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Кафедра «Системы обработки информации и управления»

Лабораторная работа №6
по дисциплине
«Методы машинного обучения»
на тему

«Ансамбли моделей машинного обучения»

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1. Цель лабораторной работы
Изучить ансамбли моделей машинного обучения.

2. Ход выполнения работы
Подключим все необходимые библиотеки и настроим отображение графиков.

In [0]:
```
from datetime import datetime
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.ensemble import RandomForestRegressor
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 ShuffleSplit
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
# Enable inline plots
%matplotlib inline
# Set plots formats to save high resolution PNG
from IPython.display import set_matplotlib_formats
set_matplotlib_formats("retina")
```

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

2.1. Предварительная подготовка данных

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)
```

Проверим полученные типы:

In [35]:
```
data.dtypes
```

Out[35]:
```
UNIXTime         int64
Data            object
Time            object
Radiation      float64
Temperature      int64
Pressure       float64
Humidity         int64
WindDirection  float64
Speed          float64
TimeSunRise     object
TimeSunSet      object
dtype: object
```

Посмотрим на данные в данном наборе данных:

In [36]:
```
data.head()
```

Out[36]:

	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 [43]:

```
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[43]:

	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 [44]:

```
df.dtypes
```

Out[44]:

```
Radiation        float64
Temperature        int64
Pressure         float64
Humidity           int64
WindDirection    float64
Speed            float64
DayPart          float64
dtype: object
```

In [45]:

```
df.shape
```

Out[45]: (32686, 7)

In [46]:

```
df.describe()
```

Out[46]:

	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 [47]:

```
df.isnull().sum()
```

Out[47]:

```
Radiation        0
Temperature      0
Pressure         0
Humidity         0
WindDirection    0
Speed            0
DayPart          0
dtype: int64
```

2.2. Разделение данных

Разделим данные на целевой столбец и признаки:

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

In [49]:
```
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 [50]:
```
print(X.shape)
print(y.shape)
```

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

In [51]:
```
columns = X.columns
scaler = StandardScaler()
X = scaler.fit_transform(X)
pd.DataFrame(X, columns=columns).describe()
```

Out[51]:

	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 [53]:
```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

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

2.3. Обучение моделей

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)))
```

2.3.1. Случайный лес

In [55]:
```
ran_100 = RandomForestRegressor(n_estimators=100)
ran_100.fit(X_train, y_train)
```

Out[55]:
```
RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
                      max_depth=None, max_features='auto', max_leaf_nodes=None,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=1,
                      min_samples_split=2, min_weight_fraction_leaf=0.0,
                      n_estimators=100, n_jobs=None, oob_score=False,
                      random_state=None, verbose=0, warm_start=False)
```

In [56]:
```
test_model(ran_100)
```

```
mean_absolute_error: 37.95223968428782
median_absolute_error: 0.6068000000000008
r2_score: 0.9162560318989921
```

2.3.2. Градиентный бустинг

In [57]:
```
gr_100 = GradientBoostingRegressor(n_estimators=100)
gr_100.fit(X_train, y_train)
```

Out[57]:
```
GradientBoostingRegressor(alpha=0.9, ccp_alpha=0.0, criterion='friedman_mse',
                          init=None, learning_rate=0.1, loss='ls', max_depth=3,
                          max_features=None, max_leaf_nodes=None,
                          min_impurity_decrease=0.0, min_impurity_split=None,
                          min_samples_leaf=1, min_samples_split=2,
                          min_weight_fraction_leaf=0.0, n_estimators=100,
                          n_iter_no_change=None, presort='deprecated',
                          random_state=None, subsample=1.0, tol=0.0001,
                          validation_fraction=0.1, verbose=0, warm_start=False)
```

In [58]:
```
test_model(gr_100)
```

```
mean_absolute_error: 58.07682041283236
median_absolute_error: 14.74142199396116
r2_score: 0.8729966247836403
```

2.4. Подбор гиперпараметра *n*

2.4.1. Случайный лес

In [59]:
```
param_range = np.arange(10, 201, 10)
tuned_parameters = [{'n_estimators': param_range}]
tuned_parameters
```

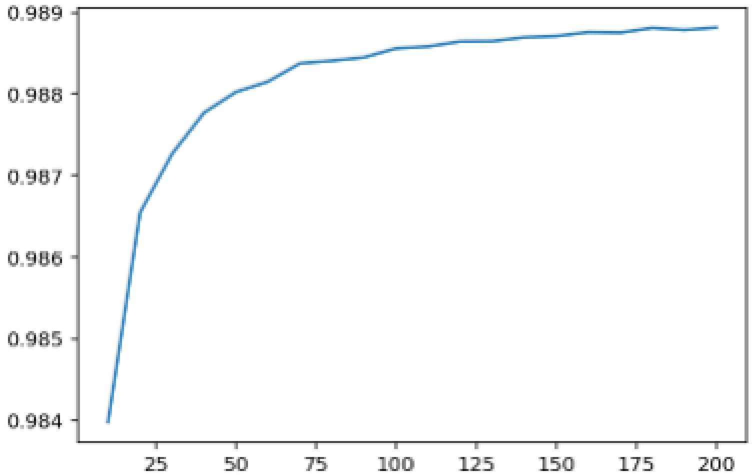
Out[59]:
```
[{'n_estimators': array([ 10,  20,  30,  40,  50,  60,  70,  80,  90, 100, 110, 120, 130,
        140, 150, 160, 170, 180, 190, 200])}]
```

In [60]:
```
gs = GridSearchCV(RandomForestRegressor(), tuned_parameters,
cv=ShuffleSplit(n_splits=10), scoring="r2",
return_train_score=True, n_jobs=-1)
gs.fit(X, y)
gs.best_estimator_
```

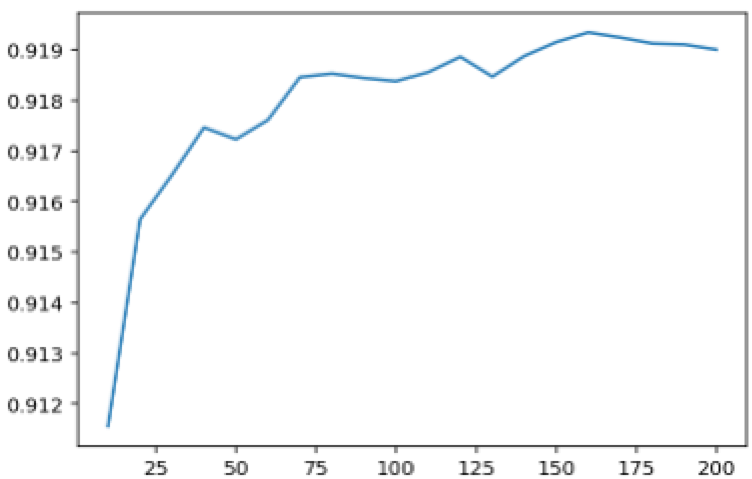
```
/usr/local/lib/python3.6/dist-packages/joblib/externals/loky/process_executor.py:706: UserWarning: A worker stopped while some jobs were given to the executor. This can be caused by a too short worker timeout or by a memory leak.
  "timeout or by a memory leak.", UserWarning
```

Out[60]:
```
RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
                      max_depth=None, max_features='auto', max_leaf_nodes=None,
                      max_samples=None, min_impurity_decrease=0.0,
                      min_impurity_split=None, min_samples_leaf=1,
                      min_samples_split=2, min_weight_fraction_leaf=0.0,
                      n_estimators=160, n_jobs=None, oob_score=False,
                      random_state=None, verbose=0, warm_start=False)
```

In [61]:
```
plt.plot(param_range, gs.cv_results_["mean_train_score"]);
```



In [62]:
```
plt.plot(param_range, gs.cv_results_["mean_test_score"]);
```



In [63]:
```
reg = gs.best_estimator_
reg.fit(X_train, y_train)
test_model(reg)
```

```
mean_absolute_error: 37.91496070423397
median_absolute_error: 0.6067500000000001
r2_score: 0.9157067495302105
```

2.4.2. Градиентный бустинг

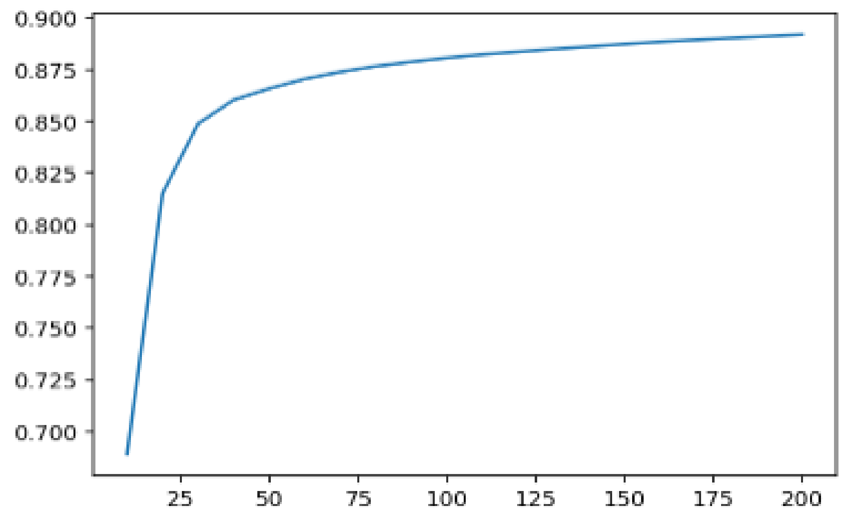
In [64]:
```
tuned_parameters
```

Out[64]:
```
[{'n_estimators': array([ 10,  20,  30,  40,  50,  60,  70,  80,  90, 100, 110, 120, 130,
        140, 150, 160, 170, 180, 190, 200])}]
```

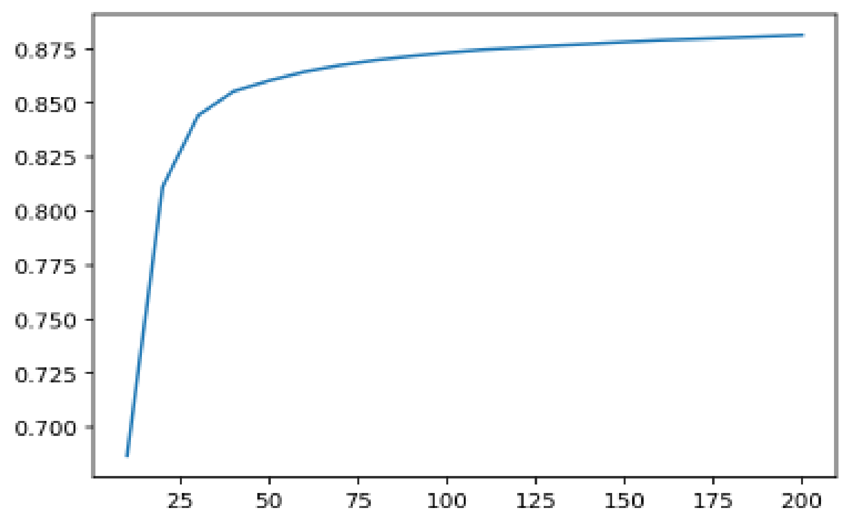
In [66]:
```
gs = GridSearchCV(GradientBoostingRegressor(), tuned_parameters,
cv=ShuffleSplit(n_splits=10), scoring="r2",
return_train_score=True, n_jobs=-1)
gs.fit(X, y)
gs.best_estimator_
```

Out[66]:
```
GradientBoostingRegressor(alpha=0.9, ccp_alpha=0.0, criterion='friedman_mse',
                          init=None, learning_rate=0.1, loss='ls', max_depth=3,
                          max_features=None, max_leaf_nodes=None,
                          min_impurity_decrease=0.0, min_impurity_split=None,
                          min_samples_leaf=1, min_samples_split=2,
                          min_weight_fraction_leaf=0.0, n_estimators=200,
                          n_iter_no_change=None, presort='deprecated',
                          random_state=None, subsample=1.0, tol=0.0001,
                          validation_fraction=0.1, verbose=0, warm_start=False)
```

In [67]:
```
plt.plot(param_range, gs.cv_results_["mean_train_score"]);
```



In [68]:
```
plt.plot(param_range, gs.cv_results_["mean_test_score"]);
```



In [69]:
```
reg = gs.best_estimator_
reg.fit(X_train, y_train)
test_model(reg)
```

```
mean_absolute_error: 55.850708420930914
median_absolute_error: 14.572172035170642
r2_score: 0.8810191887601053
```

Список литературы

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