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Кафедра «Системы обработки информации и управления»

Лабораторная работа №4 по дисциплине

«Методы машинного обучения»

«Подготовка обучающей и тестовой выборки, кросс-валидация и подбор гиперпараметров на примере метода ближайших соседей»

ИСПОЛНИТЕЛЬ:

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In [3]:

```
from datetime import datetime
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import median_absolute_error, r2_score
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import KFold, RepeatedKFold, ShuffleSplit
from sklearn.model_selection import cross_val_score, train_test_split
from sklearn.model_selection import learning_curve, validation_curve
from sklearn.neighbors import KNeighborsRegressor
from sklearn.preprocessing import StandardScaler
# Enable inline plots
%matplotlib inline
```

Выбор датасета и его исследование

In [5]:

```
data = pd.read_csv('heart.csv', sep=',')
data.head(10)
```

Out[5]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2	1
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2	1
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2	1
5	57	1	0	140	192	0	1	148	0	0.4	1	0	1	1
6	56	0	1	140	294	0	0	153	0	1.3	1	0	2	1
7	44	1	1	120	263	0	1	173	0	0.0	2	0	3	1
8	52	1	2	172	199	1	1	162	0	0.5	2	0	3	1
9	57	1	2	150	168	0	1	174	0	1.6	2	0	2	1

In [6]:

```
data.shape
```

Out[6]:

```
(303, 14)
```

In [7]:

```
data.dtypes
```

Out[7]:

```
age           int64
sex           int64
cp            int64
trestbps      int64
chol          int64
fbs           int64
restecg       int64
thalach       int64
exang         int64
oldpeak     float64
```

```
slope         int64
ca            int64
thal          int64
target        int64
dtype: object
```

In [8]:

```
data.isnull().sum()
```

Out[8]:

```
age         0
sex         0
cp          0
trestbps    0
chol        0
fbs         0
restecg     0
thalach     0
exang       0
oldpeak     0
slope       0
ca          0
thal        0
target      0
dtype: int64
```

3. Разделение выборки на обучающую и тестовую.

In [9]:

```
 # Перейдем к разделению выборки на обучающую и тестовую.
X = data.drop('target',axis = 1).values
y = data['target'].values
```

In [10]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.35, random_state=1)
```

In [11]:

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(196, 13)
(107, 13)
(196,)
(107,)
```

4.Обучите модель ближайших соседей для произвольно заданного гиперпараметра K. Оцените качество модели с помощью трех подходящих для задачи метрик.

In [12]:

```
def test_model(model):
    print("mean_absolute_error:",
    mean_absolute_error(y_test, model.predict(X_test)))
    print("median_absolute_error:",
    median_absolute_error(y_test, model.predict(X_test)))
    print("r2_score:",
    r2_score(y_test, model.predict(X_test)))
```

In [13]:

```
reg_5 = KNeighborsRegressor(n_neighbors=5)
reg_5.fit(X_train, y_train)
```

Out[13]:

```
KNeighborsRegressor(algorithm='auto', leaf_size=30, metric='minkowski',
                    metric_params=None, n_jobs=None, n_neighbors=5, p=2,
                    weights='uniform')
```

In [14]:

```
# Проверим метрики построенной модели
test_model(reg_5)
```

```
mean_absolute_error: 0.42616822429906537
median_absolute_error: 0.4
r2_score: -0.01218245614035074
```

5. Постройте модель и оцените качество модели с использованием кросс-валидации. Проведите эксперименты с тремя различными стратегиями кросс-валидации.

K-Fold

In [15]:

```
scores = cross_val_score(KNeighborsRegressor(n_neighbors=5), X, y, cv=KFold(n_splits=10), scoring="
r2")
print(scores)
print(scores.mean(), "±", scores.std())
```

```
[0.         0.         0.         0.         0.         0.16666667
 0.         0.         0.         0.        ]
0.016666666666666653 ± 0.04999999999999995
```

Repeated K-Fold

In [16]:

```
 scores = cross_val_score(KNeighborsRegressor(n_neighbors=5), X, y, cv=RepeatedKFold(n_splits=5, n_
repeats=2),
scoring="r2")
print(scores)
print(scores.mean(), "±", scores.std())
```

```
[-0.17802151 -0.10305011  0.01238095  0.3352614   0.05714286 -0.03857759
  0.02131868  0.08034858 -0.008       0.06650999]
0.024531326401118825 ± 0.1284515912142582
```

Shuffle Split

In [17]:

```
scores = cross_val_score(KNeighborsRegressor(n_neighbors=5), X, y, cv=ShuffleSplit(n_splits=10), sc
oring="r2")
print(scores)
print(scores.mean(), "±", scores.std())
```

```
[-0.03333333  0.08324786 -0.17111111 -0.09859649  0.15266667 -0.20290598
  0.40084034  0.008       0.05145299 -0.14418182]
0.004607912074165765 ± 0.1718953172265004
```

6. Произведите подбор гиперпараметра K с использованием GridSearchCV и кросс-валидации.

In [18]:

```
n_range = np.array(range(1, 14, 2))
tuned_parameters = [{'n_neighbors': n_range}]
n_range
```

Out[18]:

```
array([ 1,  3,  5,  7,  9, 11, 13])
```

In [19]:

```
gs = GridSearchCV(KNeighborsRegressor(), tuned_parameters,
cv=ShuffleSplit(n_splits=10), scoring="r2",
return_train_score=True, n_jobs=-1)
gs.fit(X, y)
gs.best_params_
```

Out[19]:

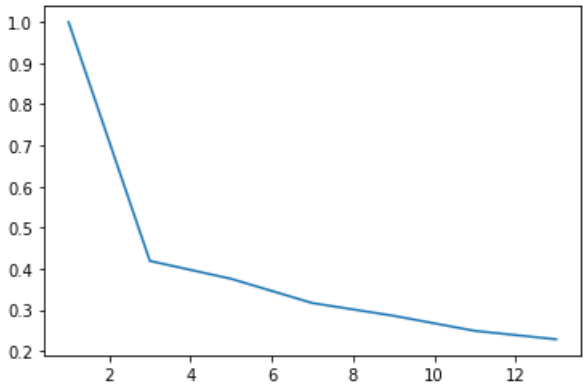
```
{'n_neighbors': 13}
```

In [20]:

```
plt.plot(n_range, gs.cv_results_["mean_train_score"])
```

Out[20]:

```
[<matplotlib.lines.Line2D at 0x7f9a51cd15f8>]
```

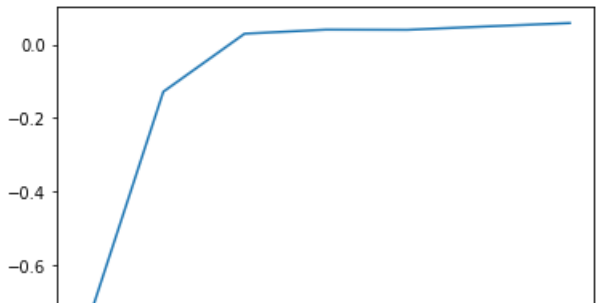


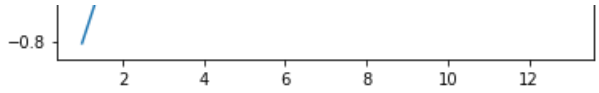
In [21]:

```
plt.plot(n_range, gs.cv_results_["mean_test_score"])
```

Out[21]:

```
[<matplotlib.lines.Line2D at 0x7f9a889fa940>]
```





7. Повторите пункт 4 для найденного оптимального значения гиперпараметра K. Сравните качество полученной модели с качеством модели, полученной в пункте 4.

In [22]:

```
reg = KNeighborsRegressor(**gs.best_params_)
reg.fit(X_train, y_train)
test_model(reg)
```

```
mean_absolute_error: 0.43278217109992817
median_absolute_error: 0.38461538461538464
r2_score: 0.05096231703519161
```

8. Постройте кривые обучения и валидации.

In [23]:

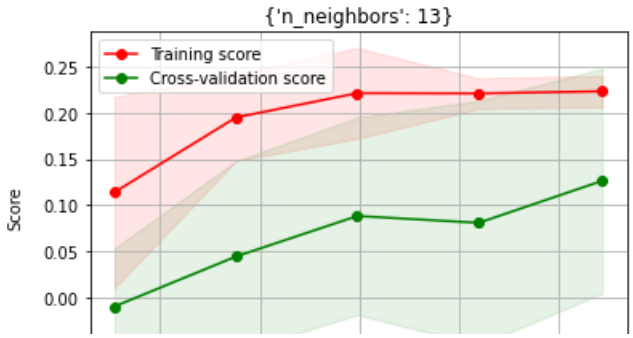
```
def plot_learning_curve(estimator, title, X, y, ylim=None, cv=None):
    train_sizes=np.linspace(.1, 1.0, 5)
    plt.figure()
    plt.title(title)
    if ylim is not None:
        plt.ylim(*ylim)
    plt.xlabel("Training examples")
    plt.ylabel("Score")
    train_sizes, train_scores, test_scores = learning_curve(
    estimator, X, y, cv=cv, n_jobs=-1, train_sizes=train_sizes)
    train_scores_mean = np.mean(train_scores, axis=1)
    train_scores_std = np.std(train_scores, axis=1)
    test_scores_mean = np.mean(test_scores, axis=1)
    test_scores_std = np.std(test_scores, axis=1)
    plt.grid()
    plt.fill_between(train_sizes, train_scores_mean - train_scores_std,
    train_scores_mean + train_scores_std, alpha=0.1, color="r")
    plt.fill_between(train_sizes, test_scores_mean - test_scores_std,
    test_scores_mean + test_scores_std, alpha=0.1, color="g")
    plt.plot(train_sizes, train_scores_mean, 'o-', color="r", label="Training score")
    plt.plot(train_sizes, test_scores_mean, 'o-', color="g", label="Cross-validation score")
    plt.legend(loc="best")
    return plt
```

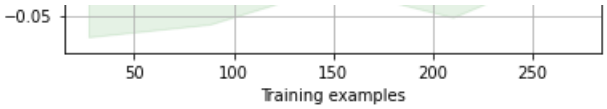
In [24]:

```
plot_learning_curve(reg, str(gs.best_params_), X, y,
cv=ShuffleSplit(n_splits=10))
```

Out[24]:

```
<module 'matplotlib.pyplot' from '/home/denis/mllabs/env/lib/python3.6/site-
packages/matplotlib/pyplot.py'>
```





In [25]:

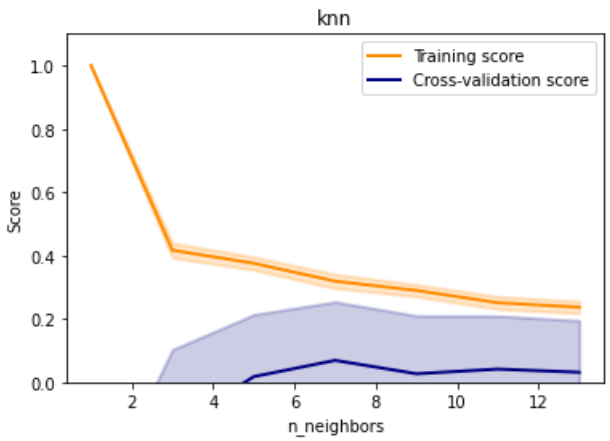
```
def plot_validation_curve(estimator, title, X, y, param_name, param_range, cv, scoring="accuracy"):
    train_scores, test_scores = validation_curve(
    estimator, X, y, param_name=param_name,
    param_range=param_range,
    cv=cv, scoring=scoring, n_jobs=-1)
    train_scores_mean = np.mean(train_scores, axis=1)
    train_scores_std = np.std(train_scores, axis=1)
    test_scores_mean = np.mean(test_scores, axis=1)
    test_scores_std = np.std(test_scores, axis=1)
    plt.title(title)
    plt.xlabel(param_name)
    plt.ylabel("Score")
    plt.ylim(0.0, 1.1)
    lw = 2
    plt.plot(param_range, train_scores_mean, label="Training score",
    color="darkorange", lw=lw)
    plt.fill_between(param_range, train_scores_mean - train_scores_std,
    train_scores_mean + train_scores_std, alpha=0.2,
    color="darkorange", lw=lw)
    plt.plot(param_range, test_scores_mean,
    label="Cross-validation score",
    color="navy", lw=lw)
    plt.fill_between(param_range, test_scores_mean - test_scores_std,
    test_scores_mean + test_scores_std, alpha=0.2,
    color="navy", lw=lw)
    plt.legend(loc="best")
    return plt
```

In [26]:

```
plot_validation_curve(KNeighborsRegressor(), "knn", X, y,
param_name="n_neighbors", param_range=n_range,
cv=ShuffleSplit(n_splits=10), scoring="r2")
```

Out[26]:

```
<module 'matplotlib.pyplot' from '/home/denis/mllabs/env/lib/python3.6/site-
packages/matplotlib/pyplot.py'>
```



In [ ]: