loc[~(outliers_temp),]
sns.violinplot(x=data_trimmed["BuildingArea"]);
```

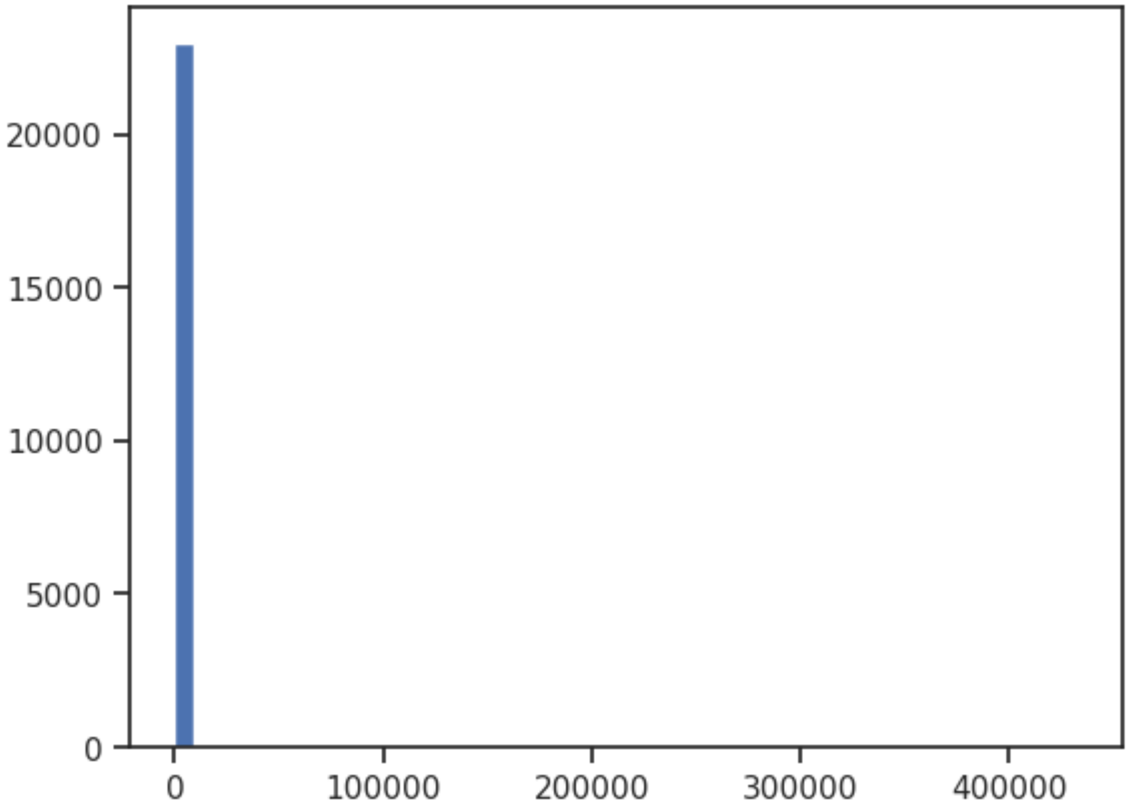


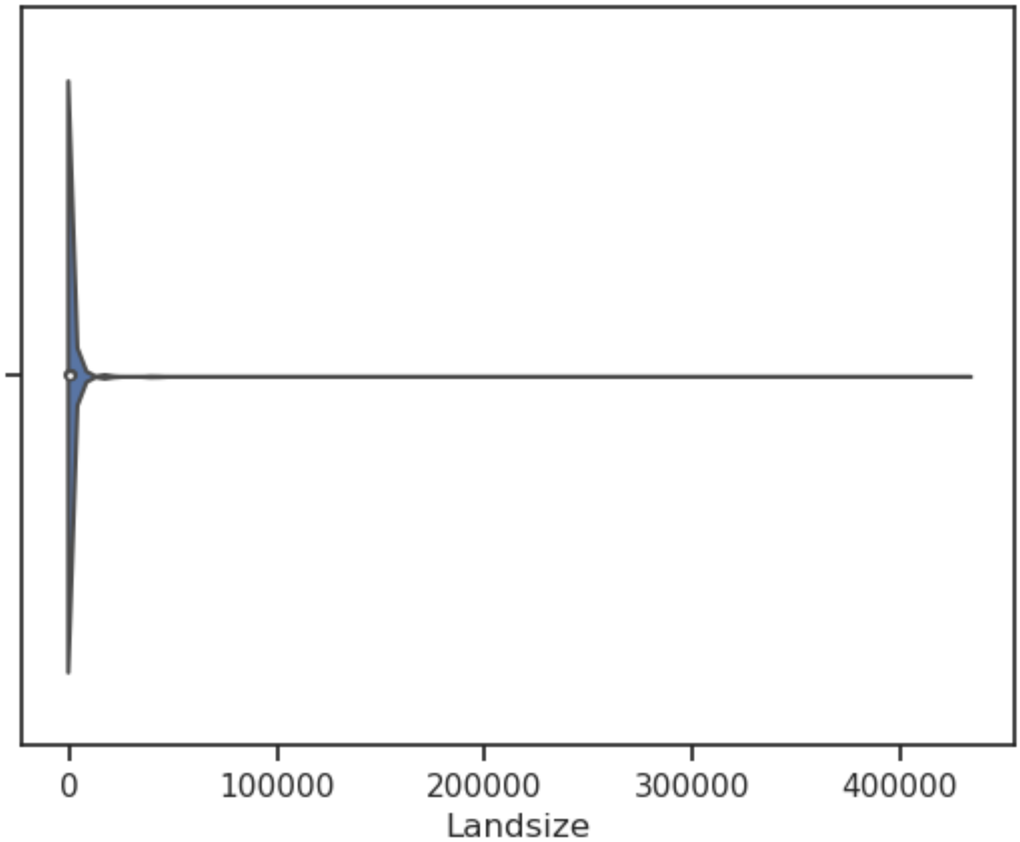
In [35]:
```
display(data[["Landsize"]].describe())

plt.hist(data[["Landsize"]], 50)
plt.show()

sns.violinplot(x=data["Landsize"]);
```

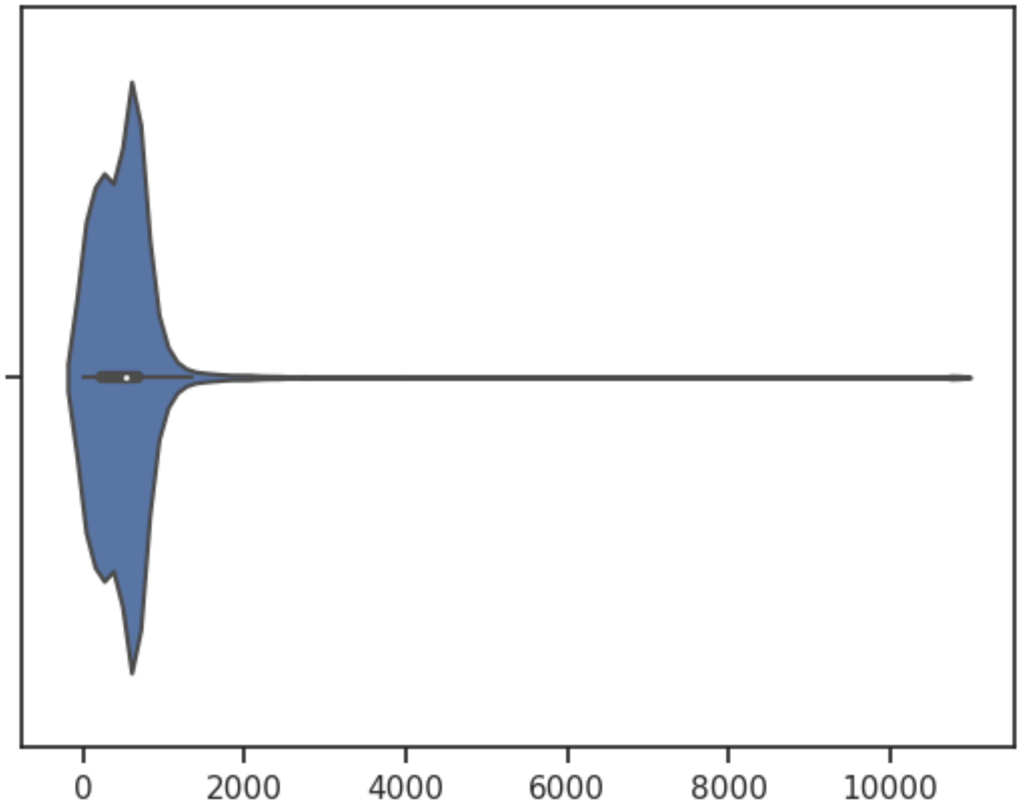
	Landsize
count	23047.000000
mean	593.598993
std	3398.841946
min	0.000000
25%	224.000000
50%	521.000000
75%	670.000000
max	433014.000000


20000
15000
10000
5000
0
0
100000
200000
300000
400000


0
100000
200000
300000
400000
Landsize

In [36]:
```
lower_boundary, upper_boundary = get_outlier_boundaries(data, "Landsize",
data_replaced = np.where(
  data['Landsize'] > upper_boundary,
  upper_boundary,
  np.where(
    data['Landsize'] < lower_boundary,
    lower_boundary,
    data['Landsize'],
  )
)

sns.violinplot(x=data_replaced);
```



Обработка нестандартного признака

In [37]:
```
display(data[['Date']], data[['Date']].dtypes)
```

	Date
0	3/09/2016
1	3/12/2016
2	4/02/2016
3	4/02/2016
4	4/03/2017
...	...
34852	24/02/2018
34853	24/02/2018
34854	24/02/2018
34855	24/02/2018
34856	24/02/2018

34857 rows × 1 columns

```
Date     object
dtype: object
```

In [38]:
```
data['Date'] = data.apply(lambda x: pd.to_datetime(x['Date'], format='%d/
display(data['Date'], data['Date'].dtypes)
```

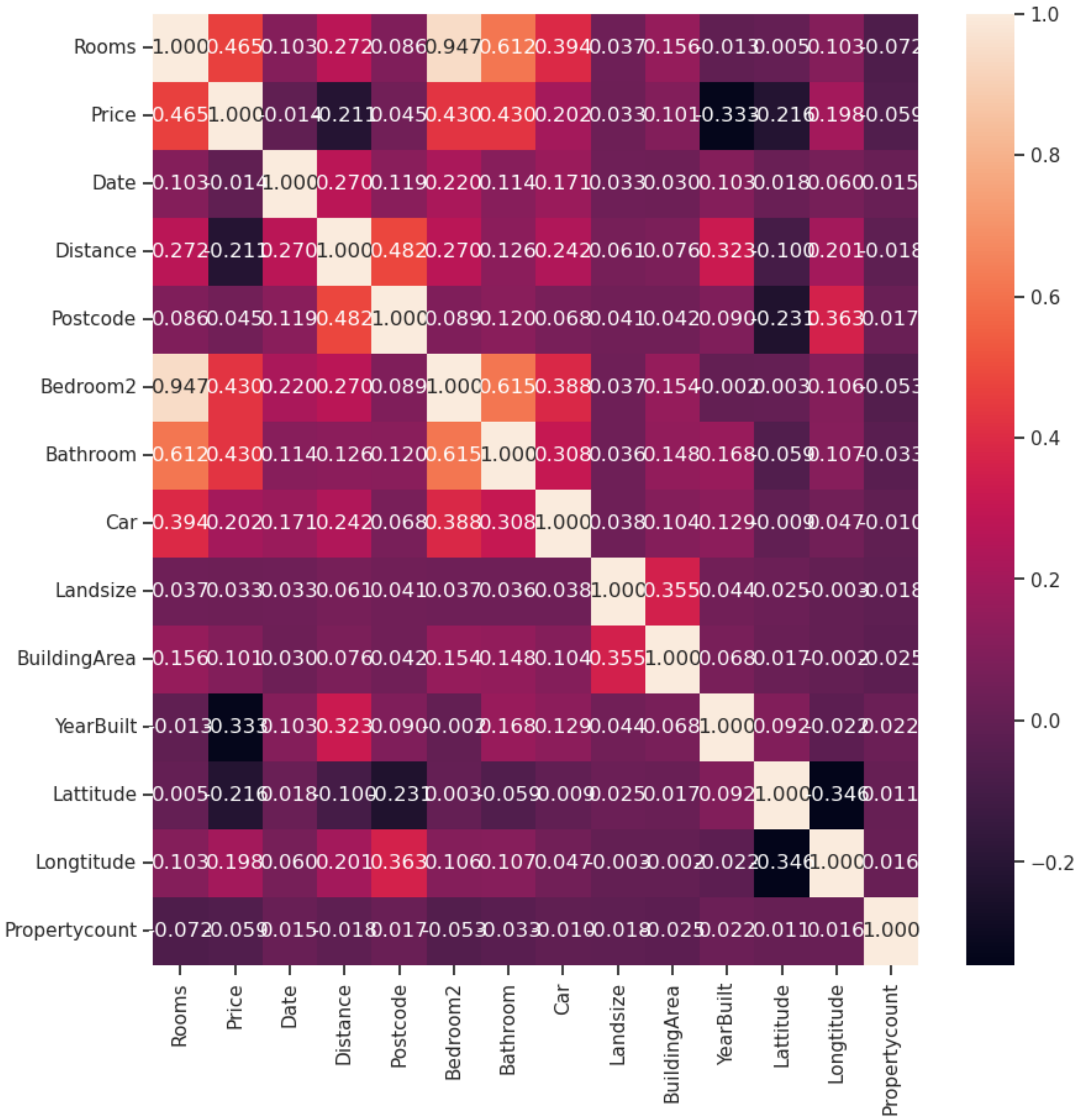
```
0        1.472861e+09
1        1.480723e+09
2        1.454544e+09
3        1.454544e+09
4        1.488586e+09
             ...
34852    1.519430e+09
34853    1.519430e+09
34854    1.519430e+09
34855    1.519430e+09
34856    1.519430e+09
Name: Date, Length: 34857, dtype: float64
dtype('float64')
```

Отбор признаков

Метод из группы методов фильтрации

In [39]:
```
# Метод, основанный на корреляции

plt.figure(figsize = (10, 10))
sns.heatmap(data.corr(numeric_only = True), annot=True, fmt='.3f');
```



In [40]:

```python
# Формирование DataFrame с сильными корреляциями
# Желательно, чтобы признаки хорошо коррелировали с целевым признаком.
# Важно, чтобы признаки не коррелировали между собой.

def make_corr_df(df):
  cr = data.corr(numeric_only = True)
  cr = cr.abs().unstack()
  cr = cr.sort_values(ascending=False)
  cr = cr[cr >= 0.8]
  cr = cr[cr < 1]
  cr = pd.DataFrame(cr).reset_index()
  cr.columns = ['f1', 'f2', 'corr']
  return cr
```

In [41]:

```python
make_corr_df(data)
```

Out[41]:

	f1	f2	corr
0	Rooms	Bedroom2	0.946755
1	Bedroom2	Rooms	0.946755

Метод из группы методов обертывания

In [42]:
```
from sklearn.neighbors import KNeighborsClassifier
from mlxtend.feature_selection import ExhaustiveFeatureSelector as EFS

dropped = data.dropna(axis=0, how='any')[["Car", "Bathroom", "BuildingAre

for c in dropped:
  print(f"{c} => {len(dropped[c].unique())}")

knn = KNeighborsClassifier(n_neighbors = 3)

efs1 = EFS(
  knn,
  min_features=2,
  max_features=4,
  scoring='accuracy',
  print_progress=True,
  cv=5
)

X = dropped.drop(columns = ['Price'])
Y = dropped[['Price']].squeeze()

efs1 = efs1.fit(X, Y)

print('Best accuracy score: %.2f' % efs1.best_score_)
print('Best subset (indices):', efs1.best_idx_)
print('Best subset (corresponding names):', efs1.best_feature_names_)
```

```
Car => 11
Bathroom => 9
BuildingArea => 593
Price => 1846
Landsize => 1237
Bedroom2 => 12
Rooms => 10
Distance => 201
Postcode => 194
YearBuilt => 143
```

```
/usr/lib/python3.10/site-packages/sklearn/model_selection/_split.py:700:
UserWarning: The least populated class in y has only 1 members, which is
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Features: 246/246
Best accuracy score: 0.01
Best subset (indices): (2, 6, 7, 8)
Best subset (corresponding names): ('BuildingArea', 'Distance', 'Postcode
', 'YearBuilt')
```

Метод из группы методов вложений

In [43]:

```
from operator import itemgetter
from sklearn.ensemble import GradientBoostingRegressor

def draw_feature_importances(tree_model, X_dataset, title, figsize=(7,4))
  # Сортировка значений важности признаков по убыванию
  list_to_sort = list(zip(X_dataset.columns.values, tree_model.feature_im
  sorted_list = sorted(list_to_sort, key=itemgetter(1), reverse = True)
  # Названия признаков
  labels = [x for x,_ in sorted_list]
  # Важности признаков
  data = [x for _,x in sorted_list]
  # Вывод графика
  fig, ax = plt.subplots(figsize=figsize)
  ax.set_title(title)
  ind = np.arange(len(labels))
  plt.bar(ind, data)
  plt.xticks(ind, labels, rotation='vertical')
  # Вывод значений
  for a,b in zip(ind, data):
    plt.text(a-0.1, b+0.005, str(round(b,3)))
  plt.show()
  return labels, data

# Градиентный бустинг
gbr1 = GradientBoostingRegressor()
gbr1.fit(X, Y);

draw_feature_importances(gbr1, X, 'Градиентный бустинг', figsize=(10,4));
```