Министерство науки и высшего образования Российской Федерации

Федеральное государственное бюджетное образовательное учреждение высшего образования

«Московский государственный технический университет имени Н.Э. Баумана (национальный исследовательский университет)»

(МГТУ им. Н.Э. Баумана)

Факультет «Информатика и системы управления»

Кафедра ИУ5 «Системы обработки информации и управления»

Курс «Технологии машинного обучения»

Отчет по лабораторной работе №2

«Обработка пропусков в данных, кодирование категориальных признаков, масштабирование данных»

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Гапанюк Ю.Е.

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Цель лабораторной работы: изучение способов предварительной обработки данных для дальнейшего формирования моделей.

Задание:

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

Для выбранного датасета (датасетов) на основе материалов лекции решить следующие задачи:

- обработку пропусков в данных;
- кодирование категориальных признаков;
- масштабирование данных.

Набор данных: Human Resources Data Set

Текст программы и экранные формы с примерами выполнения программы (ячейки ноутбука):

ИУ5-61Б Павловская А.А. Лаб2 ТМО

In [3]:

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

Загрузка и первичный анализ данных

In [12]:

```
data = pd.read_csv('archive/HRDataset_v14.csv')
```

In [14]:

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

Out[14]:

```
(311, 36)
```

In [15]:

```
# типы колонок
data.dtypes
```

Out[15]:

```
Employee_Name                object
EmpID                       float64
MarriedID                   float64
MaritalStatusID             float64
GenderID                    float64
EmpStatusID                 float64
DeptID                      float64
PerfScoreID                 float64
FromDiversityJobFairID      float64
Salary                      float64
Termd                       float64
PositionID                  float64
Position                     object
State                        object
Zip                         float64
DOB                          object
Sex                          object
MaritalDesc                  object
CitizenDesc                  object
HispanicLatino               object
RaceDesc                     object
DateofHire                   object
DateofTermination            object
TermReason                   object
EmploymentStatus             object
Department                   object
ManagerName                  object
ManagerID                   float64
RecruitmentSource            object
PerformanceScore             object
EngagementSurvey            float64
EmpSatisfaction             float64
SpecialProjectsCount        float64
LastPerformanceReview_Date   object
```

```
DaysLateLast30              float64
Absences                    float64
dtype: object
```

In [13]:

```
# Проверка на пропущенные значения
data.isnull().sum()
```

Out[13]:

```
Employee_Name                 4
EmpID                         4
MarriedID                     4
MaritalStatusID               4
GenderID                      4
EmpStatusID                   4
DeptID                        4
PerfScoreID                   4
FromDiversityJobFairID        4
Salary                        4
Termd                         4
PositionID                    4
Position                      4
State                         4
Zip                           4
DOB                           4
Sex                           4
MaritalDesc                   4
CitizenDesc                   4
HispanicLatino                4
RaceDesc                      4
DateofHire                    4
DateofTermination           211
TermReason                    4
EmploymentStatus              4
Department                    4
ManagerName                   4
ManagerID                    12
RecruitmentSource             4
PerformanceScore              4
EngagementSurvey              4
EmpSatisfaction               4
SpecialProjectsCount          4
LastPerformanceReview_Date    4
DaysLateLast30                4
Absences                      4
dtype: int64
```

In [16]:

```
# Первые 5 строк датасета
data.head()
```

Out[16]:

	Employee_Name	EmpID	MarriedID	MaritalStatusID	GenderID	EmpStatusID	DeptID	PerfScoreID	FromDiversity
Adinolfi	**Wilson K**	**10026.0**	**0.0**	**0.0**	**1.0**	**1.0**	**5.0**	**4.0**	
Ait Sidi	**Karthikeyan**	**10084.0**	**1.0**	**1.0**	**1.0**	**5.0**	**3.0**	**3.0**	
Akinkuolie	**Sarah**	**10196.0**	**1.0**	**1.0**	**0.0**	**5.0**	**5.0**	**3.0**	
Alagbe	**Trina**	**10088.0**	**1.0**	**1.0**	**0.0**	**1.0**	**5.0**	**3.0**	
Anderson	**Carol**	**10069.0**	**0.0**	**2.0**	**0.0**	**5.0**	**5.0**	**3.0**	

5 rows × 36 columns

In [17]:

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

```
Всего строк: 311
```

Обработка пропусков в данных

Удаление или заполнение нулями

In [18]:

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

Out[18]:

```
((311, 36), (311, 0))
```

In [19]:

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

Out[19]:

```
((311, 36), (100, 36))
```

In [20]:

```
data.head()
```

Out[20]:

	Employee_Name	EmpID	MarriedID	MaritalStatusID	GenderID	EmpStatusID	DeptID	PerfScoreID	FromDiversity
Adinolfi	**Wilson K**	**10026.0**	**0.0**	**0.0**	**1.0**	**1.0**	**5.0**	**4.0**	
Ait Sidi	**Karthikeyan**	**10084.0**	**1.0**	**1.0**	**1.0**	**5.0**	**3.0**	**3.0**	
Akinkuolie	**Sarah**	**10196.0**	**1.0**	**1.0**	**0.0**	**5.0**	**5.0**	**3.0**	
Alagbe	**Trina**	**10088.0**	**1.0**	**1.0**	**0.0**	**1.0**	**5.0**	**3.0**	
Anderson	**Carol**	**10069.0**	**0.0**	**2.0**	**0.0**	**5.0**	**5.0**	**3.0**	

5 rows × 36 columns

In [21]:

```
# 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()
```

Out[21]:

	Employee_Name	EmpID	MarriedID	MaritalStatusID	GenderID	EmpStatusID	DeptID	PerfScoreID	FromDiversity
Adinolfi	**Wilson K**	**10026.0**	**0.0**	**0.0**	**1.0**	**1.0**	**5.0**	**4.0**	
Ait Sidi	**Karthikeyan**	**10084.0**	**1.0**	**1.0**	**1.0**	**5.0**	**3.0**	**3.0**	
Akinkuolie	**Sarah**	**10196.0**	**1.0**	**1.0**	**0.0**	**5.0**	**5.0**	**3.0**	
Alagbe	**Trina**	**10088.0**	**1.0**	**1.0**	**0.0**	**1.0**	**5.0**	**3.0**	
Anderson	**Carol**	**10069.0**	**0.0**	**2.0**	**0.0**	**5.0**	**5.0**	**3.0**	

	Employee_Name	EmpID	MarriedID	MaritalStatusID	GenderID	EmpStatusID	DeptID	PerfScoreID	FromDiversity

5 rows × 36 columns

"Внедрение значений" - импьютация **(imputation)**

Обработка пропусков в числовых данных

In [22]:

```
# Выбор числовых колонок 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(co
l, dt, temp_null_count, temp_perc))
```

```
Колонка EmpID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка MarriedID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка MaritalStatusID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка GenderID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка EmpStatusID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка DeptID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка PerfScoreID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка FromDiversityJobFairID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка Salary. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка Termd. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка PositionID. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка Zip. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка ManagerID. Тип данных float64. Количество пустых значений 12, 3.86%.
Колонка EngagementSurvey. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка EmpSatisfaction. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка SpecialProjectsCount. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка DaysLateLast30. Тип данных float64. Количество пустых значений 4, 1.29%.
Колонка Absences. Тип данных float64. Количество пустых значений 4, 1.29%.
```

In [23]:

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

Out[23]:

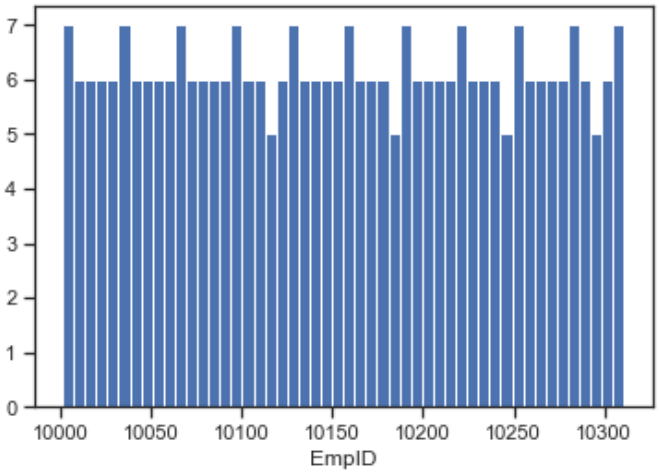
	EmpID	MarriedID	MaritalStatusID	GenderID	EmpStatusID	DeptID	PerfScoreID	FromDiversityJobFairID	Salar
Adinolfi	10026.0	0.0	0.0	1.0	1.0	5.0	4.0	0.0	62506
Ait Sidi	10084.0	1.0	1.0	1.0	5.0	3.0	3.0	0.0	104437
Akinkuolie	10196.0	1.0	1.0	0.0	5.0	5.0	3.0	0.0	64955
Alagbe	10088.0	1.0	1.0	0.0	1.0	5.0	3.0	0.0	64991
Anderson	10069.0	0.0	2.0	0.0	5.0	5.0	3.0	0.0	50825
...	...	...	...	...	...	...	...	...	
Woodson	10135.0	0.0	0.0	1.0	1.0	5.0	3.0	0.0	65893
Ybarra	10301.0	0.0	0.0	0.0	5.0	5.0	1.0	0.0	48513
Zamora	10010.0	0.0	0.0	0.0	1.0	3.0	4.0	0.0	220450
Zhou	10043.0	0.0	0.0	0.0	1.0	3.0	3.0	0.0	89292

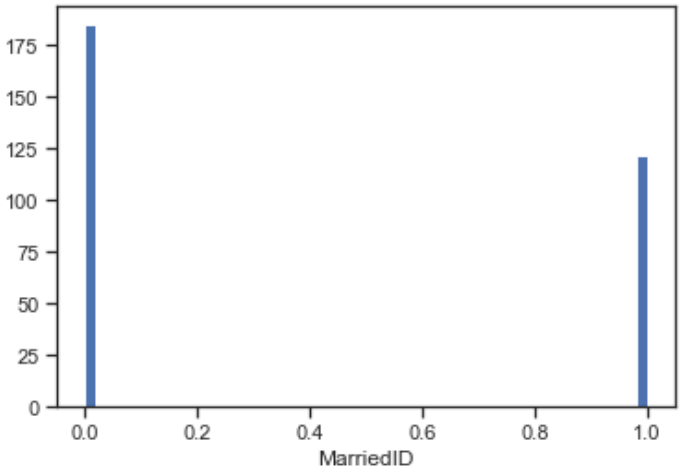
	EmpID	MarriedID	MaritalStatusID	GenderID	EmpStatusID	DeptID	PerfScoreID	FromDiversityJobFairID	Sala
Zima	10271.0	0.0	4.0	0.0	1.0	5.0	3.0	0.0	45046

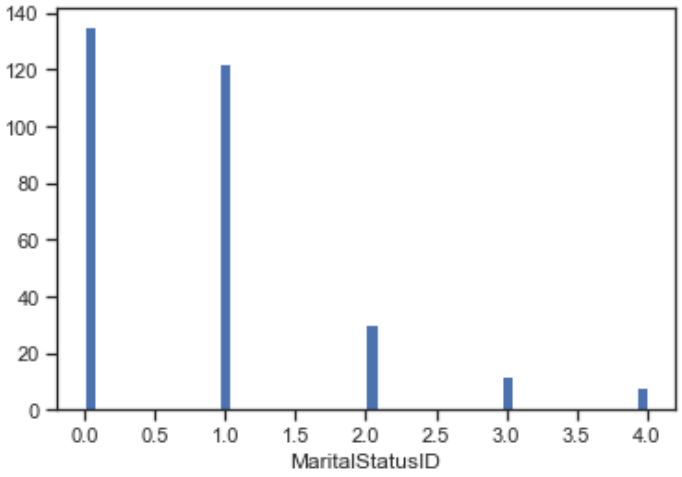
311 rows × 18 columns

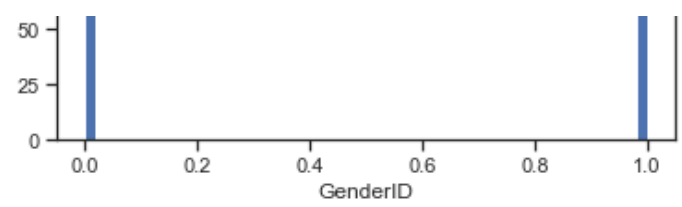
In [24]:

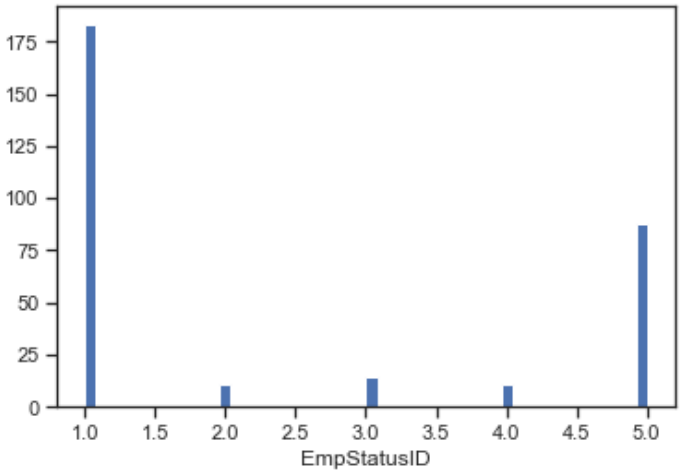
```
# Гистограмма по признакам
for col in data_num:
    plt.hist(data[col], 50)
    plt.xlabel(col)
    plt.show()
```

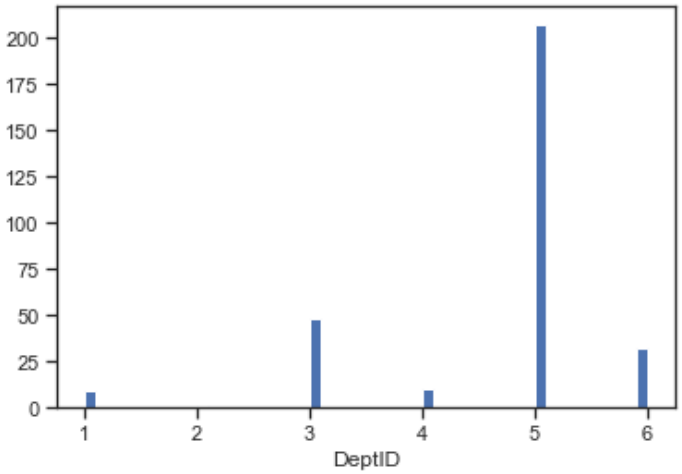


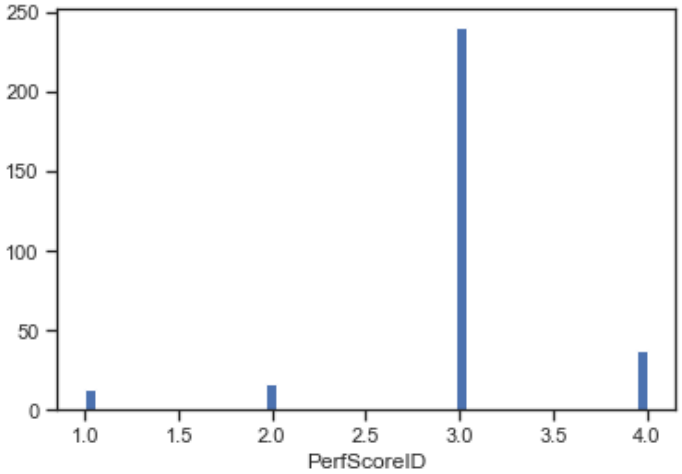


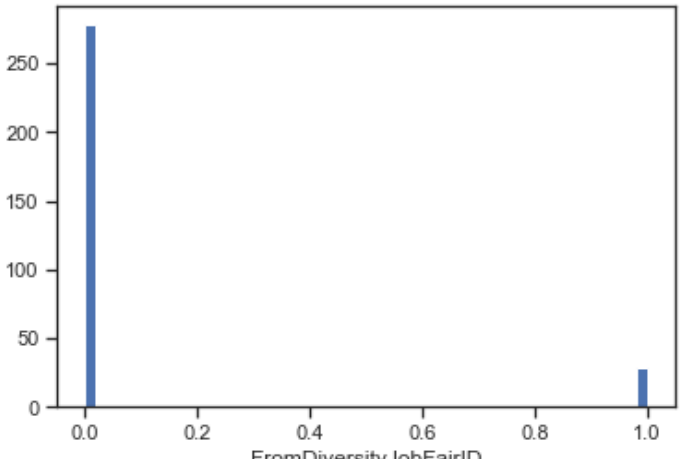


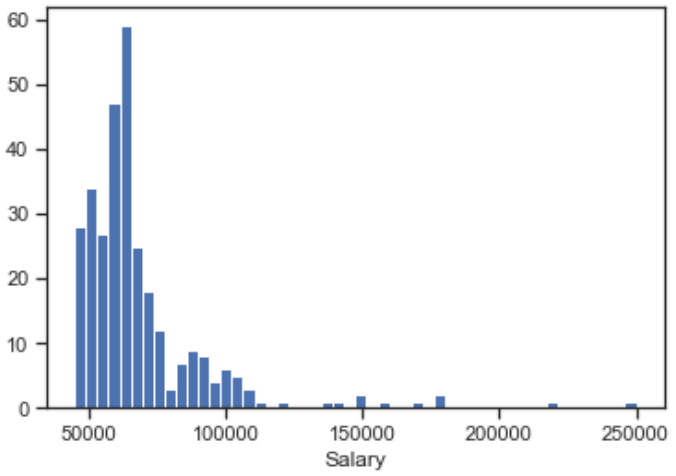

50
25
0
0.0
0.2
0.4
0.6
0.8
1.0
GenderID

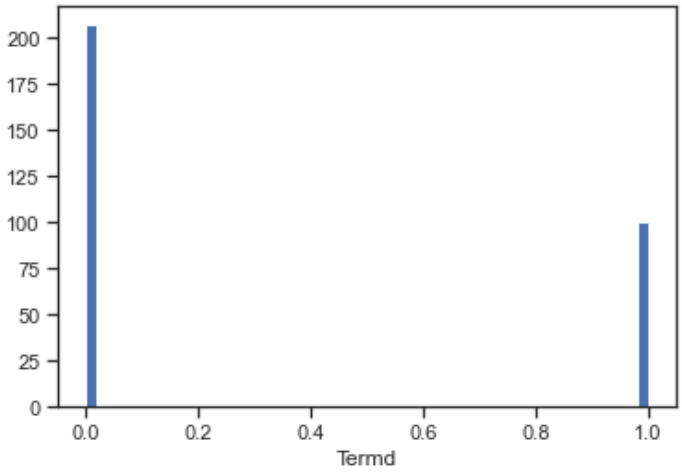

175
150
125
100
75
50
25
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
EmpStatusID

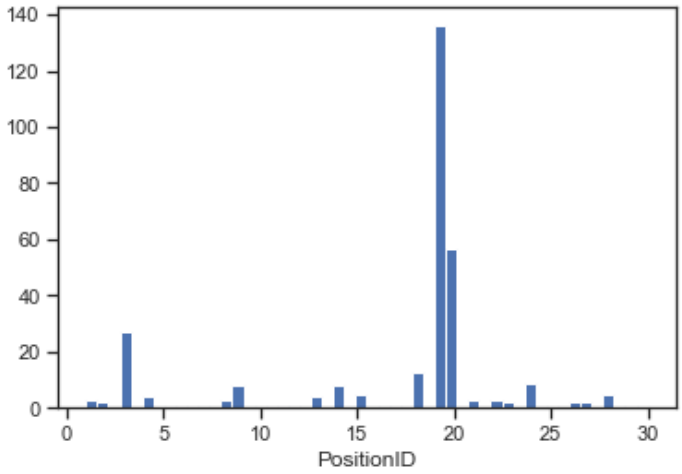

200
175
150
125
100
75
50
25
0
1
2
3
4
5
6
DeptID

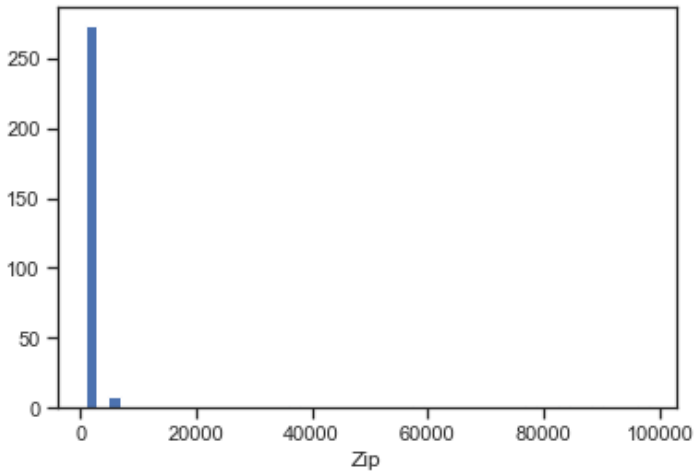

250
200
150
100
50
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
PerfScoreID


250
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8
1.0

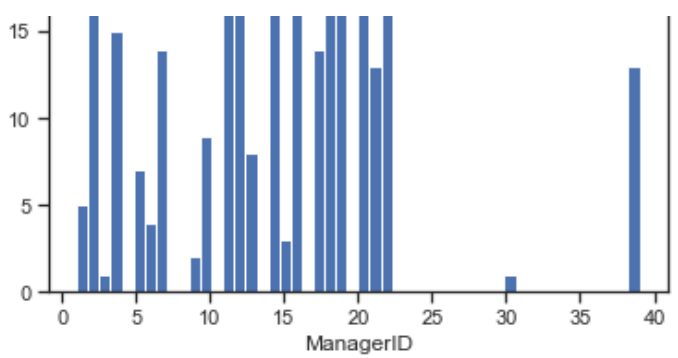

60
50
40
30
20
10
0
50000
100000
150000
200000
250000
Salary

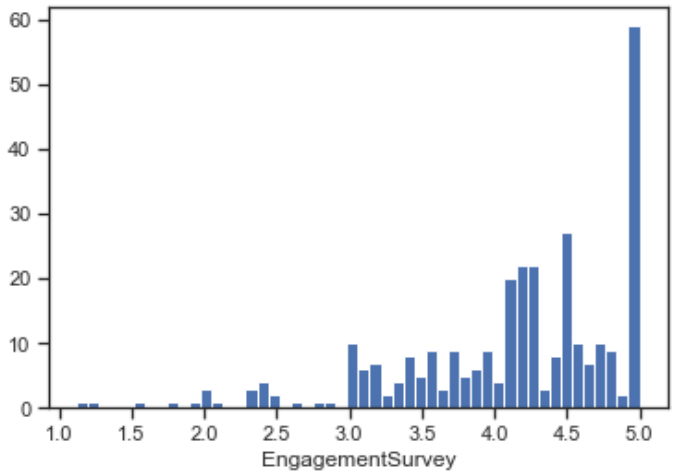

200
175
150
125
100
75
50
25
0
0.0
0.2
0.4
0.6
0.8
1.0
Termd

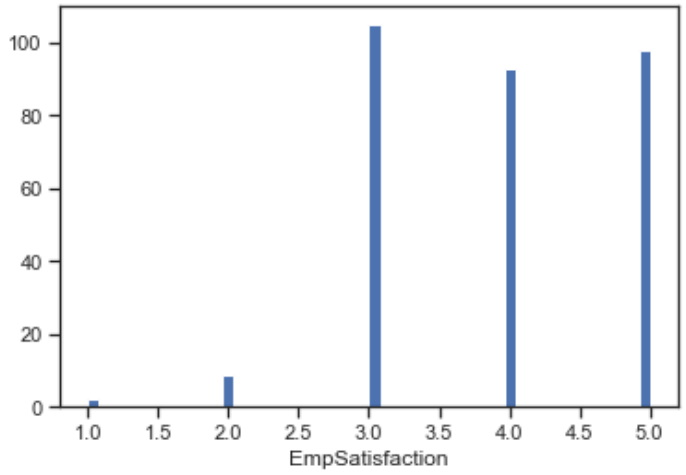

140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
PositionID

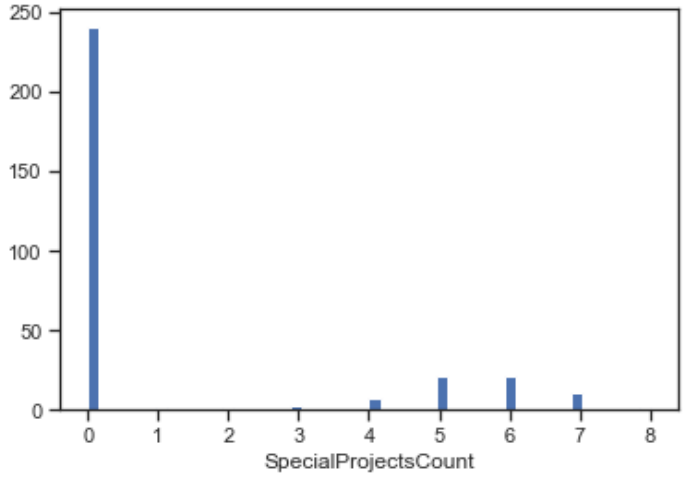

250
200
150
100
50
0
0
20000
40000
60000
80000
100000
Zip


20

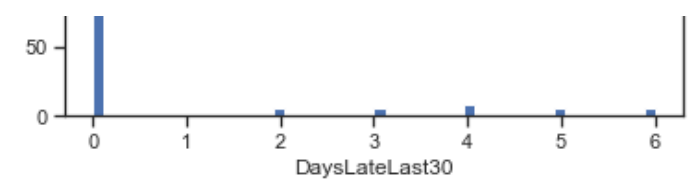

15
10
5
0
0
5
10
15
20
25
30
35
40
ManagerID

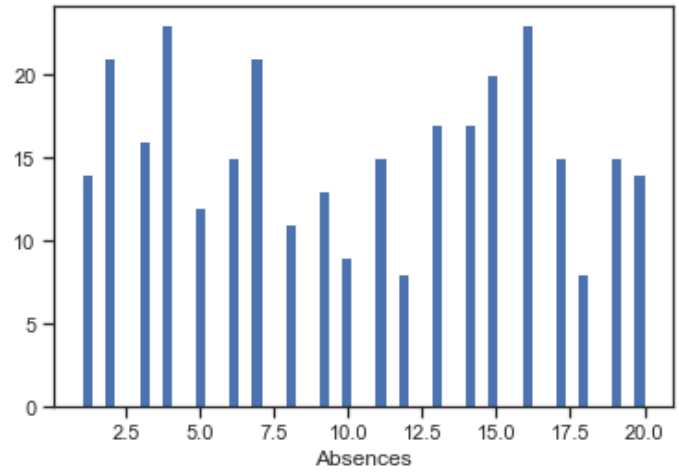

60
50
40
30
20
10
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
EngagementSurvey


100
80
60
40
20
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
EmpSatisfaction


250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
SpecialProjectsCount


250
200
150
100





In [26]:

```
# Используем встроенные средства импьютации библиотеки scikit-learn
data_num_Absences = data_num[['Absences']]
data_num_Absences.head()
```

Out[26]:

	Absences
Adinolfi	1.0
Ait Sidi	17.0
Akinkuolie	3.0
Alagbe	15.0
Anderson	2.0

In [27]:

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

In [28]:

```
# Фильтр для проверки заполнения пустых значений
indicator = MissingIndicator()
mask_missing_values_only = indicator.fit_transform(data_num_Absences)
mask_missing_values_only
```

Out[28]:

```
array([[False],
       [False],
       [False],
       [False],
       [False],
       [False],
       [False],
       [False],
       [False],
       [False],
       [False],
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       [False],
       [False],
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       [False],
       [False],
       [False]])
```

In [29]:

```
# Импьютация различными показателями центра распределения с помощью класса SimpleImputer
strategies=['mean', 'median', 'most_frequent']
```

In [34]:

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

In [35]:

```
# Среднее значение
strategies[0], test_num_impute(strategies[0])
```

Out[35]:

```
('mean', array([10.22801303, 10.22801303, 10.22801303, 10.22801303]))
```

In [36]:

```
# Медиана
strategies[1], test_num_impute(strategies[1])
```

Out[36]:

```
('median', array([10., 10., 10., 10.]))
```

In [37]:

```
# Мода
strategies[2], test_num_impute(strategies[2])
```

Out[37]:

```
('most_frequent', array([4., 4., 4., 4.]))
```

In [38]:

```
# 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]
```

In [39]:

```
data[['Zip']].describe()
```

Out[39]:

	Zip

	Zip
count	307.000000
mean	6612.508143
std	17011.083885
min	1013.000000
25%	1895.500000
50%	2132.000000
75%	2355.000000
max	98052.000000

In [40]:

```
test_num_impute_col(data, 'Zip', strategies[0])
```

Out[40]:

```
('Zip', 'mean', 4, 6612.508143322476, 6612.508143322476)
```

In [41]:

```
test_num_impute_col(data, 'Zip', strategies[1])
```

Out[41]:

```
('Zip', 'median', 4, 2132.0, 2132.0)
```

In [42]:

```
test_num_impute_col(data, 'Zip', strategies[2])
```

Out[42]:

```
('Zip', 'most_frequent', 4, 1886.0, 1886.0)
```

Обработка пропусков в категориальных данных

In [43]:

```
# Выбор категориальных колонок 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(co
l, dt, temp_null_count, temp_perc))
```

```
Колонка Employee_Name. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка Position. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка State. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка DOB. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка Sex. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка MaritalDesc. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка CitizenDesc. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка HispanicLatino. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка RaceDesc. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка DateofHire. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка DateofTermination. Тип данных object. Количество пустых значений 211, 67.85%.
Колонка TermReason. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка EmploymentStatus. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка Department. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка ManagerName. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка RecruitmentSource. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка PerformanceScore. Тип данных object. Количество пустых значений 4, 1.29%.
Колонка LastPerformanceReview_Date. Тип данных object. Количество пустых значений 4, 1.29
```

Колонка LastPerformanceReview_Date. Тип данных object. Количество пустых значений 4, 1.29 %.

In [44]:

```
# Импьютация категориальных признаков со стратегиями
# "most_frequent" или "constant" с помощью класса SimpleImputer
cat_temp_data = data[['TermReason']]
cat_temp_data.head()
```

Out[44]:

	TermReason
Adinolfi	**N/A-StillEmployed**
Ait Sidi	**career change**
Akinkuolie	**hours**
Alagbe	**N/A-StillEmployed**
Anderson	**return to school**

In [45]:

```
cat_temp_data['TermReason'].unique()
```

Out[45]:

```
array(['N/A-StillEmployed', 'career change', 'hours', 'return to school',
       'Another position', 'unhappy', 'attendance', 'performance',
       'Learned that he is a gangster', 'retiring',
       'relocation out of area', 'more money', 'military', nan,
       'Fatal attraction', 'maternity leave - did not return',
       'medical issues', 'gross misconduct'], dtype=object)
```

In [46]:

```
cat_temp_data[cat_temp_data['TermReason'].isnull()].shape
```

Out[46]:

```
(4, 1)
```

In [47]:

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

Out[47]:

```
array([['N/A-StillEmployed'],
       ['career change'],
       ['hours'],
       ['N/A-StillEmployed'],
       ['return to school'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['unhappy'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['attendance'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['performance'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
```

['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['career change'],
['Learned that he is a gangster'],
['N/A-StillEmployed'],
['retiring'],
['Another position'],
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['N/A-StillEmployed'],
['relocation out of area'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['unhappy'],
['career change'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['career change'],
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['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['more money'],
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['retiring'],
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['N/A-StillEmployed'],
['hours'],
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['relocation out of area'],
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['medical issues'],
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['return to school'],
['military'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['medical issues'],
['medical issues'],
['unhappy'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['maternity leave - did not return'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['gross misconduct'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['Another position'],
['career change'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['hours'],
['unhappy'],
['Another position'],
['relocation out of area'],
['retiring'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['Another position'],
['N/A-StillEmployed'],

```
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed']], dtype=object)
```

In [48]:

```
# Пустые значения отсутствуют
np.unique(data_imp2)
```

Out[48]:

```
array(['Another position', 'Fatal attraction',
       'Learned that he is a gangster', 'N/A-StillEmployed', 'attendance',
       'career change', 'gross misconduct', 'hours',
       'maternity leave - did not return', 'medical issues', 'military',
       'more money', 'performance', 'relocation out of area', 'retiring',
       'return to school', 'unhappy'], dtype=object)
```

In [49]:

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

Out[49]:

```
array([['N/A-StillEmployed'],
       ['career change'],
       ['hours'],
       ['N/A-StillEmployed'],
       ['return to school'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['unhappy'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['attendance'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['performance'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['career change'],
       ['Learned that he is a gangster'],
       ['N/A-StillEmployed'],
       ['retiring'],
       ['Another position'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
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       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
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       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
```

['relocation out of area'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['unhappy'],
['career change'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['performance'],
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['unhappy'],
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['N/A-StillEmployed'],
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['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['attendance'],
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['N/A-StillEmployed'],
['military'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['attendance'],
['military'],
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['N/A-StillEmployed'],
['N/A'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],

```
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['relocation out of area'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['retiring'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['hours'],
['N/A-StillEmployed'],
['relocation out of area'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['more money'],
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['N/A-StillEmployed'],
['unhappy'],
['maternity leave - did not return'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['more money'],
['more money'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['attendance'],
['Another position'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['more money'],
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['return to school'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['unhappy'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['Another position'],
['hours'],
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['N/A-StillEmployed'],
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['Another position'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['unhappy'],
['N/A-StillEmployed'],
```

```
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['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
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['N/A-StillEmployed'],
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['performance'],
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['N/A-StillEmployed'],
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['Another position'],
['performance'],
['career change'],
['unhappy'],
['medical issues'],
['more money'],
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['N/A-StillEmployed'],
['Another position'],
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['retiring'],
['N/A-StillEmployed'],
['return to school'],
['Another position'],
['attendance'],
['attendance'],
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['N/A-StillEmployed'],
['Another position'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['Another position'],
['N/A-StillEmployed'],
['hours'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['relocation out of area'],
['N/A-StillEmployed'],
['hours'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['maternity leave - did not return'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
['career change'],
['N/A-StillEmployed'],
['N/A-StillEmployed'],
```

```
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['unhappy'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['Another position'],
       ['N/A-StillEmployed'],
       ['return to school'],
       ['military'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['medical issues'],
       ['medical issues'],
       ['unhappy'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['maternity leave - did not return'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A'],
       ['gross misconduct'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['career change'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['hours'],
       ['unhappy'],
       ['Another position'],
       ['relocation out of area'],
       ['retiring'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['Another position'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed'],
       ['N/A-StillEmployed']], dtype=object)
```

In [50]:

```
np.unique(data_imp3)
```

Out[50]:

```
array(['Another position', 'Fatal attraction',
       'Learned that he is a gangster', 'N/A', 'N/A-StillEmployed',
       'attendance', 'career change', 'gross misconduct', 'hours',
       'maternity leave - did not return', 'medical issues', 'military',
       'more money', 'performance', 'relocation out of area', 'retiring',
       'return to school', 'unhappy'], dtype=object)
```

In [52]:

```
data_imp3[data_imp3=='N/A'].size
```

Out[52]:

```
4
```

Преобразование категориальных признаков в числовые

Преобразование категориальных признаков в числовые

In [53]:

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

Out[53]:

	c1
0	N/A-StillEmployed
1	career change
2	hours
3	N/A-StillEmployed
4	return to school
...	...
306	N/A-StillEmployed
307	Another position
308	N/A-StillEmployed
309	N/A-StillEmployed
310	N/A-StillEmployed

311 rows × 1 columns

Кодирование категорий целочисленными значениями - **label encoding**

In [54]:

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
```

In [55]:

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

In [56]:

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

Out[56]:

```
array(['N/A-StillEmployed', 'career change', 'hours', 'return to school',
       'Another position', 'unhappy', 'attendance', 'performance',
       'Learned that he is a gangster', 'retiring',
       'relocation out of area', 'more money', 'military',
       'Fatal attraction', 'maternity leave - did not return',
       'medical issues', 'gross misconduct'], dtype=object)
```

In [57]:

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

Out[57]:

```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16])
```

In [58]:

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

Out[58]:

```
array(['Another position', 'Fatal attraction',
       'Learned that he is a gangster', 'N/A-StillEmployed'], dtype=object)
```

Кодирование категорий наборами бинарных значений - **one-hot encoding**

In [59]:

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

In [60]:

```
cat_enc.shape
```

Out[60]:

```
(311, 1)
```

In [61]:

```
cat_enc_ohe.shape
```

Out[61]:

```
(311, 17)
```

In [62]:

```
cat_enc_ohe
```

Out[62]:

```
<311x17 sparse matrix of type '<class 'numpy.float64'>'
 with 311 stored elements in Compressed Sparse Row format>
```

In [63]:

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

Out[63]:

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

In [64]:

```
cat_enc.head(10)
```

Out[64]:

	c1
0	N/A-StillEmployed
1	career change
2	hours

	c1
3	N/A-StillEmployed
4	return to school
5	N/A-StillEmployed
6	N/A-StillEmployed
7	N/A-StillEmployed
8	N/A-StillEmployed
9	N/A-StillEmployed

Pandas get_dummies - быстрый вариант **one-hot** кодирования

In [65]:

```
pd.get_dummies(cat_enc).head()
```

Out[65]:

	c1_Another position	c1_Fatal attraction	c1_Learned that he is a gangster	c1_N/A-StillEmployed	c1_attendance	c1_career change	c1_gross misconduct	c1_hours	c1_maternity leave - did not return	c1_med iss
0	0	0	0	1	0	0	0	0	0	
1	0	0	0	0	0	1	0	0	0	
2	0	0	0	0	0	0	0	1	0	
3	0	0	0	1	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	

In [66]:

```
pd.get_dummies(cat_temp_data, dummy_na=True).head()
```

Out[66]:

	TermReason_Another position	TermReason_Fatal attraction	TermReason_Learned that he is a gangster	TermReason_N/A-StillEmployed	TermReason_attendance	Term
Adinolfi	0	0	0	1	0	
Ait Sidi	0	0	0	0	0	
Akinkuolie	0	0	0	0	0	
Alagbe	0	0	0	1	0	
Anderson	0	0	0	0	0	

Масштабирование данных

In [67]:

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

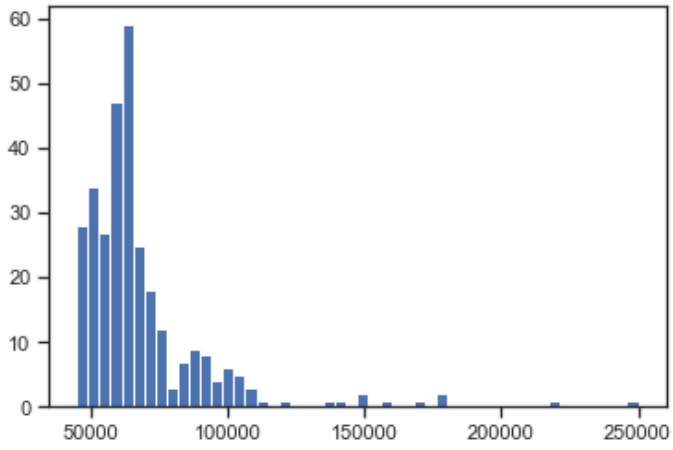
MinMax Масштабирование

In [73]:

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

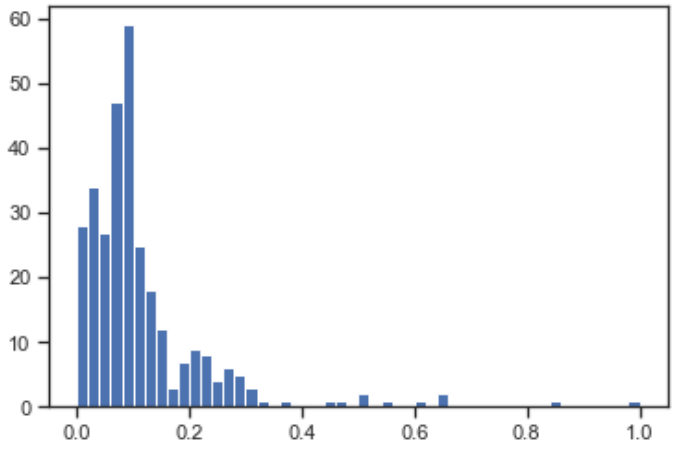
In [74]:

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



In [75]:

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



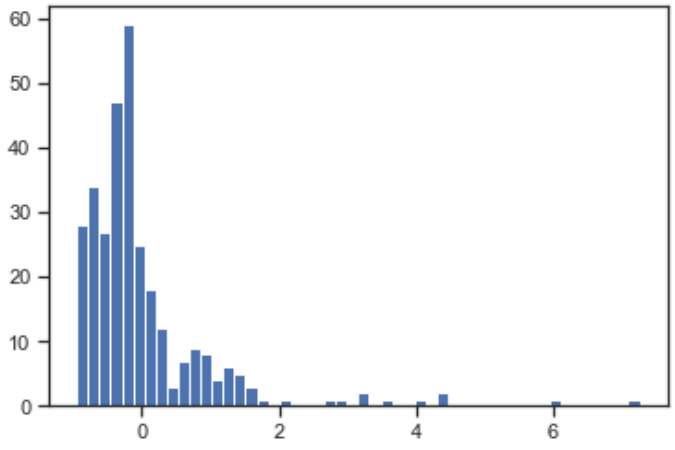
Масштабирование данных на основе **Z**-оценки - **StandardScaler**

In [76]:

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

In [77]:

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



In [ ]: