Защищено: Гапанюк Ю.Е.

" " 2023 г.

Демонстрация: Гапанюк Ю.Е.

" " 2023 г.

**Отчет по лабораторной работе № 4 по курсу Технологии машинного обучения**

**ГУИМЦ**

**Тема работы: " Линейные модели, SVM и деревья решений. "**

11

(количество листов) Вариант № **2**

ИСПОЛНИТЕЛЬ:

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(подпись)

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" " 2023 г.

Москва, МГТУ - 2023

**Цель лабораторной работы:**

изучение линейных моделей, SVM и деревьев решений.

**Задание:**

1. Выберите набор данных (датасет) для решения задачи классификации или регрессии.
2. В случае необходимости проведите удаление или заполнение пропусков и кодирование категориальных признаков.
3. С использованием метода train\_test\_split разделите выборку на обучающую и тестовую.
4. Обучите следующие модели:
   * одну из линейных моделей (линейную или полиномиальную регрессию при решении задачи регрессии, логистическую регрессию при решении задачи классификации);
   * SVM;
   * дерево решений.
5. Оцените качество моделей с помощью двух подходящих для задачи метрик. Сравните качество полученных моделей.
6. Постройте график, показывающий важность признаков в дереве решений.
7. Визуализируйте дерево решений или выведите правила дерева решений в текстовом виде.

**Ход выполнения работы**

В качестве набора данных используется dataset - Результаты студентов на экзаменах (Оценки, полученные учащимися по различным предметам).

Датасет доступен по адресу: https://www.kaggle.com/datasets/spscientist/students-performance-in-exams

Из набора данных будет рассматриваться только файл «StudentsPerformance.csv»

# **Лабораторная работа №4**

In [1]:

**import** numpy **as** np

**import** pandas **as** pd

**from** typing **import** Dict, Tuple

**import** seaborn **as** sns

**import** matplotlib.pyplot **as** plt

**%matplotlib** inline

**from** sklearn.impute **import** SimpleImputer

**import** warnings

**from** sklearn.pipeline **import** Pipeline

**from** sklearn.preprocessing **import** PolynomialFeatures

**from** sklearn.metrics **import** confusion\_matrix, precision\_score, recall\_score, f1\_scor

**from** sklearn.linear\_model **import** LinearRegression warnings**.**simplefilter("ignore")

In [2]:

*# чтение обучающей выборки*

data **=** pd**.**read\_csv('StudentsPerformance.csv') data**.**head()

Out[2]:

In [3]:

**from** sklearn.model\_selection **import** train\_test\_split

**from** sklearn.preprocessing **import** LabelEncoder

**gender race/ethnicity**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | **course** |  | | |
| **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 free/reduced none 47 57 44 | | | | | | | | |
|  |  |  | degree |  |  |  |  |  |
| **4** | male | group C | some college | standard | none | 76 | 78 | 75 |

**parental level of lunch education**

**test preparation**

**math score**

**reading**

**score**

**writing score**

In [4]:

le **=** LabelEncoder()

*# "gender" - пол*

le**.**fit(data**.**gender**.**drop\_duplicates()) data**.**gender **=** le**.**transform(data**.**gender)

*# "race/ethnicity" - раса*

le**.**fit(data["race/ethnicity"]**.**drop\_duplicates())

data["race/ethnicity"] **=** le**.**transform(data["race/ethnicity"])

*# "lunch" - обед*

le**.**fit(data**.**lunch**.**drop\_duplicates()) data**.**lunch **=** le**.**transform(data**.**lunch)

*# "parental level of education" - образование родителей*

le**.**fit(data["parental level of education"]**.**drop\_duplicates())

data["parental level of education"] **=** le**.**transform(data["parental level of education

*# "test preparation course" - подготовительный курс*

le**.**fit(data["test preparation course"]**.**drop\_duplicates())

data["test preparation course"] **=** le**.**transform(data["test preparation course"])

In [5]:

*#Построим корреляционную матрицу*

fig, ax **=** plt**.**subplots(figsize**=**(15,7))

sns**.**heatmap(data**.**corr(method**=**'pearson'), ax**=**ax, annot**=True**, fmt**=**'.2f')

Out[5]:

<AxesSubplot:>



# **Предскажем значения поля Writing score по Math score и Reading score, так как значение корреляции ближе всего к 1.**

In [6]:

X **=** data[["math score", "reading score"]] Y **=** data["writing score"]

print('Входные данные:\n\n', X**.**head(), '\n\nВыходные данные:\n\n', Y**.**head())

Входные данные:

math score reading score 0 72 72

1 69 90

2 90 95

3 47 57

4 76 78

Выходные данные:

0 74

1 88

2 93

3 44

4 75

Name: writing score, dtype: int64

In [7]:

X\_train, X\_test, Y\_train, Y\_test **=** train\_test\_split(X, Y, random\_state **=** 0, test print('Входные параметры обучающей выборки:\n\n',X\_train**.**head(), \

'\n\nВходные параметры тестовой выборки:\n\n', X\_test**.**head(), \

'\n\nВыходные параметры обучающей выборки:\n\n', Y\_train**.**head(), \ '\n\nВыходные параметры тестовой выборки:\n\n', Y\_test**.**head())

Входные параметры обучающей выборки:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | math | score | reading | score |
| 785 |  | 32 |  | 51 |
| 873 |  | 90 |  | 90 |
| 65 |  | 67 |  | 64 |
| 902 |  | 34 |  | 48 |
| 317 |  | 83 |  | 72 |

Входные параметры тестовой выборки: math score reading score

|  |  |  |
| --- | --- | --- |
| 993 | 62 | 72 |
| 859 | 87 | 73 |
| 298 | 40 | 46 |
| 553 | 77 | 62 |
| 672 | 69 | 78 |

Выходные параметры обучающей выборки:

|  |  |  |
| --- | --- | --- |
| 785 | 44 |  |
| 873 | 82 |  |
| 65 | 61 |  |
| 902 | 41 |  |
| 317 | 78 |  |
| Name: | writing score, dtype: | int64 |

Выходные параметры тестовой выборки:

|  |  |  |
| --- | --- | --- |
| 993 | 74 |  |
| 859 | 72 |  |
| 298 | 50 |  |
| 553 | 64 |  |
| 672 | 76 |  |
| Name: | writing score, dtype: | int64 |

# **Построение линейной регрессии**

In [8]:

**from** sklearn.linear\_model **import** LinearRegression

**from** sklearn.metrics **import** mean\_absolute\_error, mean\_squared\_error, median\_absolut

In [9]:

Lin\_Reg **=** LinearRegression()**.**fit(X\_train, Y\_train)

lr\_y\_pred **=** Lin\_Reg**.**predict(X\_test)

# **Возьмем тот параметр, чья корреляция ближе всего к единице, т.е. Reading score**

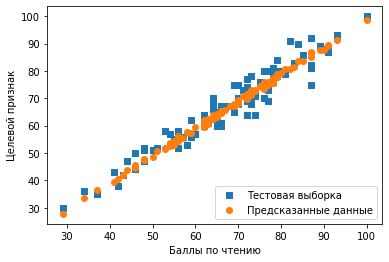
In [10]:

plt**.**scatter(X\_test["reading score"], Y\_test,

marker **=** 's', label **=** 'Тестовая выбо

plt**.**scatter(X\_test["reading score"], lr\_y\_pred, marker **=** 'o', label **=** 'Предсказанные

plt**.**legend (loc **=** 'lower right') plt**.**xlabel ('Баллы по чтению') plt**.**ylabel ('Целевой признак') plt**.**show()



# **SVM**

In [11]:

**from** sklearn.svm **import** SVC , LinearSVC

**from** sklearn.datasets.samples\_generator **import** make\_blobs

**from** matplotlib **import** pyplot **as** plt

In [12]:

svc **=** SVC(kernel**=**'linear') svc**.**fit(X\_train,Y\_train)

Out[12]:

In [13]:

pred\_y **=** svc**.**predict(X\_test)

SVC(kernel='linear')

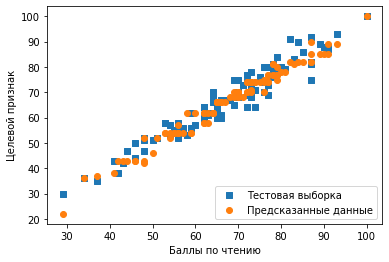
In [14]:

plt**.**scatter(X\_test["reading score"], Y\_test,

marker **=** 's', label **=** 'Тестовая выбо

plt**.**scatter(X\_test["reading score"], pred\_y, marker **=** 'o', label **=** 'Предсказанные да

plt**.**legend (loc **=** 'lower right') plt**.**xlabel ('Баллы по чтению') plt**.**ylabel ('Целевой признак') plt**.**show()



# **Tree**

In [15]:

**from** sklearn.tree **import** DecisionTreeClassifier, DecisionTreeRegressor, export\_graph

**from** sklearn.tree **import** export\_graphviz

**from** sklearn **import** tree

**import** re

In [16]:

*# Обучим дерево на всех признаках iris*

clf **=** tree**.**DecisionTreeClassifier() clf **=** clf**.**fit(X\_test, Y\_test)

In [17]:

**from** IPython.core.display **import** HTML

**from** sklearn.tree.export **import** export\_text

tree\_rules **=** export\_text(clf, feature\_names**=**list(X**.**columns)) HTML('<pre>' **+** tree\_rules **+** '</pre>')

Out[17]: |--- reading score <= 61.00

| |--- math score <= 64.50

| | |--- math score <= 53.00

| | | |--- reading score <= 56.50

| | | | |--- math score <= 46.50

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| | | | | | | | | | | |--- reading score <= 31.50 |
| | | | | | | | | | | | |--- class: 30 |
| | | | | | | | | | | |--- reading score > 31.50 |
| | | | | | | | | | | | |--- math score <= 36.00 |
| | | | | | | | | | | | | |--- class: 43 |
| | | | | | | | | | | | |--- math score > 36.00 |

|--- reading score <= 38.00

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| |--- class: 36

|--- reading score > 38.00

|--- reading score <= 42.50

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| | | | | | | | | |--- | math | | score |

| |--- class: 38

|--- reading score > 42.50

| |--- math score <= 41.00

| | |--- class: 50

| |--- math score > 41.00

| | |--- math score <= 43.00

| | | |--- class: 54

| | |--- math score > 43.00

| | | |--- truncated branch of depth 2

> 46.50

|--- reading score <= 45.00

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| |--- class: 35

|--- reading score > 45.00

|--- reading score <= 53.50

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| |--- class: 58

|--- reading score > 53.50

| |--- math score <= 47.50

| | |--- class: 53

| |--- math score > 47.50

| | |--- class: 58

| | | |--- reading score > 56.50

|--- reading score <= 58.00

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| |--- class: 56

|--- reading score > 58.00

| |--- class: 56

| | |--- math score > 53.00

| | | |--- reading score <= 49.50

| | | | |--- math score <= 58.50

|--- math score <= 54.50

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| |--- class: 52

|--- math score > 54.50

| |--- reading score <= 47.00

| | |--- class: 44

| |--- reading score > 47.00

| | |--- class: 51

|--- math score > 58.50

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| |--- class: 47

| | | |--- reading score > 49.50

| | | | |--- math score <= 63.00

|--- reading score <= 53.00

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| |--- class: 52

|--- reading score > 53.00

| |--- class: 55

| | | | |--- math score > 63.00

| | | | | |--- class: 52

| |--- math score > 64.50

| | |--- reading score <= 57.00

| | | |--- class: 57

| | |--- reading score > 57.00

|--- reading score <= 59.00

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| |--- class: 53

|--- reading score > 59.00

| |--- class: 57

|--- reading score > 61.00

| |--- reading score <= 68.50

| | |--- reading score <= 66.50

| | | |--- math score <= 69.50

|--- math score <= 60.00

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| |--- reading score <= 62.50

|--- math score <= 45.50

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| |--- class: 61

|--- math score > 45.50

| |--- math score <= 53.50

| | |--- class: 60

| |--- math score > 53.50

| | |--- class: 64

| | | | | |--- reading score > 62.50

|--- reading score <= 63.50

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| |--- class: 62

|--- reading score > 63.50

| |--- math score <= 55.00

|--- reading score <= 64.50

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| |--- class: 68

|--- reading score > 64.50

| |--- class: 65

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| |  | | |  | | |  | | |  | | |--- math score > 60.00  | |--- reading score <= 62.50 | | | |
| | | | | | | | | | | |--- class: 60 | | | |
| | | | | | | | | | |--- reading score > 62.50 | | | |
| | | | | | | | | | | | |--- reading score <= 65.50 | | |
| | | | | | | | | | | | | |--- class: 61 | | |
| | | | | | | | | | | | |--- reading score > 65.50 | | |
| | | | | | | | | | | | | |--- math score <= 62.00 | | |
| | | | | | | | | | | | | | |--- class: 61 | | |
| | | | | | | | | | | | | |--- math score > 62.00 | | |
| | | | | | | | | | | | | | |--- class: 67 | | |

| | | |--- math score > 69.50

| | | | |--- reading score <= 64.50

|--- reading score <= 63.00

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| |--- class: 64

|--- reading score > 63.00

| |--- math score <= 73.00

| | |--- class: 70

| |--- math score > 73.00

| | |--- class: 66

|--- reading score > 64.50

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| |--- class: 60

| | |--- reading score > 66.50

| | | |--- class: 67

| |--- reading score > 68.50

| | |--- reading score <= 70.50

| | | |--- reading score <= 69.50

|--- math score <= 63.00

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| |--- class: 65

|--- math score > 63.00

| |--- class: 75

| | | |--- reading score > 69.50

| | | | |--- math score <= 71.50

|--- math score <= 59.00

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| |--- math score <= 55.50

| |--- class: 70

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|--- math score > 55.50

| |--- class: 68

| |--- math score > 59.00

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| | |--- class: 70

|--- math score > 71.50

| |--- class: 75

| | |--- reading score > 70.50

| | | |--- reading score <= 81.50

|--- reading score <= 77.50

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| |--- math score <= 76.50

|--- math score <= 74.50

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| |--- reading score <= 75.00

|--- math score <= 57.50

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| |--- class: 64

|--- math score > 57.50

| |--- math score <= 62.50

| | |--- class: 74

| |--- math score > 62.50

| | |--- reading score <= 72.50

| | | |--- class: 77

| | |--- reading score > 72.50

| | | |--- truncated branch of depth 3

| | | | | | | |--- reading score > 75.00

|--- math score <= 54.50

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| |--- class: 70

|--- math score > 54.50

| |--- reading score <= 76.50

| | |--- class: 80

| |--- reading score > 76.50

| | |--- math score <= 61.00

| | | |--- class: 80

| | |--- math score > 61.00

| | | |--- truncated branch of depth 2

| |--- math score > 74.50

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| | |--- class: 68

|--- math score > 76.50

| |--- reading score <= 74.00

|--- reading score <= 72.50

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| |--- math score <= 79.50

| | |--- class: 69

| |--- math score > 79.50

| | |--- class: 73

|--- reading score > 72.50

| |--- class: 72

| | | | | | |--- reading score > 74.00

|--- reading score <= 75.50

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| |--- class: 76

|--- reading score > 75.50

| |--- reading score <= 76.50

| | |--- class: 74

| |--- reading score > 76.50

| | |--- class: 73

|--- reading score > 77.50

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| |--- math score <= 73.50

|--- math score <= 58.00

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| |--- class: 79

|--- math score > 58.00

|--- reading score <= 78.50

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| |--- class: 76

|--- reading score > 78.50

| |--- class: 79

|--- math score > 73.50

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| |--- math score <= 87.50

|--- reading score <= 78.50

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| |--- class: 81

|--- reading score > 78.50

| |--- reading score <= 79.50

| | | | | | | | | |--- math score <= 76.50

| | | | | | | | | | |--- class: 80

| | | | | | | | | |--- math score > 76.50

| | | | | | | | | | |--- class: 78

| | | | | | | | |--- reading score > 79.50

| | | | | | | | | |--- class: 80

| | | | | | |--- math score > 87.50

| | | | | | | |--- math score <= 91.50

| | | | | | | | |--- class: 79

| | | | | | | |--- math score > 91.50

| | | | | | | | |--- class: 84

| | | |--- reading score > 81.50

| | | | |--- reading score <= 89.50

| | | | | |--- math score <= 74.00

| | | | | | |--- reading score <= 85.00

| | | | | | | |--- class: 83

| | | | | | |--- reading score > 85.00

| | | | | | | |--- class: 82

| | | | | |--- math score > 74.00

| | | | | | |--- math score <= 78.00

| | | | | | | |--- class: 91

| | | | | | |--- math score > 78.00

| | | | | | | |--- math score <= 84.50

| | | | | | | | |--- reading score <= 87.00

| | | | | | | | | |--- class: 86

| | | | | | | | |--- reading score > 87.00

| | | | | | | | | |--- class: 89

| | | | | | | |--- math score > 84.50

|--- math score <= 91.50

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| |--- class: 75

|--- math score > 91.50

| |--- reading score <= 85.50

| | |--- class: 90

| |--- reading score > 85.50

| | |--- math score <= 96.50

| | | |--- class: 92

| | |--- math score > 96.50

| | | |--- class: 81

| | | | |--- reading score > 89.50

|--- math score <= 79.00

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| |--- class: 88

|--- math score > 79.00

|--- math score <= 81.50

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| |--- class: 87

|--- math score > 81.50

| |--- math score <= 87.00

| | |--- class: 93

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| | | | | | | | | | | | | | | |--- math score | > 87.00 |
| | | | | | | | | | | | | | | | |--- class: | 100 |

In [18]:

pred\_y **=** clf**.**predict(X\_test)

plt**.**scatter(X\_test["reading score"], Y\_test,

marker **=** 's', label **=** 'Тестовая выбо

plt**.**scatter(X\_test["reading score"], pred\_y, marker **=** 'o', label **=** 'Предсказанные да

plt**.**legend (loc **=** 'lower right') plt**.**xlabel ('Баллы по чтению') plt**.**ylabel ('Целевой признак') plt**.**show()

