Честнова Екатерина ИУ5-62Б

Рк 2 Вариант 20

Задание. Для заданного набора данных (по Вашему варианту) постройте модели классификации или регрессии (в зависимости от конкретной задачи, рассматриваемой в наборе данных). Для построения моделей используйте методы: Метод опорных векторов, Случайный лес. Оцените качество моделей на основе подходящих метрик качества (не менее двух метрик). Какие метрики качества Вы использовали и почему? Какие выводы Вы можете сделать о качестве построенных моделей? Для построения моделей необходимо выполнить требуемую предобработку данных: заполнение пропусков, кодирование категориальных признаков, и т.д.

In [1]:
```
from google.colab import files
uploaded = files.upload()
```

Выбрать файлы Файл не выбран

Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving impeachment-polls.csv to impeachment-polls.csv
```

In [78]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.metrics import plot_confusion_matrix
from sklearn.model_selection import train_test_split,  GridSearchCV
from sklearn.metrics import precision_score, recall_score, f1_score, classification_r
eport
from sklearn.metrics import confusion_matrix
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
```

In [4]:
```
df = pd.read_csv('./impeachment-polls.csv', sep=',')
```

```
In [5]: df.head()
```

Out[5]:

	Start	End	Pollster	Sponsor	SampleSize	Pop	tracking	Text	C
0	6/28/2019	7/1/2019	ABC News/Washington Post	NaN	1008	a	NaN	Based on what you know, do you think Congress ...	begin_proc
1	4/22/2019	4/25/2019	ABC News/Washington Post	NaN	1001	a	NaN	Based on what you know, do you think Congress ...	begin_proc
2	1/21/2019	1/24/2019	ABC News/Washington Post	NaN	1001	a	NaN	Based on what you know, do you think Congress ...	begin_proc
3	8/26/2018	8/29/2018	ABC News/Washington Post	NaN	1003	a	NaN	Based on what you know, do you think Congress ...	begin_proc
4	6/8/2019	6/12/2019	Civiqs	NaN	1559	rv	NaN	Do you think the House of Representatives shou...	begin

5 rows × 24 columns

Выполним предобработку данных

In [7]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 542 entries, 0 to 541
Data columns (total 24 columns):
 #   Column      Non-Null Count  Dtype  
---  ------      --------------  -----  
 0   Start       542 non-null    object 
 1   End         542 non-null    object 
 2   Pollster    542 non-null    object 
 3   Sponsor     276 non-null    object 
 4   SampleSize  542 non-null    int64  
 5   Pop         542 non-null    object 
 6   tracking    114 non-null    object 
 7   Text        541 non-null    object 
 8   Category    541 non-null    object 
 9   Include?    542 non-null    object 
 10  Yes         542 non-null    float64
 11  No          542 non-null    float64
 12  Unsure      521 non-null    float64
 13  Rep Sample  475 non-null    float64
 14  Rep Yes     509 non-null    float64
 15  Rep No      492 non-null    float64
 16  Dem Sample  477 non-null    float64
 17  Dem Yes     515 non-null    float64
 18  Dem No      491 non-null    float64
 19  Ind Sample  409 non-null    float64
 20  Ind Yes     447 non-null    float64
 21  Ind No      430 non-null    float64
 22  URL         541 non-null    object 
 23  Notes       7 non-null      object 
dtypes: float64(12), int64(1), object(11)
memory usage: 101.8+ KB
```

In [8]:
```
#Проверим на пропуски
df.isnull().sum()
```

Out[8]:
```
Start           0
End             0
Pollster        0
Sponsor       266
SampleSize      0
Pop             0
tracking      428
Text            1
Category        1
Include?        0
Yes             0
No              0
Unsure         21
Rep Sample     67
Rep Yes        33
Rep No         50
Dem Sample     65
Dem Yes        27
Dem No         51
Ind Sample    133
Ind Yes        95
Ind No        112
URL             1
Notes         535
dtype: int64
```

In [11]:

```
df1 = df.drop(['tracking', 'Notes', 'Sponsor'], axis=1)
#df.drop('Notes', axis=1)
df1.isnull().sum()
```

Out[11]:

```
Start            0
End              0
Pollster         0
SampleSize       0
Pop              0
Text             1
Category         1
Include?         0
Yes              0
No               0
Unsure          21
Rep Sample      67
Rep Yes         33
Rep No          50
Dem Sample      65
Dem Yes         27
Dem No          51
Ind Sample     133
Ind Yes         95
Ind No         112
URL              1
dtype: int64
```

In [16]:

```
df2 = df1.dropna()
df2.isnull().sum()
```

Out[16]:

```
Start          0
End            0
Pollster       0
SampleSize     0
Pop            0
Text           0
Category       0
Include?       0
Yes            0
No             0
Unsure         0
Rep Sample     0
Rep Yes        0
Rep No         0
Dem Sample     0
Dem Yes        0
Dem No         0
Ind Sample     0
Ind Yes        0
Ind No         0
URL            0
dtype: int64
```

In [17]:

```
df2.describe()
```

Out[17]:

	SampleSize	Yes	No	Unsure	Rep Sample	Rep Yes	Rep No	D Sam
count	390.000000	390.000000	390.000000	390.000000	390.000000	390.000000	390.000000	390.0000
mean	1652.235897	44.355641	44.868974	10.789487	530.164103	10.527692	84.239487	615.3769
std	1213.976110	4.813681	5.305436	4.862983	514.306320	3.616444	5.430177	494.5395
min	500.000000	28.000000	28.000000	1.000000	111.000000	2.000000	64.000000	164.0000
25%	1000.000000	41.000000	41.500000	7.000000	312.250000	8.000000	81.000000	355.7500
50%	1468.000000	45.000000	43.300000	12.000000	388.000000	10.950000	83.000000	480.5000
75%	1993.000000	48.000000	47.000000	14.350000	639.000000	13.000000	88.000000	736.0000
max	18101.000000	58.000000	66.000000	28.000000	8368.000000	28.000000	97.000000	6989.0000

In [29]:

```
df2.dtypes
```

Out[29]:

```
Start          object
End            object
Pollster       object
SampleSize      int64
Pop            object
Text           object
Category        int64
Include?       object
Yes           float64
No            float64
Unsure        float64
Rep Sample    float64
Rep Yes       float64
Rep No        float64
Dem Sample    float64
Dem Yes       float64
Dem No        float64
Ind Sample    float64
Ind Yes       float64
Ind No        float64
URL            object
dtype: object
```

Для решения задачи классификации выполним кодирование категориальных признаков

In [18]:

```
from sklearn.preprocessing import LabelEncoder
```

In [38]:

```
#df2['Category'].unique()
for col in df2.columns:
    print('{} - {}'.format(col, len(df2[col].unique())))
```

```
Start - 248
End - 234
Pollster - 26
SampleSize - 181
Pop - 3
Text - 94
Category - 8
Include? - 2
Yes - 68
No - 69
Unsure - 58
Rep Sample - 231
Rep Yes - 55
Rep No - 64
Dem Sample - 253
Dem Yes - 81
Dem No - 72
Ind Sample - 229
Ind Yes - 58
Ind No - 69
URL - 271
```

In [40]:

```
#преобразование
le1 = LabelEncoder()
df2["Category"] = le1.fit_transform(df2['Category'])
df2["Start"] = le1.fit_transform(df2['Start'])
df2["End"] = le1.fit_transform(df2['End'])
df2["Pollster"] = le1.fit_transform(df2['Pollster'])
df2["Pop"] = le1.fit_transform(df2['Pop'])
df2["Text"] = le1.fit_transform(df2['Text'])
df2["Include?"] = le1.fit_transform(df2['Include?'])
df2["URL"] = le1.fit_transform(df2['URL'])
df2.head()
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  This is separate from the ipykernel package so we can avoid doing imports until
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:4: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  after removing the cwd from sys.path.
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:5: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  """
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:6: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:7: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  import sys
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:8: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:9: SettingWithCopyWarni
ng:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  if __name__ == '__main__':
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:10: SettingWithCopyWarn
ing:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/u
ser_guide/indexing.html#returning-a-view-versus-a-copy
  # Remove the CWD from sys.path while we load stuff.
```

Out[40]:

	Start	End	Pollster	SampleSize	Pop	Text	Category	Include?	Yes	No	...	Rep Sample	Rep Yes	Rep No
0	190	188	0	1008	0	28	1	1	37.0	59.0	...	232.0	7.0	87.0
1	162	158	0	1001	0	28	1	1	37.0	56.0	...	260.0	10.0	87.0
2	12	16	0	1001	0	28	1	1	40.0	55.0	...	240.0	7.0	90.0
3	224	213	0	1003	0	28	1	1	49.0	46.0	...	251.0	15.0	82.0
4	198	178	4	1559	2	63	0	1	43.0	51.0	...	483.0	5.0	93.0

5 rows × 21 columns

In [41]:
```
df2.dtypes
```

Out[41]:
```
Start            int64
End              int64
Pollster         int64
SampleSize       int64
Pop              int64
Text             int64
Category         int64
Include?         int64
Yes            float64
No             float64
Unsure         float64
Rep Sample     float64
Rep Yes        float64
Rep No         float64
Dem Sample     float64
Dem Yes        float64
Dem No         float64
Ind Sample     float64
Ind Yes        float64
Ind No         float64
URL              int64
dtype: object
```

Решение задачи классификации

Будем оценить модели при помощи метрик F1, Precision и Recall, а также построим матрицы ошибок. Дисбаланс классов учитываем в виде веса классов.

In [105]:
```
def print_metrics(y_test, y_pred):
  sns.heatmap(confusion_matrix(y_test, y_pred), annot=True, cmap="Blues")
  print(f"Precision: {precision_score(y_test, y_pred, average='weighted', labels=np.unique(y_pred))}")
  print(f"Recall: {recall_score(y_test, y_pred, average='weighted', labels=np.unique(y_pred))}")
  print(f"F1: {f1_score(y_test, y_pred, average='weighted', labels=np.unique(y_pred))}")
  #print(f"Report: {classification_report(y_test, y_pred, output_dict=True)}")
```

In [48]:
```
y = df2['Category']
x = df2.drop('Category', axis=1)
```

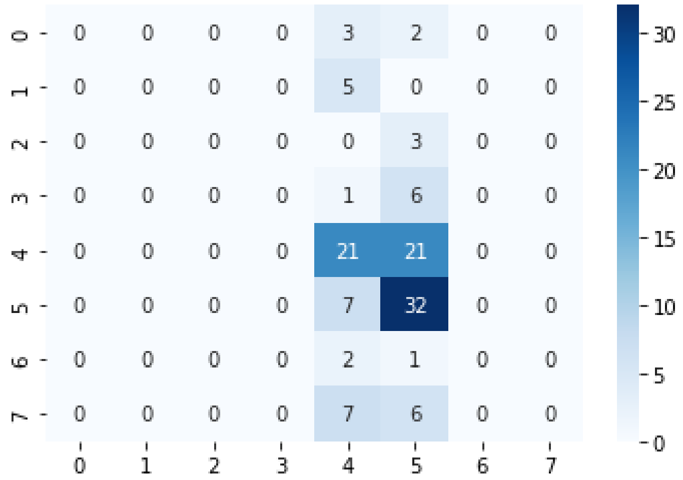
In [106]:
```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.3, random_state=5)
```

Метод SVM

In [107]:

```
svm1 = SVC()
est1 = svm1.fit(x_train, y_train)
y_pred1 = est1.predict(x_test)
print_metrics(y_test, y_pred1)
```

```
Precision: 0.45372071397790925
Recall: 0.654320987654321
F1: 0.5276094276094276
```



	0	1	2	3	4	5	6	7
0	0	0	0	0	3	2	0	0
1	0	0	0	0	5	0	0	0
2	0	0	0	0	0	3	0	0
3	0	0	0	0	1	6	0	0
4	0	0	0	0	21	21	0	0
5	0	0	0	0	7	32	0	0
6	0	0	0	0	2	1	0	0
7	0	0	0	0	7	6	0	0

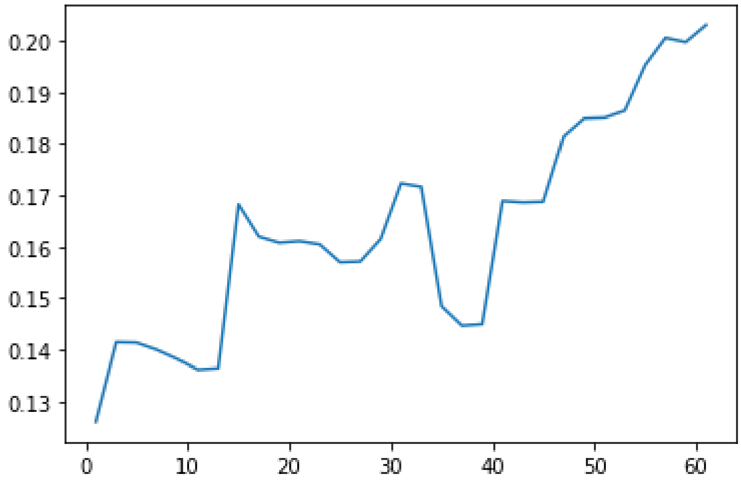
In [112]:

```
param_range = np.arange(1, 62, 2)
svm_parameters = [{'C': param_range}]
svm_best = GridSearchCV(svm1, svm_parameters,
                        cv=5, scoring="f1_weighted", n_jobs=-1)
svm_best.fit(x, y)
print(svm_best.best_params_)
```

```
{'C': 61}
```

In [101]:

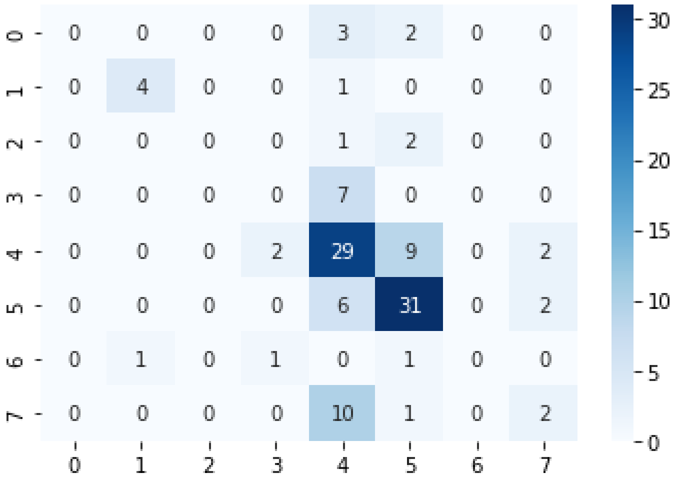
```
plt.plot(param_range, svm_best.cv_results_["mean_test_score"]);
```



In [113]:

```
est2 = svm_best.best_estimator_.fit(x_train, y_train)
y_pred2 = est2.predict(x_test)
print_metrics(y_test, y_pred2)
```

```
Precision: 0.5281543686945008
Recall: 0.6226415094339622
F1: 0.5640562408948413
```



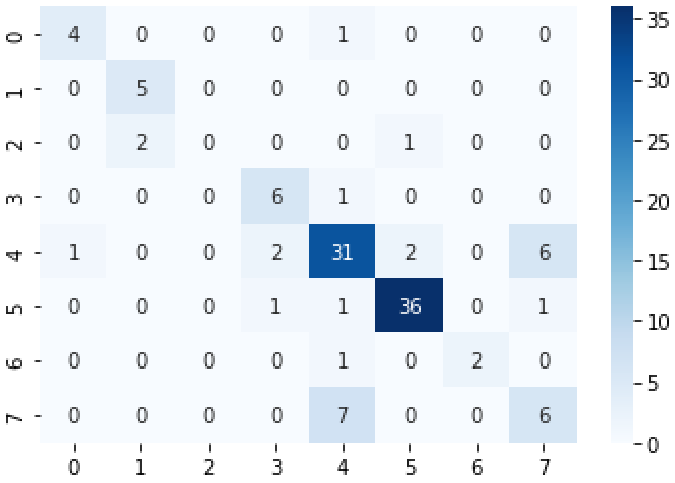
	0	1	2	3	4	5	6	7
0	0	0	0	0	3	2	0	0
1	0	4	0	0	1	0	0	0
2	0	0	0	0	1	2	0	0
3	0	0	0	0	7	0	0	0
4	0	0	0	2	29	9	0	2
5	0	0	0	0	6	31	0	2
6	0	1	0	1	0	1	0	0
7	0	0	0	0	10	1	0	2

Случайный лес

In [122]:

```
forest1 = RandomForestClassifier()
est3 = forest1.fit(x_train, y_train)
y_pred3 = est3.predict(x_test)
print_metrics(y_test, y_pred3)
```

```
Precision: 0.7740183792815372
Recall: 0.7894736842105263
F1: 0.7790935672514621
```



	0	1	2	3	4	5	6	7
0	4	0	0	0	1	0	0	0
1	0	5	0	0	0	0	0	0
2	0	2	0	0	0	1	0	0
3	0	0	0	6	1	0	0	0
4	1	0	0	2	31	2	0	6
5	0	0	0	1	1	36	0	1
6	0	0	0	0	1	0	2	0
7	0	0	0	0	7	0	0	6

In [ ]:

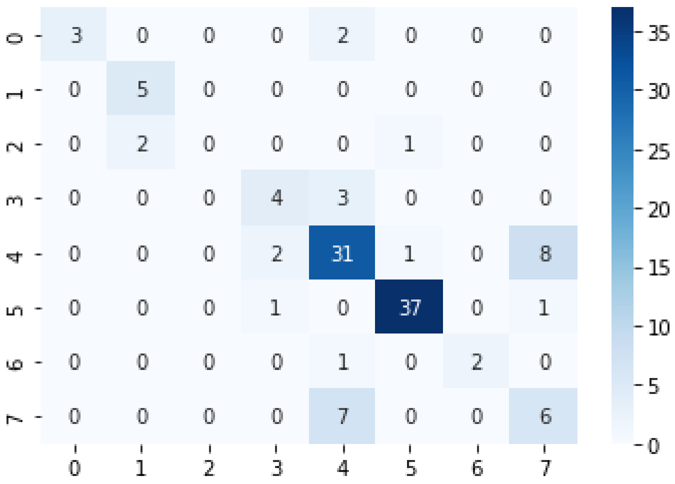
```
In [123]: f_params = {'n_estimators': [5, 10, 50, 100], 'max_features': [2, 3, 4], 'criterion':
          ['gini', 'entropy'], 'min_samples_leaf': [1, 2, 3, 4, 5]}
          forest_best = GridSearchCV(forest1, f_params, cv=10, n_jobs=-1, scoring='f1_weighted'
          )
          forest_best.fit(x, y)
          print(forest_best.best_params_)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/model_selection/_split.py:680: UserWa
rning: The least populated class in y has only 5 members, which is less than n_split
s=10.
  UserWarning,

{'criterion': 'entropy', 'max_features': 4, 'min_samples_leaf': 1, 'n_estimators': 5
0}
```

```
In [124]: est4 = forest_best.best_estimator_.fit(x_train, y_train)
          y_pred4 = est4.predict(x_test)
          print_metrics(y_test, y_pred4)
```

```
Precision: 0.7663362952836638
Recall: 0.7719298245614035
F1: 0.764624254434536
```



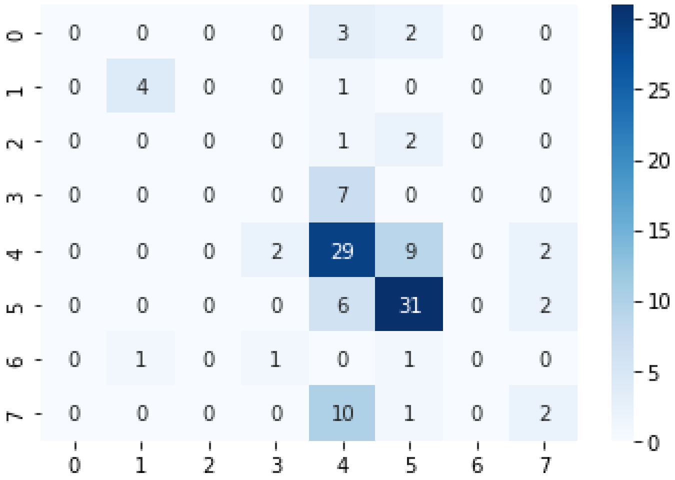
	0	1	2	3	4	5	6	7
0	3	0	0	0	2	0	0	0
1	0	5	0	0	0	0	0	0
2	0	2	0	0	0	1	0	0
3	0	0	0	4	3	0	0	0
4	0	0	0	2	31	1	0	8
5	0	0	0	1	0	37	0	1
6	0	0	0	0	1	0	2	0
7	0	0	0	0	7	0	0	6

Сравнение результатов

Выведем лучшие результаты моделей

```
In [127]: print("Метод SVM")
          print_metrics(y_test, y_pred2)
```

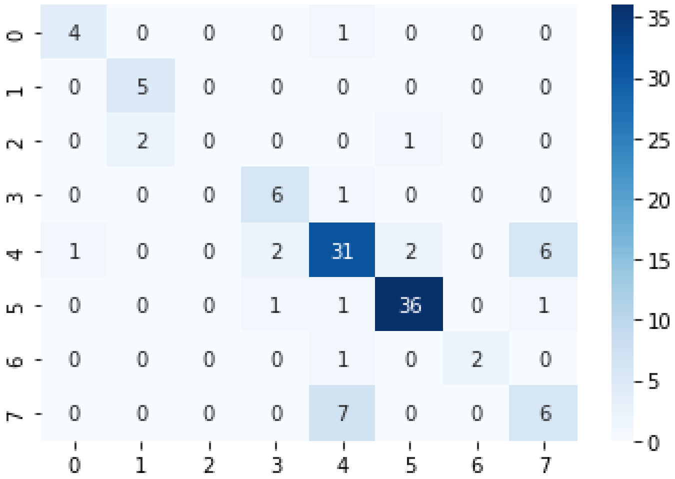
```
Метод SVM
Precision: 0.5281543686945008
Recall: 0.6226415094339622
F1: 0.5640562408948413
```



	0	1	2	3	4	5	6	7
0	0	0	0	0	3	2	0	0
1	0	4	0	0	1	0	0	0
2	0	0	0	0	1	2	0	0
3	0	0	0	0	7	0	0	0
4	0	0	0	2	29	9	0	2
5	0	0	0	0	6	31	0	2
6	0	1	0	1	0	1	0	0
7	0	0	0	0	10	1	0	2

```
In [130]: print("Метод Случайного леса")
          print_metrics(y_test, y_pred3)
```

```
Метод Случайного леса
Precision: 0.7740183792815372
Recall: 0.7894736842105263
F1: 0.7790935672514621
```



	0	1	2	3	4	5	6	7
0	4	0	0	0	1	0	0	0
1	0	5	0	0	0	0	0	0
2	0	2	0	0	0	1	0	0
3	0	0	0	6	1	0	0	0
4	1	0	0	2	31	2	0	6
5	0	0	0	1	1	36	0	1
6	0	0	0	0	1	0	2	0
7	0	0	0	0	7	0	0	6

Для метода случайного леса модель по умолчанию оказалась лучше модели с подобранными параметрами. Эта же модель показала лучшие результаты по сравнению с моделями SVM. Вывод: небинарную классификацию в условии дисбаланса класса лучше всего реализовал метод Случайного леса.