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Рубежный контроль №2

In [1]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.ensemble import RandomForestRegressor
from sklearn.svm import LinearSVR, SVR, NuSVR
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_absolute_error, mean_squared_error, mean_squared_log_err
or, median_absolute_error, r2_score
%matplotlib inline
sns.set(style="ticks")
```

In [2]:

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

In [3]:

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

Out[3]:

```
(54294, 39)
```

In [4]:

```
# типы колонок
data.dtypes
```

Out[4]:

```
permalink                object
name                     object
homepage_url             object
category_list            object
 market                  object
 funding_total_usd       object
status                   object
country_code             object
state_code               object
region                   object
city                     object
funding_rounds          float64
founded_at               object
founded_month            object
founded_quarter          object
founded_year            float64
first_funding_at         object
last_funding_at          object
seed                    float64
venture                 float64
equity_crowdfunding     float64
undisclosed             float64
convertible_note        float64
debt_financing          float64
angel                   float64
grant                   float64
private_equity          float64
post_ipo_equity         float64
```

```
post_ipo_equity           float64
post_ipo_debt             float64
secondary_market          float64
product_crowdfunding      float64
round_A                   float64
round_B                   float64
round_C                   float64
round_D                   float64
round_E                   float64
round_F                   float64
round_G                   float64
round_H                   float64
dtype: object
```

In [5]:

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

Out[5]:

```
permalink                  4856
name                       4857
homepage_url               8305
category_list              8817
 market                    8824
 funding_total_usd         4856
status                     6170
country_code              10129
state_code                24133
region                    10129
city                      10972
funding_rounds             4856
founded_at                15740
founded_month             15812
founded_quarter           15812
founded_year              15812
first_funding_at           4856
last_funding_at            4856
seed                       4856
venture                    4856
equity_crowdfunding        4856
undisclosed                4856
convertible_note           4856
debt_financing             4856
angel                      4856
grant                      4856
private_equity             4856
post_ipo_equity            4856
post_ipo_debt              4856
secondary_market           4856
product_crowdfunding       4856
round_A                    4856
round_B                    4856
round_C                    4856
round_D                    4856
round_E                    4856
round_F                    4856
round_G                    4856
round_H                    4856
dtype: int64
```

In [6]:

```
# текстовые данные преобразуем в числовые
columns_string = data.select_dtypes(include='object').columns.tolist()
```

In [7]:

```
for column_string in columns_string:
    data[column_string] = pd.factorize(data[column_string])[0]
```

In [8]:

```
# приведем все числа к значениям от 0 до 1
scaler = MinMaxScaler()
```

In [9]:

```
scaler.fit_transform(data)
```

Out[9]:

```
array([[2.02281738e-05, 2.02634245e-05, 2.18102508e-05, ...,
        0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
       [4.04563476e-05, 4.05268490e-05, 4.36205016e-05, ...,
        0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
       [6.06845214e-05, 6.07902736e-05, 6.54307525e-05, ...,
        0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
       ...,
       [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, ...,
                   nan,             nan,             nan],
       [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, ...,
                   nan,             nan,             nan],
       [0.00000000e+00, 0.00000000e+00, 0.00000000e+00, ...,
                   nan,             nan,             nan]])
```

In [10]:

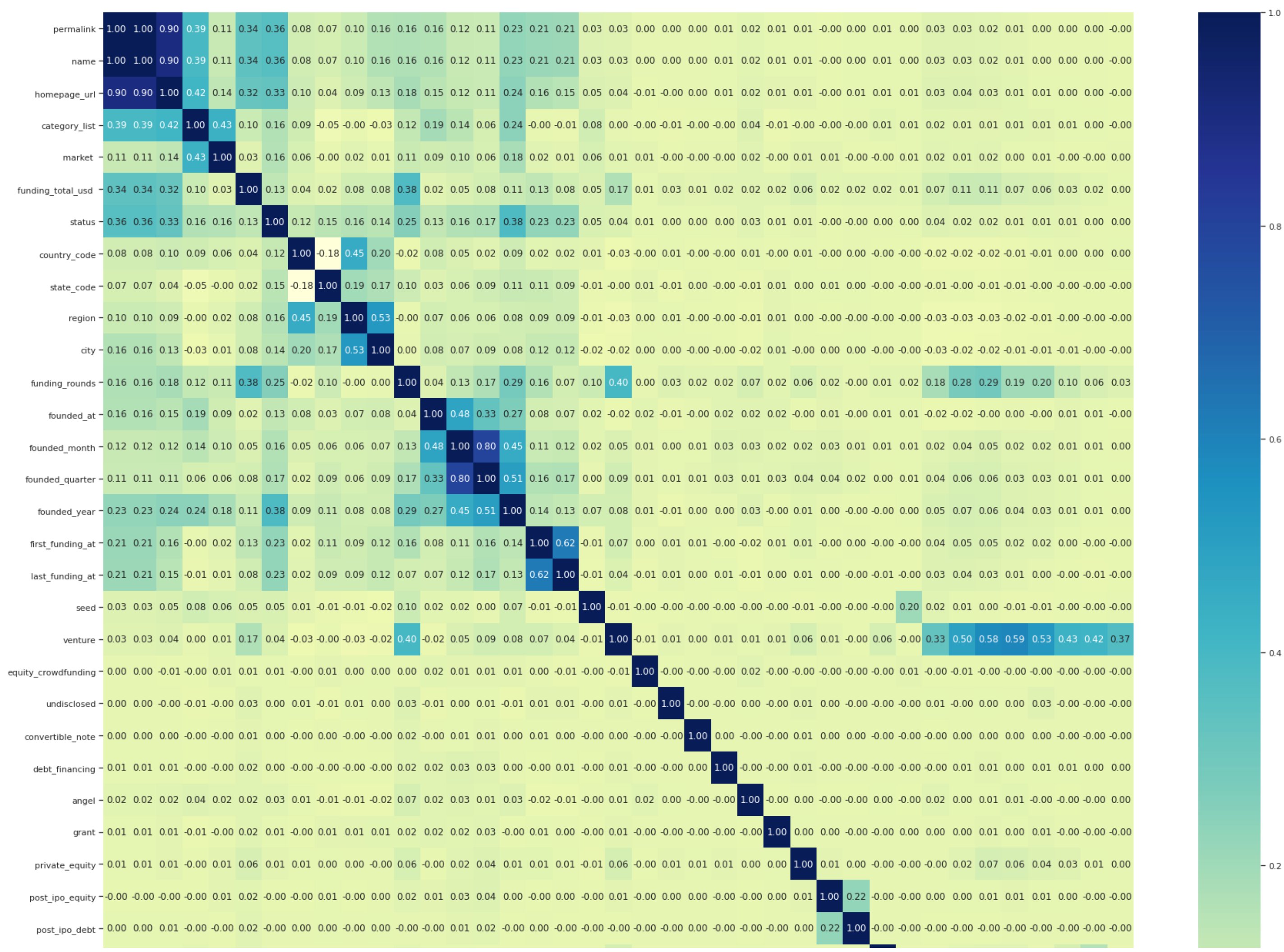
```
# занулим пропущенные данные (nan)
data.fillna(0, inplace=True)
```

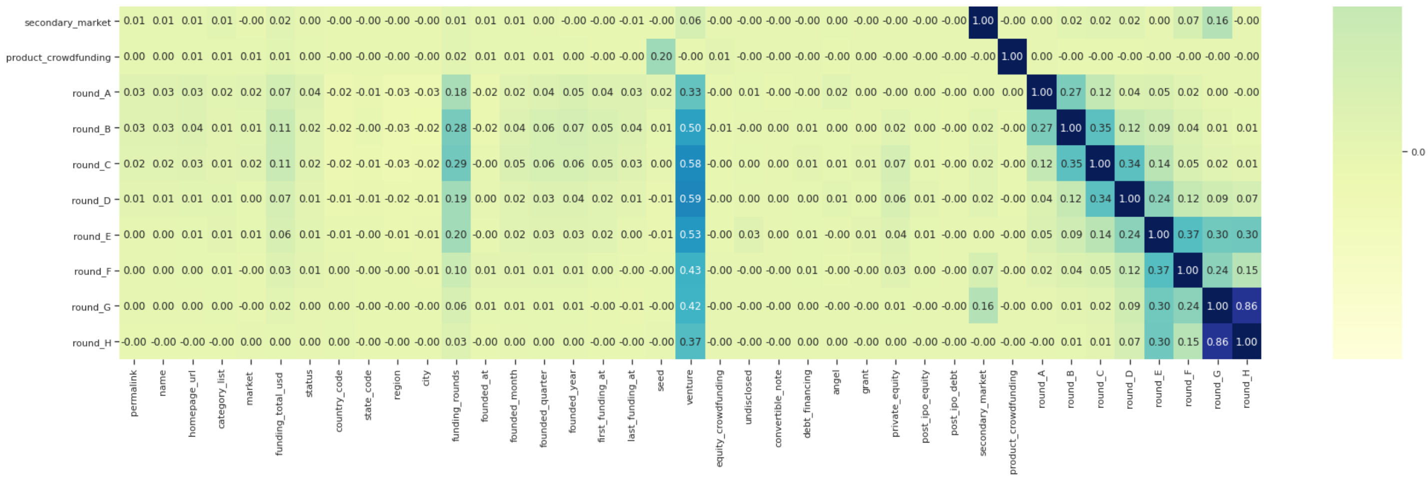
In [11]:

```
fig, ax = plt.subplots(figsize=(30,30))
sns.heatmap(data.corr(), annot=True, fmt='.2f', cmap="YlGnBu")
```

Out[11]:

<AxesSubplot:>





In [12]:

```
# data = data.drop(['permalink', 'name', 'homepage_url', 'category_list', ' market ', ' f
unding_total_usd ', 'status', 'country_code', 'state_code', 'region', 'city', 'founded_at
', 'founded_month', 'founded_quarter', 'first_funding_at', 'last_funding_at'], 1)
data.shape
```

Out[12]:

(54294, 39)

In [13]:

```
data.head()
```

Out[13]:

	permalink	name	homepage_url	category_list	market	funding_total_usd	status	country_code	state_code	region	...	sec
0	0	0	0	0	0	0	0	0	0	0	...	
1	1	1	1	1	1	1	1	0	1	1	...	
2	2	2	2	2	2	2	1	1	-1	2	...	
3	3	3	3	3	3	3	1	2	-1	3	...	
4	4	4	-1	4	4	4	1	0	2	4	...	

5 rows × 39 columns

Метод опорных векторов: визуализация

In [52]:

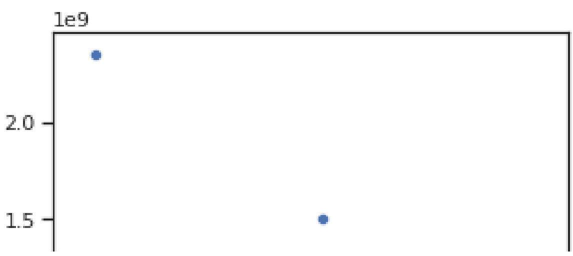
```
data_x = data['round_C'].values
data_y = data['venture'].values
```

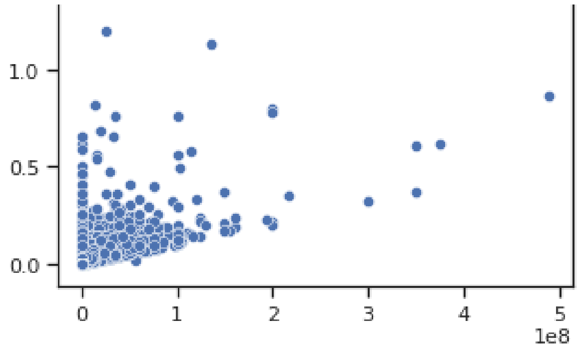
In [53]:

```
fig, ax = plt.subplots(figsize=(5,5))
sns.scatterplot(ax=ax, x=data_x, y=data_y)
```

Out[53]:

<AxesSubplot:>





In [54]:

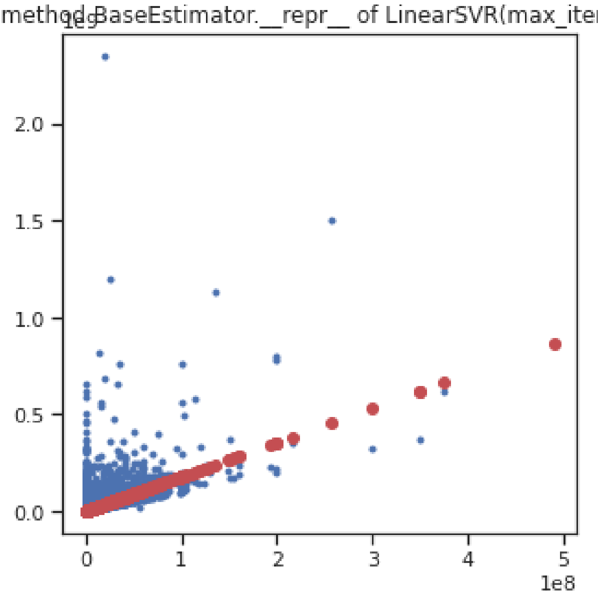
```
def plot_regr(clf):
    title = clf.__repr__
    clf.fit(data_x.reshape(-1, 1), data_y)
    data_y_pred = clf.predict(data_x.reshape(-1, 1))
    fig, ax = plt.subplots(figsize=(5,5))
    ax.set_title(title)
    ax.plot(data_x, data_y, 'b.')
    ax.plot(data_x, data_y_pred, 'ro')
    plt.show()
```

In [55]:

```
plot_regr(LinearSVR(C=1.0, max_iter=100000))
```

```
/root/miniconda3/lib/python3.8/site-packages/sklearn/svm/_base.py:985: ConvergenceWarning
: Liblinear failed to converge, increase the number of iterations.
  warnings.warn("Liblinear failed to converge, increase "
```

<bound method BaseEstimator.__repr__ of LinearSVR(max_iter=100000)>



In [ ]:

```
plot_regr(SVR(kernel='linear', C=1.0))
```

In [ ]:

```
plot_regr(SVR(kernel='rbf', gamma=0.8, C=1.0))
```

In [ ]:

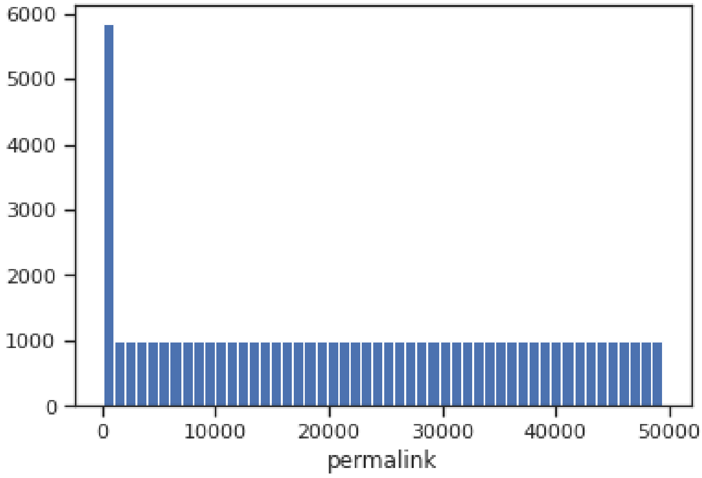
```
plot_regr(NuSVR(kernel='rbf', gamma=0.4, nu=0.9, C=1.0))
```

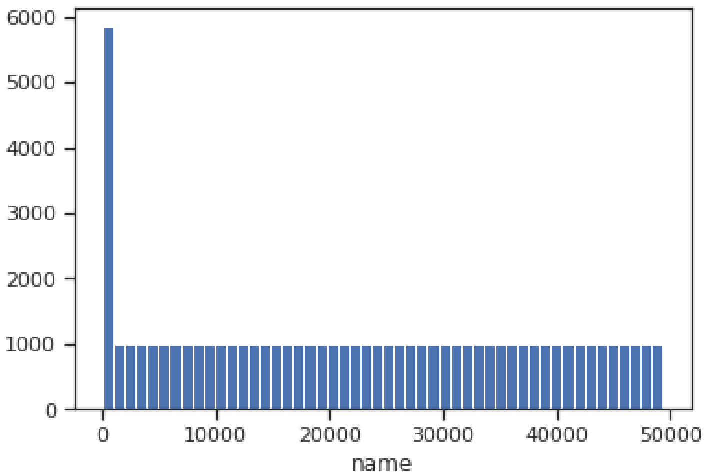
Масштабирование данных

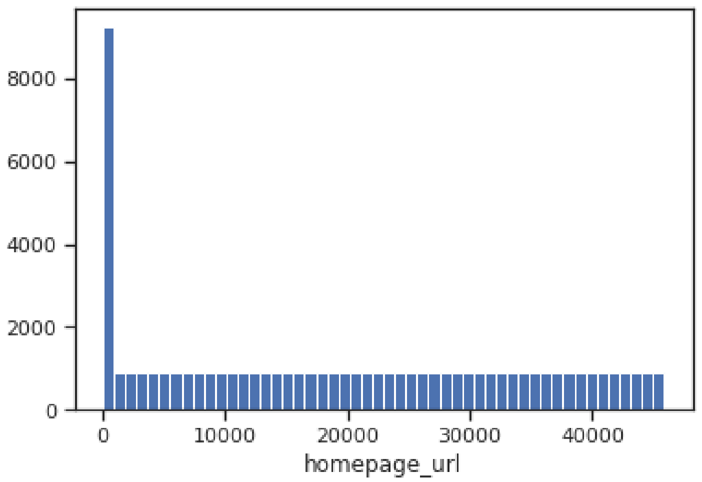
In [14]:

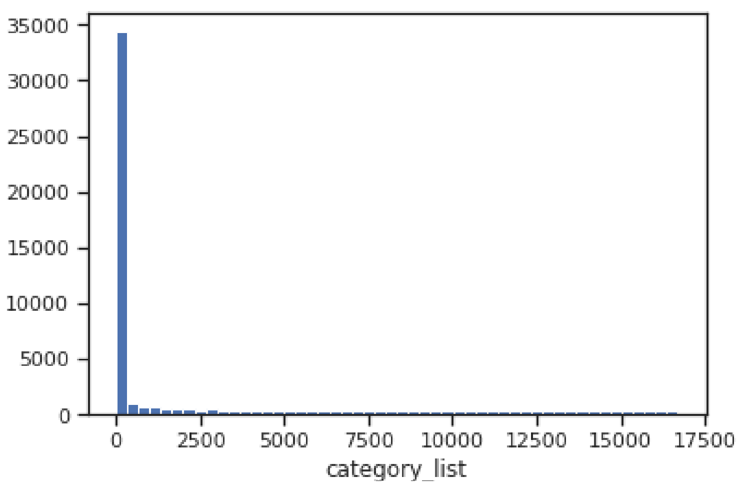
```
# Гистограмма по признакам
```

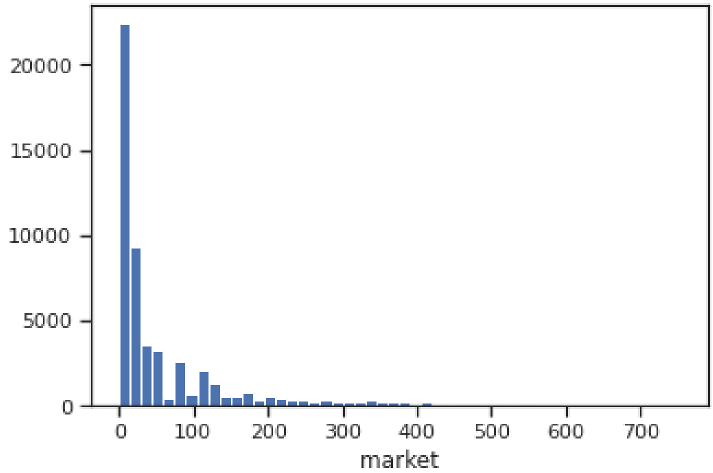
```
# Гистограмма по признакам
num_col = data.columns.tolist()
for col in num_col:
    plt.hist(data[col], 50)
    plt.xlabel(col)
    plt.show()
```

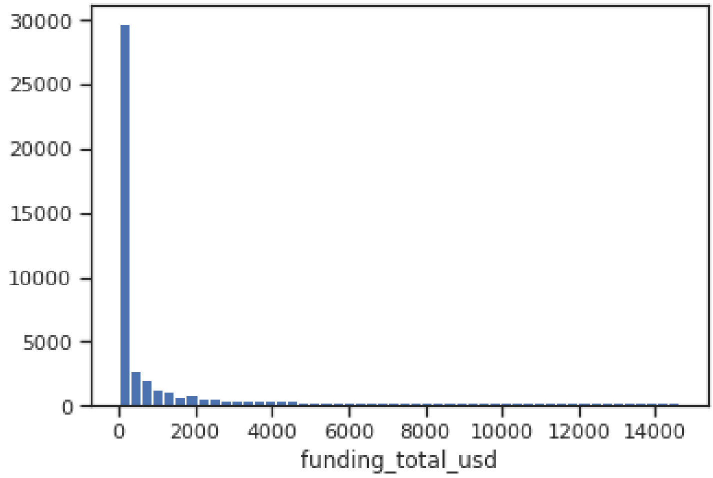


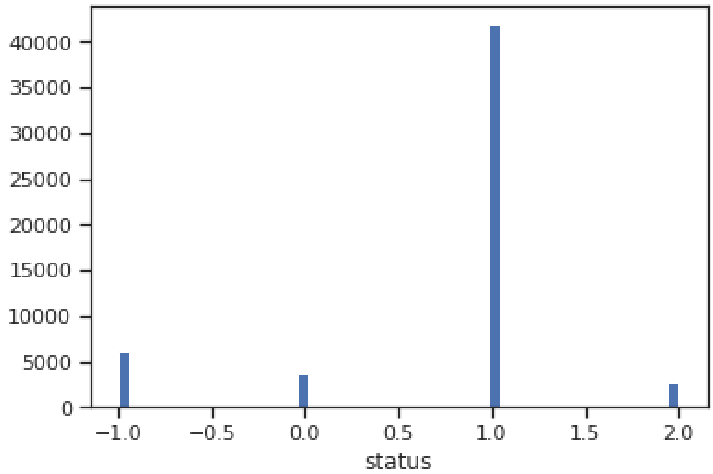


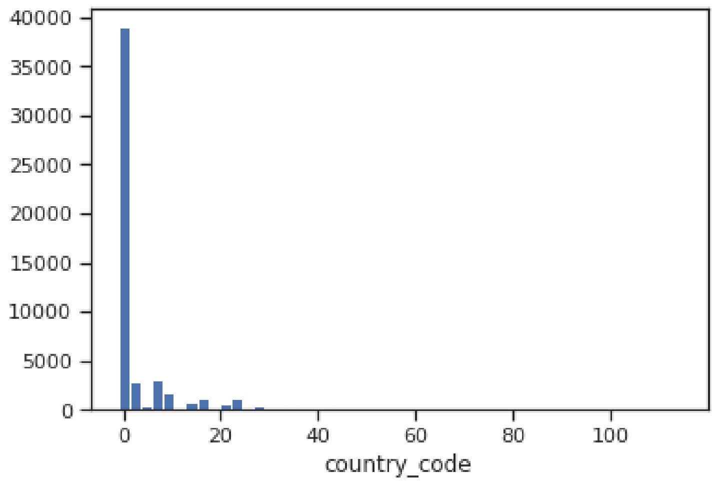




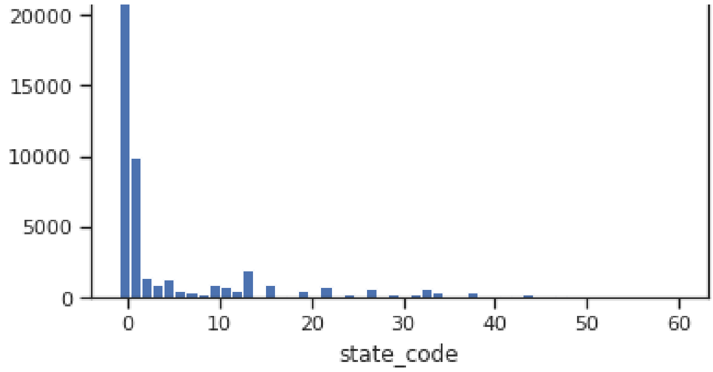

20000
15000
10000
5000
0
0 100 200 300 400 500 600 700
market


30000
25000
20000
15000
10000
5000
0
0 2000 4000 6000 8000 10000 12000 14000
funding_total_usd

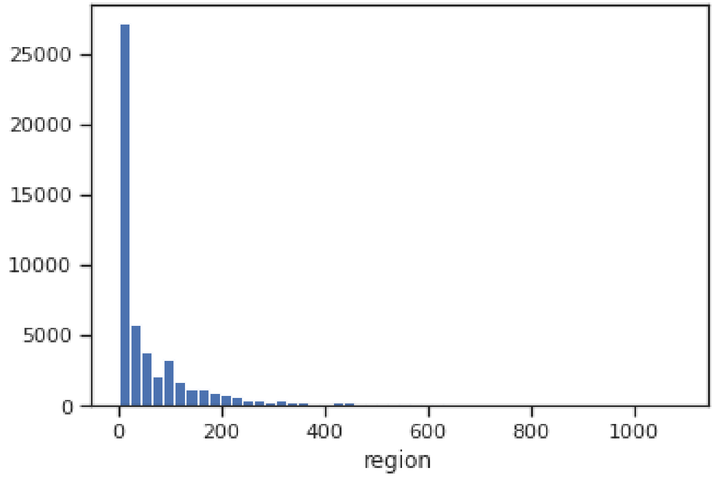

40000
35000
30000
25000
20000
15000
10000
5000
0
−1.0 −0.5 0.0 0.5 1.0 1.5 2.0
status


40000
35000
30000
25000
20000
15000
10000
5000
0
0 20 40 60 80 100
country_code

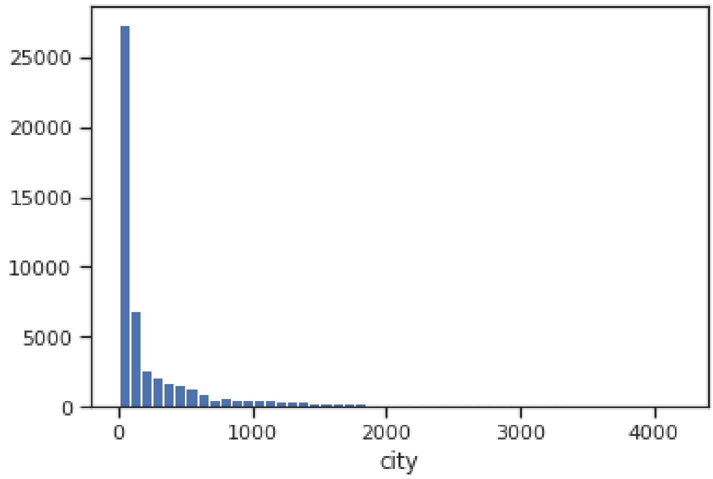

25000



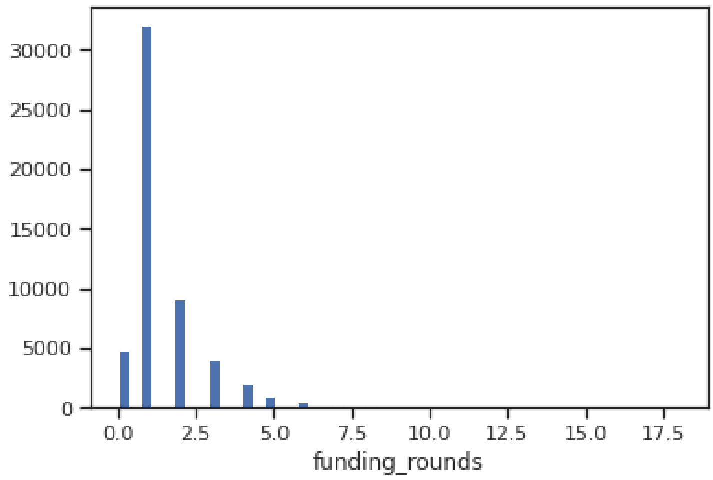
20000
15000
10000
5000
0
0
10
20
30
40
50
60
state_code



25000
20000
15000
10000
5000
0
0
200
400
600
800
1000
region

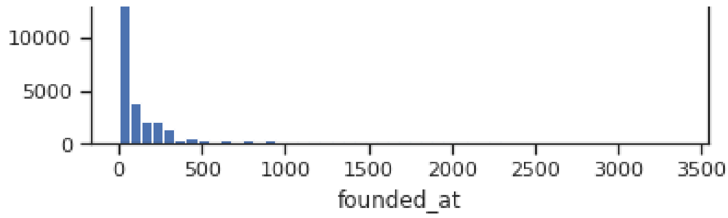


25000
20000
15000
10000
5000
0
0
1000
2000
3000
4000
city

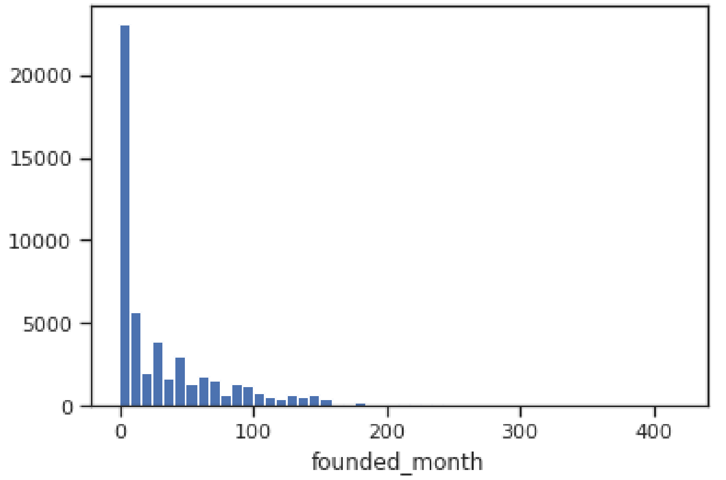


30000
25000
20000
15000
10000
5000
0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
funding_rounds

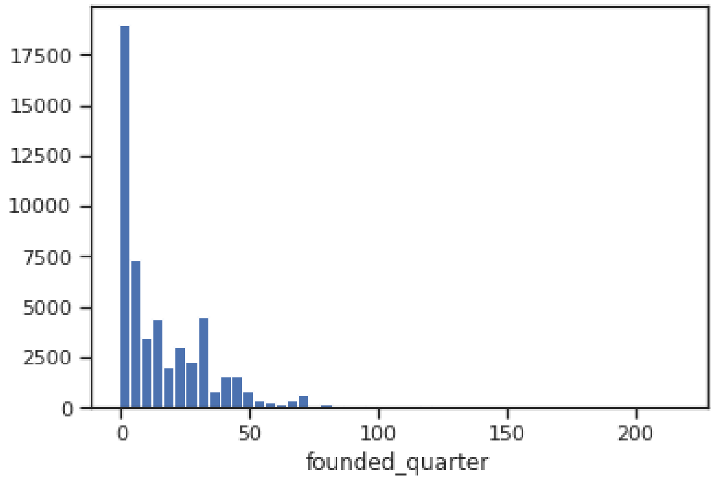
35000
30000
25000
20000
15000



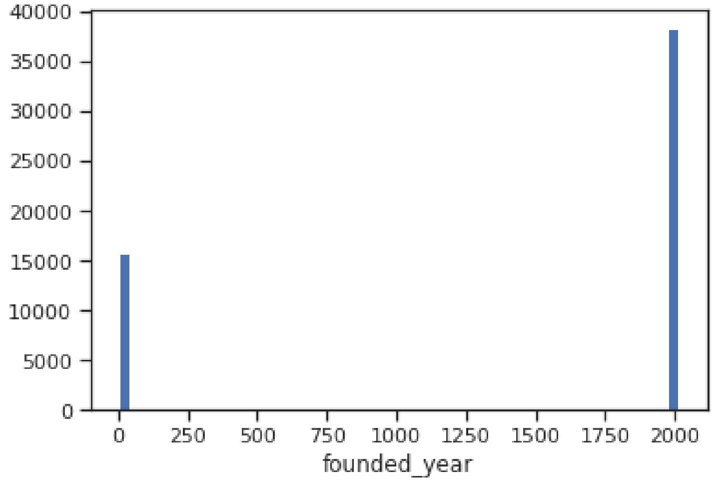
10000
5000
0
0 500 1000 1500 2000 2500 3000 3500
founded_at



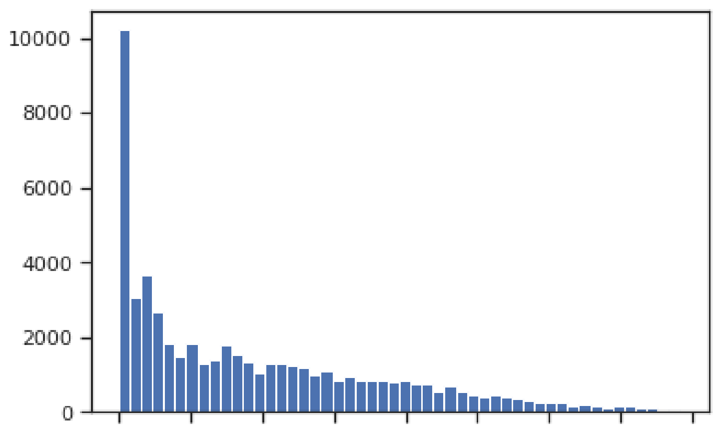
20000
15000
10000
5000
0
0 100 200 300 400
founded_month



17500
15000
12500
10000
7500
5000
2500
0
0 50 100 150 200
founded_quarter

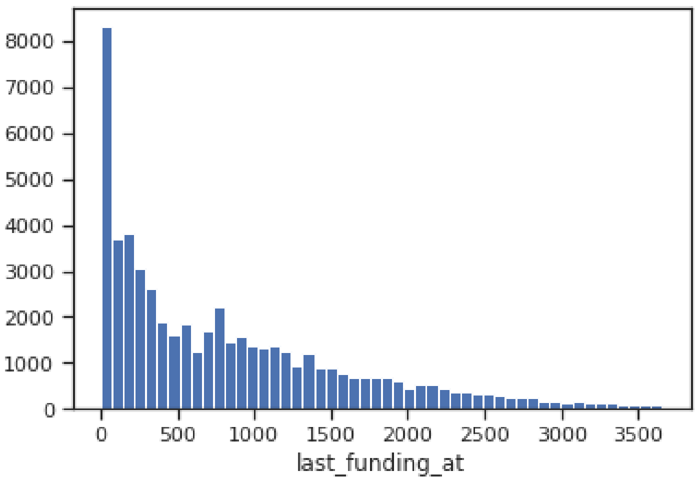


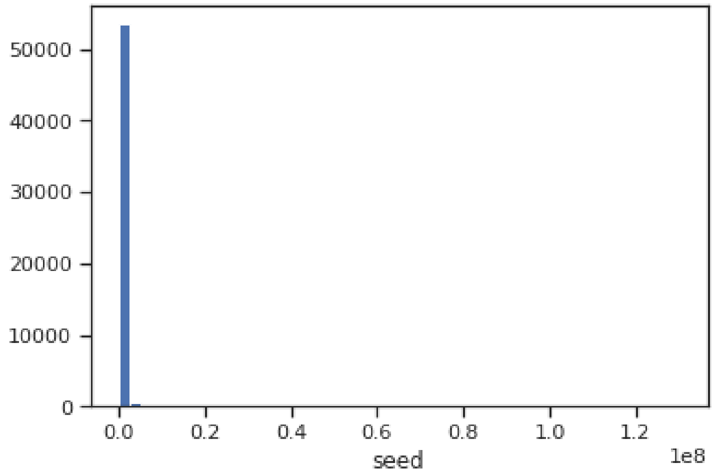
40000
35000
30000
25000
20000
15000
10000
5000
0
0 250 500 750 1000 1250 1500 1750 2000
founded_year

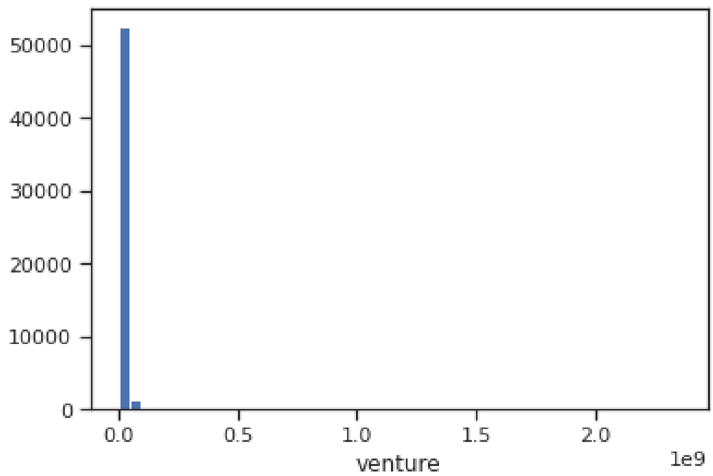


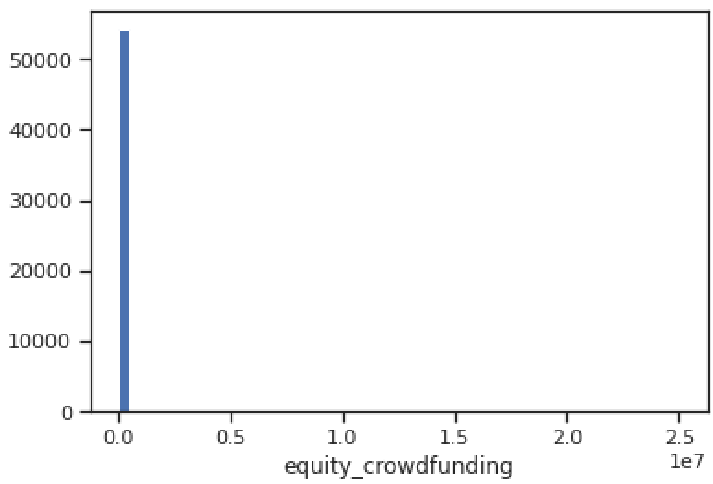
10000
8000
6000
4000
2000
0


0 500 1000 1500 2000 2500 3000 3500 4000
first_funding_at

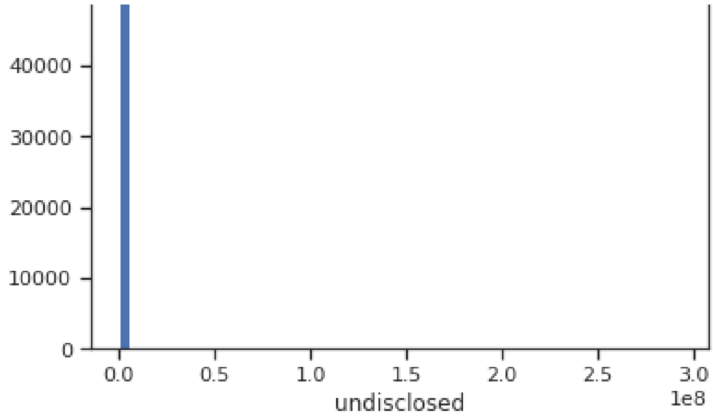

8000
7000
6000
5000
4000
3000
2000
1000
0
0 500 1000 1500 2000 2500 3000 3500
last_funding_at

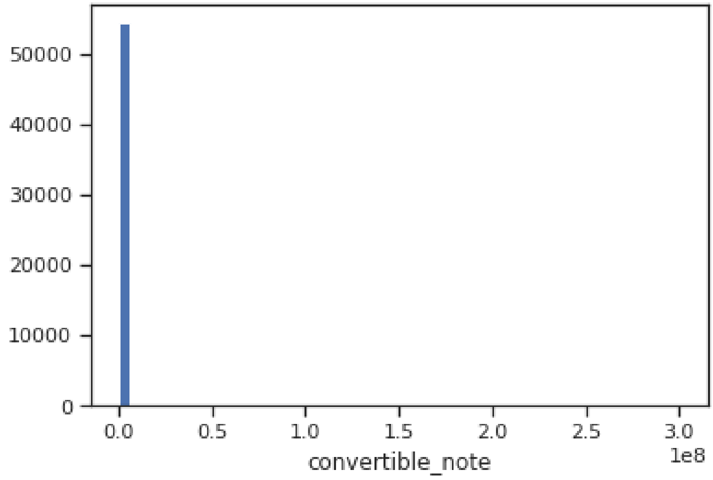

50000
40000
30000
20000
10000
0
0.0 0.2 0.4 0.6 0.8 1.0 1.2
1e8
seed

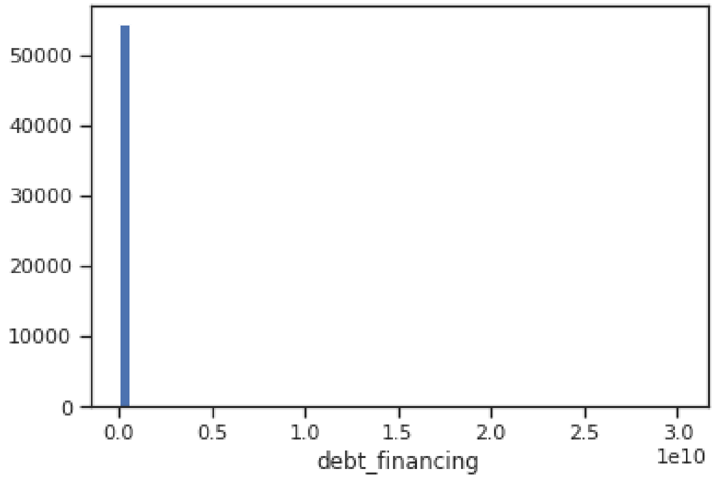

50000
40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0
1e9
venture

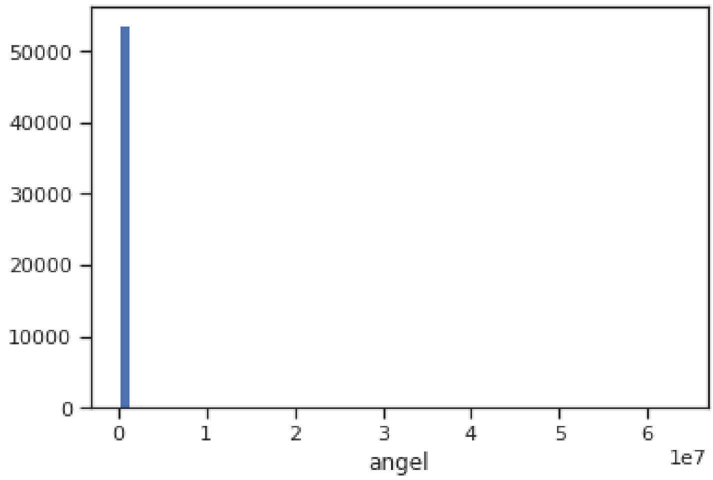

50000
40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0 2.5
1e7
equity_crowdfunding


50000

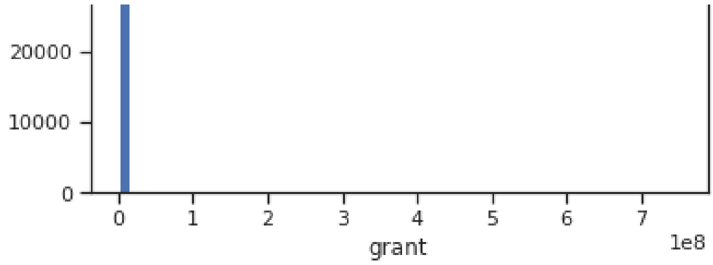

40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
1e8
undisclosed

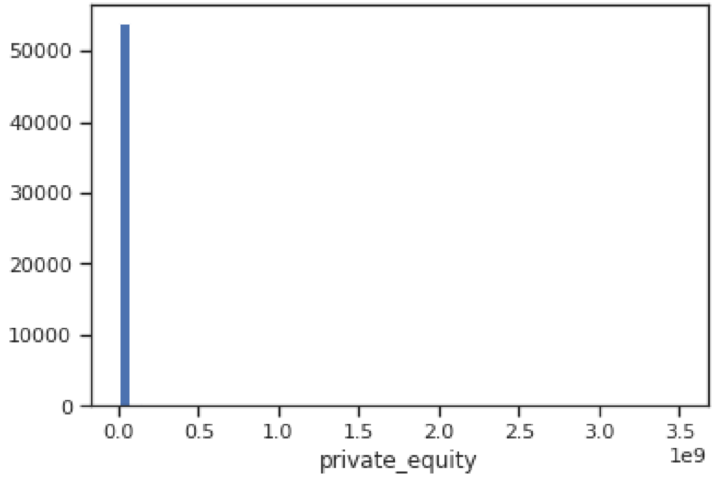

50000
40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
1e8
convertible_note

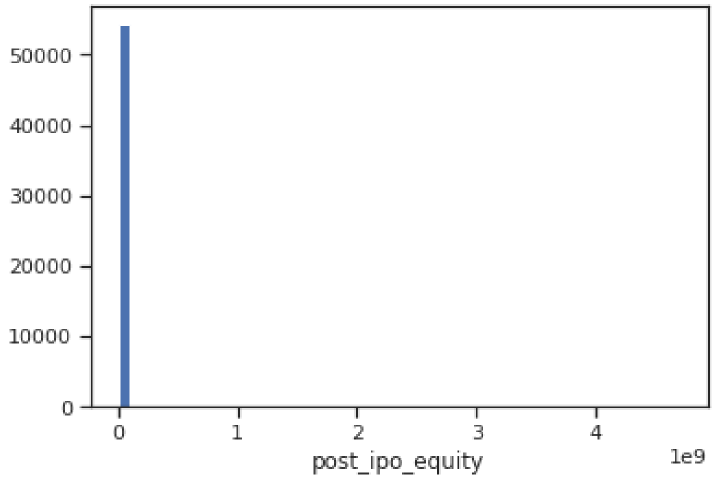

50000
40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
1e10
debt_financing

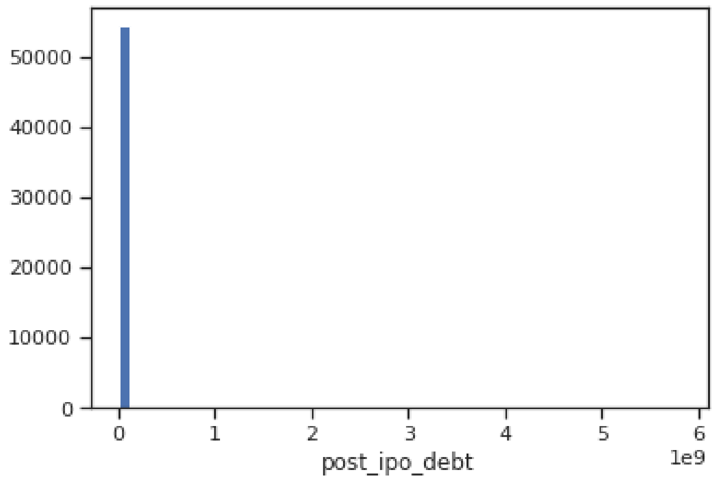

50000
40000
30000
20000
10000
0
0 1 2 3 4 5 6
1e7
angel


50000
40000
30000

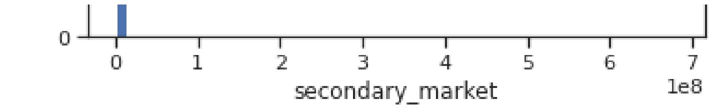

20000
10000
0
0 1 2 3 4 5 6 7
1e8
grant

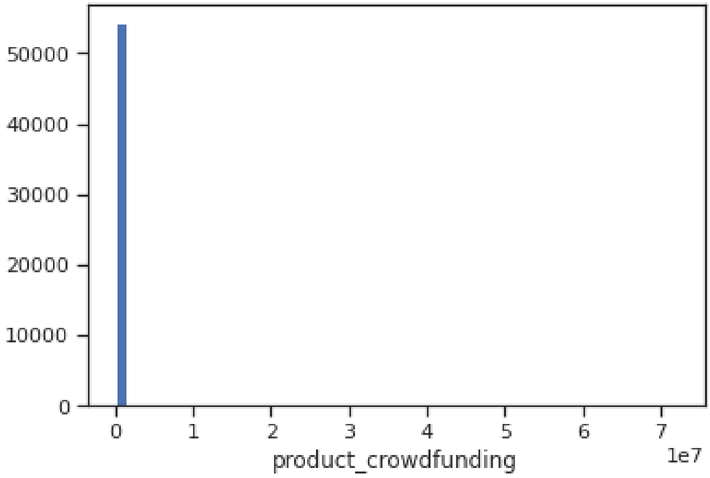

50000
40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
1e9
private_equity

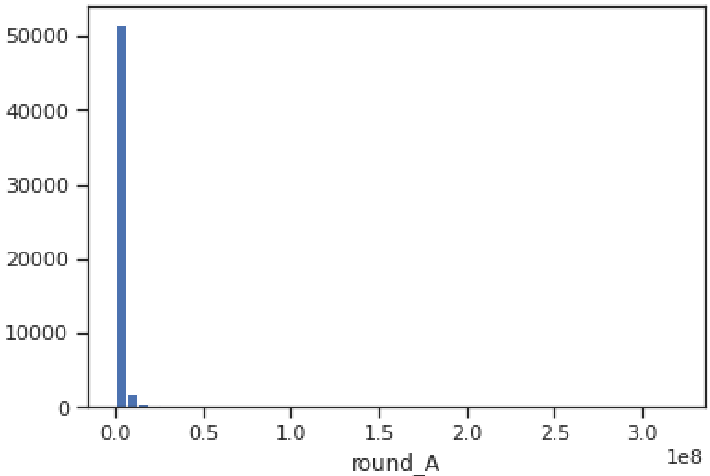

50000
40000
30000
20000
10000
0
0 1 2 3 4
1e9
post_ipo_equity

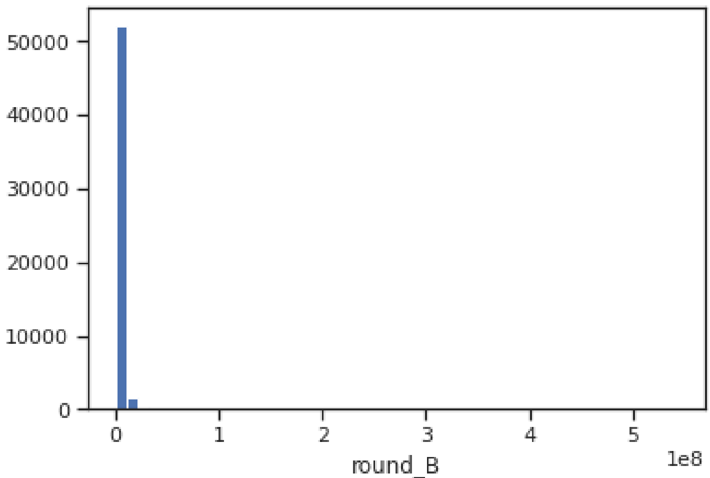

50000
40000
30000
20000
10000
0
0 1 2 3 4 5 6
1e9
post_ipo_debt

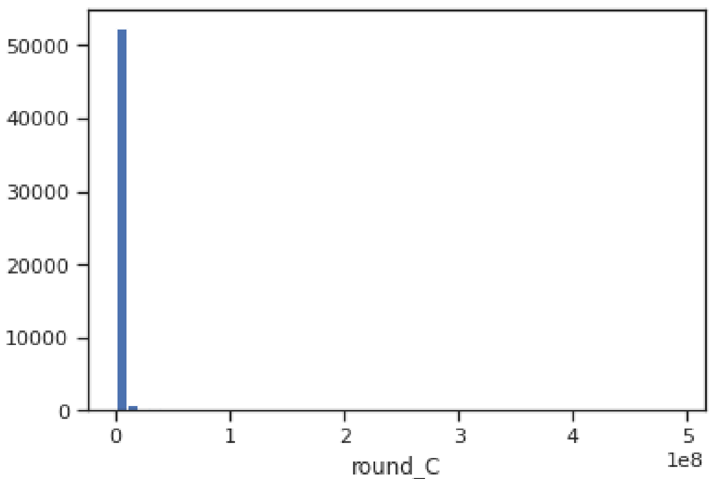

50000
40000
30000
20000
10000

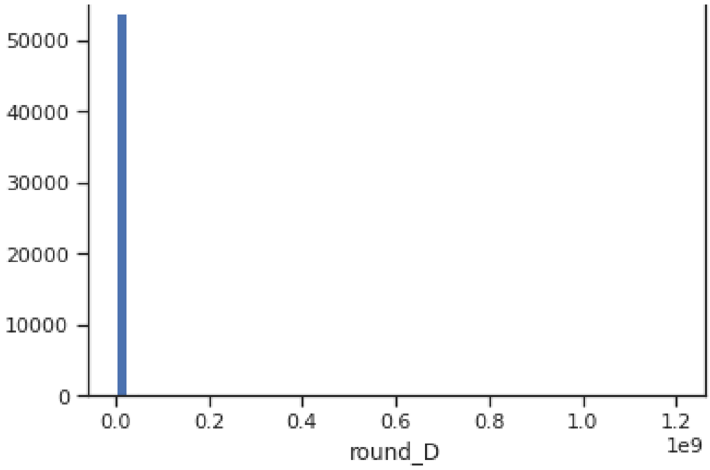

0
0 1 2 3 4 5 6 7
secondary_market
1e8

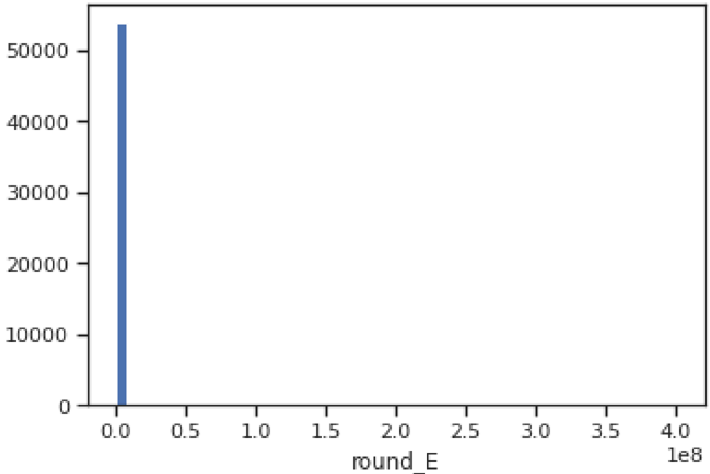

50000
40000
30000
20000
10000
0
0 1 2 3 4 5 6 7
product_crowdfunding
1e7

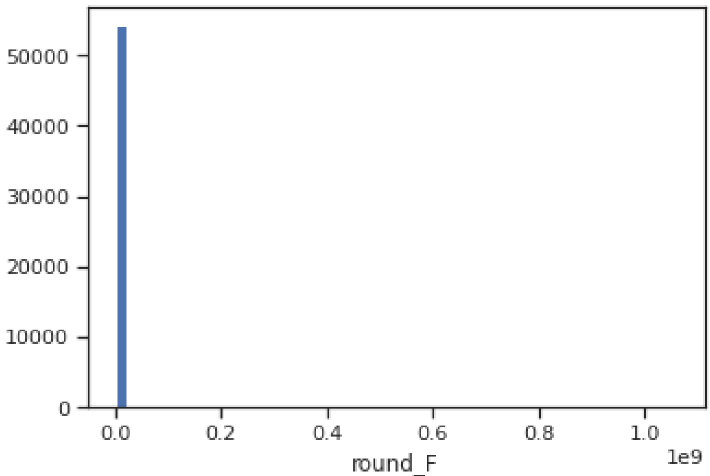

50000
40000
30000
20000
10000
0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
round_A
1e8

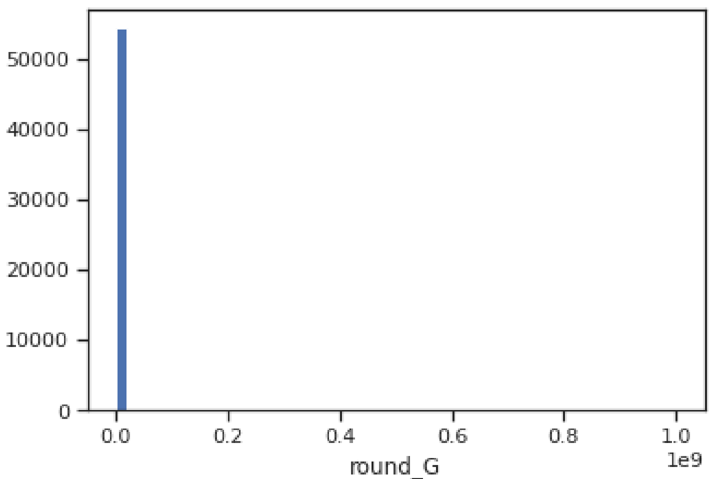

50000
40000
30000
20000
10000
0
0 1 2 3 4 5
round_B
1e8


50000
40000
30000
20000
10000
0
0 1 2 3 4 5
round_C
1e8

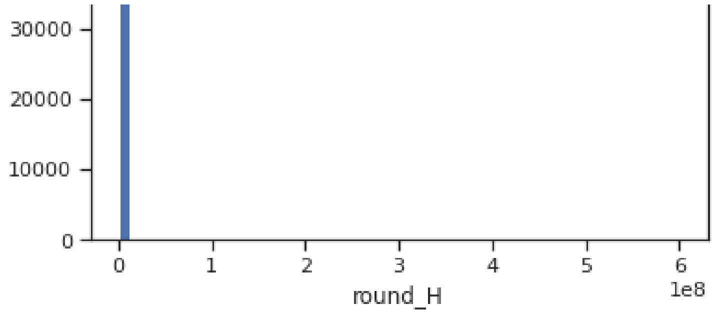

50000
40000
30000
20000
10000
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1e9
round_D


50000
40000
30000
20000
10000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
1e8
round_E


50000
40000
30000
20000
10000
0
0.0
0.2
0.4
0.6
0.8
1.0
1e9
round_F


50000
40000
30000
20000
10000
0
0.0
0.2
0.4
0.6
0.8
1.0
1e9
round_G


50000
40000



Выбор класса для задачи регрессии метода опорных векторов

In [15]:

```
data_X_train, data_X_test, data_y_train, data_y_test = train_test_split(
    data[num_col], data['first_funding_at'], test_size=0.5, random_state=1)

data_X_train.shape, data_X_test.shape
```

Out[15]:

```
((27147, 39), (27147, 39))
```

In [16]:

```
svr_1 = SVR()
svr_1.fit(data_X_train, data_y_train)
```

Out[16]:

```
SVR()
```

In [17]:

```
data_y_pred = svr_1.predict(data_X_test)
```

In [18]:

```
mean_absolute_error(data_y_test, data_y_pred), mean_squared_error(data_y_test, data_y_pre
d)
```

Out[18]:

```
(727.7916571538794, 897568.1810097131)
```

In [19]:

```
nusvr_1 = NuSVR(gamma=0.4, nu=0.9, C=1.0)
nusvr_1.fit(data_X_train, data_y_train)
```

Out[19]:

```
NuSVR(gamma=0.4, nu=0.9)
```

In [20]:

```
data_y_pred = nusvr_1.predict(data_X_test)
```

In [21]:

```
mean_absolute_error(data_y_test, data_y_pred), mean_squared_error(data_y_test, data_y_pre
d)
```

Out[21]:

```
(673.9775777051882, 828358.56736201)
```

NuSVR(gamma=0.4, nu=0.9) имеет меньшие средние абсолютную и квадратичную ошибки по сравнению с **SVR()**. Поэтому для построения модели будем использовать **NuSVR(gamma=0.4, nu=0.9).**

Построение моделей регрессии и оценка качеств моделей

In [22]:

```
def vis_models_quality(array_metric, array_labels, str_header, figsize=(5, 5)):
    fig, ax1 = plt.subplots(figsize=figsize)
    pos = np.arange(len(array_metric))
    rects = ax1.barh(pos, array_metric,
                     align='center',
                     height=0.5,
                     tick_label=array_labels)
    ax1.set_title(str_header)
    for a,b in zip(pos, array_metric):
        plt.text(0, a, str(round(b,4)), color='black')
    plt.show()
```

In [23]:

```
# Качество отдельных моделей
def val_mae(model, array_mae, array_mse, array_r2):
    model.fit(data_X_train, data_y_train)
    data_y_pred = model.predict(data_X_test)
    result = mean_absolute_error(data_y_test, data_y_pred)
    result1 = mean_squared_error(data_y_test, data_y_pred)
    result2 = r2_score(data_y_test, data_y_pred)
    print(model)
    print('mean_absolute_error={}'.format(result))
    print('mean_squared_error={}'.format(result1))
    print('r2_score={}'.format(result2))
    array_mae += [result]
    array_mse += [result1]
    array_r2 += [result2]
```

In [24]:

```
array_labels = ['NuSVR','RandomForestRegressor']
```

In [25]:

```
array_mae =[]
array_mse =[]
array_r2 =[]
# Точность на отдельных моделях
for model in [
    NuSVR(kernel='rbf', gamma=0.4, nu=0.9, C=1.0),
    RandomForestRegressor()
]:
    val_mae(model, array_mae, array_mse, array_r2)
    print('==========================')
    print()
```

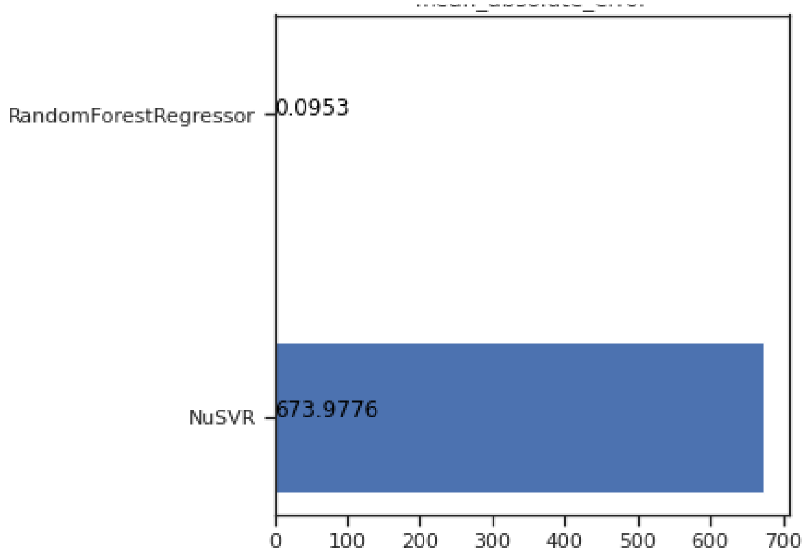
```
NuSVR(gamma=0.4, nu=0.9)
mean_absolute_error=673.9775777051882
mean_squared_error=828358.56736201
r2_score=0.021739542947291413
==========================

RandomForestRegressor()
mean_absolute_error=0.09527793126312128
mean_squared_error=0.23062522930710674
r2_score=0.999999727640238
==========================
```

In [26]:

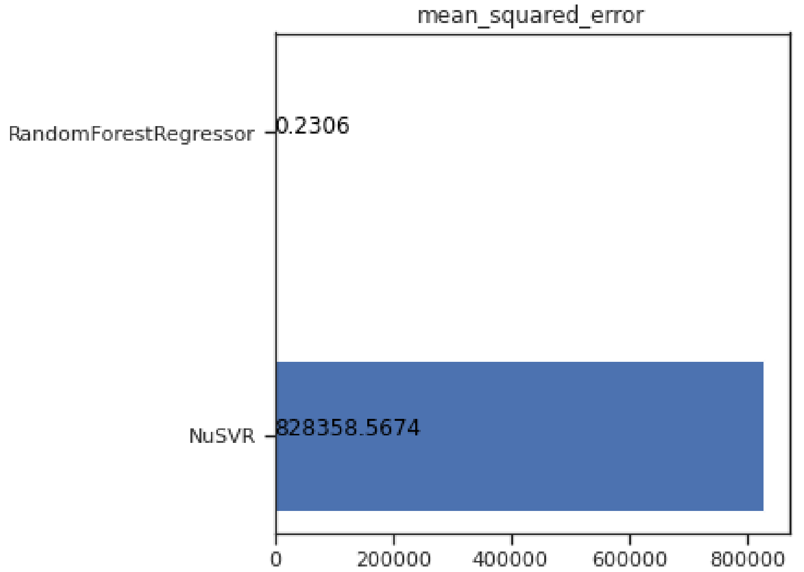
```
# Визуализация результатов
vis_models_quality(array_mae, array_labels, 'mean_absolute_error')
```

mean absolute error



In [27]:

```
# Визуализация результатов
vis_models_quality(array_mse, array_labels, 'mean_squared_error')
```



In [28]:

```
# Визуализация результатов
vis_models_quality(array_r2, array_labels, 'r2_score')
```