Лабораторная работа №5

Линейные модели, SVM и деревья решений.

Цель лабораторной работы: изучение линейных моделей, SVM и деревьев решений.

In [33]:

```
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.neighbors import KNeighborsRegressor, KNeighborsClassifier
from sklearn.metrics import accuracy_score, balanced_accuracy_score
from sklearn import preprocessing
from sklearn.linear_model import LinearRegression
from sklearn.svm import SVC, NuSVC, LinearSVC, OneClassSVM, SVR, NuSVR, LinearSVR
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor, export_graphviz

import math
from sklearn import utils
from typing import Dict, Tuple
%matplotlib inline
sns.set(style="ticks")
```

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

Используем данные о баллах за экзамены.

In [34]:

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

In [35]:

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

Out[35]:

```
(1000, 8)
```

In [36]:

```
# типы колонок
data.dtypes
```

Out[36]:

```
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 [37]:

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

Out[37]:

```
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 [38]:

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

Out[38]:

	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 [39]:

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

```
Всего строк: 1000
```

In [40]:

```
#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 [41]:

```
#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 course'] = 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 level 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 of education'] = 0
data.loc[data['parental level of education'] == "bachelor's degree",'parental level of education'] = 1
data.loc[data['parental level of education'] == "master's degree",'parental level of education'] = 1
data.loc[data['parental level of education'] == "associate's degree",'parental level of education'] = 1
```

In [42]:

```
data.head()
```

Out[42]:

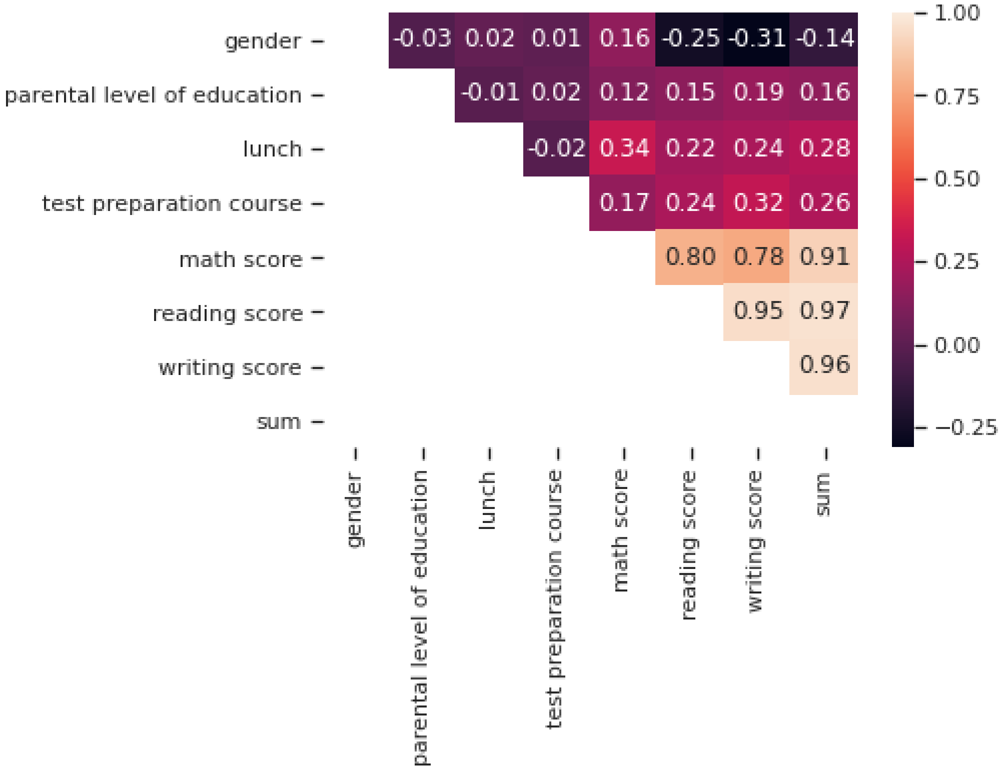
	gender	parental level of education	lunch	test preparation course	math score	reading score	writing score	sum
0	0	1	1	0	72	72	74	218
1	0	0	1	1	69	90	88	247
2	0	1	1	0	90	95	93	278
3	1	1	0	0	47	57	44	148
4	1	0	1	0	76	78	75	229

In [43]:

```
# Треугольный вариант матрицы
mask = np.zeros_like(data.corr(), dtype=np.bool)
mask[np.tril_indices_from(mask)] = True
sns.heatmap(data.corr(method='spearman'), mask=mask, annot=True, fmt='.2f')
```

Out[43]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f85f971cc10>
```

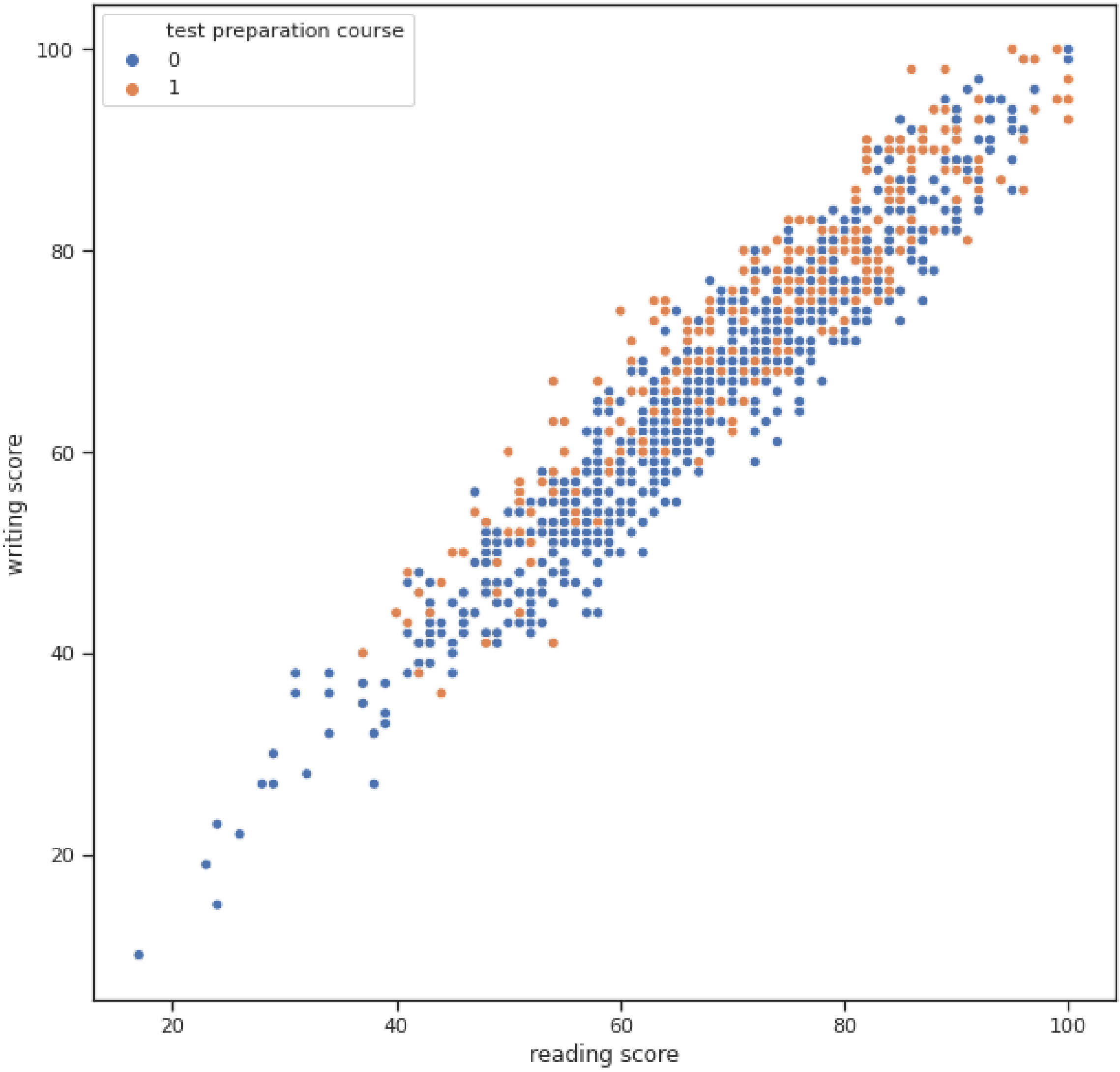


In [45]:

```
fig, ax = plt.subplots(figsize=(10,10))
sns.scatterplot(ax=ax, x='reading score', y='writing score', data=data, hue='tes
t preparation course')
```

Out[45]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f85f95a47d0>
```



In [46]:

```
# Аналитическое вычисление коэффициентов регрессии
def analytic_regr_coef(x_array : np.ndarray, 
                       y_array : np.ndarray) -> Tuple[float, float]:
    x_mean = np.mean(x_array)
    y_mean = np.mean(y_array)
    var1 = np.sum([(x-x_mean)**2 for x in x_array])
    cov1 = np.sum([(x-x_mean)*(y-x_mean) for x, y in zip(x_array, y_array)])
    b1 = cov1 / var1
    b0 = y_mean - b1*x_mean
    return b0, b1
```

In [47]:

```
x_array = data['reading score'].values
y_array = data['writing score'].values
```

In [48]:

```
b0, b1 = analytic_regr_coef(x_array, y_array)
b0, b1
```

Out[48]:

```
(-0.6675536409329368, 0.9935311142409596)
```

In [49]:

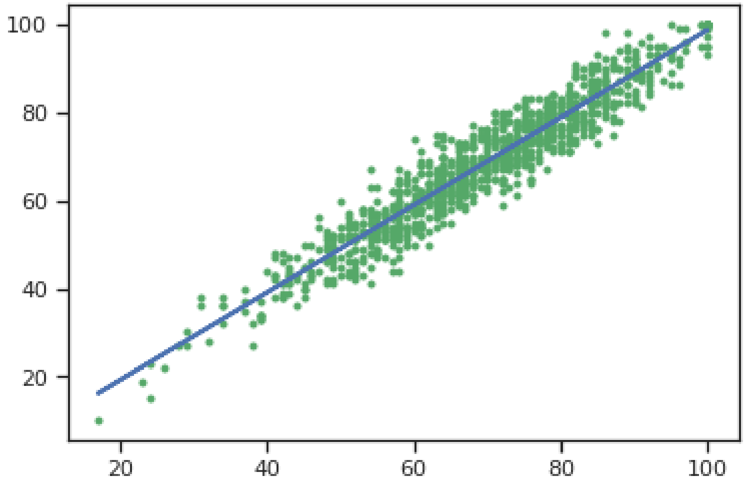
```
# Вычисление значений y на основе x для регрессии
def y_regr(x_array : np.ndarray, b0: float, b1: float) -> np.ndarray:
    res = [b1*x+b0 for x in x_array]
    return res
```

In [50]:

```
y_array_regr = y_regr(x_array, b0, b1)
```

In [52]:

```
plt.plot(x_array, y_array, 'g.')
plt.plot(x_array, y_array_regr, 'b', linewidth=2.0)
plt.show()
```



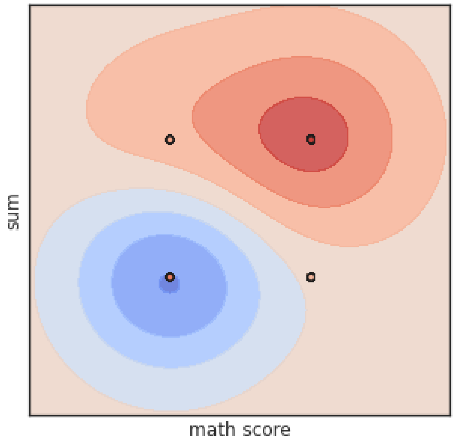
In [67]:

```
iris = data
iris_X = arr[:, [1,2]]
iris_y = arr2

def make_meshgrid(x, y, h=.02):
    """Create a mesh of points to plot in

    Parameters
    ----------
    x: data to base x-axis meshgrid on
    y: data to base y-axis meshgrid on
    h: stepsize for meshgrid, optional

    Returns
    -------
    xx, yy : ndarray
    """
    x_min, x_max = x.min() - 1, x.max() + 1
    y_min, y_max = y.min() - 1, y.max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h),
                         np.arange(y_min, y_max, h))
    return xx, yy

def plot_contours(ax, clf, xx, yy, **params):
    """Plot the decision boundaries for a classifier.

    Parameters
    ----------
    ax: matplotlib axes object
    clf: a classifier
    xx: meshgrid ndarray
    yy: meshgrid ndarray
    params: dictionary of params to pass to contourf, optional
    """
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    #Можно проверить все ли метки классов предсказываются
    #print(np.unique(Z))
    out = ax.contourf(xx, yy, Z, **params)
    return out


def plot_cl(clf):
    title = clf.__repr__
    clf.fit(iris_X, iris_y)
    fig, ax = plt.subplots(figsize=(5,5))
    X0, X1 = iris_X[:, 0], iris_X[:, 1]
    xx, yy = make_meshgrid(X0, X1)
    plot_contours(ax, clf, xx, yy, cmap=plt.cm.coolwarm, alpha=0.8)
    ax.scatter(X0, X1, c=iris_y, cmap=plt.cm.coolwarm, s=20, edgecolors='k')
    ax.set_xlim(xx.min(), xx.max())
    ax.set_ylim(yy.min(), yy.max())
    ax.set_xlabel('math score')
    ax.set_ylabel('sum')
    ax.set_xticks(())
    ax.set_yticks(())
    ax.set_title(title)
    plt.show()
```

In [68]:

```
plot_cl(SVR())
```

```
<bound method BaseEstimator.__repr__ of SVR(C=1.0, cache_size=200, coef0=0.0, degree=3, epsilon=0.1, gamma='scale',
    kernel='rbf', max_iter=-1, shrinking=True, tol=0.001, verbose=False)>
```

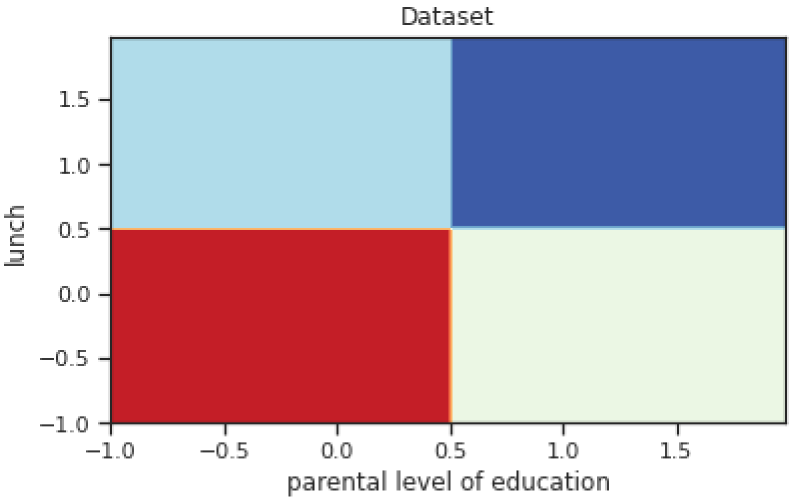


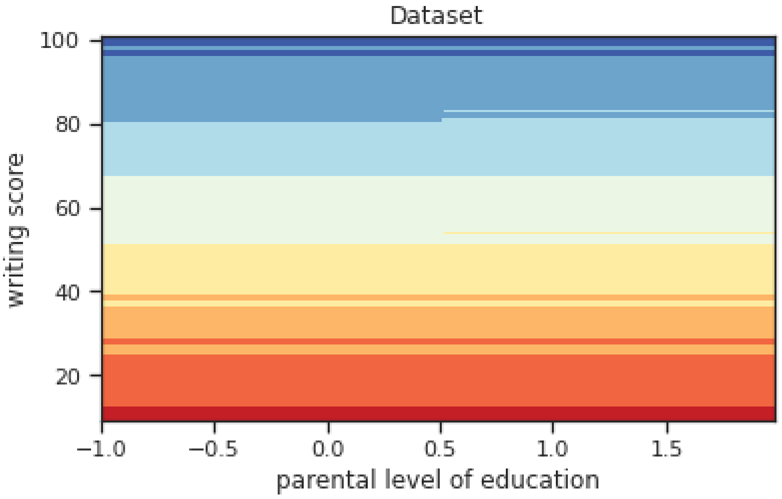
In [71]:

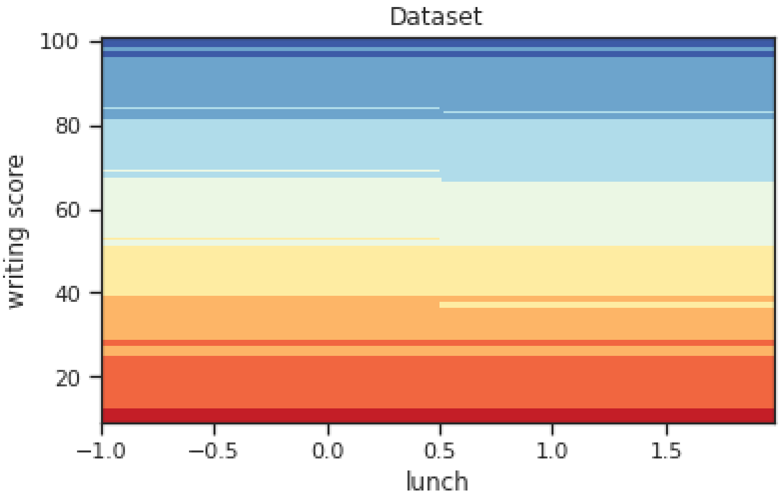
```
def plot_tree_classification(title_param, ds):
    """
    Построение деревьев и вывод графиков для заданного датасета
    """

    n_classes = 4
    plot_colors = "ryb"
    plot_step = 0.02
    arr=data.to_numpy()
    for pairidx, pair in enumerate([[1, 2], [1, 6], [2, 6]]):
        # We only take the two corresponding features
        X = arr[:, pair]
        y = arr[:, [7]]

        # Train
        clf = DecisionTreeRegressor(random_state=0).fit(X, y)

        plt.title(title_param)

        x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
        y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
        xx, yy = np.meshgrid(np.arange(x_min, x_max, plot_step),
                             np.arange(y_min, y_max, plot_step))
        plt.tight_layout(h_pad=0.5, w_pad=0.5, pad=2.5)

        Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
        Z = Z.reshape(xx.shape)
        cs = plt.contourf(xx, yy, Z, cmap=plt.cm.RdYlBu)

        plt.xlabel(data.columns[pair[0]])
        plt.ylabel(data.columns[pair[1]])

        # Plot the training points
        for i, color in zip(range(n_classes), plot_colors):
            idx = np.where(y == i)
            plt.scatter(X[idx, 0], X[idx, 1], c=color, label=data.columns[i],
                        cmap=plt.cm.RdYlBu, edgecolor='black', s=15)

        plt.show()
```

In [72]:

```
plot_tree_classification('Dataset', data)
```


Dataset
lunch
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
1.5
parental level of education


Dataset
writing score
100
80
60
40
20
−1.0
−0.5
0.0
0.5
1.0
1.5
parental level of education


Dataset
writing score
100
80
60
40
20
lunch
−1.0
−0.5
0.0
0.5
1.0
1.5