Демонстрация:
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"__"_____2022 г.

Защищено:
Гапанюк Ю.Е.

"__"_____2022 г.

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

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

11
(количество листов)
Вариант № **4**

ИСПОЛНИТЕЛЬ:

студент группы ИУ5Ц-84Б _____
(подпись)

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"__"_____2022 г.

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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]:

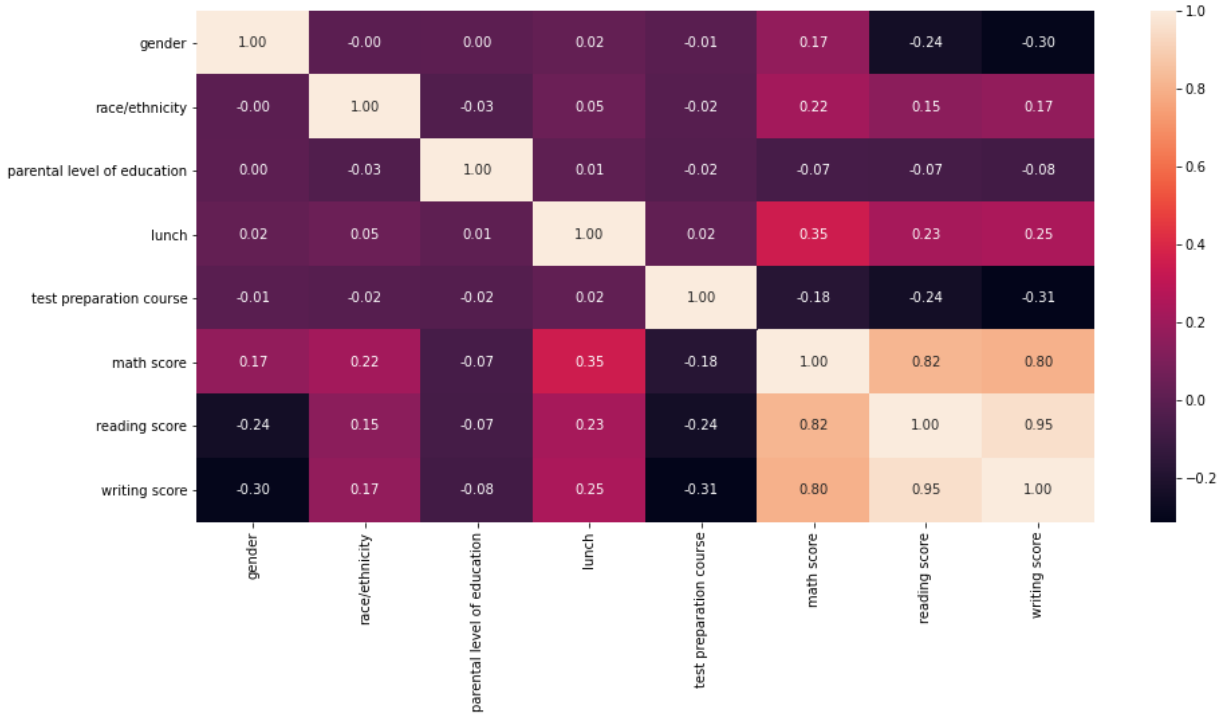
	gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score
0	female	group B	bachelor's degree	standard	none	72	72	74
1	female	group C	some college	standard	completed	69	90	88
2	female	group B	master's degree	standard	none	90	95	93
3	male	group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

In [3]:
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
```

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

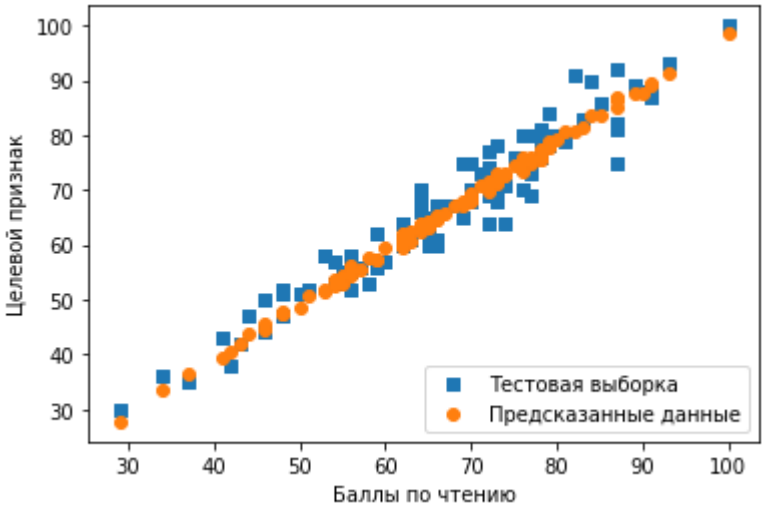
In [8]:
```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error,   median_absolut
```

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
```

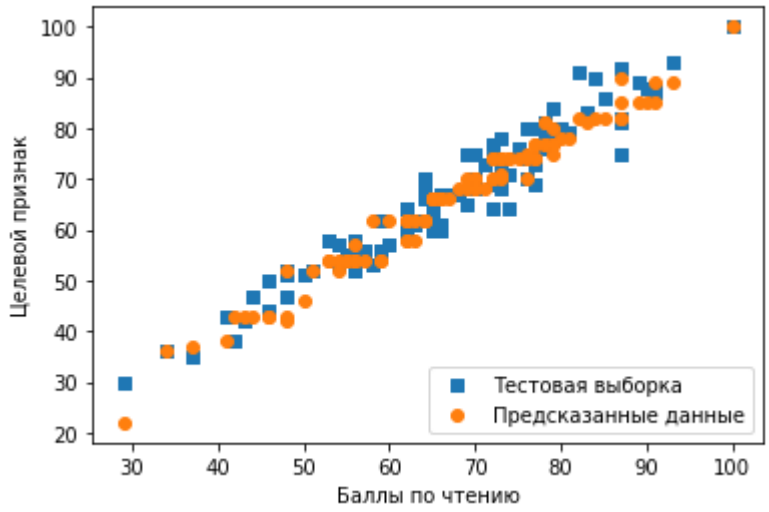
```
from sklearn.datasets.samples_generator import make_blobs
from matplotlib import pyplot as plt
```

In [12]:
```
svc = SVC(kernel='linear')
svc.fit(X_train,Y_train)
```

Out[12]:
```
SVC(kernel='linear')
```

In [13]:
```
pred_y = svc.predict(X_test)
```

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

```
|   |   |   |   |   |   |   |--- reading score <= 38.00
|   |   |   |   |   |   |   |   |--- class: 36
|   |   |   |   |   |   |   |--- reading score >  38.00
|   |   |   |   |   |   |   |   |--- reading score <= 42.50
|   |   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |--- math score >  46.50
|   |   |   |   |   |   |--- reading score <= 45.00
|   |   |   |   |   |   |   |--- class: 35
|   |   |   |   |   |   |--- reading score >  45.00
|   |   |   |   |   |   |   |--- reading score <= 53.50
|   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |--- class: 56
|   |   |   |   |   |--- reading score >  58.00
|   |   |   |   |   |   |--- class: 56
|   |   |   |--- math score >  53.00
|   |   |   |   |--- reading score <= 49.50
|   |   |   |   |   |--- math score <= 58.50
|   |   |   |   |   |   |--- math score <= 54.50
|   |   |   |   |   |   |   |--- class: 52
|   |   |   |   |   |   |--- math score >  54.50
|   |   |   |   |   |   |   |--- reading score <= 47.00
|   |   |   |   |   |   |   |   |--- class: 44
|   |   |   |   |   |   |   |--- reading score >  47.00
|   |   |   |   |   |   |   |   |--- class: 51
|   |   |   |   |   |--- math score >  58.50
|   |   |   |   |   |   |--- class: 47
|   |   |   |   |--- reading score >  49.50
|   |   |   |   |   |--- math score <= 63.00
|   |   |   |   |   |   |--- reading score <= 53.00
|   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |--- 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
|   |   |   |   |   |--- reading score <= 62.50
|   |   |   |   |   |   |--- math score <= 45.50
|   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |   |--- class: 62
|   |   |   |   |   |   |--- reading score >  63.50
|   |   |   |   |   |   |   |--- math score <= 55.00
|   |   |   |   |   |   |   |   |--- reading score <= 64.50
|   |   |   |   |   |   |   |   |   |--- class: 68
|   |   |   |   |   |   |   |   |--- reading score >  64.50
|   |   |   |   |   |   |   |   |   |--- class: 65
|   |   |   |   |   |   |   |--- math score >  55.00
|   |   |   |   |   |   |   |   |--- class: 63
|   |   |   |   |--- 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
|   |   |   |   |   |   |--- class: 64
|   |   |   |   |   |--- reading score >  63.00
|   |   |   |   |   |   |--- math score <= 73.00
|   |   |   |   |   |   |   |--- class: 70
|   |   |   |   |   |   |--- math score >  73.00
|   |   |   |   |   |   |   |--- class: 66
|   |   |   |   |--- reading score >  64.50
|   |   |   |   |   |--- class: 60
|   |   |--- reading score >  66.50
|   |   |   |--- class: 67
|   |--- reading score >  68.50
|   |   |--- reading score <= 70.50
|   |   |   |--- reading score <= 69.50
|   |   |   |   |--- math score <= 63.00
|   |   |   |   |   |--- class: 65
|   |   |   |   |--- math score >  63.00
|   |   |   |   |   |--- class: 75
|   |   |   |--- reading score >  69.50
|   |   |   |   |--- math score <= 71.50
|   |   |   |   |   |--- math score <= 59.00
|   |   |   |   |   |   |--- math score <= 55.50
```

```
|   |   |   |   |   |   |   |   |--- class: 70
|   |   |   |   |   |   |   |--- math score >  55.50
|   |   |   |   |   |   |   |   |--- class: 68
|   |   |   |   |   |   |--- math score >  59.00
|   |   |   |   |   |   |   |--- class: 70
|   |   |   |   |   |--- math score >  71.50
|   |   |   |   |   |   |--- class: 75
|   |   |   |--- reading score >  70.50
|   |   |   |   |--- reading score <= 81.50
|   |   |   |   |   |--- reading score <= 77.50
|   |   |   |   |   |   |--- math score <= 76.50
|   |   |   |   |   |   |   |--- math score <= 74.50
|   |   |   |   |   |   |   |   |--- reading score <= 75.00
|   |   |   |   |   |   |   |   |   |--- math score <= 57.50
|   |   |   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |   |   |--- class: 68
|   |   |   |   |   |   |--- math score >  76.50
|   |   |   |   |   |   |   |--- reading score <= 74.00
|   |   |   |   |   |   |   |   |--- reading score <= 72.50
|   |   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |   |   |   |--- class: 76
|   |   |   |   |   |   |   |   |--- reading score >  75.50
|   |   |   |   |   |   |   |   |   |--- reading score <= 76.50
|   |   |   |   |   |   |   |   |   |   |--- class: 74
|   |   |   |   |   |   |   |   |   |--- reading score >  76.50
|   |   |   |   |   |   |   |   |   |   |--- class: 73
|   |   |   |   |   |--- reading score >  77.50
|   |   |   |   |   |   |--- math score <= 73.50
|   |   |   |   |   |   |   |--- math score <= 58.00
|   |   |   |   |   |   |   |   |--- class: 79
|   |   |   |   |   |   |--- math score >  58.00
```

```
|   |   |   |   |   |   |   |   |--- reading score <= 78.50
|   |   |   |   |   |   |   |   |   |--- class: 76
|   |   |   |   |   |   |   |   |--- reading score >  78.50
|   |   |   |   |   |   |   |   |   |--- class: 79
|   |   |   |   |   |   |--- math score >  73.50
|   |   |   |   |   |   |   |--- math score <= 87.50
|   |   |   |   |   |   |   |   |--- reading score <= 78.50
|   |   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |   |   |   |   |--- 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
|   |   |   |   |   |   |--- class: 88
|   |   |   |   |   |--- math score >  79.00
|   |   |   |   |   |   |--- math score <= 81.50
|   |   |   |   |   |   |   |--- class: 87
|   |   |   |   |   |   |--- math score >  81.50
|   |   |   |   |   |   |   |--- math score <= 87.00
|   |   |   |   |   |   |   |   |--- class: 93
```

```
|   |   |   |   |   |   |   |--- 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()
```