Лабораторная работа №6

Ансамбли моделей машинного обучения.

Цель лабораторной работы: изучение ансамблей моделей машинного обучения.

In [4]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import string
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier, RandomForestRegressor
from sklearn.ensemble import GradientBoostingClassifier, GradientBoostingRegress
or

from sklearn.metrics import accuracy_score, balanced_accuracy_score
from sklearn.metrics import precision_score, recall_score, f1_score, classificat
ion_report
```

Выберите набор данных (датасет) для решения задачи классификации или регрессии.

Используем данные о баллах за экзамены.

In [5]:

```
# Будем использовать только обучающую выборку
data = pd.read_csv('datasets_74977_169835_StudentsPerformance.csv', sep=",")
```

In [6]:

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

Out[6]:

```
(1000, 8)
```

In [7]:

```
# типы колонок
data.dtypes
```

Out[7]:

```
gender                         object
race/ethnicity                 object
parental level of education    object
lunch                          object
test preparation course        object
math score                      int64
reading score                   int64
writing score                   int64
dtype: object
```

In [8]:

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

Out[8]:

```
gender                         0
race/ethnicity                 0
parental level of education    0
lunch                          0
test preparation course        0
math score                     0
reading score                  0
writing score                  0
dtype: int64
```

In [9]:

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

Out[9]:

```
gender                         0
race/ethnicity                 0
parental level of education    0
lunch                          0
test preparation course        0
math score                     0
reading score                  0
writing score                  0
dtype: int64
```

In [10]:

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

Out[10]:

	gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score
0	female	group B	bachelor's degree	standard	none	72	72	74
1	female	group C	some college	standard	completed	69	90	88
2	female	group B	master's degree	standard	none	90	95	93
3	male	group A	associate's degree	free/reduced	none	47	57	44
4	male	group C	some college	standard	none	76	78	75

In [11]:

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

```
Всего строк: 1000
```

In [12]:

```
#сумма баллов будет более полезным столбцом
data['sum'] = data['math score'] + data['reading score'] + data['writing score']
#удалим избыточные столбцы

del data['race/ethnicity']
```

In [13]:

```
#заменим строковые значения целевого признака на числовые
data.loc[data['test preparation course'] == 'none', 'test preparation course'] =
0
data.loc[data['test preparation course'] == 'completed', 'test preparation cours
e'] = 1

data.loc[data['gender'] == 'female', 'gender'] = 0
data.loc[data['gender'] == 'male', 'gender'] = 1

data.loc[data['lunch'] ==  'free/reduced', 'lunch'] = 0
data.loc[data['lunch'] == 'standard', 'lunch'] = 1

data.loc[data['parental level of education'] ==  'some high school', 'parental l
evel of education'] = 0
data.loc[data['parental level of education'] == 'some college', 'parental level
 of education'] = 0
data.loc[data['parental level of education'] == 'high school', 'parental level o
f education'] = 0
data.loc[data['parental level of education'] == "bachelor's degree",'parental le
vel of education'] = 1
data.loc[data['parental level of education'] == "master's degree",'parental leve
l of education'] = 1
data.loc[data['parental level of education'] == "associate's degree",'parental l
evel of education'] = 1
```

In [15]:

```
data.head()
```

Out[15]:

	gender	parental level of education	lunch	test preparation course	math score	reading score	writing score	sum
0	0	1	1	0	72	72	74	218
1	0	0	1	1	69	90	88	247
2	0	1	1	0	90	95	93	278
3	1	1	0	0	47	57	44	148
4	1	0	1	0	76	78	75	229

In [18]:

```
def regr_to_class(y: int) -> int:
    if y>199:
        result = 1
    else:
        result = 0
    return result
```

In [19]:

```
data['res'] = data.apply(lambda row: regr_to_class(row['sum']),axis=1)
```

In [20]:

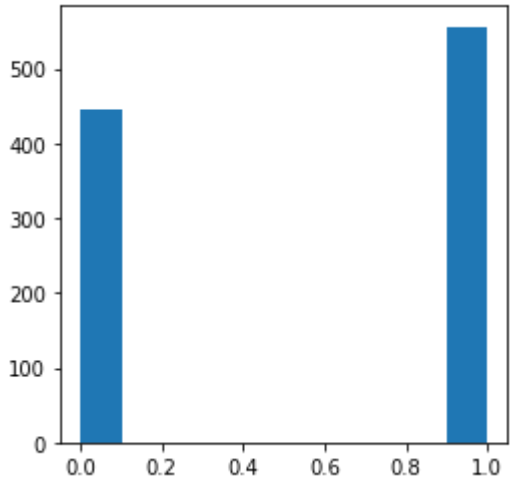
```
data['res'].unique()
```

Out[20]:

```
array([1, 0])
```

In [21]:

```
fig, ax = plt.subplots(figsize=(4,4))
plt.hist(data['res'])
plt.show()
```



In [22]:

```
data['res'].value_counts()
```

Out[22]:

```
1    556
0    444
Name: res, dtype: int64
```

In [24]:

```
total = data.shape[0]
class_1, class_0 = data['res'].value_counts()
print('Класс 0: {}%, а класс 1: {}%.'
      .format(round(class_0 / total, 2)*100, round(class_1 / total, 2)*100))
```

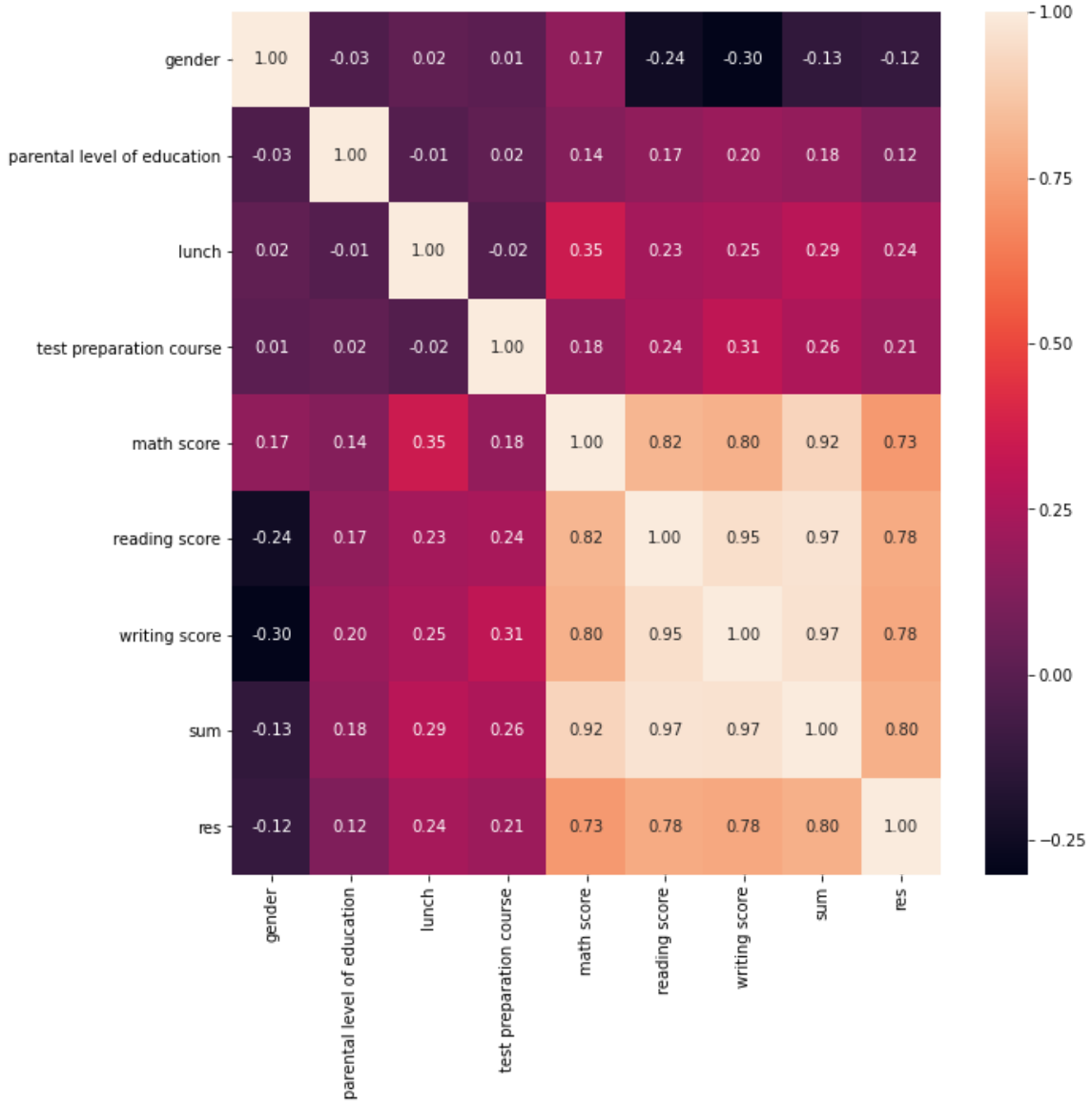
```
Класс 0: 44.0%, а класс 1: 56.00000000000001%.
```

In [25]:

```
fig, ax = plt.subplots(figsize=(10,10))
sns.heatmap(data.corr(), annot=True, fmt='.2f')
```

Out[25]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc293aed790>
```



In [26]:

```
data.drop(['gender'], axis=1, inplace=True)
```

In [27]:

```
class_cols = ['math score', 'reading score', 'writing score','sum']
```

In [28]:

```
X = data[class_cols]
y = data['res']
print(X, "\n")
print(y)
```

	math score	reading score	writing score	sum
0	72	72	74	218
1	69	90	88	247
2	90	95	93	278
3	47	57	44	148
4	76	78	75	229
5	71	83	78	232
6	88	95	92	275
7	40	43	39	122
8	64	64	67	195
9	38	60	50	148
10	58	54	52	164
11	40	52	43	135
12	65	81	73	219
13	78	72	70	220
14	50	53	58	161
15	69	75	78	222
16	88	89	86	263
17	18	32	28	78
18	46	42	46	134
19	54	58	61	173
20	66	69	63	198
21	65	75	70	210
22	44	54	53	151
23	69	73	73	215
24	74	71	80	225
25	73	74	72	219
26	69	54	55	178
27	67	69	75	211
28	70	70	65	205
29	62	70	75	207
..	...	...	...	...
970	89	100	100	289
971	78	72	69	219
972	53	50	60	163
973	49	65	61	175
974	54	63	67	184
975	64	82	77	223
976	60	62	60	182
977	62	65	58	185
978	55	41	48	144
979	91	95	94	280
980	8	24	23	55
981	81	78	78	237
982	79	85	86	250
983	78	87	91	256
984	74	75	82	231
985	57	51	54	162
986	40	59	51	150
987	81	75	76	232
988	44	45	45	134
989	67	86	83	236
990	86	81	75	242
991	65	82	78	225
992	55	76	76	207
993	62	72	74	208
994	63	63	62	188
995	88	99	95	282
996	62	55	55	172
997	59	71	65	195
998	68	78	77	223

```
999          77             86             86  249

[1000 rows x 4 columns]

0      1
1      1
2      1
3      0
4      1
5      1
6      1
7      0
8      0
9      0
10     0
11     0
12     1
13     1
14     0
15     1
16     1
17     0
18     0
19     0
20     0
21     1
22     0
23     1
24     1
25     1
26     0
27     1
28     1
29     1
      ..
970    1
971    1
972    0
973    0
974    0
975    1
976    0
977    0
978    0
979    1
980    0
981    1
982    1
983    1
984    1
985    0
986    0
987    1
988    0
989    1
990    1
991    1
992    1
993    1
994    0
995    1
```

```
996    0
997    0
998    1
999    1
Name: res, Length: 1000, dtype: int64
```

In [29]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random
_state=1)
print("X_train:", X_train.shape)
print("X_test:", X_test.shape)
print("y_train:", y_train.shape)
print("y_test:", y_test.shape)
```

```
X_train: (750, 4)
X_test: (250, 4)
y_train: (750,)
y_test: (250,)
```

In [30]:

```
class MetricLogger:

    def __init__(self):
        self.df = pd.DataFrame(
            {'metric': pd.Series([], dtype='str'),
            'alg': pd.Series([], dtype='str'),
            'value': pd.Series([], dtype='float')})

    def add(self, metric, alg, value):
        """
        Добавление значения
        """
        # Удаление значения если оно уже было ранее добавлено
        self.df.drop(self.df[(self.df['metric']==metric)&(self.df['alg']==alg)].
index, inplace = True)
        # Добавление нового значения
        temp = [{'metric':metric, 'alg':alg, 'value':value}]
        self.df = self.df.append(temp, ignore_index=True)

    def get_data_for_metric(self, metric, ascending=True):
        """
        Формирование данных с фильтром по метрике
        """
        temp_data = self.df[self.df['metric']==metric]
        temp_data_2 = temp_data.sort_values(by='value', ascending=ascending)
        return temp_data_2['alg'].values, temp_data_2['value'].values

    def plot(self, str_header, metric, ascending=True, figsize=(5, 5)):
        """
        Вывод графика
        """
        array_labels, array_metric = self.get_data_for_metric(metric, ascending)
        fig, ax1 = plt.subplots(figsize=figsize)
        pos = np.arange(len(array_metric))
        rects = ax1.barh(pos, array_metric,
                         align='center',
                         height=0.5,
                         tick_label=array_labels)
        ax1.set_title(str_header)
        for a,b in zip(pos, array_metric):
            plt.text(0.5, a-0.05, str(round(b,3)), color='white')
        plt.show()
```

In [31]:

```
metricLogger = MetricLogger()
```

In [32]:

```
def test_model(model_name, model, metricLogger):
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)

    accuracy = accuracy_score(y_test, y_pred)
    f1 = f1_score(y_test, y_pred)
    precision = precision_score(y_test, y_pred)
    recall = recall_score(y_test, y_pred)

    metricLogger.add('precision', model_name, precision)
    metricLogger.add('recall', model_name, recall)
    metricLogger.add('f1', model_name, f1)
    metricLogger.add('accuracy', model_name, accuracy)

    print('**********************************************************')
    print(model)
    print(model_name)
    print("accuracy:", accuracy)
    print("f1_score:", f1)
    print("precision_score:", precision)
    print("recall:", recall)
    print('**********************************************************')
```

In [33]:

```
test_model('Random forest', RandomForestClassifier(), metricLogger)
test_model('GB', GradientBoostingClassifier(), metricLogger)
```

```
**************************************************
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=N
one,
                       criterion='gini', max_depth=None, max_feature
s='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split
=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=10
0,
                       n_jobs=None, oob_score=False, random_state=No
ne,
                       verbose=0, warm_start=False)
Random forest
accuracy: 1.0
f1_score: 1.0
precision_score: 1.0
recall: 1.0
**************************************************
**************************************************
GradientBoostingClassifier(ccp_alpha=0.0, criterion='friedman_mse',
init=None,
                           learning_rate=0.1, loss='deviance', max_d
epth=3,
                           max_features=None, max_leaf_nodes=None,
                           min_impurity_decrease=0.0, min_impurity_s
plit=None,
                           min_samples_leaf=1, min_samples_split=2,
                           min_weight_fraction_leaf=0.0, n_estimator
s=100,
                           n_iter_no_change=None, presort='deprecate
d',
                           random_state=None, subsample=1.0, tol=0.0
001,
                           validation_fraction=0.1, verbose=0,
                           warm_start=False)
GB
accuracy: 1.0
f1_score: 1.0
precision_score: 1.0
recall: 1.0
**************************************************
```

In [34]:

```
metrics = metricLogger.df['metric'].unique()
metrics
```

Out[34]:

```
array(['precision', 'recall', 'f1', 'accuracy'], dtype=object)
```

In [35]:

```
for metric in metrics:
    metricLogger.plot('Метрика: ' + metric, metric, figsize=(3, 3))
```