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Кафедра «Системы обработки информации и управления»

Лабораторная работа №3
по дисциплине
«Методы машинного обучения»
на тему
«Обработка пропусков, кодирование категориальных признаков, масштабирование данных»

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

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

[98]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.set(style="ticks")
```

1.1. Загрузка и первичный анализ данных

Используем данные из соревнования House Prices: Advanced Regression Techniques

[99]:
```
# Будем использовать только обучающую выборку
data = pd.read_csv('data/gun_violence.csv', sep=",")
```

[100]:
```
# размер набора данных
data.shape
```

[100]:
```
(162867, 29)
```

[101]:
```
# типы колонок
data.dtypes
```

[101]:
```
incident_id                        int64
date                              object
state                             object
city_or_county                    object
address                           object
n_killed                           int64
n_injured                          int64
incident_url                      object
source_url                        object
incident_url_fields_missing         bool
congressional_district           float64
gun_stolen                        object
gun_type                          object
incident_characteristics          object
latitude                         float64
location_description              object
longitude                        float64
n_guns_involved                  float64
notes                             object
participant_age                   object
participant_age_group             object
participant_gender                object
```

```
       participant_name                object
       participant_relationship        object
       participant_status              object
       participant_type                object
       sources                         object
       state_house_district           float64
       state_senate_district          float64
       dtype: object
```

```
[102]: # проверим есть ли пропущенные значения
       data.isnull().sum()
```

```
[102]: incident_id                         0
       date                                0
       state                               0
       city_or_county                      0
       address                         12303
       n_killed                            0
       n_injured                           0
       incident_url                        0
       source_url                        276
       incident_url_fields_missing         0
       congressional_district           4865
       gun_stolen                      99311
       gun_type                        99299
       incident_characteristics          242
       latitude                         4715
       location_description           140476
       longitude                        4715
       n_guns_involved                 99299
       notes                           56008
       participant_age                 63464
       participant_age_group           27678
       participant_gender              23832
       participant_name                84207
       participant_relationship       152618
       participant_status              18510
       participant_type                16327
       sources                           516
       state_house_district            24163
       state_senate_district           20659
       dtype: int64
```

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

```
[103]:    incident_id        date           state city_or_county  \
       0       461105  2013-01-01    Pennsylvania     Mckeesport
       1       460726  2013-01-01      California      Hawthorne
       2       478855  2013-01-01            Ohio         Lorain
```

```
3       478925  2013-01-05        Colorado        Aurora
4       478959  2013-01-07  North Carolina    Greensboro

                                     address  n_killed  n_injured
 ↪ \
0  1506 Versailles Avenue and Coursin Street         0          4
1               13500 block of Cerise Avenue         1          3
2                      1776 East 28th Street         1          3
3           16000 block of East Ithaca Place         4          0
4                  307 Mourning Dove Terrace         2          2

                                        incident_url  \
0  http://www.gunviolencearchive.org/incident/461105
1  http://www.gunviolencearchive.org/incident/460726
2  http://www.gunviolencearchive.org/incident/478855
3  http://www.gunviolencearchive.org/incident/478925
4  http://www.gunviolencearchive.org/incident/478959

                                          source_url  \
0  http://www.post-gazette.com/local/south/2013/0…
1  http://www.dailybulletin.com/article/zz/201301…
2  http://chronicle.northcoastnow.com/2013/02/14/…
3  http://www.dailydemocrat.com/20130106/aurora-s…
4  http://www.journalnow.com/news/local/article_d…

   incident_url_fields_missing  …
 ↪participant_age  \
0                        False  …                              0::
 ↪20
1                        False  …                              0::
 ↪20
2                        False  …  0::25||1::31||2::33||3::34||4::
 ↪33
3                        False  …         0::29||1::33||2::56||3::
 ↪33
4                        False  …         0::18||1::46||2::14||3::
 ↪47

                               participant_age_group  \
0  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
1  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
2  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
3  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
4  0::Adult 18+||1::Adult 18+||2::Teen 12-17||3::…

                            participant_gender  \
0         0::Male||1::Male||3::Male||4::Female
1                                      0::Male
2  0::Male||1::Male||2::Male||3::Male||4::Male
```

```
3         0::Female||1::Male||2::Male||3::Male
4       0::Female||1::Male||2::Male||3::Female

                                    participant_name  \
0                                     0::Julian Sims
1                                  0::Bernard Gillis
2  0::Damien Bell||1::Desmen Noble||2::Herman Sea…
3  0::Stacie Philbrook||1::Christopher Ratliffe||…
4  0::Danielle Imani Jameison||1::Maurice Eugene …

   participant_relationship  \
0                       NaN
1                       NaN
2                       NaN
3                       NaN
4                 3::Family

                                  participant_status  \
0  0::Arrested||1::Injured||2::Injured||3::Injure…
1      0::Killed||1::Injured||2::Injured||3::Injured
2  0::Injured, Unharmed, Arrested||1::Unharmed, A…
3         0::Killed||1::Killed||2::Killed||3::Killed
4       0::Injured||1::Injured||2::Killed||3::Killed

                                    participant_type  \
0  0::Victim||1::Victim||2::Victim||3::Victim||4:…
1  0::Victim||1::Victim||2::Victim||3::Victim||4:…
2  0::Subject-Suspect||1::Subject-Suspect||2::Vic…
3  0::Victim||1::Victim||2::Victim||3::Subject-Su…
4  0::Victim||1::Victim||2::Victim||3::Subject-Su…

                                             sources□
 ↪state_house_district  \
0  http://pittsburgh.cbslocal.com/2013/01/01/4-pe…             □
 ↪  NaN
1  http://losangeles.cbslocal.com/2013/01/01/man-…             □
 ↪ 62.0
2  http://www.morningjournal.com/general-news/201…             □
 ↪ 56.0
3  http://denver.cbslocal.com/2013/01/06/officer-…             □
 ↪ 40.0
4  http://myfox8.com/2013/01/08/update-mother-sho…             □
 ↪ 62.0

  state_senate_district
0                   NaN
1                  35.0
2                  13.0
3                  28.0
```

```
4                  27.0

[5 rows x 29 columns]
```

[104]:
```
total_count = data.shape[0]
print('Всего строк: {}'.format(total_count))
```

```
Всего строк: 162867
```

2. 1. Обработка пропусков в данных

2.1. 1.1. Простые стратегии - удаление или заполнение нулями

[105]:
```
# Удаление колонок, содержащих пустые значения
data_new_1 = data.dropna(axis=1, how='any')
(data.shape, data_new_1.shape)
```

[105]:
```
((162867, 29), (162867, 8))
```

[106]:
```
# Удаление строк, содержащих пустые значения
data_new_2 = data.dropna(axis=0, how='any')
(data.shape, data_new_2.shape)
```

[106]:
```
((162867, 29), (450, 29))
```

[107]:
```
data.head()
```

[107]:
```
   incident_id        date           state city_or_county  \
0       461105  2013-01-01    Pennsylvania     Mckeesport
1       460726  2013-01-01      California      Hawthorne
2       478855  2013-01-01            Ohio         Lorain
3       478925  2013-01-05        Colorado         Aurora
4       478959  2013-01-07  North Carolina     Greensboro

                                       address  n_killed  n_injured□
 ↪ \
0  1506 Versailles Avenue and Coursin Street         0          4
1                   13500 block of Cerise Avenue         1          3
2                          1776 East 28th Street         1          3
3               16000 block of East Ithaca Place         4          0
4                     307 Mourning Dove Terrace         2          2

                                      incident_url  \
0  http://www.gunviolencearchive.org/incident/461105
1  http://www.gunviolencearchive.org/incident/460726
2  http://www.gunviolencearchive.org/incident/478855
3  http://www.gunviolencearchive.org/incident/478925
4  http://www.gunviolencearchive.org/incident/478959

                                        source_url  \
0  http://www.post-gazette.com/local/south/2013/0…
1  http://www.dailybulletin.com/article/zz/201301…
2  http://chronicle.northcoastnow.com/2013/02/14/…
3  http://www.dailydemocrat.com/20130106/aurora-s…
4  http://www.journalnow.com/news/local/article_d…

   incident_url_fields_missing  …
 ↪participant_age  \
0                         False  …                              0::
 ↪20
1                         False  …                              0::
 ↪20
2                         False  …   0::25||1::31||2::33||3::34||4::
 ↪33
3                         False  …          0::29||1::33||2::56||3::
 ↪33
4                         False  …          0::18||1::46||2::14||3::
 ↪47

                               participant_age_group  \
0  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
1  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
2  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
3  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
4  0::Adult 18+||1::Adult 18+||2::Teen 12-17||3::…

                            participant_gender  \
0         0::Male||1::Male||3::Male||4::Female
1                                      0::Male
2  0::Male||1::Male||2::Male||3::Male||4::Male
3         0::Female||1::Male||2::Male||3::Male
4       0::Female||1::Male||2::Male||3::Female

                                    participant_name  \
0                                      0::Julian Sims
1                                   0::Bernard Gillis
2  0::Damien Bell||1::Desmen Noble||2::Herman Sea…
3  0::Stacie Philbrook||1::Christopher Ratliffe||…
4  0::Danielle Imani Jameison||1::Maurice Eugene …

   participant_relationship  \
0                       NaN
1                       NaN
2                       NaN
3                       NaN
4                 3::Family

                                  participant_status  \
0  0::Arrested||1::Injured||2::Injured||3::Injure…
```

```
1       0::Killed||1::Injured||2::Injured||3::Injured
2  0::Injured, Unharmed, Arrested||1::Unharmed, A…
3          0::Killed||1::Killed||2::Killed||3::Killed
4        0::Injured||1::Injured||2::Killed||3::Killed

                                    participant_type  \
0  0::Victim||1::Victim||2::Victim||3::Victim||4:…
1  0::Victim||1::Victim||2::Victim||3::Victim||4:…
2  0::Subject-Suspect||1::Subject-Suspect||2::Vic…
3  0::Victim||1::Victim||2::Victim||3::Subject-Su…
4  0::Victim||1::Victim||2::Victim||3::Subject-Su…

                                             sources
  ↪state_house_district  \
0  http://pittsburgh.cbslocal.com/2013/01/01/4-pe…
  ↪  NaN
1  http://losangeles.cbslocal.com/2013/01/01/man-…
  ↪ 62.0
2  http://www.morningjournal.com/general-news/201…
  ↪ 56.0
3  http://denver.cbslocal.com/2013/01/06/officer-…
  ↪ 40.0
4  http://myfox8.com/2013/01/08/update-mother-sho…
  ↪ 62.0

  state_senate_district
0                   NaN
1                  35.0
2                  13.0
3                  28.0
4                  27.0

[5 rows x 29 columns]
```

[108]:

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

[108]:

```
   incident_id        date           state city_or_county  \
0       461105  2013-01-01    Pennsylvania     Mckeesport
1       460726  2013-01-01      California      Hawthorne
2       478855  2013-01-01            Ohio         Lorain
3       478925  2013-01-05        Colorado         Aurora
4       478959  2013-01-07  North Carolina     Greensboro

                                     address  n_killed  n_injured
  ↪ \
0  1506 Versailles Avenue and Coursin Street        0          4
1                 13500 block of Cerise Avenue        1          3
2                        1776 East 28th Street        1          3
3             16000 block of East Ithaca Place        4          0
4                    307 Mourning Dove Terrace        2          2

                                         incident_url  \
0  http://www.gunviolencearchive.org/incident/461105
1  http://www.gunviolencearchive.org/incident/460726
2  http://www.gunviolencearchive.org/incident/478855
3  http://www.gunviolencearchive.org/incident/478925
4  http://www.gunviolencearchive.org/incident/478959

                                           source_url  \
0  http://www.post-gazette.com/local/south/2013/0…
1  http://www.dailybulletin.com/article/zz/201301…
2  http://chronicle.northcoastnow.com/2013/02/14/…
3  http://www.dailydemocrat.com/20130106/aurora-s…
4  http://www.journalnow.com/news/local/article_d…

   incident_url_fields_missing  …                    □
 ↪participant_age  \
0                        False  …                              0::
 ↪20
1                        False  …                              0::
 ↪20
2                        False  …  0::25||1::31||2::33||3::34||4::
 ↪33
3                        False  …         0::29||1::33||2::56||3::
 ↪33
4                        False  …         0::18||1::46||2::14||3::
 ↪47

                                participant_age_group  \
0  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
1  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
2  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
3  0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
4  0::Adult 18+||1::Adult 18+||2::Teen 12-17||3::…

                             participant_gender  \
0         0::Male||1::Male||3::Male||4::Female
1                                      0::Male
2  0::Male||1::Male||2::Male||3::Male||4::Male
3         0::Female||1::Male||2::Male||3::Male
4       0::Female||1::Male||2::Male||3::Female

                                     participant_name  \
0                                      0::Julian Sims
```

```
1                                  0::Bernard Gillis
2  0::Damien Bell||1::Desmen Noble||2::Herman Sea…
3  0::Stacie Philbrook||1::Christopher Ratliffe||…
4  0::Danielle Imani Jameison||1::Maurice Eugene …

   participant_relationship  \
0                         0
1                         0
2                         0
3                         0
4                 3::Family

                                  participant_status  \
0  0::Arrested||1::Injured||2::Injured||3::Injure…
1      0::Killed||1::Injured||2::Injured||3::Injured
2  0::Injured, Unharmed, Arrested||1::Unharmed, A…
3         0::Killed||1::Killed||2::Killed||3::Killed
4       0::Injured||1::Injured||2::Killed||3::Killed

                                    participant_type  \
0  0::Victim||1::Victim||2::Victim||3::Victim||4:…
1  0::Victim||1::Victim||2::Victim||3::Victim||4:…
2  0::Subject-Suspect||1::Subject-Suspect||2::Vic…
3  0::Victim||1::Victim||2::Victim||3::Subject-Su…
4  0::Victim||1::Victim||2::Victim||3::Subject-Su…

                                             sources
 ↪state_house_district  \
0  http://pittsburgh.cbslocal.com/2013/01/01/4-pe…
 ↪  0.0
1  http://losangeles.cbslocal.com/2013/01/01/man-…
 ↪ 62.0
2  http://www.morningjournal.com/general-news/201…
 ↪ 56.0
3  http://denver.cbslocal.com/2013/01/06/officer-…
 ↪ 40.0
4  http://myfox8.com/2013/01/08/update-mother-sho…
 ↪ 62.0

  state_senate_district
0                   0.0
1                  35.0
2                  13.0
3                  28.0
4                  27.0

[5 rows x 29 columns]
```

2.2. 1.2. “Внедрение значений” - импьютация (imputation)

2.2.1. 1.2.1. Обработка пропусков в числовых данных

[109]:
```
# Выберем числовые колонки с пропущенными значениями
# Цикл по колонкам датасета
num_cols = []
for col in data.columns:
    # Количество пустых значений
    temp_null_count = data[data[col].isnull()].shape[0]
    dt = str(data[col].dtype)
    if temp_null_count>0 and (dt=='float64' or dt=='int64'):
        num_cols.append(col)
        temp_perc = round((temp_null_count / total_count) * 100.
 ↪0, 2)
        print('Колонка {}. Тип данных {}. Количество пустых
 ↪значений {}, {}%.'.format(col, dt, temp_null_count, temp_perc))
```

```
Колонка congressional_district. Тип данных float64. Количество
 ↪пустых значений
4865, 2.99%.
Колонка latitude. Тип данных float64. Количество пустых значений
 ↪4715, 2.9%.
Колонка longitude. Тип данных float64. Количество пустых значений
 ↪4715, 2.9%.
Колонка n_guns_involved. Тип данных float64. Количество пустых
 ↪значений 99299,
60.97%.
Колонка state_house_district. Тип данных float64. Количество
 ↪пустых значений
24163, 14.84%.
Колонка state_senate_district. Тип данных float64. Количество
 ↪пустых значений
20659, 12.68%.
```

[110]:
```
# Фильтр по колонкам с пропущенными значениями
data_num = data[num_cols]
data_num
```

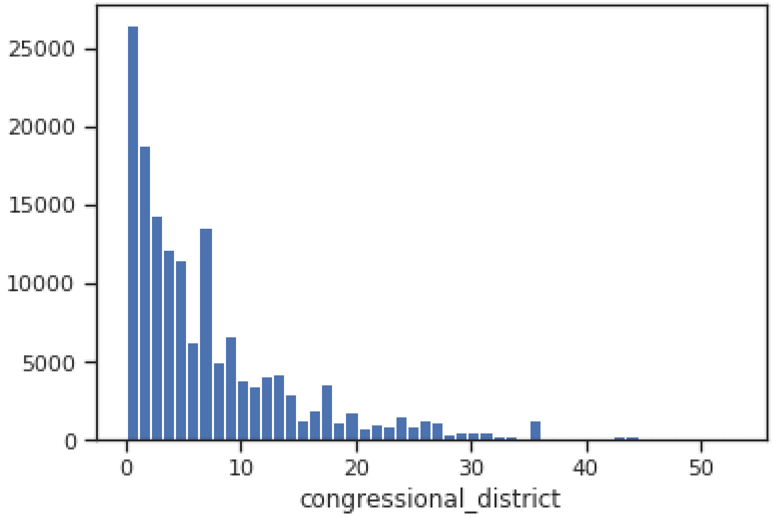
[110]:
```
        congressional_district  latitude  longitude
 ↪n_guns_involved  \
0                         14.0   40.3467   -79.8559
 ↪NaN
1                         43.0   33.9090  -118.3330
 ↪NaN
2                          9.0   41.4455   -82.1377
 ↪2.0
3                          6.0   39.6518  -104.8020
 ↪NaN
```

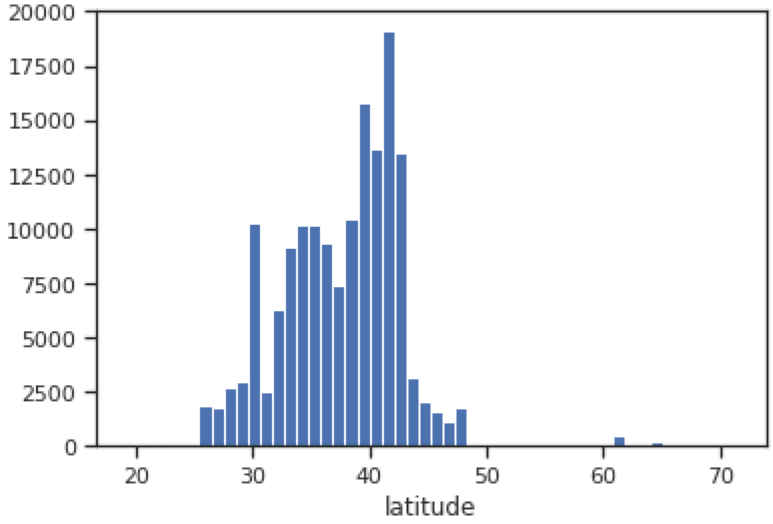
```
4                          6.0   36.1140   -79.9569
  ↪2.0
…                         …       …         …              …
162862                    13.0   33.7938   -84.5894
  ↪1.0
162863                    13.0   37.7338  -122.1790
  ↪1.0
162864                     NaN       NaN        NaN
  ↪1.0
162865                     1.0   34.2190   -88.7378
  ↪1.0
162866                     8.0   35.0708   -89.6713
  ↪1.0

        state_house_district  state_senate_district
0                        NaN                    NaN
1                       62.0                   35.0
2                       56.0                   13.0
3                       40.0                   28.0
4                       62.0                   27.0
…                      …                    …
162862                  39.0                   38.0
162863                  18.0                    9.0
162864                   NaN                    NaN
162865                  16.0                    7.0
162866                  95.0                   32.0

[162867 rows x 6 columns]
```

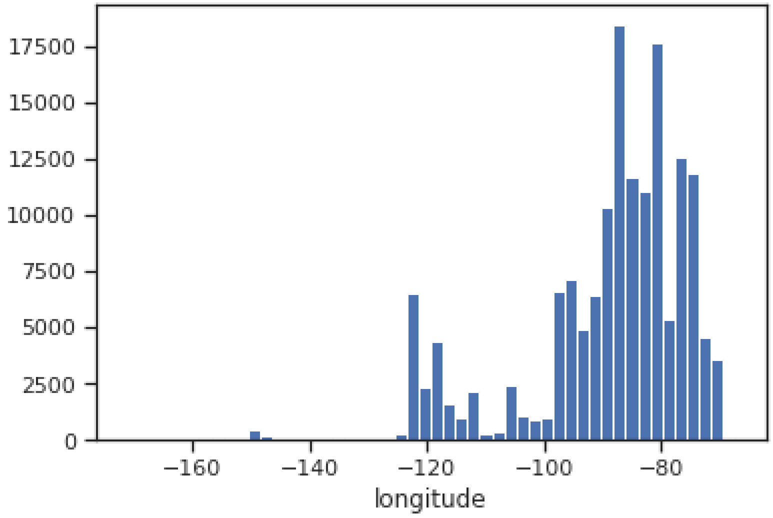
[111]:

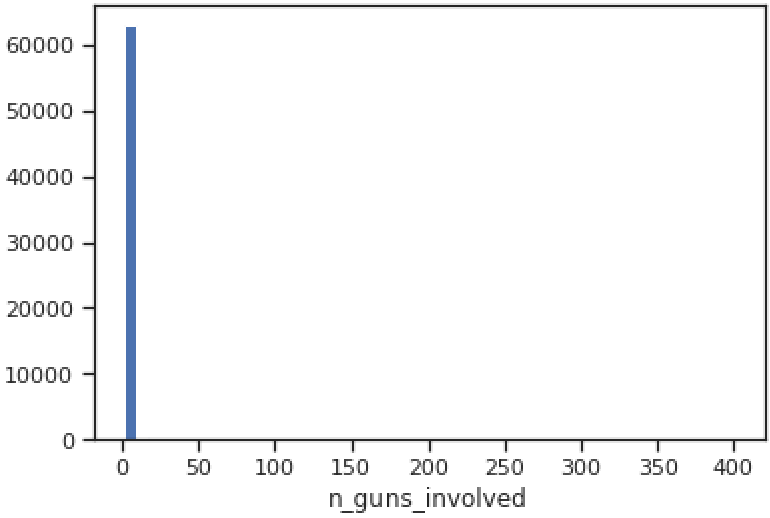
```
# Гистограмма по признакам
for col in data_num:
    plt.hist(data[col], 50)
    plt.xlabel(col)
    plt.show()
```

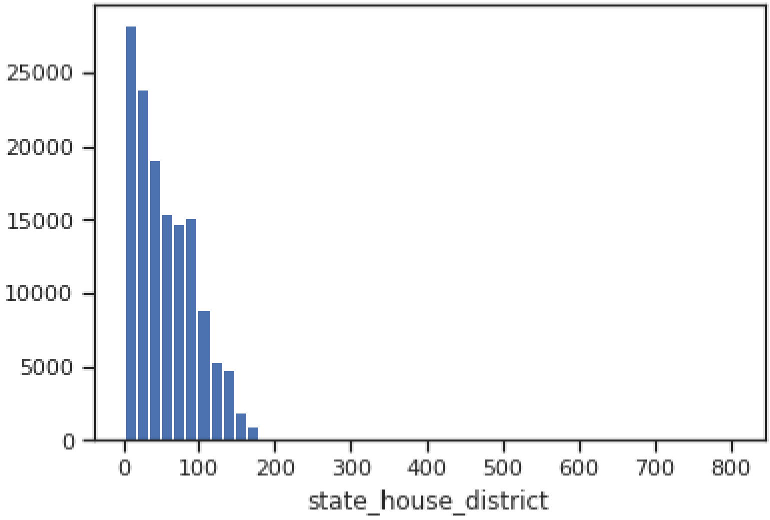
```
/home/dan/anaconda3/lib/python3.7/site-packages/numpy/lib/
  ↪histograms.py:839:
RuntimeWarning: invalid value encountered in greater_equal
  keep = (tmp_a >= first_edge)
/home/dan/anaconda3/lib/python3.7/site-packages/numpy/lib/
  ↪histograms.py:840:
RuntimeWarning: invalid value encountered in less_equal
  keep &= (tmp_a <= last_edge)
```

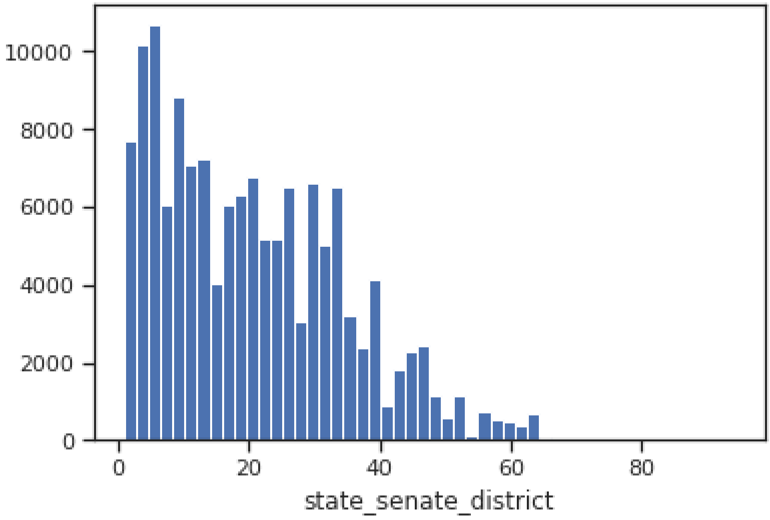

25000
20000
15000
10000
5000
0
0
10
20
30
40
50
congressional_district


20000
17500
15000
12500
10000
7500
5000
2500
0
20
30
40
50
60
70
latitude


17500
15000
12500
10000
7500
5000
2500
0
−160
−140
−120
−100
−80
longitude


60000
50000
40000
30000
20000
10000
0
0
50
100
150
200
250
300
350
400
n_guns_involved


25000
20000
15000
10000
5000
0
0
100
200
300
400
500
600
700
800
state_house_district


10000
8000
6000
4000
2000
0
0
20
40
60
80
state_senate_district

```
[112]: # Фильтр по пустым значениям поля n_guns_involved
       data[data['n_guns_involved'].isnull()]
```

```
[112]:         incident_id        date         state city_or_county  \
0            461105  2013-01-01  Pennsylvania     Mckeesport
1            460726  2013-01-01    California      Hawthorne
3            478925  2013-01-05      Colorado         Aurora
5            478948  2013-01-07      Oklahoma          Tulsa
7            479374  2013-01-21     Louisiana    New Orleans
…             …         …           …            …
161927       729430  2016-12-16     Wisconsin        Madison
162166       730843  2016-12-18       Florida         Naples
162373       729453  2016-12-19    California        Brawley
162740       730974  2016-12-21      Arkansas   Fayetteville
162801       732054  2016-12-22       Florida    Palm Harbor

                                                  address □
  ↪n_killed  \
0                1506 Versailles Avenue and Coursin Street        □
  ↪0
1                             13500 block of Cerise Avenue        □
  ↪1
3                         16000 block of East Ithaca Place        □
  ↪4
5                               6000 block of South Owasso        □
  ↪4
7       LaSalle Street and Martin Luther King Jr. Boul…         0
…                                                    …       …
161927                                       Fourth Street        □
  ↪0
162166              Pine Ridge Rd and Airport Pulling Road        □
  ↪0
162373                         500 block of North Imperial        □
  ↪1
162740                             800 South School Avenue        □
  ↪1
162801                               252 Whisper Lake Road        □
  ↪1

        n_injured                                    □
  ↪incident_url  \
0               4  http://www.gunviolencearchive.org/incident/
  ↪461105
1               3  http://www.gunviolencearchive.org/incident/
  ↪460726
3               0  http://www.gunviolencearchive.org/incident/
  ↪478925
```

```
5               0  http://www.gunviolencearchive.org/incident/
  ↪478948
7               5  http://www.gunviolencearchive.org/incident/
  ↪479374
…           …                                                …
161927          0  http://www.gunviolencearchive.org/incident/
  ↪729430
162166          0  http://www.gunviolencearchive.org/incident/
  ↪730843
162373          0  http://www.gunviolencearchive.org/incident/
  ↪729453
162740          0  http://www.gunviolencearchive.org/incident/
  ↪730974
162801          0  http://www.gunviolencearchive.org/incident/
  ↪732054

                                               source_url  \
0       http://www.post-gazette.com/local/south/2013/0…
1       http://www.dailybulletin.com/article/zz/201301…
3       http://www.dailydemocrat.com/20130106/aurora-s…
5       http://usnews.nbcnews.com/_news/2013/01/07/163…
7       http://www.nola.com/crime/index.ssf/2013/01/no…
…                                                   …
161927  http://www.nbc15.com/content/news/2-teens-arre…
162166  http://www.naplesnews.com/story/news/crime/201…
162373  http://www.kyma.com/news/fatal-officer-involve…
162740  http://www.4029tv.com/article/officer-involved…
162801  http://web.tampabay.com/news/publicsafety/crim…

        incident_url_fields_missing  …            □
  ↪participant_age  \
0                             False  …                       0::20
1                             False  …                       0::20
3                             False  …  0::29||1::33||2::56||3::33
5                             False  …  0::23||1::23||2::33||3::55
7                             False  …                         NaN
…                             …  …                         …
161927                        False  …                0::18||1::18
162166                        False  …                       0::24
162373                        False  …                         NaN
162740                        False  …                       0::25
162801                        False  …                       0::55

                                    participant_age_group  \
0       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
1       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
3       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
5       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
7                                                   NaN
```

```
…                                                   …
161927                         0::Adult 18+||1::Adult 18+
162166                                       0::Adult 18+
162373                                       0::Adult 18+
162740                                       0::Adult 18+
162801                                       0::Adult 18+

                                       participant_gender  \
0                    0::Male||1::Male||3::Male||4::Female
1                                                 0::Male
3                    0::Female||1::Male||2::Male||3::Male
5       0::Female||1::Female||2::Female||3::Female||4:…
7             0::Male||1::Male||2::Male||3::Male||4::Male
…                                                   …
161927                                   0::Male||1::Male
162166                                            0::Male
162373                                            0::Male
162740                                            0::Male
162801                                            0::Male

                                         participant_name  \
0                                          0::Julian Sims
1                                       0::Bernard Gillis
3       0::Stacie Philbrook||1::Christopher Ratliffe||…
5       0::Rebeika Powell||1::Kayetie Melchor||2::Mist…
7                                                     NaN
…                                                   …
161927                 0::Taylor Loving||1::Theron Walker
162166                                  0::Sean Blackwell
162373                                                NaN
162740                                  0::Benjamin Ortiz
162801                                0::Stanley Eversole

        participant_relationship  \
0                            NaN
1                            NaN
3                            NaN
5                            NaN
7                            NaN
…                          …
161927                       NaN
162166                       NaN
162373                       NaN
162740                       NaN
162801                       NaN

                                       participant_status  \
0       0::Arrested||1::Injured||2::Injured||3::Injure…
1           0::Killed||1::Injured||2::Injured||3::Injured
3              0::Killed||1::Killed||2::Killed||3::Killed
```

```
5       0::Killed||1::Killed||2::Killed||3::Killed||4:…
7       0::Injured||1::Injured||2::Injured||3::Injured…
…                                                    …
161927       0::Unharmed, Arrested||1::Unharmed, Arrested
162166                              0::Unharmed, Arrested
162373                                          0::Killed
162740                                          0::Killed
162801                                          0::Killed

                                         participant_type  \
0       0::Victim||1::Victim||2::Victim||3::Victim||4:…
1       0::Victim||1::Victim||2::Victim||3::Victim||4:…
3       0::Victim||1::Victim||2::Victim||3::Subject-Su…
5       0::Victim||1::Victim||2::Victim||3::Victim||4:…
7       0::Victim||1::Victim||2::Victim||3::Victim||4:…
…                                                    …
161927             0::Subject-Suspect||1::Subject-Suspect
162166                                 0::Subject-Suspect
162373                                 0::Subject-Suspect
162740                                 0::Subject-Suspect
162801                                 0::Subject-Suspect

                                                  sources  \
0       http://pittsburgh.cbslocal.com/2013/01/01/4-pe…
1       http://losangeles.cbslocal.com/2013/01/01/man-…
3       http://denver.cbslocal.com/2013/01/06/officer-…
5       http://www.kjrh.com/news/local-news/4-found-sh…
7       http://www.huffingtonpost.com/2013/01/21/new-o…
…                                                    …
161927  http://www.nbc15.com/content/news/2-teens-arre…
162166  http://www.naplesnews.com/story/news/crime/201…
162373  http://www.kyma.com/news/fatal-officer-involve…
162740  http://www.4029tv.com/article/officer-involved…
162801  http://www.nbcmiami.com/news/local/Deputies-Sh…

       state_house_district state_senate_district
0                       NaN                   NaN
1                      62.0                  35.0
3                      40.0                  28.0
5                      72.0                  11.0
7                      93.0                   5.0
…                     …                   …
161927                 76.0                  26.0
162166                106.0                  23.0
162373                 56.0                  40.0
162740                 85.0                   4.0
162801                  NaN                   NaN

[99299 rows x 29 columns]
```

[113]:
```
# Запоминаем индексы строк с пустыми значениями
flt_index = data[data['n_guns_involved'].isnull()].index
flt_index
```

[113]:
```
Int64Index([     0,      1,      3,      5,      7,      8,
 ↪9,     14,
                17,     19,
            …
            160630, 160803, 160878, 161236, 161836, 161927,
 ↪162166, 162373,
            162740, 162801],
           dtype='int64', length=99299)
```

[114]:
```
# Проверяем что выводятся нужные строки
data[data.index.isin(flt_index)]
```

[114]:
```
        incident_id        date         state city_or_county  \
0            461105  2013-01-01  Pennsylvania     Mckeesport
1            460726  2013-01-01    California      Hawthorne
3            478925  2013-01-05      Colorado         Aurora
5            478948  2013-01-07      Oklahoma          Tulsa
7            479374  2013-01-21     Louisiana    New Orleans
…                 …           …             …              …
161927       729430  2016-12-16     Wisconsin        Madison
162166       730843  2016-12-18       Florida         Naples
162373       729453  2016-12-19    California        Brawley
162740       730974  2016-12-21      Arkansas   Fayetteville
162801       732054  2016-12-22       Florida    Palm Harbor

                                                  address
 ↪n_killed  \
0                1506 Versailles Avenue and Coursin Street
 ↪0
1                             13500 block of Cerise Avenue
 ↪1
3                         16000 block of East Ithaca Place
 ↪4
5                              6000 block of South Owasso
 ↪4
7       LaSalle Street and Martin Luther King Jr. Boul…        0
…                                                     …       …
161927                                       Fourth Street
 ↪0
162166             Pine Ridge Rd and Airport Pulling Road
 ↪0
162373                          500 block of North Imperial
 ↪1
162740                              800 South School Avenue
 ↪1
```

```
162801                  252 Whisper Lake Road
  ↪1

        n_injured
  ↪incident_url  \
0               4  http://www.gunviolencearchive.org/incident/
  ↪461105
1               3  http://www.gunviolencearchive.org/incident/
  ↪460726
3               0  http://www.gunviolencearchive.org/incident/
  ↪478925
5               0  http://www.gunviolencearchive.org/incident/
  ↪478948
7               5  http://www.gunviolencearchive.org/incident/
  ↪479374
…            …                                                …
161927          0  http://www.gunviolencearchive.org/incident/
  ↪729430
162166          0  http://www.gunviolencearchive.org/incident/
  ↪730843
162373          0  http://www.gunviolencearchive.org/incident/
  ↪729453
162740          0  http://www.gunviolencearchive.org/incident/
  ↪730974
162801          0  http://www.gunviolencearchive.org/incident/
  ↪732054

                                               source_url  \
0       http://www.post-gazette.com/local/south/2013/0…
1       http://www.dailybulletin.com/article/zz/201301…
3       http://www.dailydemocrat.com/20130106/aurora-s…
5       http://usnews.nbcnews.com/_news/2013/01/07/163…
7       http://www.nola.com/crime/index.ssf/2013/01/no…
…                                                    …
161927  http://www.nbc15.com/content/news/2-teens-arre…
162166  http://www.naplesnews.com/story/news/crime/201…
162373  http://www.kyma.com/news/fatal-officer-involve…
162740  http://www.4029tv.com/article/officer-involved…
162801  http://web.tampabay.com/news/publicsafety/crim…

        incident_url_fields_missing  …
  ↪participant_age  \
0                             False  …                      0::20
1                             False  …                      0::20
3                             False  …  0::29||1::33||2::56||3::33
5                             False  …  0::23||1::23||2::33||3::55
7                             False  …                        NaN
…                               …  …                        …
161927                        False  …               0::18||1::18
```

```
162166                        False  …                       0::24
162373                        False  …                         NaN
162740                        False  …                       0::25
162801                        False  …                       0::55

                                    participant_age_group  \
0       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
1       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
3       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
5       0::Adult 18+||1::Adult 18+||2::Adult 18+||3::A…
7                                                     NaN
…                                                   …
161927                         0::Adult 18+||1::Adult 18+
162166                                       0::Adult 18+
162373                                       0::Adult 18+
162740                                       0::Adult 18+
162801                                       0::Adult 18+

                                       participant_gender  \
0                    0::Male||1::Male||3::Male||4::Female
1                                                 0::Male
3                    0::Female||1::Male||2::Male||3::Male
5       0::Female||1::Female||2::Female||3::Female||4:…
7             0::Male||1::Male||2::Male||3::Male||4::Male
…                                                   …
161927                                   0::Male||1::Male
162166                                            0::Male
162373                                            0::Male
162740                                            0::Male
162801                                            0::Male

                                         participant_name  \
0                                          0::Julian Sims
1                                       0::Bernard Gillis
3       0::Stacie Philbrook||1::Christopher Ratliffe||…
5       0::Rebeika Powell||1::Kayetie Melchor||2::Mist…
7                                                     NaN
…                                                   …
161927                 0::Taylor Loving||1::Theron Walker
162166                                  0::Sean Blackwell
162373                                                NaN
162740                                  0::Benjamin Ortiz
162801                                0::Stanley Eversole

        participant_relationship  \
0                            NaN
1                            NaN
3                            NaN
5                            NaN
7                            NaN
```

```
…                          …
161927                       NaN
162166                       NaN
162373                       NaN
162740                       NaN
162801                       NaN

                                       participant_status  \
0       0::Arrested||1::Injured||2::Injured||3::Injure…
1           0::Killed||1::Injured||2::Injured||3::Injured
3              0::Killed||1::Killed||2::Killed||3::Killed
5       0::Killed||1::Killed||2::Killed||3::Killed||4:…
7       0::Injured||1::Injured||2::Injured||3::Injured…
…                                                   …
161927       0::Unharmed, Arrested||1::Unharmed, Arrested
162166                              0::Unharmed, Arrested
162373                                          0::Killed
162740                                          0::Killed
162801                                          0::Killed

                                         participant_type  \
0       0::Victim||1::Victim||2::Victim||3::Victim||4:…
1       0::Victim||1::Victim||2::Victim||3::Victim||4:…
3       0::Victim||1::Victim||2::Victim||3::Subject-Su…
5       0::Victim||1::Victim||2::Victim||3::Victim||4:…
7       0::Victim||1::Victim||2::Victim||3::Victim||4:…
…                                                   …
161927             0::Subject-Suspect||1::Subject-Suspect
162166                                 0::Subject-Suspect
162373                                 0::Subject-Suspect
162740                                 0::Subject-Suspect
162801                                 0::Subject-Suspect

                                                  sources  \
0       http://pittsburgh.cbslocal.com/2013/01/01/4-pe…
1       http://losangeles.cbslocal.com/2013/01/01/man-…
3       http://denver.cbslocal.com/2013/01/06/officer-…
5       http://www.kjrh.com/news/local-news/4-found-sh…
7       http://www.huffingtonpost.com/2013/01/21/new-o…
…                                                   …
161927  http://www.nbc15.com/content/news/2-teens-arre…
162166  http://www.naplesnews.com/story/news/crime/201…
162373  http://www.kyma.com/news/fatal-officer-involve…
162740  http://www.4029tv.com/article/officer-involved…
162801  http://www.nbcmiami.com/news/local/Deputies-Sh…

       state_house_district state_senate_district
0                       NaN                   NaN
1                      62.0                  35.0
3                      40.0                  28.0
```

```
5                     72.0                  11.0
7                     93.0                   5.0
…                      …                   …
161927                76.0                  26.0
162166               106.0                  23.0
162373                56.0                  40.0
162740                85.0                   4.0
162801                 NaN                   NaN

[99299 rows x 29 columns]
```

[115]:
```
# фильтр по колонке
data_num[data_num.index.isin(flt_index)]['n_guns_involved']
```

[115]:
```
0         NaN
1         NaN
3         NaN
5         NaN
7         NaN
           ..
161927    NaN
162166    NaN
162373    NaN
162740    NaN
162801    NaN
Name: n_guns_involved, Length: 99299, dtype: float64
```

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

[116]:
```
data_num_guns = data_num[['n_guns_involved']]
data_num_guns.head()
```

[116]:
```
   n_guns_involved
0              NaN
1              NaN
2              2.0
3              NaN
4              2.0
```

[117]:
```
from sklearn.impute import SimpleImputer
from sklearn.impute import MissingIndicator
```

[118]:
```
# Фильтр для проверки заполнения пустых значений
indicator = MissingIndicator()
mask_missing_values_only = indicator.fit_transform(data_num_guns)
mask_missing_values_only
```

[118]:
```
array([[ True],
       [ True],
       [False],
       …,
       [False],
       [False],
       [False]])
```

С помощью класса SimpleImputer можно проводить импьютацию различными показателями центра распределения

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

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

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

```
[121]: ('mean',
        array([1.5237069, 1.5237069, 1.5237069, …, 1.5237069, 1.5237069,
               1.5237069]))
```

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

```
[122]: ('median', array([1., 1., 1., …, 1., 1., 1.]))
```

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

```
[123]: ('most_frequent', array([1., 1., 1., …, 1., 1., 1.]))
```

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

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

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

           filled_data = data_num_imp[mask_missing_values_only]

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

```
[125]: test_num_impute_col(data, 'n_guns_involved', strategies[0])
```

```
[125]: ('n_guns_involved', 'mean', 99299, 1.5237068965517242, 1.
         ↪5237068965517242)
```

```
[126]: test_num_impute_col(data, 'n_guns_involved', strategies[1])
```

```
[126]: ('n_guns_involved', 'median', 99299, 1.0, 1.0)
```

```
[127]: test_num_impute_col(data, 'n_guns_involved', strategies[2])
```

```
[127]: ('n_guns_involved', 'most_frequent', 99299, 1.0, 1.0)
```

2.2.2. 1.2.2. Обработка пропусков в категориальных данных

```
[128]: # Выберем категориальные колонки с пропущенными значениями
       # Цикл по колонкам датасета
       cat_cols = []
       for col in data.columns:
           # Количество пустых значений
           temp_null_count = data[data[col].isnull()].shape[0]
           dt = str(data[col].dtype)
           if temp_null_count>0 and (dt=='object'):
               cat_cols.append(col)
               temp_perc = round((temp_null_count / total_count) * 100.
         ↪0, 2)
               print('Колонка {}. Тип данных {}. Количество пустых□
         ↪значений {}, {}%.'.format(col, dt, temp_null_count, temp_perc))
```

```
Колонка address. Тип данных object. Количество пустых значений□
  ↪12303, 7.55%.
Колонка source_url. Тип данных object. Количество пустых значений□
  ↪276, 0.17%.
Колонка gun_stolen. Тип данных object. Количество пустых значений□
  ↪99311, 60.98%.
Колонка gun_type. Тип данных object. Количество пустых значений□
  ↪99299, 60.97%.
Колонка incident_characteristics. Тип данных object. Количество□
  ↪пустых значений
242, 0.15%.
Колонка location_description. Тип данных object. Количество пустых□
  ↪значений
140476, 86.25%.
Колонка notes. Тип данных object. Количество пустых значений□
  ↪56008, 34.39%.
Колонка participant_age. Тип данных object. Количество пустых□
  ↪значений 63464,
38.97%.
Колонка participant_age_group. Тип данных object. Количество□
  ↪пустых значений
27678, 16.99%.
Колонка participant_gender. Тип данных object. Количество пустых□
  ↪значений 23832,
14.63%.
Колонка participant_name. Тип данных object. Количество пустых□
  ↪значений 84207,
51.7%.
```

```
Колонка participant_relationship. Тип данных object. Количество
  ↪пустых значений
152618, 93.71%.
Колонка participant_status. Тип данных object. Количество пустых
  ↪значений 18510,
11.37%.
Колонка participant_type. Тип данных object. Количество пустых
  ↪значений 16327,
10.02%.
Колонка sources. Тип данных object. Количество пустых значений
  ↪516, 0.32%.
```

Класс SimpleImputer можно использовать для категориальных признаков со стратегиями “most_frequent” или “constant”.

```
[129]: cat_temp_data = data[['gun_stolen']]
       cat_temp_data.head()
```

```
[129]:                  gun_stolen
       0                       NaN
       1                       NaN
       2  0::Unknown||1::Unknown
       3                       NaN
       4  0::Unknown||1::Unknown
```

```
[130]: cat_temp_data['gun_stolen'].unique()[0:10]
```

```
[130]: array([nan, '0::Unknown||1::Unknown', '0::Unknown',
              '0::Unknown||1::Unknown||2::Unknown||3::Unknown',
              '0::Not-stolen||1::Unknown', '0::Unknown||1::Unknown||2::
         ↪Unknown',
              '0::Stolen||1::Stolen', '0::Not-stolen', '0::Stolen',
              '0::Stolen||1::Stolen||2::Unknown||3::Unknown'],
         ↪dtype=object)
```

```
[131]: cat_temp_data[cat_temp_data['gun_stolen'].isnull()].shape
```

```
[131]: (99311, 1)
```

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

```
[132]: array([['0::Unknown'],
              ['0::Unknown'],
              ['0::Unknown||1::Unknown'],
              …,
              ['0::Unknown'],
              ['0::Unknown'],
              ['0::Unknown']], dtype=object)
```

[133]:
```
# Пустые значения отсутствуют
np.unique(data_imp2)[0:5]
```

[133]:
```
array(['0::Not-stolen', '0::Not-stolen||1::Not-stolen',
       '0::Not-stolen||1::Not-stolen||2::Not-stolen',
       '0::Not-stolen||1::Not-stolen||2::Not-stolen||3::
 ↪Not-stolen',
       '0::Not-stolen||1::Not-stolen||2::Not-stolen||3::
 ↪Not-stolen||4::Not-
stolen'],
      dtype=object)
```

[134]:
```
# Импьютация константой
imp3 = SimpleImputer(missing_values=np.nan, strategy='constant',▫
 ↪fill_value='!!!')
data_imp3 = imp3.fit_transform(cat_temp_data)
data_imp3
```

[134]:
```
array([['!!!'],
       ['!!!'],
       ['0::Unknown||1::Unknown'],
       …,
       ['0::Unknown'],
       ['0::Unknown'],
       ['0::Unknown']], dtype=object)
```

[135]:
```
np.unique(data_imp3)[0:5]
```

[135]:
```
array(['!!!', '0::Not-stolen', '0::Not-stolen||1::Not-stolen',
       '0::Not-stolen||1::Not-stolen||2::Not-stolen',
       '0::Not-stolen||1::Not-stolen||2::Not-stolen||3::
 ↪Not-stolen'],
      dtype=object)
```

[136]:
```
data_imp3[data_imp3=='!!!'].size
```

[136]:
```
99311
```

3. 2. Преобразование категориальных признаков в числовые

[137]:
```
cat_enc = pd.DataFrame({'c1':data_imp2.T[0]})
cat_enc
```

[137]:
```
                             c1
0                    0::Unknown
1                    0::Unknown
2        0::Unknown||1::Unknown
3                    0::Unknown
4        0::Unknown||1::Unknown
```

```
…                         …
162862          0::Unknown
162863          0::Unknown
162864          0::Unknown
162865          0::Unknown
162866          0::Unknown

[162867 rows x 1 columns]
```

3.1. 2.1. Кодирование категорий целочисленными значениями - label encoding

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

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

```
[140]: cat_enc['c1'].unique()[0:5]
```

```
[140]: array(['0::Unknown', '0::Unknown||1::Unknown',
              '0::Unknown||1::Unknown||2::Unknown||3::Unknown',
              '0::Not-stolen||1::Unknown', '0::Unknown||1::Unknown||2::
         ↪Unknown'],
             dtype=object)
```

```
[141]: np.unique(cat_enc_le)[0:10]
```

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

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

```
[142]: array(['0::Not-stolen', '0::Not-stolen||1::Not-stolen',
              '0::Not-stolen||1::Not-stolen||2::Not-stolen',
              '0::Not-stolen||1::Not-stolen||2::Not-stolen||3::
         ↪Not-stolen'],
             dtype=object)
```

3.2. 2.2. Кодирование категорий наборами бинарных значений - one-hot encoding

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

```
[144]: cat_enc.shape
```

```
[144]: (162867, 1)
```

```
[145]: cat_enc_ohe.shape
```

```
[145]: (162867, 277)
```

```
[146]: cat_enc_ohe
```

```
[146]: <162867x277 sparse matrix of type '<class 'numpy.float64'>'
            with 162867 stored elements in Compressed Sparse Row
      ↪format>
```

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

```
[147]: matrix([[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., 0., …, 0., 0., 0.]])
```

```
[148]: cat_enc.head(10)
```

```
[148]:                           c1
       0                0::Unknown
       1                0::Unknown
       2    0::Unknown||1::Unknown
       3                0::Unknown
       4    0::Unknown||1::Unknown
       5                0::Unknown
       6    0::Unknown||1::Unknown
       7                0::Unknown
       8                0::Unknown
       9                0::Unknown
```

4. 3. Масштабирование данных

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

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

$$x = \frac{x - min(X)}{max(X) - min(X)}$$

В этом случае значения лежат в диапазоне от 0 до 1. - Масштабирование данных на основе Z-оценки:

$$x = \frac{x - AVG(X)}{\sigma(X)}$$

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

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

[149]:

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

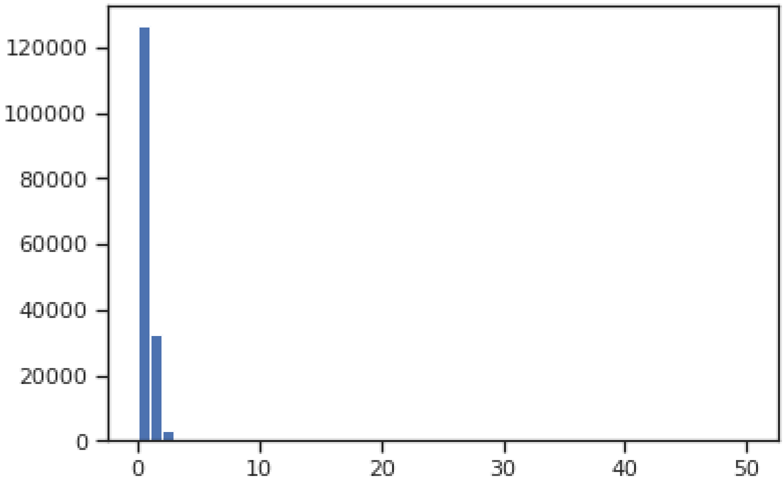
4.1. 3.1. MinMax масштабирование

[150]:

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

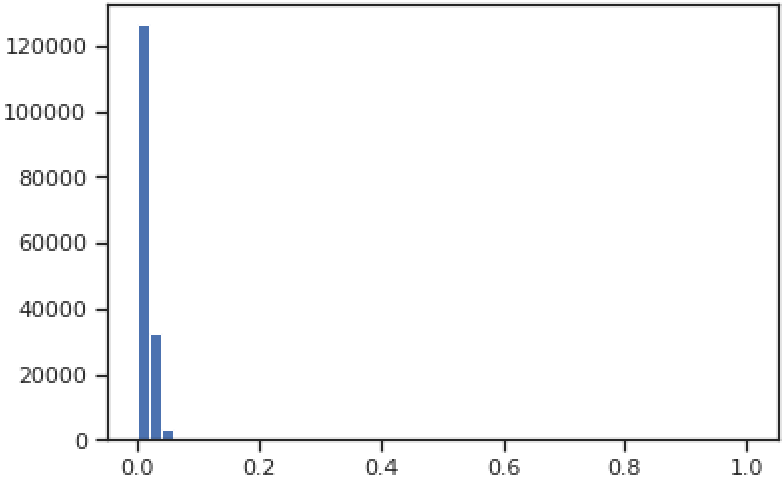
[151]:

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



[152]:

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



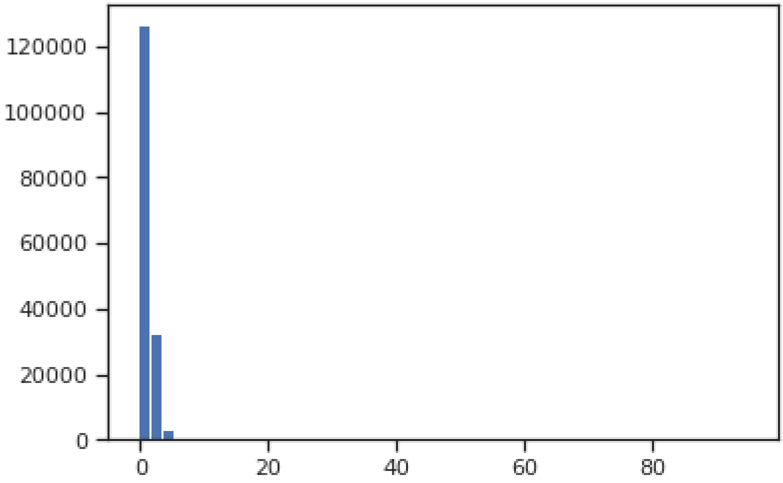
4.2. 3.2. Масштабирование данных на основе Z-оценки - StandardScaler

[153]:

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

[154]:

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



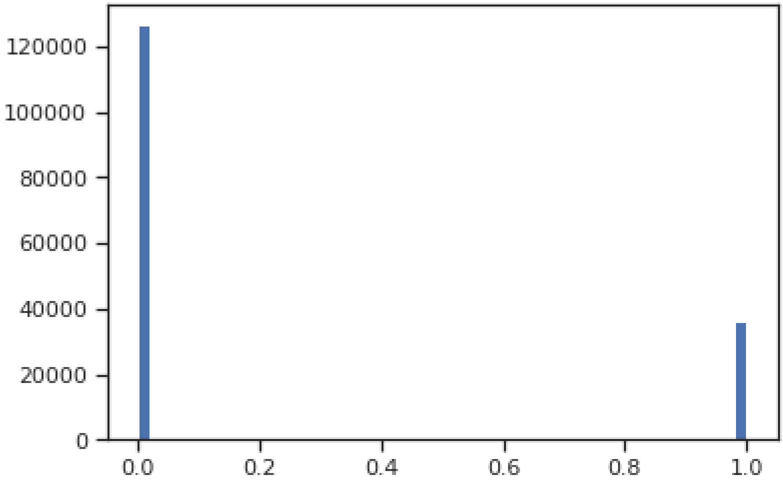
4.3. 3.3. Нормализация данных

[155]:

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

[156]:

```
plt.hist(sc3_data, 50)
plt.show()
```



120000
100000
80000
60000
40000
20000
0
0.0
0.2
0.4
0.6
0.8
1.0