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Кафедра «Системы обработки информации и управления»

Лабораторная работа №4
по дисциплине
«Методы машинного обучения»
на тему

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

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1. Цель лабораторной работы

Изучить сложные способы подготовки выборки и подбора гиперпараметров на при-мере метода ближайших соседей.

2. Ход выполнения работы

In [0]:
```
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
```

In [0]:
```
pd.set_option("display.width", 70)
```

In [0]:
```
data = pd.read_csv("SolarPrediction.csv")
```

In [0]:
```
data["Time"] = (pd
.to_datetime(data["UNIXTime"], unit="s", utc=True)
.dt.tz_convert("Pacific/Honolulu")).dt.time
data["TimeSunRise"] = (pd
.to_datetime(data["TimeSunRise"],
infer_datetime_format=True)
.dt.time)
data["TimeSunSet"] = (pd
.to_datetime(data["TimeSunSet"],
infer_datetime_format=True)
.dt.time)
data = data.rename({"WindDirection(Degrees)": "WindDirection"},
axis=1)
```

In [7]:
```
data.dtypes
```

Out[7]:
```
UNIXTime          int64
Data             object
Time             object
Radiation       float64
Temperature       int64
Pressure        float64
Humidity          int64
WindDirection   float64
Speed           float64
TimeSunRise      object
TimeSunSet       object
dtype: object
```

In [8]:
```
data.head()
```

Out[8]:

	UNIXTime	Data	Time	Radiation	Temperature	Pressure	Humidity	WindDirection	Speed	TimeSunRise	Time
0	1475229326	9/29/2016 12:00:00 AM	23:55:26	1.21	48	30.46	59	177.39	5.62	06:13:00	18:13
1	1475229023	9/29/2016 12:00:00 AM	23:50:23	1.21	48	30.46	58	176.78	3.37	06:13:00	18:13
2	1475228726	9/29/2016 12:00:00 AM	23:45:26	1.23	48	30.46	57	158.75	3.37	06:13:00	18:13
3	1475228421	9/29/2016 12:00:00 AM	23:40:21	1.21	48	30.46	60	137.71	3.37	06:13:00	18:13
4	1475228124	9/29/2016 12:00:00 AM	23:35:24	1.17	48	30.46	62	104.95	5.62	06:13:00	18:13

In [0]:
```
def time_to_second(t):
  return ((datetime.combine(datetime.min, t) - datetime.min)
.total_seconds())
```

In [10]:
```
df = data.copy()
timeInSeconds = df["Time"].map(time_to_second)
sunrise = df["TimeSunRise"].map(time_to_second)
sunset = df["TimeSunSet"].map(time_to_second)
df["DayPart"] = (timeInSeconds - sunrise) / (sunset - sunrise)
df = df.drop(["UNIXTime", "Data", "Time",
"TimeSunRise", "TimeSunSet"], axis=1)
df.head()
```

Out[10]:

	Radiation	Temperature	Pressure	Humidity	WindDirection	Speed	DayPart
0	1.21	48	30.46	59	177.39	5.62	1.475602
1	1.21	48	30.46	58	176.78	3.37	1.468588
2	1.23	48	30.46	57	158.75	3.37	1.461713
3	1.21	48	30.46	60	137.71	3.37	1.454653
4	1.17	48	30.46	62	104.95	5.62	1.447778

In [11]:
```
df.dtypes
```
Out[11]:
```
Radiation        float64
Temperature        int64
Pressure         float64
Humidity           int64
WindDirection    float64
Speed            float64
DayPart          float64
dtype: object
```

In [12]:
```
df.shape
```
Out[12]:
```
(32686, 7)
```

In [13]:
```
df.describe()
```
Out[13]:

	Radiation	Temperature	Pressure	Humidity	WindDirection	Speed	DayPart
count	32686.000000	32686.000000	32686.000000	32686.000000	32686.000000	32686.000000	32686.000000
mean	207.124697	51.103255	30.422879	75.016307	143.489821	6.243869	0.482959
std	315.916387	6.201157	0.054673	25.990219	83.167500	3.490474	0.602432
min	1.110000	34.000000	30.190000	8.000000	0.090000	0.000000	-0.634602
25%	1.230000	46.000000	30.400000	56.000000	82.227500	3.370000	-0.040139
50%	2.660000	50.000000	30.430000	85.000000	147.700000	5.620000	0.484332
75%	354.235000	55.000000	30.460000	97.000000	179.310000	7.870000	1.006038
max	1601.260000	71.000000	30.560000	103.000000	359.950000	40.500000	1.566061

In [14]:
```
df.isnull().sum()
```
Out[14]:
```
Radiation      0
Temperature    0
Pressure       0
```

In [0]:
```
X = df.drop("Radiation", axis=1)
y = df["Radiation"]
```

In [16]:
```
print(X.head(), "\n")
print(y.head())
```

```
   Temperature  Pressure  Humidity  WindDirection  Speed   DayPart
0           48     30.46        59         177.39   5.62  1.475602
1           48     30.46        58         176.78   3.37  1.468588
2           48     30.46        57         158.75   3.37  1.461713
3           48     30.46        60         137.71   3.37  1.454653
4           48     30.46        62         104.95   5.62  1.447778

0    1.21
1    1.21
2    1.23
3    1.21
4    1.17
Name: Radiation, dtype: float64
```

In [17]:
```
print(X.shape)
print(y.shape)
```

```
(32686, 6)
(32686,)
```

In [18]:
```
columns = X.columns
scaler = StandardScaler()
X = scaler.fit_transform(X)
pd.DataFrame(X, columns=columns).describe()
```

Out[18]:

	Temperature	Pressure	Humidity	WindDirection	Speed	DayPart
count	3.268600e+04	3.268600e+04	3.268600e+04	3.268600e+04	3.268600e+04	3.268600e+04
mean	8.257741e-15	-8.589409e-14	9.563964e-16	-6.186353e-16	-2.072571e-14	-2.846377e-17
std	1.000015e+00	1.000015e+00	1.000015e+00	1.000015e+00	1.000015e+00	1.000015e+00
min	-2.758117e+00	-4.259540e+00	-2.578560e+00	-1.724255e+00	-1.788859e+00	-1.855112e+00
25%	-8.229646e-01	-4.184734e-01	-7.316829e-01	-7.366250e-01	-8.233591e-01	-8.683240e-01
50%	-1.779139e-01	1.302504e-01	3.841386e-01	5.062367e-02	-1.787376e-01	2.279483e-03
75%	6.283995e-01	6.789742e-01	8.458578e-01	4.307058e-01	4.658840e-01	8.682924e-01
max	3.208603e+00	2.508053e+00	1.076717e+00	2.602741e+00	9.814329e+00	1.797910e+00

In [0]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.25, random_state=346705925)
```

In [20]:
```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(24514, 6)
(8172, 6)
(24514,)
(8172,)
```

In [0]:
```
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 [22]:
```
reg_5 = KNeighborsRegressor(n_neighbors=5)
reg_5.fit(X_train, y_train)
```

Out[22]:
```
KNeighborsRegressor(algorithm='auto', leaf_size=30, metric='minkowski',
                    metric_params=None, n_jobs=None, n_neighbors=5, p=2,
                    weights='uniform')
```

In [23]:
```
test_model(reg_5)
```

```
mean_absolute_error: 55.39857905041605
median_absolute_error: 4.017000000000004
r2_score: 0.8677873476991447
```

In [24]:
```
scores = cross_val_score(KNeighborsRegressor(n_neighbors=5), X, y,
cv=KFold(n_splits=10), scoring="r2")
print(scores)
print(scores.mean(), "±", scores.std())
```

```
[0.83276085 0.5984654  0.83547149 0.75974839 0.76407458 0.81422383
 0.85420738 0.79432111 0.74927049 0.28234327]
0.7284886763598686 ± 0.16383980384698185
```

In [25]:
```
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())
```

```
[0.8658354  0.86767018 0.86469993 0.86345582 0.86466673 0.86513717
 0.87446329 0.85387619 0.8689856  0.86894182]
0.865773213307843 ± 0.0049916891472404174
```

In [26]:
```
scores = cross_val_score(KNeighborsRegressor(n_neighbors=5), X, y,
cv=ShuffleSplit(n_splits=10), scoring="r2")
print(scores)
print(scores.mean(), "±", scores.std())
```

```
[0.88563539 0.87185473 0.8772186  0.88205667 0.87127365 0.85638232
 0.86746013 0.87180973 0.88101467 0.86715061]
0.8731856499008485 ± 0.008186114959377015
```

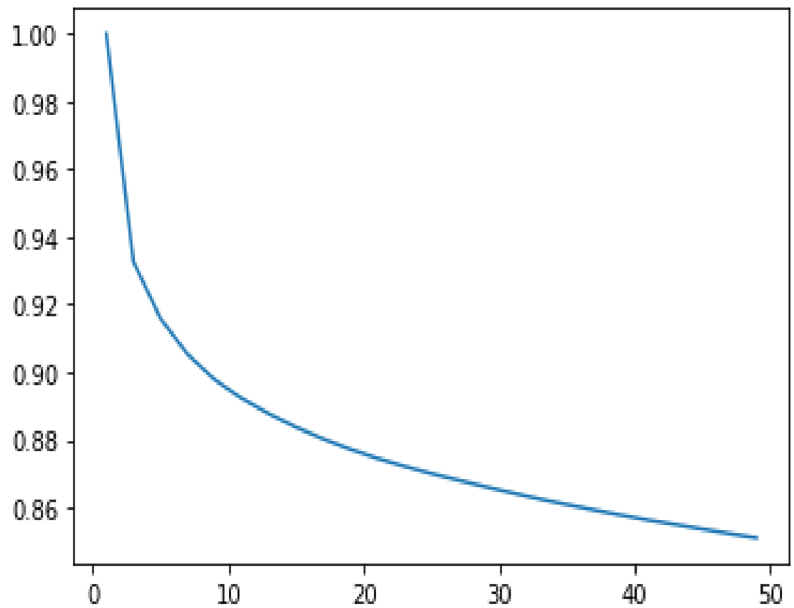
In [33]:
```
n_range = np.array(range(1, 50, 2))
tuned_parameters = [{'n_neighbors': n_range}]
n_range
```

Out[33]:
```
array([ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33,
       35, 37, 39, 41, 43, 45, 47, 49])
```

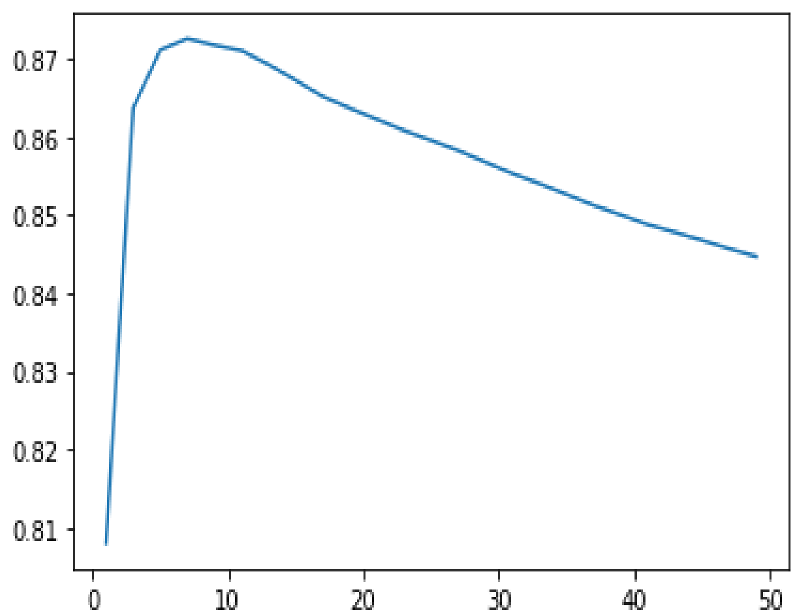
In [62]:
```
gs = GridSearchCV(KNeighborsRegressor(), tuned_parameters,
cv=ShuffleSplit(n_splits=10), scoring="r2",
return_train_score=True, n_jobs=-1)
gs.fit(X, y)
gs.best_params_
```

Out[62]:
```
{'n_neighbors': 7}
```

In [63]:
```
plt.plot(n_range, gs.cv_results_["mean_train_score"]);
```



In [64]:
```
plt.plot(n_range, gs.cv_results_["mean_test_score"]);
```

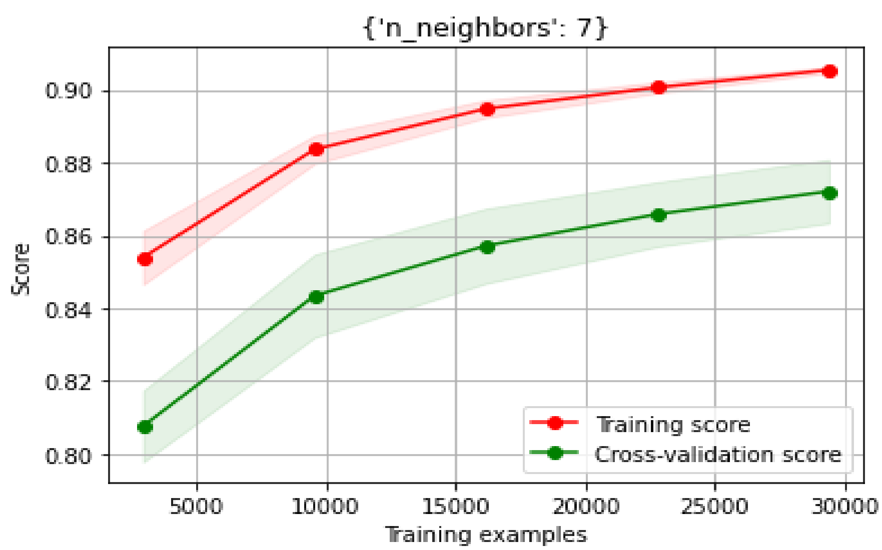


In [65]:
```
reg = KNeighborsRegressor(**gs.best_params_)
reg.fit(X_train, y_train)
test_model(reg)
```

```
mean_absolute_error: 56.07154831829942
median_absolute_error: 4.7735714285714295
r2_score: 0.8687906728428422
```

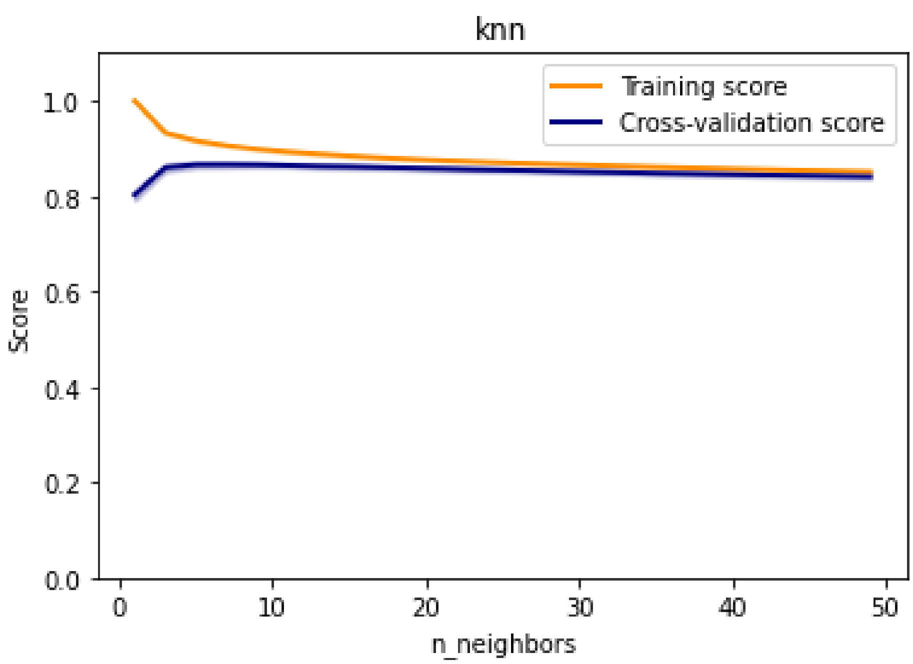
In [0]:
```
def plot_learning_curve(estimator, title, X, y, ylim=None, cv=None):
  train_sizes= np.linspace(.1,1.0,num=5)
  plt.figure()
  plt.title(title)
  if ylim is not None:
    plt.ylim(*ylim)
  plt.xlabel("Training examples")
  plt.ylabel("Score")
  train_sizes, train_scores, test_scores = learning_curve(
   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 [97]:
```
plot_learning_curve(reg, str(gs.best_params_), X, y,
cv=ShuffleSplit(n_splits=10));
```



In [0]:
```
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 [106]:
```
plot_validation_curve(KNeighborsRegressor(), "knn", X, y,
  param_name="n_neighbors", param_range=n_range,
  cv=ShuffleSplit(n_splits=10), scoring="r2");
```



Список литературы

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