Лабораторная работа №4. Оценка качества моделей машинного обучения.

Часть 2. Задача многоклассовой классификации.

Используемый набор данных: Wine (https://archive.ics.uci.edu/ml/datasets/Wine)

In [1]:

```
from IPython.display import display
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import label_binarize
from sklearn.multiclass import OneVsRestClassifier
from sklearn.svm import SVC
from sklearn.metrics import classification_report, roc_curve, roc_auc_score
from itertools import cycle
import os
import requests

%matplotlib inline

pd.options.display.max_columns = None
```

In [2]:

```
def downloadFile(url, filePath):
    if not os.path.exists(filePath):
        req = requests.get(url)
        f = open(filePath, "wb")
        f.write(req.content)
        f.close

url = "https://archive.ics.uci.edu/ml/machine-learning-databases/wine"
downloadFile(url + "/wine.data", "dataset/wine.data")
downloadFile(url + "/wine.names", "dataset/wine.names")
```

In [3]:

```
headers = ["Class", "Alcohol", "Malic acid", "Ash", "Alcalinity of ash", "Magnesium",
"Total phenols", "Flavanoids",
           "Nonflavanoid phenols", "Proanthocyanins", "Color intensity", "Hue", "OD280/
OD315 of diluted wines", "Proline"]
data = pd.read_csv("dataset/wine.data", names=headers)
data["Class"] = data["Class"].astype("category")
data.sample(40)
```

Out[3]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols
97	2	12.29	1.41	1.98	16.0	85	2.55	2.50	0.29
47	1	13.90	1.68	2.12	16.0	101	3.10	3.39	0.21
101	2	12.60	1.34	1.90	18.5	88	1.45	1.36	0.29
164	3	13.78	2.76	2.30	22.0	90	1.35	0.68	0.41
146	3	13.88	5.04	2.23	20.0	80	0.98	0.34	0.40
136	3	12.25	4.72	2.54	21.0	89	1.38	0.47	0.53
115	2	11.03	1.51	2.20	21.5	85	2.46	2.17	0.52
63	2	12.37	1.13	2.16	19.0	87	3.50	3.10	0.19
151	3	12.79	2.67	2.48	22.0	112	1.48	1.36	0.24
108	2	12.22	1.29	1.94	19.0	92	2.36	2.04	0.39
15	1	13.63	1.81	2.70	17.2	112	2.85	2.91	0.30
16	1	14.30	1.92	2.72	20.0	120	2.80	3.14	0.33
126	2	12.43	1.53	2.29	21.5	86	2.74	3.15	0.39
24	1	13.50	1.81	2.61	20.0	96	2.53	2.61	0.28
74	2	11.96	1.09	2.30	21.0	101	3.38	2.14	0.13
121	2	11.56	2.05	3.23	28.5	119	3.18	5.08	0.47
9	1	13.86	1.35	2.27	16.0	98	2.98	3.15	0.22
152	3	13.11	1.90	2.75	25.5	116	2.20	1.28	0.26
50	1	13.05	1.73	2.04	12.4	92	2.72	3.27	0.17
110	2	11.46	3.74	1.82	19.5	107	3.18	2.58	0.24
59	2	12.37	0.94	1.36	10.6	88	1.98	0.57	0.28
42	1	13.88	1.89	2.59	15.0	101	3.25	3.56	0.17
92	2	12.69	1.53	2.26	20.7	80	1.38	1.46	0.58
46	1	14.38	3.59	2.28	16.0	102	3.25	3.17	0.27
140	3	12.93	2.81	2.70	21.0	96	1.54	0.50	0.53
130	3	12.86	1.35	2.32	18.0	122	1.51	1.25	0.21
56	1	14.22	1.70	2.30	16.3	118	3.20	3.00	0.26
6	1	14.39	1.87	2.45	14.6	96	2.50	2.52	0.30
33	1	13.76	1.53	2.70	19.5	132	2.95	2.74	0.50
107	2	12.72	1.75	2.28	22.5	84	1.38	1.76	0.48
147	3	12.87	4.61	2.48	21.5	86	1.70	0.65	0.47
17	1	13.83	1.57	2.62	20.0	115	2.95	3.40	0.40
45	1	14.21	4.04	2.44	18.9	111	2.85	2.65	0.30
91	2	12.00	1.51	2.42	22.0	86	1.45	1.25	0.50
68	2	13.34	0.94	2.36	17.0	110	2.53	1.30	0.55
162	3	12.85	3.27	2.58	22.0	106	1.65	0.60	0.60

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols
27	1	13.30	1.72	2.14	17.0	94	2.40	2.19	0.27
67	2	12.37	1.17	1.92	19.6	78	2.11	2.00	0.27
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52
5	1	14.20	1.76	2.45	15.2	112	3.27	3.39	0.34

In [4]:

```
data.isna().sum()
```

Out[4]:

```
Class                           0
Alcohol                         0
Malic acid                      0
Ash                             0
Alcalinity of ash               0
Magnesium                       0
Total phenols                   0
Flavanoids                      0
Nonflavanoid phenols            0
Proanthocyanins                 0
Color intensity                 0
Hue                             0
OD280/OD315 of diluted wines    0
Proline                         0
dtype: int64
```

Пропусков в данных нет.

Подготовим данные для классификации: выберем признаки и метки и сформируем тренировочные и тестовые наборы.

In [5]:

```
classes = data["Class"].unique()
n_classes = len(classes)
y = label_binarize(data["Class"], classes=classes)
X = data.drop(columns=["Class"]).copy()

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=.5, random_state=25
)
```

Создадим классификатор, обучим его, а затем выполним классификацию. Для этой задачи используем подход One-Vs-All (https://ru.coursera.org/lecture/supervised-learning/mnoghoklassovaia-klassifikatsiia-21cCQ), также известный как One-Vs-The-Rest (https://scikit-learn.org/stable/modules/multiclass.html#one-vs-the-rest)

In [6]:

```
clf = OneVsRestClassifier(SVC(kernel='linear', probability=True, random_state=159))
y_score = clf.fit(X_train, y_train).decision_function(X_test)
```

Для каждого класса вычислим ROC-кривую и значение показателя AUC.

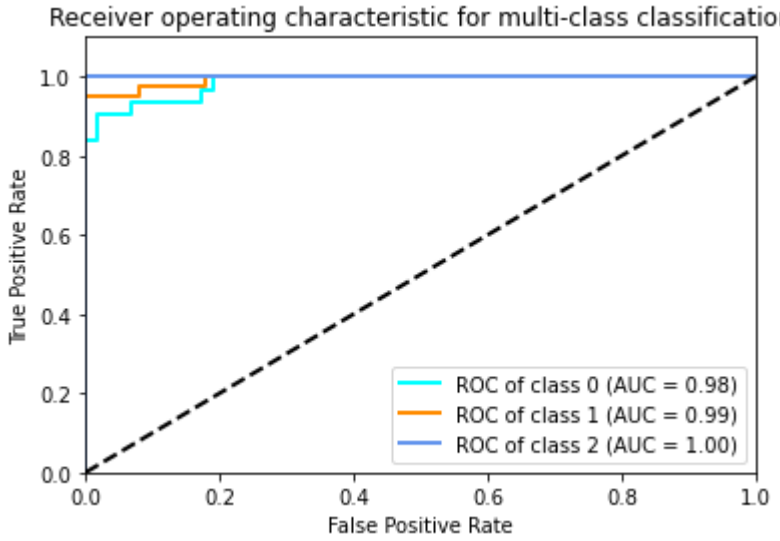
In [7]:

```
fpr, tpr, auc = dict(), dict(), dict()
for i in range(n_classes):
    y_test_cl = y_test[:,i]
    y_score_cl = y_score[:,i]
    fpr[i], tpr[i], _ = roc_curve(y_test_cl, y_score_cl)
    auc[i] = roc_auc_score(y_test_cl, y_score_cl)
```

Построим ROC-кривые.

In [8]:

```
lw = 2
colors = cycle(['aqua', 'darkorange', 'cornflowerblue'])
for i, color in zip(range(n_classes), colors):
    plt.plot(fpr[i], tpr[i], color=color, lw=lw, label='ROC of class {0} (AUC = {1:0.2
f})'.format(i, auc[i]))
plt.plot([0, 1], [0, 1], 'k--', lw=lw)
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.1])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic for multi-class classification')
plt.legend(loc="lower right")
plt.show()
```



Высокие значения AUC говорят о качественной классификации.

Построим таблицы сопряженности.

In [9]:

```
cols = list(data.columns)
used = dict()
cnt = 0
for i in cols:
    for j in cols:
        if i == j or used.get((j,i)) == True: continue
        print(f"\n\tТаблица сопряженности для атрибутов '{i}' и '{j}'")
        display(pd.DataFrame(pd.crosstab(data[i], data[j])))
        used[(i,j)] = True
```

Таблица сопряженности для атрибутов 'Class' и 'Alcohol'

Alcohol	11.03	11.41	11.45	11.46	11.56	11.61	11.62	11.64	11.65	11.66	11.76	11.79	11.
Class													
1	0	0	0	0	0	0	0	0	0	0	0	0	
2	1	1	1	1	1	1	1	1	1	1	1	1	
3	0	0	0	0	0	0	0	0	0	0	0	0	

Таблица сопряженности для атрибутов 'Class' и 'Malic acid'

Malic acid	0.74	0.89	0.90	0.92	0.94	0.98	0.99	1.01	1.07	1.09	1.10	1.13	1.17	1.19	1.21
Class															
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Таблица сопряженности для атрибутов 'Class' и 'Ash'

Ash	1.36	1.70	1.71	1.75	1.82	1.88	1.90	1.92	1.94	1.95	1.98	1.99	2.00	2.02	2.04
Class															
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	1	2	1	1	1	1	1	3	1	1	3	1	2	1	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Таблица сопряженности для атрибутов 'Class' и 'Alcalinity of ash'

Alcalinity of ash	10.6	11.2	11.4	12.0	12.4	13.2	14.0	14.6	14.8	15.0	15.2	15.5	15.6	16.0	1
Class															
1	0	1	1	1	1	1	2	1	0	1	2	2	1	6	
2	1	0	0	0	0	0	0	0	1	1	0	0	0	5	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Таблица сопряженности для атрибутов 'Class' и 'Magnesium'

Magnesium	70	78	80	81	82	84	85	86	87	88	89	90	91	92	93	94	95	96	97	9
Class																				
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	3	1	
2	1	3	4	1	1	3	5	9	3	9	0	2	0	2	0	3	0	1	2	
3	0	0	1	0	0	0	1	2	0	4	4	1	1	2	1	1	1	4	2	

Таблица сопряженности для атрибутов 'Class' и 'Total phenols'

Total phenols	0.98	1.10	1.15	1.25	1.28	1.30	1.35	1.38	1.39	1.40	1.41	1.45	1.48	1.50	1.5
Class															
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	1	0	0	0	0	0	2	0	0	0	2	0	0	
3	1	0	1	1	1	1	1	2	2	2	1	0	3	1	

Таблица сопряженности для атрибутов 'Class' и 'Flavanoids'

Flavanoids	0.34	0.47	0.48	0.49	0.50	0.51	0.52	0.55	0.56	0.57	0.58	0.60	0.61	0.63
Class														
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	1	0	0	0	0
3	1	2	1	1	2	1	1	1	1	0	3	3	1	1

Таблица сопряженности для атрибутов 'Class' и 'Nonflavanoid phenol
s'

Nonflavanoid phenols	0.13	0.14	0.17	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.28	0.29	0.3(
Class														
1	0	0	3	1	2	2	4	2	1	6	4	4	6	
2	1	2	1	1	0	3	1	3	1	4	2	1	3	
3	0	0	1	0	0	1	1	2	0	1	2	0	1	(

Таблица сопряженности для атрибутов 'Class' и 'Proanthocyanins'

Proanthocyanins	0.41	0.42	0.55	0.62	0.64	0.68	0.73	0.75	0.80	0.81	0.83	0.84	0.86
Class													
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	2	0	1	0	0	1	0	0	0	1	0	0
3	0	0	1	0	2	1	1	1	2	1	2	1	1

Таблица сопряженности для атрибутов 'Class' и 'Color intensity'

Color intensity	1.280000	1.740000	1.900000	1.950000	2.000000	2.060000	2.080000	2.120000	2.
Class									
1	0	0	0	0	0	0	0	0	
2	1	1	1	2	1	2	1	1	
3	0	0	0	0	0	0	0	0	

Таблица сопряженности для атрибутов 'Class' и 'Hue'

Hue	0.480	0.540	0.550	0.560	0.570	0.580	0.590	0.600	0.610	0.620	0.640	0.650	0.6
Class													
1	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	
3	1	1	1	2	5	2	2	3	2	1	1	1	

Таблица сопряженности для атрибутов 'Class' и 'OD280/OD315 of dilu
ted wines'

OD280/OD315 of diluted wines	1.27	1.29	1.30	1.33	1.36	1.42	1.47	1.48	1.51	1.55	1.56	1.58	1.59	1.6
Class														
1	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	1	2	1	3	1	1	1	1	2	1	3	2	0	

Таблица сопряженности для атрибутов 'Class' и 'Proline'

Proline	278	290	312	315	325	342	345	352	355	365	372	378	380	385	392	406
Class																
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1	1
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Таблица сопряженности для атрибутов 'Alcohol' и 'Malic acid'

Malic acid	0.74	0.89	0.90	0.92	0.94	0.98	0.99	1.01	1.07	1.09	1.10	1.13	1.17	1.19	1.2
Alcohol															
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

126 rows × 133 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Ash'

Ash Alcohol	1.36	1.70	1.71	1.75	1.82	1.88	1.90	1.92	1.94	1.95	1.98	1.99	2.00	2.02	2.0
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

126 rows × 79 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Alcalinity of ash'

Alcalinity of ash Alcohol	10.6	11.2	11.4	12.0	12.4	13.2	14.0	14.6	14.8	15.0	15.2	15.5	15.6	16.0	1
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	1	0	0	0	0	0	0	0	0	0	1	
14.39	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
14.75	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	1	0	0	0	0	0	0	0	

126 rows × 63 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Magnesium'

Magnesium	70	78	80	81	82	84	85	86	87	88	89	90	91	92	93	94	95	96	97	9
Alcohol																				
11.03	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

126 rows × 53 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Total phenols'

Total phenols	0.98	1.10	1.15	1.25	1.28	1.30	1.35	1.38	1.39	1.40	1.41	1.45	1.48	1.50	1.5
Alcohol															
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

126 rows × 97 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Flavanoids'

Flavanoids	0.34	0.47	0.48	0.49	0.50	0.51	0.52	0.55	0.56	0.57	0.58	0.60	0.61	0.63
Alcohol														
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0

126 rows × 132 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Nonflavanoid phenols'

Nonflavanoid phenols	0.13	0.14	0.17	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.28	0.29	0.3
Alcohol														
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	1	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	.
14.37	0	0	0	0	0	0	0	1	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	1	0	1	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	1	

126 rows × 39 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Proanthocyanins'

Proanthocyanins	0.41	0.42	0.55	0.62	0.64	0.68	0.73	0.75	0.80	0.81	0.83	0.84	0.86
Alcohol													
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0

126 rows × 101 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Color intensity'

Color intensity	1.280000	1.740000	1.900000	1.950000	2.000000	2.060000	2.080000	2.120000	2.
Alcohol									
11.03	0	0	1	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	

126 rows × 132 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Hue'

Hue	0.480	0.540	0.550	0.560	0.570	0.580	0.590	0.600	0.610	0.620	0.640	0.650	(
Alcohol													
11.03	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	
14.37	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	

126 rows × 78 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'OD280/OD315 of diluted wines'

OD280/OD315 of diluted wines	1.27	1.29	1.30	1.33	1.36	1.42	1.47	1.48	1.51	1.55	1.56	1.58	1.59	1.6
Alcohol														
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	

126 rows × 122 columns

Таблица сопряженности для атрибутов 'Alcohol' и 'Proline'

Proline	278	290	312	315	325	342	345	352	355	365	372	378	380	385	392	406
Alcohol																
11.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

126 rows × 121 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Ash'

Ash	1.36	1.70	1.71	1.75	1.82	1.88	1.90	1.92	1.94	1.95	1.98	1.99	2.00	2.02	2.04
Malic acid															
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.90	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0.92	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0.94	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

133 rows × 79 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Alcalinity of ash'

Alcalinity of ash	10.6	11.2	11.4	12.0	12.4	13.2	14.0	14.6	14.8	15.0	15.2	15.5	15.6	16.0	1
Malic acid															
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.94	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
5.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

133 rows × 63 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Magnesium'

Magnesium	70	78	80	81	82	84	85	86	87	88	89	90	91	92	93	94	95	96	97	9
Malic acid																				
0.74	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
0.90	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
0.92	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
0.94	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
5.04	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
5.80	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	

133 rows × 53 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Total phenols'

Total phenols / Malic acid	0.98	1.10	1.15	1.25	1.28	1.30	1.35	1.38	1.39	1.40	1.41	1.45	1.48	1.50	1.5
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
5.04	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

133 rows × 97 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Flavanoids'

Flavanoids / Malic acid	0.34	0.47	0.48	0.49	0.50	0.51	0.52	0.55	0.56	0.57	0.58	0.60	0.61	0.63
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.94	0	0	0	0	0	0	0	0	0	1	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5.04	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5.51	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5.65	0	0	0	0	0	0	0	0	0	0	0	0	1	0
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0

133 rows × 132 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Nonflavanoid phenols'

Nonflavanoid phenols / Malic acid	0.13	0.14	0.17	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.28	0.29	0.3
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	1	0	0	0	0	0	0	
0.90	0	0	0	0	0	0	0	1	0	0	0	0	0	
0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.94	0	0	0	0	0	0	0	0	0	0	0	1	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	.
5.04	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0	

133 rows × 39 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Proanthocyanins'

Proanthocyanins / Malic acid	0.41	0.42	0.55	0.62	0.64	0.68	0.73	0.75	0.80	0.81	0.83	0.84	0.86
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0
0.92	0	0	0	0	0	0	0	0	0	0	0	0	0
0.94	0	2	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
5.04	0	0	0	0	0	1	0	0	0	0	0	0	0
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0

133 rows × 101 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Color intensity'

Color intensity	1.280000	1.740000	1.900000	1.950000	2.000000	2.060000	2.080000	2.120000	2.
Malic acid									
0.74	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	0	0	
0.90	0	0	0	0	0	0	0	0	
0.92	0	0	0	0	0	0	0	0	
0.94	0	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
5.04	0	0	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	
5.65	0	0	0	0	0	0	0	0	
5.80	0	0	0	0	0	0	0	0	

133 rows × 132 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Hue'

Hue	0.480	0.540	0.550	0.560	0.570	0.580	0.590	0.600	0.610	0.620	0.640	0.650	0.6
Malic acid													
0.74	0	0	0	0	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	0	0	0	0	0	0	
0.90	0	0	0	0	0	0	0	0	0	0	0	0	
0.92	0	0	0	0	0	0	0	0	0	0	0	0	
0.94	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	
5.04	0	0	0	0	0	1	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	1	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	0	0	0	0	
5.65	0	0	0	0	0	0	0	0	0	0	1	0	
5.80	0	0	0	0	0	0	0	0	0	0	0	0	

133 rows × 78 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'OD280/OD315 of diluted wines'

OD280/OD315 of diluted wines	1.27	1.29	1.30	1.33	1.36	1.42	1.47	1.48	1.51	1.55	1.56	1.58	1.59	1.6
Malic acid														
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	
0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5.04	0	0	0	1	0	0	0	0	0	0	0	0	0	
5.19	0	0	0	0	0	0	0	1	0	0	0	0	0	
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	
5.80	0	0	0	0	0	0	0	0	0	0	0	0	0	

133 rows × 122 columns

Таблица сопряженности для атрибутов 'Malic acid' и 'Proline'

Proline	278	290	312	315	325	342	345	352	355	365	372	378	380	385	392	406
Malic acid																
0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0.92	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.80	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

133 rows × 121 columns

Таблица сопряженности для атрибутов 'Ash' и 'Alcalinity of ash'

Alcalinity of ash	10.6	11.2	11.4	12.0	12.4	13.2	14.0	14.6	14.8	15.0	15.2	15.5	15.6	16.0	1
Ash															
1.36	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.70	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
1.71	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

79 rows × 63 columns

Таблица сопряженности для атрибутов 'Ash' и 'Magnesium'

Magnesium	70	78	80	81	82	84	85	86	87	88	89	90	91	92	93	94	95	96	97	9
Ash																				
1.36	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
1.70	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
1.71	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

79 rows × 53 columns

Таблица сопряженности для атрибутов 'Ash' и 'Total phenols'

Total phenols	0.98	1.10	1.15	1.25	1.28	1.30	1.35	1.38	1.39	1.40	1.41	1.45	1.48	1.50	1.5
Ash															
1.36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

79 rows × 97 columns

Таблица сопряженности для атрибутов 'Ash' и 'Flavanoids'

Flavanoids	0.34	0.47	0.48	0.49	0.50	0.51	0.52	0.55	0.56	0.57	0.58	0.60	0.61	0.63
Ash														
1.36	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0

79 rows × 132 columns

Таблица сопряженности для атрибутов 'Ash' и 'Nonflavanoid phenols'

Nonflavanoid phenols	0.13	0.14	0.17	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.28	0.29	0.3
Ash														
1.36	0	0	0	0	0	0	0	0	0	0	0	1	0	
1.70	0	0	0	0	0	0	0	0	0	2	0	0	0	
1.71	0	0	0	0	0	0	0	1	0	0	0	0	0	
1.75	0	1	0	0	0	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	1	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	.
2.86	0	0	0	0	0	0	0	0	0	0	1	0	0	
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	

79 rows × 39 columns

Таблица сопряженности для атрибутов 'Ash' и 'Proanthocyanins'

Proanthocyanins	0.41	0.42	0.55	0.62	0.64	0.68	0.73	0.75	0.80	0.81	0.83	0.84	0.86
Ash													
1.36	0	1	0	0	0	0	0	0	0	0	0	0	0
1.70	0	0	0	0	0	0	0	0	0	0	0	0	0
1.71	0	0	0	0	0	0	0	0	0	0	0	0	0
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0

79 rows × 101 columns

Таблица сопряженности для атрибутов 'Ash' и 'Color intensity'

Color intensity	1.280000	1.740000	1.900000	1.950000	2.000000	2.060000	2.080000	2.120000	2.
Ash									
1.36	0	0	0	1	0	0	0	0	
1.70	0	0	0	0	0	0	0	0	
1.71	0	0	0	0	0	0	0	0	
1.75	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2.86	0	0	0	0	0	0	0	0	
2.87	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	

79 rows × 132 columns

Таблица сопряженности для атрибутов 'Ash' и 'Hue'

Hue	0.480	0.540	0.550	0.560	0.570	0.580	0.590	0.600	0.610	0.620	0.640	0.650	0.66
Ash													
1.36	0	0	0	0	0	0	0	0	0	0	0	0	
1.70	0	0	0	0	0	0	0	0	0	0	0	0	
1.71	0	0	0	0	0	0	0	0	0	0	0	0	
1.75	0	0	0	0	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	.
2.86	0	0	0	0	0	0	0	0	0	0	0	0	
2.87	0	0	0	0	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	0	0	0	0	

79 rows × 78 columns

Таблица сопряженности для атрибутов 'Ash' и 'OD280/OD315 of diluted wines'

OD280/OD315 of diluted wines	1.27	1.29	1.30	1.33	1.36	1.42	1.47	1.48	1.51	1.55	1.56	1.58	1.59	1.6
Ash														
1.36	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.70	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.71	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	

79 rows × 122 columns

Таблица сопряженности для атрибутов 'Ash' и 'Proline'

Proline	278	290	312	315	325	342	345	352	355	365	372	378	380	385	392	406
Ash																
1.36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

79 rows × 121 columns

Таблица сопряженности для атрибутов 'Alcalinity of ash' и 'Magnesium'

Magnesium	70	78	80	81	82	84	85	86	87	88	89	90	91	92	93	94	95	96	97	9
Alcalinity of ash																				
10.6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12.4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
26.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

63 rows × 53 columns

Таблица сопряженности для атрибутов 'Alcalinity of ash' и 'Total phenols'

Total phenols	0.98	1.10	1.15	1.25	1.28	1.30	1.35	1.38	1.39	1.40	1.41	1.45	1.48	1.50	1
Alcalinity of ash															
10.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

63 rows × 97 columns

Таблица сопряженности для атрибутов 'Alcalinity of ash' и 'Flavanoids'

Flavanoids / Alcalinity of ash	0.34	0.47	0.48	0.49	0.50	0.51	0.52	0.55	0.56	0.57	0.58	0.60	0.61	0.63
10.6	0	0	0	0	0	0	0	0	0	1	0	0	0	0
11.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

63 rows × 132 columns

Таблица сопряженности для атрибутов 'Alcalinity of ash' и 'Nonflavanoid phenols'

Nonflavanoid phenols / Alcalinity of ash	0.13	0.14	0.17	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.28	0.29	0.3(
10.6	0	0	0	0	0	0	0	0	0	0	0	1	0	(
11.2	0	0	0	0	0	0	0	0	0	1	0	0	0	(
11.4	0	0	0	0	0	0	0	0	0	0	0	0	0	(
12.0	0	0	0	0	0	0	0	0	0	0	0	0	1	(
12.4	0	0	1	0	0	0	0	0	0	0	0	0	0	(
...	...	...	...	...	...	...	...	...	...	...	...	...	...	.
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	(
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	(
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0	(
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	(
30.0	0	0	0	0	0	1	0	0	0	0	0	0	0	(

63 rows × 39 columns

Таблица сопряженности для атрибутов 'Alcalinity of ash' и 'Proanthocyanins'

Proanthocyanins	0.41	0.42	0.55	0.62	0.64	0.68	0.73	0.75	0.80	0.81	0.83	0.84	0.86
Alcalinity of ash													
10.6	0	1	0	0	0	0	0	0	0	0	0	0	0
11.2	0	0	0	0	0	0	0	0	0	0	0	0	0
11.4	0	0	0	0	0	0	0	0	0	0	0	0	0
12.0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.4	0	0	0	0	0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0	0	0	0	0	0