□Portfolio: Toshkent shahrida uylarning narxini aniqlash.

Ushbu amaliyotda bizning vazifamiz berilgan ma`lumotlar asosida Toshkent shahridagi uylarning narxini aniqlash.

Bizda uylarning joylashgan hududi, o`lchamlari, xonalar soni, qavati hamda narxi berilgan. Biz shu parametrlardan foydalanib uy narxlarini bashorat qilishimiz kerak!

Analitik yondashuvni aniqlaymiz.

1.2 Analitik yondoshuvni aniqlash

Bu bosqichda biz bir nechta narsalarni aniqlashtirib olamiz:

- Model: Supervised, Unsupervised, Reinforcement?
- Algoritm: klassifikasiya, regressiya, yoki boshqa turda
- Usul: Online yoki offline

Yuqoridagi savollarga javob beramiz:

1. Supervised learning - sababi bizda ma'lumotlarda label (yorliq) mavjud. Bu hududdadi median narx. Biz ham aynan shu narxni bashorat qilmoqchimiz.
2. Regressiya - "Bashorat" (prognoz) dedikmi demak bu regressia algoritmlari yordamida hal qilinadi
3. Offline - sababi ma'lumotlar bizga avvaldan bir marta berilgan. Doimiy ma'lumotlar oqimi yo'q.

Model aniqligini qanday baholaymiz?

Aniqlikni baholashning turli usullari bor, regressiya algoritmlar uchun odatda **o'rtacha kvadrat xatolik** (Root Mean Square Error - RMSE) ko'p ishlatiladi:

$$\mathrm{RMSE}(\mathbf{X}, h) = \sqrt{\frac{1}{m} \sum_{i=1}^{m} \left(h\left(\mathbf{x}^{(i)}\right) - y^{(i)}\right)^2}$$

Bu yerda:

- m - datasetdagi qatorlar soni (har bir qator bitta ma'lumot)
- $x^{(i)}$ - i-qator uchun barcha parametrlar vektori (*label* dan tashqari)
- $y^{(i)}$ - i-qator uchun label (bizdagi misolda median uy narxi)
- X - labeldan boshqa barcha parametrlar
- h - sizning modelingizdan qaytgan bashorat (hypothesis).
  - $h(x^{(i)})$ - i-qator uchun model qaytargan bashorat.

Aniqlikni baholashning yana bir usuli, o'rtacha absolyut xatolik (mean absolute error - MAE).

$$\mathrm{MAE}(\mathbf{X}, h) = \frac{1}{m}\sum_{i=1}^{m}\left|h\left(\mathbf{x}^{(i)}\right) - y^{(i)}\right|$$

RMSE ham MAE ham ikki vektor, bashorat va label o'rtasidagi farqni hisoblaydi. Xato qancha kam bo'lsa, natija shuncha yaxshi hisoblanadi.

⍰Kerakli kutubxonalar:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import sklearn
```

datasetni chaqirib olamiz:

```
df = pd.read_csv('https://raw.githubusercontent.com/BehruzDS/DS-praktikum-datasets/main
df.head()
```

	location	district	rooms	size	level	max_levels	price
0	город Ташкент, Юнусабадский район, Юнусабад 8-...	Юнусабадский	3	57	4	4	52000
1	город Ташкент, Яккасарайский район, 1-й тупик ...	Яккасарайский	2	52	4	5	56000
2	город Ташкент, Чиланзарский район, Чиланзар 2-...	Чиланзарский	2	42	4	4	37000
3	город Ташкент, Чиланзарский район, Чиланзар 9-...	Чиланзарский	3	65	1	4	49500
4	город Ташкент, Чиланзарский район, площадь Актепа	Чиланзарский	3	70	3	5	55000

2.1 Ma'lumotlarni ko'ramiz

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7565 entries, 0 to 7564
Data columns (total 7 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   location    7565 non-null   object
 1   district    7565 non-null   object
 2   rooms       7565 non-null   int64
 3   size        7565 non-null   object
 4   level       7565 non-null   int64
 5   max_levels  7565 non-null   int64
 6   price       7565 non-null   object
```

```
dtypes: int64(3), object(4)
memory usage: 413.8+ KB
```

NaN qiymatlar yo'q. ammo bazi ustunlar object(matn) ko'rinishida. Machine Learning faqat raqamli ustunlar bilan ishlagani uchun biz keyingi o`rinlarda raqamli ustunlarni matnli ustunga o'takazib olamiz.

`size` va `price` ustunlarini malumot turini sonli korinishga olib kelamiz yani int(float) turga o`tkazamiz

```
df['size'].astype(dtype='float')
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-4-234dcd0e28f1> in <module>
----> 1 df['size'].astype(dtype='float')

/usr/local/lib/python3.7/dist-packages/pandas/core/generic.py in astype(self, dtype,
copy, errors)
   5813         else:
   5814             # else, only a single dtype is given
-> 5815             new_data = self._mgr.astype(dtype=dtype, copy=copy, errors=errors)
   5816             return self._constructor(new_data).__finalize__(self,
method="astype")
   5817

/usr/local/lib/python3.7/dist-packages/pandas/core/internals/managers.py in astype(self,
dtype, copy, errors)
    416
    417     def astype(self: T, dtype, copy: bool = False, errors: str = "raise") -> T:
--> 418         return self.apply("astype", dtype=dtype, copy=copy, errors=errors)
    419
    420     def convert(

/usr/local/lib/python3.7/dist-packages/pandas/core/internals/managers.py in apply(self,
f, align_keys, ignore_failures, **kwargs)
    325                     applied = b.apply(f, **kwargs)
    326                 else:
--> 327                     applied = getattr(b, f)(**kwargs)
    328             except (TypeError, NotImplementedError):
    329                 if not ignore_failures:

/usr/local/lib/python3.7/dist-packages/pandas/core/internals/blocks.py in astype(self,
dtype, copy, errors)
    589         values = self.values
    590
--> 591         new_values = astype_array_safe(values, dtype, copy=copy, errors=errors)
    592
    593         new_values = maybe_coerce_values(new_values)
```

```
/usr/local/lib/python3.7/dist-packages/pandas/core/dtypes/cast.py in
astype_array_safe(values, dtype, copy, errors)
   1307
   1308     try:
-> 1309         new_values = astype_array(values, dtype, copy=copy)
   1310     except (ValueError, TypeError):
   1311         # e.g. astype_nansafe can fail on object-dtype of strings

/usr/local/lib/python3.7/dist-packages/pandas/core/dtypes/cast.py in
astype_array(values, dtype, copy)
   1255
   1256     else:
-> 1257         values = astype_nansafe(values, dtype, copy=copy)
   1258
   1259     # in pandas we don't store numpy str dtypes, so convert to object

/usr/local/lib/python3.7/dist-packages/pandas/core/dtypes/cast.py in astype_nansafe(arr,
dtype, copy, skipna)
   1199     if copy or is_object_dtype(arr.dtype) or is_object_dtype(dtype):
   1200         # Explicit copy, or required since NumPy can't view from / to object.
-> 1201         return arr.astype(dtype, copy=True)
   1202
   1203     return arr.astype(dtype, copy=copy)

ValueError: could not convert string to float: 'Площадьземли:1сот'
```

Bu ustunda Площадьземли:1сот qiymati ham bor ekan . Buni 1sotix (100 m^2) ga o`zgartiramiz.

```
df['size'][df['size']== 'Площадьземли:1сот']=100
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """Entry point for launching an IPython kernel.
```

```
df['size'] = df['size'].astype(dtype='float')
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7565 entries, 0 to 7564
Data columns (total 7 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   location    7565 non-null   object
 1   district    7565 non-null   object
 2   rooms       7565 non-null   int64
 3   size        7565 non-null   float64
 4   level       7565 non-null   int64
 5   max_levels  7565 non-null   int64
 6   price       7565 non-null   object
dtypes: float64(1), int64(3), object(3)
memory usage: 413.8+ KB
```

price ustuni o'zgartiramiz.

```
df['price'] = df['price'].astype(dtype = 'int')
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-8-da47ff5902b3> in <module>
----> 1 df['price'] = df['price'].astype(dtype = 'int')

/usr/local/lib/python3.7/dist-packages/pandas/core/generic.py in astype(self, dtype,
copy, errors)
   5813         else:
   5814             # else, only a single dtype is given
-> 5815             new_data = self._mgr.astype(dtype=dtype, copy=copy, errors=errors)
   5816             return self._constructor(new_data).__finalize__(self,
method="astype")
   5817

/usr/local/lib/python3.7/dist-packages/pandas/core/internals/managers.py in astype(self,
dtype, copy, errors)
    416
    417     def astype(self: T, dtype, copy: bool = False, errors: str = "raise") -> T:
--> 418         return self.apply("astype", dtype=dtype, copy=copy, errors=errors)
    419
    420     def convert(

/usr/local/lib/python3.7/dist-packages/pandas/core/internals/managers.py in apply(self,
f, align_keys, ignore_failures, **kwargs)
    325                     applied = b.apply(f, **kwargs)
    326                 else:
--> 327                     applied = getattr(b, f)(**kwargs)
    328             except (TypeError, NotImplementedError):
    329                 if not ignore_failures:

/usr/local/lib/python3.7/dist-packages/pandas/core/internals/blocks.py in astype(self,
dtype, copy, errors)
    589         values = self.values
    590
--> 591         new_values = astype_array_safe(values, dtype, copy=copy, errors=errors)
```

```
    592
    593         new_values = maybe_coerce_values(new_values)

/usr/local/lib/python3.7/dist-packages/pandas/core/dtypes/cast.py in
astype_array_safe(values, dtype, copy, errors)
   1307
   1308     try:
-> 1309         new_values = astype_array(values, dtype, copy=copy)
   1310     except (ValueError, TypeError):
   1311         # e.g. astype_nansafe can fail on object-dtype of strings

/usr/local/lib/python3.7/dist-packages/pandas/core/dtypes/cast.py in
astype_array(values, dtype, copy)
   1255
   1256     else:
-> 1257         values = astype_nansafe(values, dtype, copy=copy)
   1258
   1259     # in pandas we don't store numpy str dtypes, so convert to object

/usr/local/lib/python3.7/dist-packages/pandas/core/dtypes/cast.py in astype_nansafe(arr,
dtype, copy, skipna)
   1172         # work around NumPy brokenness, #1987
   1173         if np.issubdtype(dtype.type, np.integer):
-> 1174             return lib.astype_intsafe(arr, dtype)
   1175
   1176         # if we have a datetime/timedelta array of objects

/usr/local/lib/python3.7/dist-packages/pandas/_libs/lib.pyx in
pandas._libs.lib.astype_intsafe()

ValueError: invalid literal for int() with base 10: 'Договорная'
```

```
df[df['price']=='Договорная']
```

	location	district	rooms	size	level	max_levels	price
202	город Ташкент, Яккасарайский район, Баходыра	Яккасарайский	3	119.0	3	9	Договорная
411	город Ташкент, Яккасарайский район, Баходыра	Яккасарайский	4	160.0	4	9	Договорная
439	город Ташкент, Мирзо-Улугбекский район, улица ...	Мирзо-Улугбекский	3	105.0	5	6	Договорная
460	город Ташкент, Чиланзарский район, Чиланзар 1-...	Чиланзарский	3	90.0	6	8	Договорная
507	город Ташкент, Яшнободский район, 1-й проезд А...	Яшнободский	2	48.0	4	4	Договорная
...	...	...	...	...	...	...	...
7039	город Ташкент, Яшнободский район, Городок Авиа...	Яшнободский	1	38.7	3	8	Договорная
7196	город Ташкент, Чиланзарский район, Чиланзар-16	Чиланзарский	2	51.0	3	4	Договорная

	location	district	rooms	size	level	max_levels	price
7323	город Ташкент, Мирзо-Улугбекский район, жилой ...	Мирзо-Улугбекский	6	208.0	1	7	Договорная
7403	город Ташкент, Учтепинский район, Чиланзар 14-...	Учтепинский	2	35.0	2	9	Договорная
7404	город Ташкент, Учтепинский район, Чиланзар 14-...	Учтепинский	2	35.0	2	9	Договорная

99 rows × 7 columns

Bunday qiymatli qatorlarni tashlab yuboramiz. chunki ularni taxminiy qiymatlar bilan to'ldirib bolmaydi.

```
# df[df['price']=='Договорная'].index
df.drop(index = df[df['price']=='Договорная'].index, inplace=True)

# yoki
# df = df[df['price']!='Договорная']
```

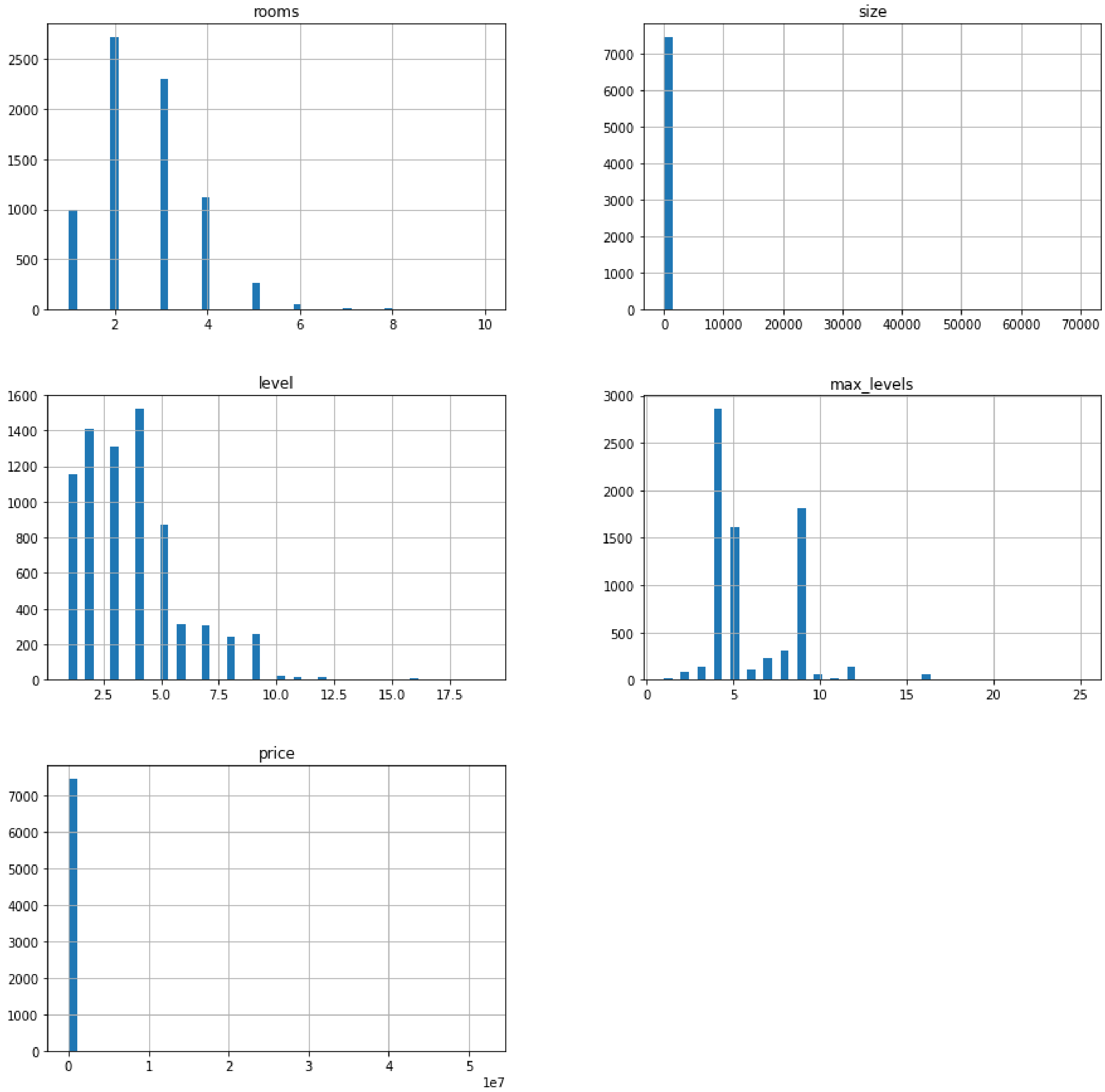
```
df['price'] = df['price'].astype(dtype ='int')
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7466 entries, 0 to 7564
Data columns (total 7 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   location    7466 non-null   object
 1   district    7466 non-null   object
 2   rooms       7466 non-null   int64
 3   size        7466 non-null   float64
 4   level       7466 non-null   int64
 5   max_levels  7466 non-null   int64
 6   price       7466 non-null   int64
dtypes: float64(1), int64(4), object(2)
memory usage: 466.6+ KB
```

Malumotlarni tahlil qilishda davom etamiz

```
%matplotlib inline
df.hist(bins=50, figsize=(15,15))
plt.show()
```



Grafikdan ma'lumki bizda g'ayritabiiy qiymatlar mavjud. `size` hamda `price` ustunida ko`rishimiz mumkin. qiymatlar bitta ustunga yig'ilib qolgan.

```
df.describe()
```

	rooms	size	level	max_levels	price
count	7466.000000	7466.000000	7466.000000	7466.000000	7.466000e+03
mean	2.622288	113.535205	3.693678	6.023841	7.133421e+04
std	1.083200	1501.057455	2.236770	2.606955	6.405237e+05
min	1.000000	1.000000	1.000000	1.000000	2.000000e+00
25%	2.000000	50.000000	2.000000	4.000000	3.500000e+04
50%	3.000000	65.000000	3.000000	5.000000	4.650000e+04
75%	3.000000	85.000000	5.000000	9.000000	6.700000e+04

	rooms	size	level	max_levels	price
max	10.000000	70000.000000	19.000000	25.000000	5.200000e+07

Ko'rinib Turibdiki, size ustunida maydoni `70000 kv` gacha bo'lgan uylar ham borekan.price ustunida esa `52 mln $` gacha uylar. Ular g`ayritabiiy qiymatlar sifatida tashlab yuboriladi.

Ma`lumotlarni tozalaymiz:

```
df = df[(df['size'] < 250) & (df['size'] > 15)]
```

```
df = df[(df['price']<400000) & (df['price']>10000)]
```

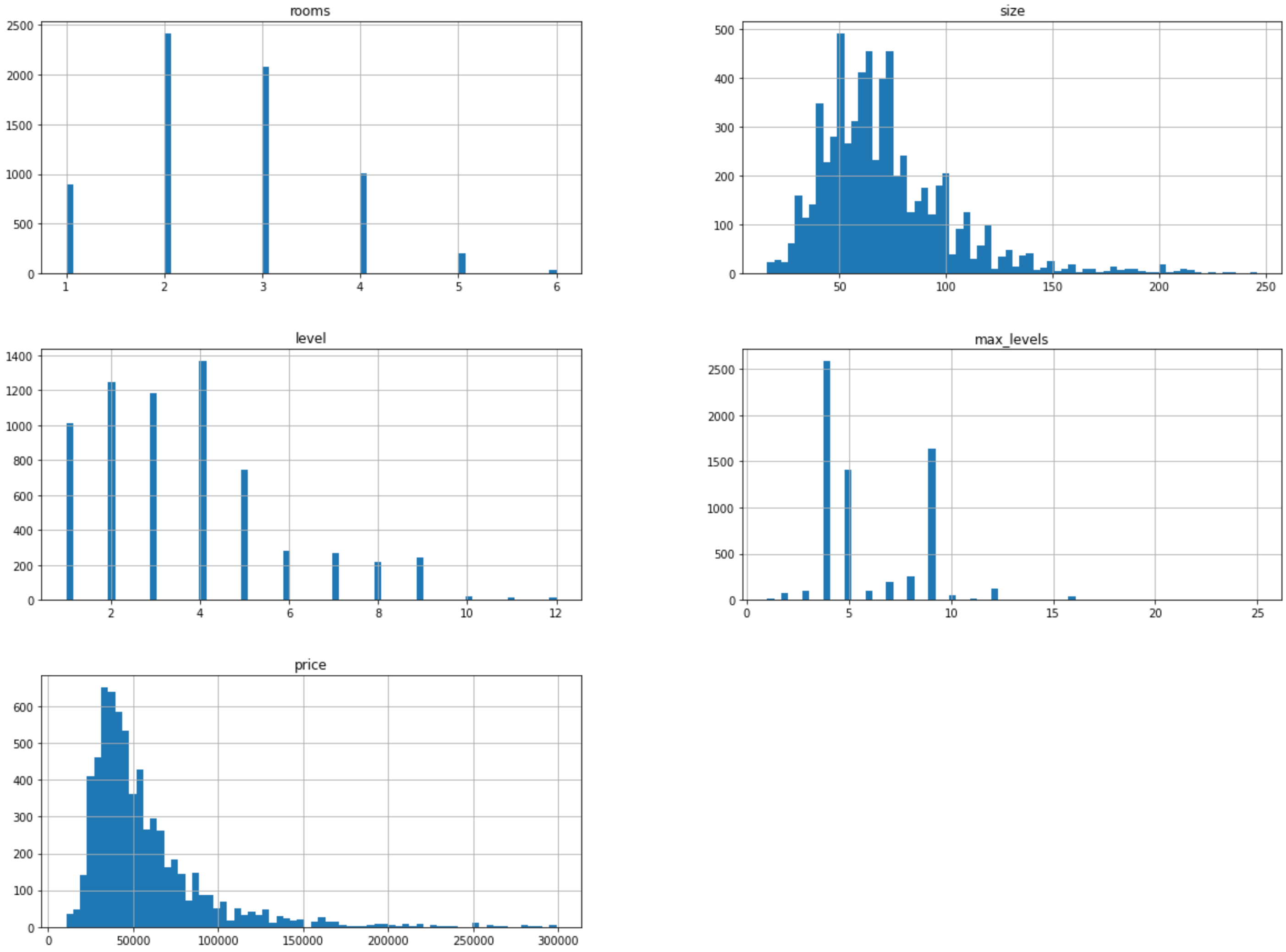
```
df = df[df['rooms']<7]
```

```
df = df[df['level']<13]
```

Takroriy qiymatlarni o`chiramiz:

```
df.drop_duplicates(inplace=True)
```

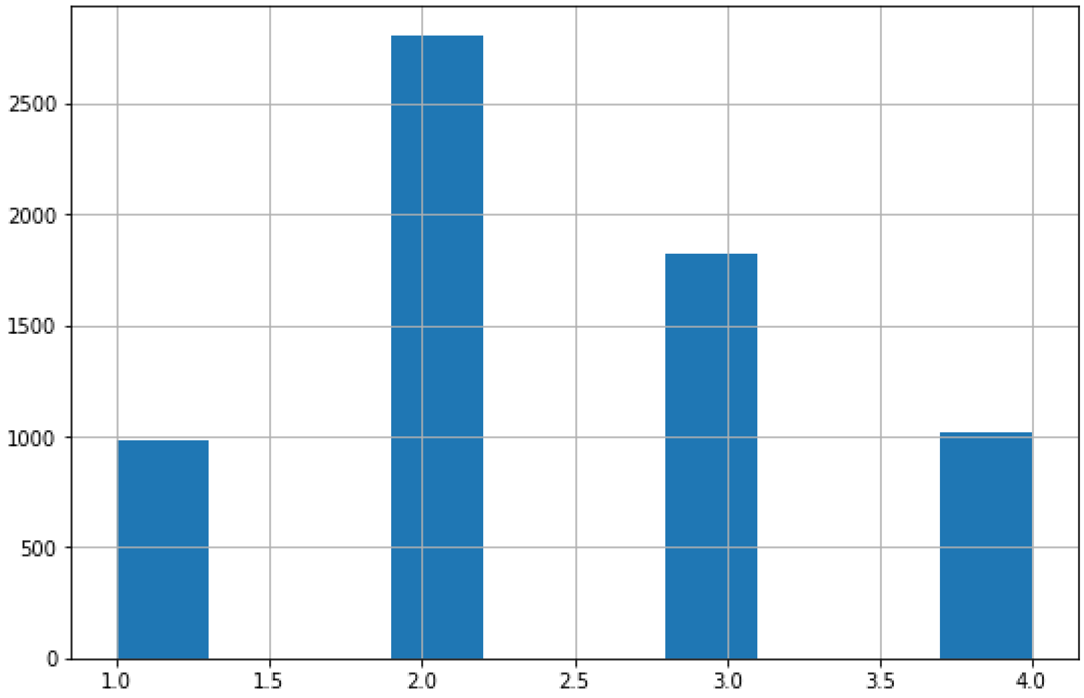
```
%matplotlib inline
df.hist(bins = 70, figsize=(20,15))
plt.show()
```



`price` ustunida aksariyat qiymatlar `300000$` dan kichik, undan kattalari esa kopmas va ular model ishlashi uchun yomon tasir o`tkazadi.

```
df = df[df['price']<300000] # tashlab yuboramiz:
```

```
df['price_cat'] = pd.cut(df['price'], bins=[0., 30000.0, 50000.0, 80000.0, 300000.0, np
df['price_cat'].hist(figsize=(9,6))
plt.show()
```



```python
df.head()
```

	location	district	rooms	size	level	max_levels	price	price_cat
0	город Ташкент, Юнусабадский район, Юнусабад 8-...	Юнусабадский	3	57.0	4	4	52000	3
1	город Ташкент, Яккасарайский район, 1-й тупик ...	Яккасарайский	2	52.0	4	5	56000	3
2	город Ташкент, Чиланзарский район, Чиланзар 2-...	Чиланзарский	2	42.0	4	4	37000	2
3	город Ташкент, Чиланзарский район, Чиланзар 9-...	Чиланзарский	3	65.0	1	4	49500	2
4	город Ташкент, Чиланзарский район, площадь Актепа	Чиланзарский	3	70.0	3	5	55000	3

```python
df.to_csv('Tashkent_inc-prep.csv',index=False)
```

```python
df = pd.read_csv('Tashkent_inc-prep.csv')
df.head()
```

	location	district	rooms	size	level	max_levels	price	price_cat
0	город Ташкент, Юнусабадский район, Юнусабад 8-...	Юнусабадский	3	57.0	4	4	52000	3
1	город Ташкент, Яккасарайский район, 1-й тупик ...	Яккасарайский	2	52.0	4	5	56000	3
2	город Ташкент, Чиланзарский район, Чиланзар 2-...	Чиланзарский	2	42.0	4	4	37000	2
3	город Ташкент, Чиланзарский район, Чиланзар 9-...	Чиланзарский	3	65.0	1	4	49500	2
4	город Ташкент, Чиланзарский район, площадь Актепа	Чиланзарский	3	70.0	3	5	55000	3

Malumotlarni train va test setga ajratamiz:

Muvozanatli train va test set

```
from sklearn.model_selection import StratifiedShuffleSplit
stratified_split = StratifiedShuffleSplit(n_splits=1, test_size=0.2, random_state=42)

# stratified_split.split funksiyasi indekslar qaytaradi
for train_index, test_index in stratified_split.split(df,df['price_cat']):
      strat_train_set = df.loc[train_index]
      strat_test_set = df.loc[test_index]
```

Muvozanatsiz test va train set

```
from sklearn.model_selection import train_test_split
train_set, test_set = train_test_split(df, test_size=0.2, random_state=42)
```

Bizga muvozanatlisini olamiz

`price_cat` ustuni endi kerak emas, train va test setlardan o'chirib tashlaymiz.

```
strat_train_set.drop('price_cat', axis=1, inplace=True)
strat_test_set.drop('price_cat', axis=1, inplace=True)
```

2.3 Ma'lumotlarni tahlil qilamiz.

Keling endi bevosita ma'lumotlarni tahlil qilishga o'taylik. Esingizda bo'lsa biz endi `train` set bilan ishlashimiz kerak. Bizda hozircha 2 ta alohida train set bo'lib qoldi:

- `train_set` - `train_test_split` yordamida bo'lingan (muvozanatsiz)
- `strat_train_set` - `StratifiedShuffleSplit` yordamida bo'lingan.

Biz ikkinchi setdan foydalanamiz. Qulaylik uchun bu setimizda nusxa ko'chirib olamiz.

```
strat_train_set.head()
```

	district	rooms	size	level	max_levels	price
3797	Чиланзарский	2	40.0	4	4	30000
6025	Шайхантахурский	5	97.0	4	5	58000
1120	Яшнободский	5	110.0	3	5	58000
6464	Мирабадский	2	70.0	4	9	55000
6215	Чиланзарский	2	62.0	2	4	40000

```
housing = strat_train_set.copy()
```

```
housing
```

	location	district	rooms	size	level	max_levels	price
5273	город Ташкент, Яккасарайский район, 1-й тупик ...	Яккасарайский	2	60.00	5	9	47000
4576	город Ташкент, Яшнободский район, Фергана Йули	Яшнободский	3	72.00	5	9	36500
5158	город Ташкент, Мирабадский район, 2-й проезд К...	Мирабадский	3	75.00	6	9	57500
6416	город Ташкент, Шайхантахурский район, Дружба Н...	Шайхантахурский	4	100.26	9	9	65000
5764	город Ташкент, Яшнободский район, Паркент	Яшнободский	2	52.50	3	9	42423
...	...	...	...	...	...	...	...
4606	город Ташкент, Мирзо-Улугбекский район, Дархон	Мирзо-Улугбекский	2	65.00	3	9	57000
1799	город Ташкент, Мирабадский район, Нукус	Мирабадский	4	120.00	1	4	135000
2191	город Ташкент, Мирзо-Улугбекский район, Феруза-1	Мирзо-Улугбекский	1	33.00	4	4	23000
4111	город Ташкент, Учтепинский район, Чиланзар ква...	Учтепинский	2	54.00	3	4	37500
4634	город Ташкент, Чиланзарский район, Чиланзар-7	Чиланзарский	2	48.00	2	5	35000

5301 rows × 7 columns

```
from sklearn.preprocessing import OrdinalEncoder
ordinal_encoder = OrdinalEncoder()
loc_prep = ordinal_encoder.fit_transform(housing[['location']])
dist_prep = ordinal_encoder.fit_transform(housing[['district']])
```

```
housing['location'] = loc_prep
housing['district'] = dist_prep
```

```
housing.head()
```

	location	district	rooms	size	level	max_levels	price
5273	1079.0	9.0	2	60.00	5	9	47000
4576	1320.0	11.0	3	72.00	5	9	36500
5158	11.0	1.0	3	75.00	6	9	57500
6416	850.0	7.0	4	100.26	9	9	65000
5764	1294.0	11.0	2	52.50	3	9	42423

Korrelyasiya

Bizning asl maqsadimiz bizga berilgan ma'lumotlar orasida uyning narxiga ta'sir qiluvchi parametrlarni topish. Bunda esa bizga aynan korrelyasiya juda qo'l keladi.

```
housing.corrwith(housing['price']).sort_values(ascending=False)
```

```
price         1.000000
size          0.796596
rooms         0.577010
max_levels    0.243505
level         0.082082
location     -0.095832
district     -0.096470
dtype: float64
```

Vizual ko`rinishda⍰

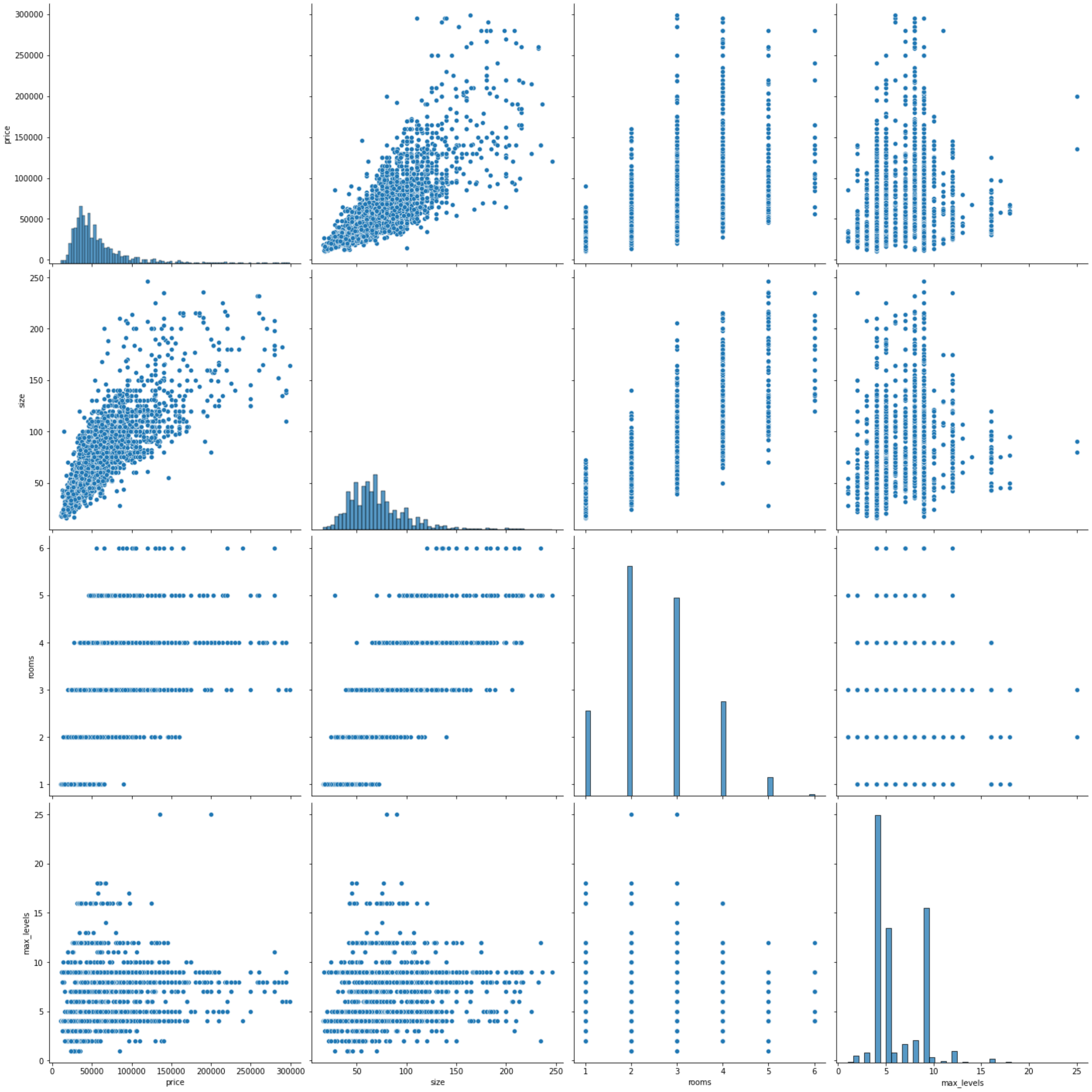
```
corr_matrix = housing.corr().abs()
corr_matrix.style.background_gradient(cmap='coolwarm')
```

	location	district	rooms	size	level	max_levels	price
location	1.000000	0.989575	0.050826	0.075209	0.034112	0.018112	0.095832
district	0.989575	1.000000	0.049205	0.076235	0.026288	0.010171	0.096470
rooms	0.050826	0.049205	1.000000	0.806390	0.146406	0.182527	0.577010
size	0.075209	0.076235	0.806390	1.000000	0.197711	0.310967	0.796596
level	0.034112	0.026288	0.146406	0.197711	1.000000	0.566083	0.082082
max_levels	0.018112	0.010171	0.182527	0.310967	0.566083	1.000000	0.243505
price	0.095832	0.096470	0.577010	0.796596	0.082082	0.243505	1.000000

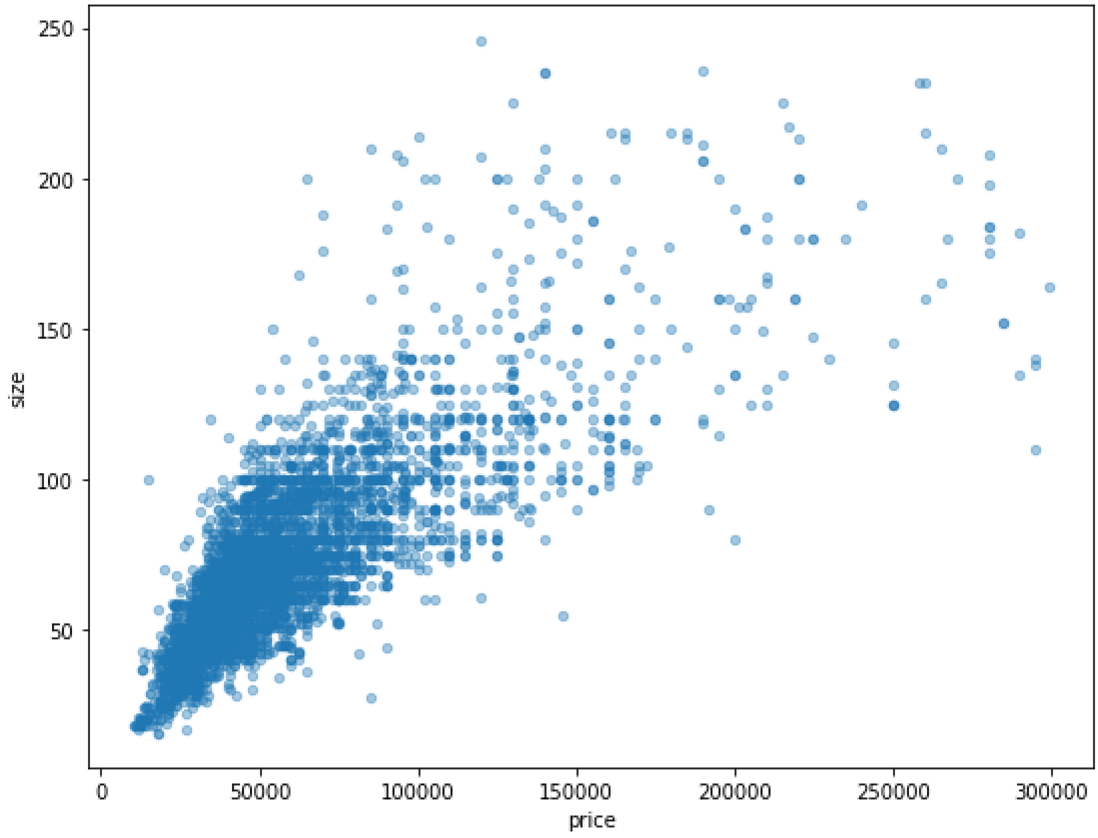
Ko'rishimiz mumkinki, `price va size`, `rooms`, `max_levels` ustunlari orasida korrelyatsiya nisbatan kuchli. qolgan ustunlar esa ahamiyatsiz ekan. Shu sabab ularni tashlab yuboramiz

`seabron` tarkibidagi `pairplot` funksiyasi yordamida korrelyasiya qiymatlarini grafik ko'rinishida chiqarishimiz ham mumkin.

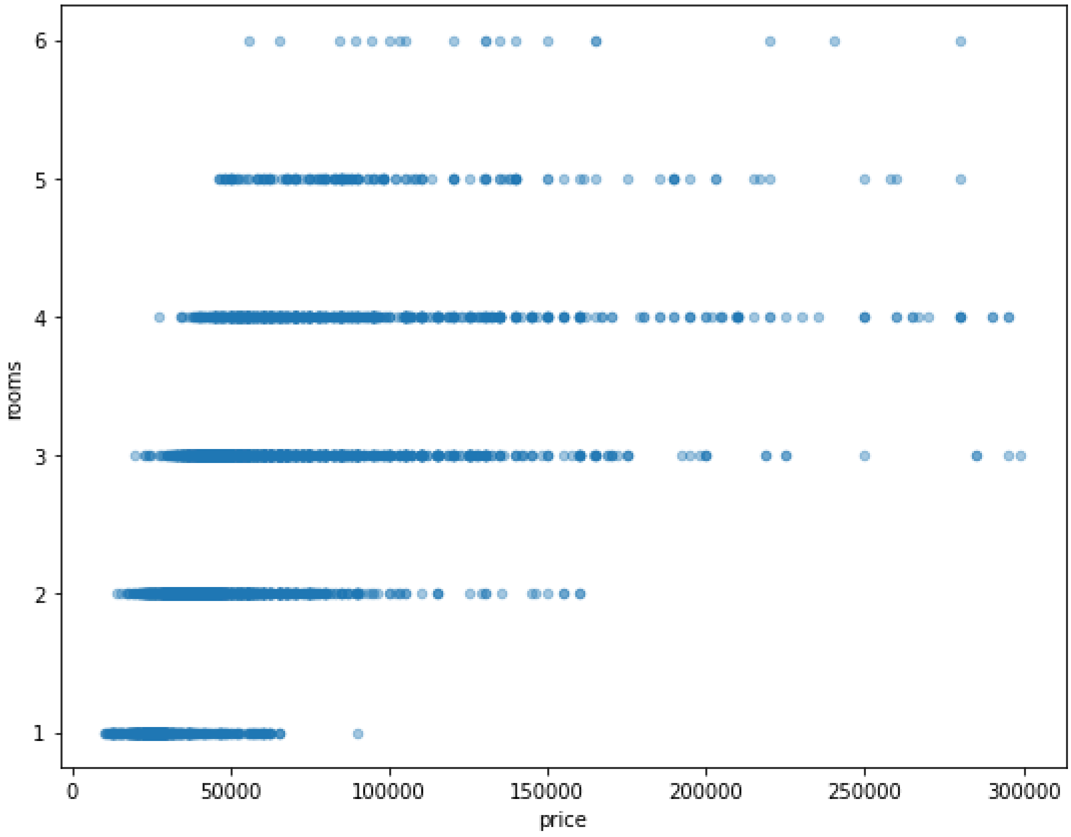
```
cols = ['price','size','rooms','max_levels']
sns.pairplot(housing[cols], height=5)
plt.show()
```



```
housing.plot(kind='scatter', x="price", y="size", alpha=0.4, figsize=(9,7),)
plt.show()
```



```
housing.plot(kind='scatter', x="price", y="rooms", alpha=0.4, figsize=(9,7))
plt.show()
```



Ma`lumotlarni ML uchun tayyorlaymiz

```
# Trainset
X_train = strat_train_set.drop("price", axis=1)
```

```
X_train_labels = strat_train_set[["price"]].copy()

# Testset
X_test = strat_test_set.drop('price', axis=1)
X_test_labels = strat_test_set[['price']].copy()
```

```
X_train.drop('location', axis=1, inplace=True)
X_test.drop('location', axis=1, inplace=True)
```

raqamli ustunlar:

```
X_train_num = X_train.drop('district', axis=1)
X_train_num
```

	rooms	size	level	max_levels
5273	2	60.00	5	9
4576	3	72.00	5	9
5158	3	75.00	6	9
6416	4	100.26	9	9
5764	2	52.50	3	9
...	...	...	...	...
4606	2	65.00	3	9
1799	4	120.00	1	4
2191	1	33.00	4	4
4111	2	54.00	3	4
4634	2	48.00	2	5

5301 rows × 4 columns

```
X_train_cat = X_train[['district']]
X_train_cat
```

	district
5273	Яккасарайский
4576	Яшнободский
5158	Мирабадский
6416	Шайхантахурский
5764	Яшнободский
...	...
4606	Мирзо-Улугбекский
1799	Мирабадский
2191	Мирзо-Улугбекский
4111	Учтепинский
4634	Чиланзарский

5301 rows × 1 columns

ML algoritmlar sonlar bilan ishlaydi. Shuning uchun bu ustunni ham sonlarga o'zgartirishimiz kerak.

Buning uchun sklearn tarkibida `OrdinalEncoder` dan foydalanamiz:

```
from sklearn.preprocessing import OrdinalEncoder
ordinal_encoder = OrdinalEncoder()
X_train_cat_encoded = ordinal_encoder.fit_transform(X_train_cat)
X_train_cat_encoded[:10]
```

```
array([[ 9.],
       [11.],
       [ 1.],
       [ 7.],
       [11.],
       [ 2.],
       [ 5.],
       [ 2.],
       [11.],
       [11.]])
```

```
ordinal_encoder.categories_
```

```
[array(['Бектемирский', 'Мирабадский', 'Мирзо-Улугбекский', 'Олмазорский',
        'Сергелийский', 'Учтепинский', 'Чиланзарский', 'Шайхантахурский',
        'Юнусабадский', 'Яккасарайский', 'Янгихаётский', 'Яшнободский'],
       dtype=object)]
```

```
X_train.head()
```

	district	rooms	size	level	max_levels
5273	Яккасарайский	2	60.00	5	9
4576	Яшнободский	3	72.00	5	9
5158	Мирабадский	3	75.00	6	9
6416	Шайхантахурский	4	100.26	9	9
5764	Яшнободский	2	52.50	3	9

```
from sklearn.preprocessing import StandardScaler
standart_scaler = StandardScaler()
standart_scaler.fit_transform(X_train_num)
```

```
array([[-0.57355106, -0.36227147,  0.61669148,  1.19296113],
       [ 0.40975883,  0.03549406,  0.61669148,  1.19296113],
       [ 0.40975883,  0.13493545,  1.08078597,  1.19296113],
       ...,
       [-1.55686095, -1.25724393,  0.152597  , -0.78758599],
       [-0.57355106, -0.56115424, -0.31149749, -0.78758599],
       [-0.57355106, -0.76003701, -0.77559197, -0.39147656]])
```

Pipline

Mavzu boshida biz jarayonlarni avtomatlashtirish haqida gapirdik. Buning uchun scikit-learn da maxsus **pipeline** tushunchasi bor. Pipeline ingliz tilidan gaz (neft) quvuri deb tarjima qilinadi. Gaz A nuqtadan B nuqtaga yetkazib berilishida bir nechta oraliq ishlov berish stansiyalaridan o'tadi.

Bizning ma'lumotlar ham shunday, boshlang'ich nuqtasidan bevosita MLga yetib kelunga qadar bir nechta jarayonolardan o'tdi. Yuqorida biz har bir jarayonni qo'lda yozib chiqdik, pipeline yordamida esa biz barcha qadamlarni birlashtirib - pipeline (yoki konveyer) hosil qilishimiz mumkin.

Pipeline so'zini konveyer deb tarjima qilishimga sabab, ma'lumotlarimiz huddi konveyerdan o'tgani kabi turli bosqichlarda turli o'zgarishlardan o'tayapti.

Biz konveyerni 2 qismga bo'lamiz:

- Sonli ustunlarga ishlov berish
- Matnli ustunlarga ishlov berish

```
from sklearn.pipeline import Pipeline
from sklearn.impute import SimpleImputer
from sklearn.preprocessing import StandardScaler

num_pipeline = Pipeline([
          ('imputer', SimpleImputer(strategy='median')),
          ('std_scaler', StandardScaler())
])
```

Yuoqirda biz sonli ustunlar uchun konveyer yaratdik (`num_pipeline`).

Pipeline ishga tushrish uchun `.fit_transform()` metodiga murojaat qilamiz.

```
num_pipeline.fit_transform(X_train_num)
```

```
array([[-0.57355106, -0.36227147,  0.61669148,  1.19296113],
       [ 0.40975883,  0.03549406,  0.61669148,  1.19296113],
       [ 0.40975883,  0.13493545,  1.08078597,  1.19296113],
       ...,
       [-1.55686095, -1.25724393,  0.152597  , -0.78758599],
       [-0.57355106, -0.56115424, -0.31149749, -0.78758599],
       [-0.57355106, -0.76003701, -0.77559197, -0.39147656]])
```

Sonli ustunlarga ishlov beruvchi konveyer tayyor, matni ustunlarchi?

Buning uchun maxsus `ColumnTransformer` obyektiga murojaat qilamiz, bu ham pipeline bir ko'rinishi. `ColumnTransformer` ichiga biz yuqorida yasalgan `num_ipeline` ham qo'shib yuboramiz.

```
from sklearn.compose import ColumnTransformer

num_attribs = list(X_train_num)
cat_attribs = ['district']
```

```
full_pipeline = ColumnTransformer([
    ('num', num_pipeline, num_attribs),
    ('cat', OrdinalEncoder(), cat_attribs)
])
```

Mana yakuniy, to'liq konveyer tayyor bo'ldi (`full_pipeline`).

Konveyerni ishga tushirish uchun `.fit_transform()` metodini chaqrisih kifoya.

ML ga tayyor bo'lgan dataset

```
X_prepared = full_pipeline.fit_transform(X_train)
X_prepared
```

```
array([[-0.57355106, -0.36227147,  0.61669148,  1.19296113,  9.        ],
       [ 0.40975883,  0.03549406,  0.61669148,  1.19296113, 11.        ],
       [ 0.40975883,  0.13493545,  1.08078597,  1.19296113,  1.        ],
       ...,
       [-1.55686095, -1.25724393,  0.152597  , -0.78758599,  2.        ],
       [-0.57355106, -0.56115424, -0.31149749, -0.78758599,  5.        ],
       [-0.57355106, -0.76003701, -0.77559197, -0.39147656,  6.        ]])
```

```
X_prepared.shape
```

```
(5301, 5)
```

Nihoyat ma'lumotlarimiz ML uchun tayyor.

Machine Learning

Linear Regression - Chiziqli regressiya

`sklearn` tarkibidagi `LinearRegression` klassidan yangi model yaratamiz.

```
from sklearn.linear_model import LinearRegression

LR_model = LinearRegression()

LR_model.fit(X_prepared, X_train_labels)
```

```
LinearRegression()
```

5-QADAM. Modelni baholaymiz

`X_test ni fullpipeline` dan o'tkamiz.

```
X_test_prepared = full_pipeline.transform(X_test)
```

Bashorat

```
y_predicted = LR_model.predict(X_test_prepared)
```

```
y_predicted
```

```
array([[19223.03040459],
       [33887.38398382],
       [70132.27911085],
       ...,
       [56003.4731856 ],
       [51883.879316  ],
       [39347.01416853]])
```

```
from sklearn.metrics import mean_squared_error, mean_absolute_error

lin_mae = mean_absolute_error(X_test_labels, y_predicted)
lin_mse = mean_squared_error(X_test_labels, y_predicted)

# RMSE hisoblaymiz
lin_rmse = np.sqrt(lin_mse)

print(lin_rmse)
print(lin_mae)
```

```
21995.21097432492
13602.891123633606
```

Demak, `RMSE=21995$` chiqdi. Yomon emas, lekin yaxshi ham emas. Ya'ni modelimiz uylarni baholashda o'rtacha `22000$` ga adashayapti.

Model aniqligini oshirish uchun yagona, universal yechim yo'q. Qilib ko'rishimiz mumkin bo'lgan ishlar:

- Yaxhsiroq paramterlar topish
- Yaxhsiroq model (algoritm) tanlash
- Ko'proq ma'lumot yig'ish va hokazo.

Biz hozir boshqa model bilan sinab ko'ramiz.

DecisionTree

```
from sklearn.tree import DecisionTreeRegressor
Tree_model = DecisionTreeRegressor()
Tree_model.fit(X_prepared, X_train_labels)

y_predicted = Tree_model.predict(X_test_prepared)

mae = mean_absolute_error(X_test_labels, y_predicted)
mse = mean_squared_error(X_test_labels, y_predicted)

# RMSE hisoblaymiz
```

```
rmse = np.sqrt(mse)

print('RMSE: ',rmse)
print('MAE:' ,mae)
```

```
RMSE:  25706.883830581468
MAE: 12986.105847170304
```

RandomForest

```
from sklearn.ensemble import RandomForestRegressor
RF_model = RandomForestRegressor()
RF_model.fit(X_prepared, X_train_labels)

y_predicted = RF_model.predict(X_test_prepared)

mae = mean_absolute_error(X_test_labels, y_predicted)
mse = mean_squared_error(X_test_labels, y_predicted)

# RMSE hisoblaymiz
rmse = np.sqrt(mse)

print('RMSE: ',rmse)
print('MAE:' ,mae)
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
  This is separate from the ipykernel package so we can avoid doing imports until
```

```
RMSE:  19620.919331638837
MAE: 11149.003567882786
```

Bu holatda ancha yaxshi chiqdi

Cross-Validation usuli bilan baholash

Yuqorida biz modelni baholash uchun ma'lumotlarni test va train setlarga ajratdik. Bu usulning kamchiligi biz test va train uchun doim bir xil ma'lumotlardan foydalanayapmiz.

Cross-validation yordamida biz ma'lumotlarni bir necha qismga ajratib, modelni turli qismlar yordamida bir nechta bor train va test qilishimiz mumkin.

Misol uchun, quyidagi rasmda ma'lumotlarni 5 ga ajratib train va test qilish ko'rsatilgan.

Cross validation uchun ma'lumotlarni train va testga bo'lish shart emas, buni sklearn o'zi qiladi.

```
df
```

	location	district	rooms	size	level	max_levels	price	price_cat

	location	district	rooms	size	level	max_levels	price	price_cat
0	город Ташкент, Юнусабадский район, Юнусабад 8-...	Юнусабадский	3	57.0	4	4	52000	3
1	город Ташкент, Яккасарайский район, 1-й тупик ...	Яккасарайский	2	52.0	4	5	56000	3
2	город Ташкент, Чиланзарский район, Чиланзар 2-...	Чиланзарский	2	42.0	4	4	37000	2
3	город Ташкент, Чиланзарский район, Чиланзар 9-...	Чиланзарский	3	65.0	1	4	49500	2
4	город Ташкент, Чиланзарский район, площадь Актепа	Чиланзарский	3	70.0	3	5	55000	3
...	...	...	...	...	...	...	...	...
6622	город Ташкент, Яшнободский район, Городок Авиа...	Яшнободский	1	38.0	5	5	24500	1
6623	город Ташкент, Яшнободский район, 1-й проезд А...	Яшнободский	2	49.0	1	4	32000	2
6624	город Ташкент, Шайхантахурский район, Зульфиях...	Шайхантахурский	2	64.0	3	9	40000	2
6625	город Ташкент, Мирзо-Улугбекский район, Буюк И...	Мирзо-Улугбекский	1	18.0	1	4	11000	1
6626	город Ташкент, Чиланзарский район, Чиланзар 6-...	Чиланзарский	1	30.0	2	4	22914	1

6627 rows × 8 columns

```
df.drop('location', axis=1, inplace=True)
```

```
X = df.drop("price", axis=1)
y = df["price"].copy()

X_prepared = full_pipeline.transform(X)
```

Validation natijalarini ko'rsatish uchun sodda funksiya yasab olamiz

```
def display_scores(scores):
    print("Scores:", scores)
    print("Mean:", scores.mean())
    print("Std.dev:", scores.std())
```

Cross-validation

```
from sklearn.model_selection import cross_val_score
```

LinearRegression

```
scores = cross_val_score(LR_model, X_prepared, y, scoring="neg_mean_absolute_error", cv

display_scores(-scores)
```

```
Scores: [11859.17851689 11803.95049448 15451.98676188 15091.06368489
 14595.8845893  14532.58774108 13472.44409197 12291.82863013
 12661.85216536 11945.4085178 ]
Mean: 13370.618519378477
Std.dev: 1363.4553050846412
```

Decision Tree

```
scores = cross_val_score(Tree_model, X_prepared, y, scoring="neg_mean_absolute_error",

display_scores(-scores)
```

```
Scores: [10630.97420438 11623.87264152 13822.79119117 14827.29865012
 13273.07707349 13811.31409952 13052.07914981 11060.7834865
 12896.10702221 10293.95437545]
Mean: 12529.225189416591
Std.dev: 1453.7976977030876
```

Random Forest

```
scores = cross_val_score(RF_model, X_prepared, y, scoring="neg_mean_absolute_error", cv

display_scores(-scores)
```

```
Scores: [ 8696.53491289  9579.91679661 12272.95658044 12507.77749688
 11261.07581525 11602.93024528 10444.27143945  9166.41586531
 10470.43551698  9045.01438983]
Mean: 10504.732905890589
Std.dev: 1302.6304907551632
```

Modelni saqlash

Buning uchun Pythondagi `pickle` yoki `joblib` modullaridan foydalanamiz.

`pickle` yordamida saqlash

```
import pickle

filename = 'RF_model.pkl' # faylga istalgan nom beramiz
with open(filename, 'wb') as file:
    pickle.dump(RF_model, file)
```

Modelni qayta o`qish

```
with open(filename, 'rb') as file:
    model = pickle.load(file)
```

```
scores = cross_val_score(model, X_prepared, y, scoring="neg_mean_absolute_error", cv=5)

display_scores(-scores)
```

```
Scores: [ 9375.39937916 12759.00967542 11954.33281245 10342.23130278
  9988.41245305]
Mean: 10883.877124573133
Std.dev: 1267.4967254837293
```

`joblib` yordamida saqlash

joblib katta NumPy martrisalarni siqib saqlash uchun afzal.

`joblib` o'rnatilmagan bo'lsa `pip install joblib` yordamida o'rnatib olamiz.

```
import joblib

filename = 'RF_model.jbl' # faylga istalgan nom beramiz
joblib.dump(RF_model, filename)
```

```
['RF_model.jbl']
```

Etiboringiz uchun tashkkur, foydali bo`ladi degan umiddaman✔