Московский государственный технический университет имени Н.Э.Баумана

Кафедра «Системы обработки информации и управления»

ОТЧЕТ

Лабораторная работа №5
по дисциплине
«Методы машинного обучения»
на тему
«Линейные модели, SVM и деревья решений.»

Выполнил:

Студент ИУ5-24М

Гаврилюк А.Г.

Москва, 2020

Задание:

Выберите набор данных (датасет) для решения задачи классификации или регрессии. В случае необходимости проведите удаление или заполнение пропусков и кодирование категориальных признаков. С использованием метода train_test_split разделите выборку на обучающую и тестовую. Обучите следующие модели: одну из линейных моделей; SVM; дерево решений. Оцените качество моделей с помощью трех подходящих для задачи метрик. Сравните качество полученных моделей. Произведите для каждой модели подбор одного гиперпараметра с использованием GridSearchCV и кросс-валидации. Повторите пункт 4 для найденных оптимальных значений гиперпараметров. Сравните качество полученных моделей с качеством моделей, полученных в пункте 4.

In [1]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn import preprocessing, svm
from sklearn import model_selection
from sklearn.model_selection import train_test_split
from sklearn.linear_model import BayesianRidge
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor, export_graphviz
from sklearn.metrics import r2_score
```

In [2]:

```
data = pd.read_csv("Admission_Predict.csv")
```

In [3]:

```
data.head()
```

Out[3]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
0	1	337	118	4	4.5	4.5	9.65	1	0.92
1	2	324	107	4	4.0	4.5	8.87	1	0.76
2	3	316	104	3	3.0	3.5	8.00	1	0.72
3	4	322	110	3	3.5	2.5	8.67	1	0.80
4	5	314	103	2	2.0	3.0	8.21	0	0.65

In [4]:

```
data.describe()
```

Out[4]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
count	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000	400.000000
mean	200.500000	316.807500	107.410000	3.087500	3.400000	3.452500	8.598925	0.547500	0.724350
std	115.614301	11.473646	6.069514	1.143728	1.006869	0.898478	0.596317	0.498362	0.142609
min	1.000000	290.000000	92.000000	1.000000	1.000000	1.000000	6.800000	0.000000	0.340000
25%	100.750000	308.000000	103.000000	2.000000	2.500000	3.000000	8.170000	0.000000	0.640000
50%	200.500000	317.000000	107.000000	3.000000	3.500000	3.500000	8.610000	1.000000	0.730000
75%	300.250000	325.000000	112.000000	4.000000	4.000000	4.000000	9.062500	1.000000	0.830000
max	400.000000	340.000000	120.000000	5.000000	5.000000	5.000000	9.920000	1.000000	0.970000

In [8]:

```
data.columns
```

Out[8]:

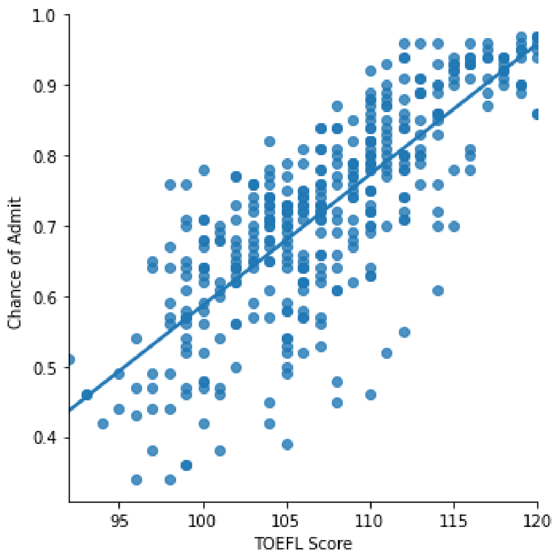
```
Index(['Serial No.', 'GRE Score', 'TOEFL Score', 'University Rating', 'SOP',
       'LOR ', 'CGPA', 'Research', 'Chance of Admit '],
      dtype='object')
```

In [9]:

```
sns.lmplot(x="TOEFL Score", y="Chance of Admit ", data=data, order=2, ci=None)
```

Out[9]:

```
<seaborn.axisgrid.FacetGrid at 0x125a56b90>
```

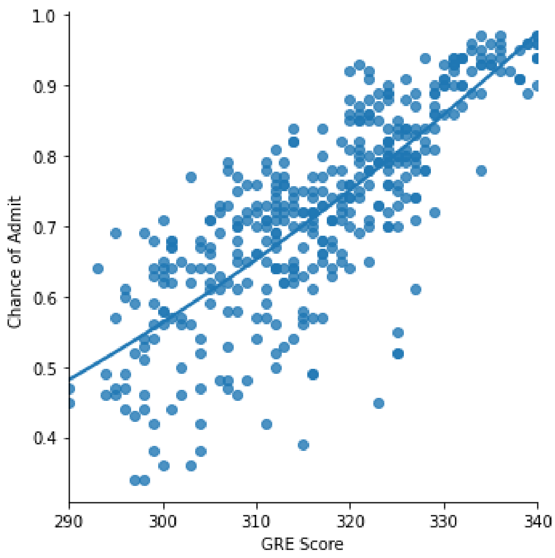


In [11]:

```
sns.lmplot(x="GRE Score", y="Chance of Admit ", data=data, order=2, ci=None)
```

Out[11]:

```
<seaborn.axisgrid.FacetGrid at 0x127b43810>
```

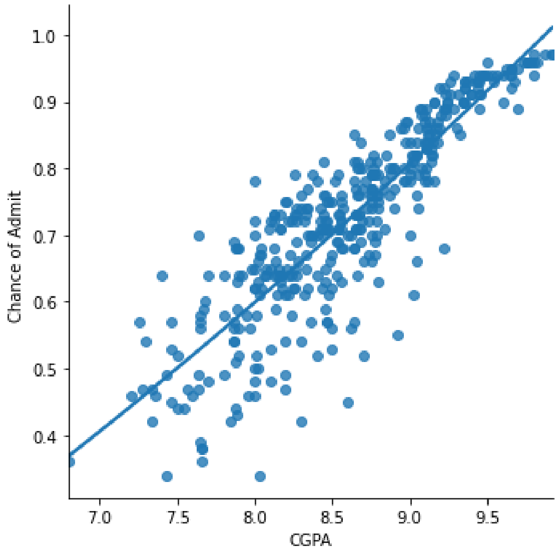


In [12]:

```
sns.lmplot(x="CGPA", y="Chance of Admit ", data=data, order=2, ci=None)
```

Out[12]:

```
<seaborn.axisgrid.FacetGrid at 0x127c33cd0>
```



In [10]:

```
data.corr()
```

Out[10]:

	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
Serial No.	1.000000	-0.097526	-0.147932	-0.169948	-0.166932	-0.088221	-0.045608	-0.063138	0.042336
GRE Score	-0.097526	1.000000	0.835977	0.668976	0.612831	0.557555	0.833060	0.580391	0.802610
TOEFL Score	-0.147932	0.835977	1.000000	0.695590	0.657981	0.567721	0.828417	0.489858	0.791594
University Rating	-0.169948	0.668976	0.695590	1.000000	0.734523	0.660123	0.746479	0.447783	0.711250
SOP	-0.166932	0.612831	0.657981	0.734523	1.000000	0.729593	0.718144	0.444029	0.675732
LOR	-0.088221	0.557555	0.567721	0.660123	0.729593	1.000000	0.670211	0.396859	0.669889
CGPA	-0.045608	0.833060	0.828417	0.746479	0.718144	0.670211	1.000000	0.521654	0.873289
Research	-0.063138	0.580391	0.489858	0.447783	0.444029	0.396859	0.521654	1.000000	0.553202
Chance of Admit	0.042336	0.802610	0.791594	0.711250	0.675732	0.669889	0.873289	0.553202	1.000000

In [13]:

```
x = data["CGPA"].values
y = data["Chance of Admit "].values

reg = BayesianRidge(fit_intercept=True).fit(x.reshape(-1, 1), y.reshape(-1, 1))
reg.coef_
reg.intercept_
```

```
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/utils/validation.py:760: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[13]:

```
-1.07011083805518
```

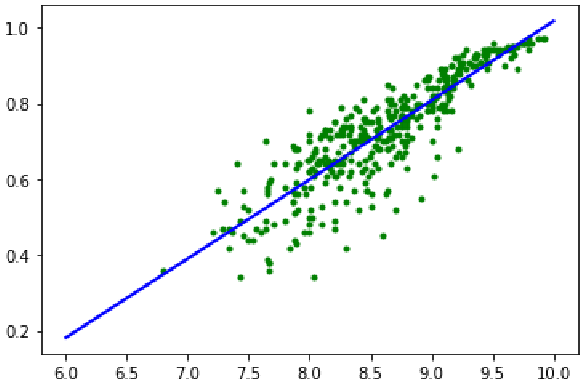
In [14]:

```
def func(w, b, x):
    return w * x + b
```

In [22]:

```
x_t = list(range(6, 11))
y_t = [func(reg.coef_[0], reg.intercept_, x) for x in x_t]
y_tt = reg.predict(x.reshape(-1, 1))


plt.plot(x, y, 'g.')
plt.plot(x_t, y_t, 'b', linewidth=2.0)
plt.show()
```



In [23]:

```
from sklearn.svm import SVC, NuSVC, LinearSVC, OneClassSVM, SVR, NuSVR, LinearSVR
```

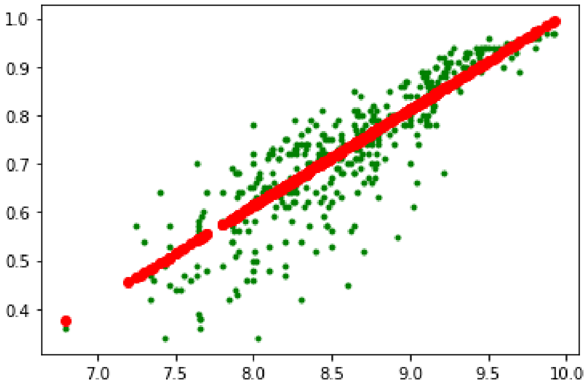
In [24]:

```
lin_SVR = LinearSVR(C=1.0, max_iter=10000)
lin_SVR.fit(x.reshape(-1, 1), y)
predict = lin_SVR.predict(x.reshape(-1, 1))
plt.plot(x, y, 'g.')
plt.plot(x, predict, 'ro')
```

```
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
```

Out[24]:

```
[<matplotlib.lines.Line2D at 0x129cccb10>]
```



In [29]:

```
dec_tree = DecisionTreeRegressor(random_state=1, max_depth=2)
dec_tree.fit(data, data["Chance of Admit "])
dec_tree
```

Out[29]:

```
DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse', max_depth=2,
                      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, presort='deprecated',
                      random_state=1, splitter='best')
```

In [30]:

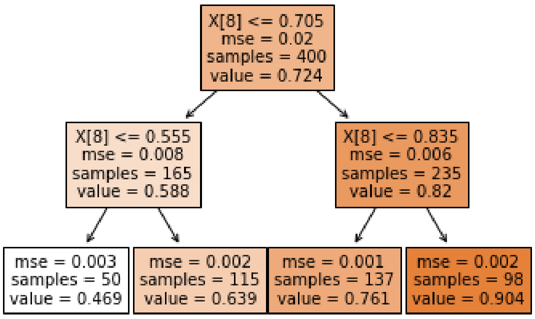
```
from sklearn import tree
dec_predict = dec_tree.predict(data)
```

In [31]:

```
tree.plot_tree(dec_tree, filled=True)
```

Out[31]:

```
[Text(167.4, 181.2, 'X[8] <= 0.705\nmse = 0.02\nsamples = 400\nvalue = 0.724'),
 Text(83.7, 108.72, 'X[8] <= 0.555\nmse = 0.008\nsamples = 165\nvalue = 0.588'),
 Text(41.85, 36.23999999999998, 'mse = 0.003\nsamples = 50\nvalue = 0.469'),
 Text(125.55000000000001, 36.23999999999998, 'mse = 0.002\nsamples = 115\nvalue = 0.639'),
 Text(251.10000000000002, 108.72, 'X[8] <= 0.835\nmse = 0.006\nsamples = 235\nvalue = 0.82'),
 Text(209.25, 36.23999999999998, 'mse = 0.001\nsamples = 137\nvalue = 0.761'),
 Text(292.95, 36.23999999999998, 'mse = 0.002\nsamples = 98\nvalue = 0.904')]
```



In [32]:

```
from sklearn.metrics import mean_absolute_error, mean_squared_error, mean_squared_log_error,
median_absolute_error, r2_score

print("Метрики для линейной модели:\n")
print("Средняя абсолютная ошибка: ", mean_absolute_error(y, y_tt))
print("Средняя квадратичная ошибка: ", mean_squared_error(y, y_tt))
print("Коэффициент детерминации: ", r2_score(y, y_tt))

print("\n\nМетрики для SVM-модели:\n")
print("Средняя абсолютная ошибка: ", mean_absolute_error(y, predict))
print("Средняя квадратичная ошибка: ", mean_squared_error(y, predict))
print("Коэффициент детерминации: ", r2_score(y, predict))


print("\n\nМетрики для Decision Tree:\n")
print("Средняя абсолютная ошибка: ", mean_absolute_error(y, dec_predict))
print("Средняя квадратичная ошибка: ", mean_squared_error(y, dec_predict))
print("Коэффициент детерминации: ", r2_score(y, dec_predict))
```

```
Метрики для линейной модели:

Средняя абсолютная ошибка:  0.05104503741170578
Средняя квадратичная ошибка:  0.004815356189900225
Коэффициент детерминации:  0.7626333870313893


Метрики для SVM-модели:

Средняя абсолютная ошибка:  0.05048348999524928
Средняя квадратичная ошибка:  0.0049113689299560065
Коэффициент детерминации:  0.7579005660291389


Метрики для Decision Tree:
```

```
Метрики для Decision Tree:

Средняя абсолютная ошибка:  0.03445446715328467
Средняя квадратичная ошибка:  0.0017170380603501324
Коэффициент детерминации:  0.9153608803480956
```

In [33]:

```
from sklearn.model_selection import cross_validate
```

In [34]:

```
scoring = {'mean': 'neg_mean_absolute_error', 'square': 'neg_mean_squared_error', 'r2': 'r2'}
scores_regr = cross_validate(BayesianRidge(fit_intercept=True), x.reshape(-1, 1), y, cv=3, scoring=scoring)
scores_regr
```

Out[34]:

```
{'fit_time': array([0.00100613, 0.0006609 , 0.0009222 ]),
 'score_time': array([0.00087094, 0.00096798, 0.00104594]),
 'test_mean': array([-0.0716128 , -0.04348902, -0.04577832]),
 'test_square': array([-0.00971581, -0.00279908, -0.0035624 ]),
 'test_r2': array([0.64987987, 0.74535865, 0.80736343])}
```

In [35]:

```
scores_svm = cross_validate(LinearSVR(C=1.0, max_iter=10000),
                         x.reshape(-1, 1), y, cv=3, scoring=scoring)
scores_svm
```

```
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
```

Out[35]:

```
{'fit_time': array([0.02764702, 0.02198672, 0.02688718]),
 'score_time': array([0.00075412, 0.00156617, 0.00119877]),
 'test_mean': array([-0.07574868, -0.04028163, -0.0457559 ]),
 'test_square': array([-0.01079283, -0.00244456, -0.00355868]),
 'test_r2': array([0.61106854, 0.7776104 , 0.80756491])}
```

In [37]:

```
scores_dec = cross_validate(DecisionTreeRegressor(random_state=1, max_depth=3),
                         data, data["Chance of Admit "], cv=5, scoring=scoring)
scores_dec
```

Out[37]:

```
{'fit_time': array([0.00444412, 0.00273585, 0.00238109, 0.00234079, 0.00249195]),
 'score_time': array([0.001863  , 0.00152016, 0.00166106, 0.00128818, 0.00138783]),
 'test_mean': array([-0.01870436, -0.02000891, -0.01670752, -0.01697581, -0.02027721]),
 'test_square': array([-0.00055445, -0.00066768, -0.0004061 , -0.00040907, -0.00065116]),
 'test_r2': array([0.97950964, 0.97375859, 0.96674048, 0.96134872, 0.97062417])}
```

In [38]:

```
print("Метрики для линейной модели:\n")
print("Средняя абсолютная ошибка: ", np.mean(scores_regr['test_mean']))
print("Средняя квадратичная ошибка: ", np.mean(scores_regr['test_square']))
print("Коэффициент детерминации: ", np.mean(scores_regr['test_r2']))

print("\n\nМетрики для SVM-модели:\n")
print("Средняя абсолютная ошибка: ", np.mean(scores_svm['test_mean']))
print("Средняя абсолютная ошибка: ", np.mean(scores_svm['test_mean']))
print("Средняя квадратичная ошибка: ", np.mean(scores_svm['test_square']))
print("Коэффициент детерминации: ", np.mean(scores_svm['test_r2']))


print("\n\nМетрики для Decision Tree:\n")
print("Средняя абсолютная ошибка: ", np.mean(scores_dec['test_mean']))
print("Средняя квадратичная ошибка: ", np.mean(scores_dec['test_square']))
print("Коэффициент детерминации: ", np.mean(scores_dec['test_r2']))
```

```
Метрики для линейной модели:

Средняя абсолютная ошибка:  -0.05362670974848763
Средняя квадратичная ошибка:  -0.005359098126698869
Коэффициент детерминации:  0.734200649353169


Метрики для SVM-модели:

Средняя абсолютная ошибка:  -0.05392873725436854
Средняя квадратичная ошибка:  -0.005598687258181815
Коэффициент детерминации:  0.7320812849700434


Метрики для Decision Tree:

Средняя абсолютная ошибка:  -0.018534761073709237
Средняя квадратичная ошибка:  -0.0005376912342868803
Коэффициент детерминации:  0.9703963193456253
```

In [39]:

```
from sklearn.model_selection import GridSearchCV
```

In [40]:

```
n_range = np.array(range(1,10,1))
tuned_parameters = [{'max_depth': n_range}]
tuned_parameters
```

Out[40]:

```
[{'max_depth': array([1, 2, 3, 4, 5, 6, 7, 8, 9])}]
```

In [41]:

```
%%time
clf_gs = GridSearchCV(DecisionTreeRegressor(), tuned_parameters, cv=5, scoring='r2')
clf_gs.fit(x.reshape(-1, 1), y)
```

```
CPU times: user 53.6 ms, sys: 2.17 ms, total: 55.8 ms
Wall time: 55 ms
```

Out[41]:

```
GridSearchCV(cv=5, error_score=nan,
             estimator=DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse',
                                             max_depth=None, 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,
                                             presort='deprecated',
                                             random_state=None,
                                             splitter='best'),
             iid='deprecated', n_jobs=None,
             param_grid=[{'max_depth': array([1, 2, 3, 4, 5, 6, 7, 8, 9])}],
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring='r2', verbose=0)
```

In [42]:

```
clf_gs.best_estimator_
```

Out[42]:

```
DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse', max_depth=4,
                      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, presort='deprecated',
                      random_state=None, splitter='best')
```

In [44]:

```
clf_gs.best_score_, clf_gs.best_params_
```

Out[44]:

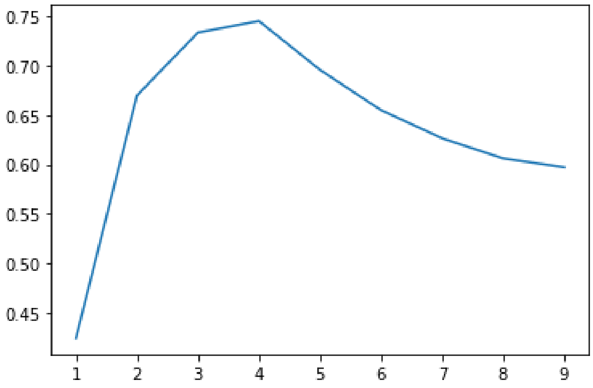
```
(0.744873963342546, {'max_depth': 4})
```

In [45]:

```
plt.plot(n_range, clf_gs.cv_results_['mean_test_score'])
```

Out[45]:

```
[<matplotlib.lines.Line2D at 0x12a142450>]
```



In [46]:

```
param_grid = {'C': [0.1,1, 10, 100], 'epsilon': [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]}
```

In [47]:

```
grid = GridSearchCV(LinearSVR(),param_grid,refit=True,verbose=2)
grid.fit(x.reshape(-1, 1),y)
```

```
Fitting 5 folds for each of 40 candidates, totalling 200 fits
[CV] C=0.1, epsilon=0.1 ..............................................
[CV] ............................... C=0.1, epsilon=0.1, total=   0.0s
[CV] C=0.1, epsilon=0.1 ..............................................
[CV] ............................... C=0.1, epsilon=0.1, total=   0.0s
[CV] C=0.1, epsilon=0.1 ..............................................
[CV] ............................... C=0.1, epsilon=0.1, total=   0.0s
[CV] C=0.1, epsilon=0.1 ..............................................
[CV] ............................... C=0.1, epsilon=0.1, total=   0.0s
[CV] C=0.1, epsilon=0.1 ..............................................
[CV] ............................... C=0.1, epsilon=0.1, total=   0.0s
[CV] C=0.1, epsilon=0.2 ..............................................
[CV] ............................... C=0.1, epsilon=0.2, total=   0.0s
[CV] C=0.1, epsilon=0.2 ..............................................
[CV] ............................... C=0.1, epsilon=0.2, total=   0.0s
[CV] C=0.1, epsilon=0.2 ..............................................
[CV] ............................... C=0.1, epsilon=0.2, total=   0.0s
[CV] C=0.1, epsilon=0.2 ..............................................
```

```
[CV] .............................. C=0.1, epsilon=0.2, total=   0.0s
[CV] C=0.1, epsilon=0.2 ..............................................
[CV] .............................. C=0.1, epsilon=0.2, total=   0.0s
[CV] C=0.1, epsilon=0.3 ..............................................
[CV] .............................. C=0.1, epsilon=0.3, total=   0.0s
[CV] C=0.1, epsilon=0.3 ..............................................
[CV] .............................. C=0.1, epsilon=0.3, total=   0.0s
[CV] C=0.1, epsilon=0.3 ..............................................
[CV] .............................. C=0.1, epsilon=0.3, total=   0.0s
[CV] C=0.1, epsilon=0.3 ..............................................
[CV] .............................. C=0.1, epsilon=0.3, total=   0.0s
[CV] C=0.1, epsilon=0.3 ..............................................
[CV] .............................. C=0.1, epsilon=0.3, total=   0.0s
[CV] C=0.1, epsilon=0.4 ..............................................
[CV] .............................. C=0.1, epsilon=0.4, total=   0.0s
[CV] C=0.1, epsilon=0.4 ..............................................
[CV] .............................. C=0.1, epsilon=0.4, total=   0.0s
[CV] C=0.1, epsilon=0.4 ..............................................
[CV] .............................. C=0.1, epsilon=0.4, total=   0.0s
[CV] C=0.1, epsilon=0.4 ..............................................
[CV] .............................. C=0.1, epsilon=0.4, total=   0.0s
[CV] C=0.1, epsilon=0.4 ..............................................
[CV] .............................. C=0.1, epsilon=0.4, total=   0.0s
[CV] C=0.1, epsilon=0.5 ..............................................
[CV] .............................. C=0.1, epsilon=0.5, total=   0.0s
[CV] C=0.1, epsilon=0.5 ..............................................
[CV] .............................. C=0.1, epsilon=0.5, total=   0.0s
[CV] C=0.1, epsilon=0.5 ..............................................
[CV] .............................. C=0.1, epsilon=0.5, total=   0.0s
[CV] C=0.1, epsilon=0.5 ..............................................
[CV] .............................. C=0.1, epsilon=0.5, total=   0.0s
[CV] C=0.1, epsilon=0.5 ..............................................
[CV] .............................. C=0.1, epsilon=0.5, total=   0.0s
[CV] C=0.1, epsilon=0.6 ..............................................
[CV] .............................. C=0.1, epsilon=0.6, total=   0.0s
[CV] C=0.1, epsilon=0.6 ..............................................
[CV] .............................. C=0.1, epsilon=0.6, total=   0.0s
[CV] C=0.1, epsilon=0.6 ..............................................
[CV] .............................. C=0.1, epsilon=0.6, total=   0.0s
[CV] C=0.1, epsilon=0.6 ..............................................
[CV] .............................. C=0.1, epsilon=0.6, total=   0.0s
[CV] C=0.1, epsilon=0.6 ..............................................
[CV] .............................. C=0.1, epsilon=0.6, total=   0.0s
[CV] C=0.1, epsilon=0.7 ..............................................
[CV] .............................. C=0.1, epsilon=0.7, total=   0.0s
[CV] C=0.1, epsilon=0.7 ..............................................
[CV] .............................. C=0.1, epsilon=0.7, total=   0.0s
[CV] C=0.1, epsilon=0.7 ..............................................
[CV] .............................. C=0.1, epsilon=0.7, total=   0.0s
[CV] C=0.1, epsilon=0.7 ..............................................
[CV] .............................. C=0.1, epsilon=0.7, total=   0.0s
[CV] C=0.1, epsilon=0.7 ..............................................
[CV] .............................. C=0.1, epsilon=0.7, total=   0.0s
[CV] C=0.1, epsilon=0.8 ..............................................
[CV] .............................. C=0.1, epsilon=0.8, total=   0.0s
[CV] C=0.1, epsilon=0.8 ..............................................
[CV] .............................. C=0.1, epsilon=0.8, total=   0.0s
[CV] C=0.1, epsilon=0.8 ..............................................
[CV] .............................. C=0.1, epsilon=0.8, total=   0.0s
[CV] C=0.1, epsilon=0.8 ..............................................
[CV] .............................. C=0.1, epsilon=0.8, total=   0.0s
[CV] C=0.1, epsilon=0.8 ..............................................
[CV] .............................. C=0.1, epsilon=0.8, total=   0.0s
[CV] C=0.1, epsilon=0.9 ..............................................
[CV] .............................. C=0.1, epsilon=0.9, total=   0.0s
[CV] C=0.1, epsilon=0.9 ..............................................
[CV] .............................. C=0.1, epsilon=0.9, total=   0.0s
[CV] C=0.1, epsilon=0.9 ..............................................
[CV] .............................. C=0.1, epsilon=0.9, total=   0.0s
[CV] C=0.1, epsilon=0.9 ..............................................
[CV] .............................. C=0.1, epsilon=0.9, total=   0.0s
[CV] C=0.1, epsilon=0.9 ..............................................
[CV] .............................. C=0.1, epsilon=0.9, total=   0.0s
[CV] C=0.1, epsilon=1.0 ..............................................
[CV] .............................. C=0.1, epsilon=1.0, total=   0.0s
[CV] C=0.1, epsilon=1.0 ..............................................
[CV] .............................. C=0.1, epsilon=1.0, total=   0.0s
```

```
[CV] C=0.1, epsilon=1.0 ..............................................
[CV] ............................... C=0.1, epsilon=1.0, total=   0.0s
[CV] C=0.1, epsilon=1.0 ..............................................
[CV] ............................... C=0.1, epsilon=1.0, total=   0.0s
[CV] C=0.1, epsilon=1.0 ..............................................
[CV] ............................... C=0.1, epsilon=1.0, total=   0.0s
[CV] C=1, epsilon=0.1 ................................................
[CV] ................................. C=1, epsilon=0.1, total=   0.0s
[CV] C=1, epsilon=0.1 ................................................
[CV] ................................. C=1, epsilon=0.1, total=   0.0s
[CV] C=1, epsilon=0.1 ................................................
[CV] ................................. C=1, epsilon=0.1, total=   0.0s
[CV] C=1, epsilon=0.1 ................................................
[CV] ................................. C=1, epsilon=0.1, total=   0.0s
[CV] C=1, epsilon=0.1 ................................................
[CV] ................................. C=1, epsilon=0.1, total=   0.0s
[CV] C=1, epsilon=0.2 ................................................
[CV] ................................. C=1, epsilon=0.2, total=   0.0s
[CV] C=1, epsilon=0.2 ................................................
[CV] ................................. C=1, epsilon=0.2, total=   0.0s
[CV] C=1, epsilon=0.2 ................................................
[CV] ................................. C=1, epsilon=0.2, total=   0.0s
[CV] C=1, epsilon=0.2 ................................................
[CV] ................................. C=1, epsilon=0.2, total=   0.0s
[CV] C=1, epsilon=0.2 ................................................
[CV] ................................. C=1, epsilon=0.2, total=   0.0s
[CV] C=1, epsilon=0.3 ................................................
[CV] ................................. C=1, epsilon=0.3, total=   0.0s
[CV] C=1, epsilon=0.3 ................................................
[CV] ................................. C=1, epsilon=0.3, total=   0.0s
[CV] C=1, epsilon=0.3 ................................................
[CV] ................................. C=1, epsilon=0.3, total=   0.0s
[CV] C=1, epsilon=0.3 ................................................
[CV] ................................. C=1, epsilon=0.3, total=   0.0s
[CV] C=1, epsilon=0.3 ................................................
[CV] ................................. C=1, epsilon=0.3, total=   0.0s
[CV] C=1, epsilon=0.4 ................................................
[CV] ................................. C=1, epsilon=0.4, total=   0.0s
[CV] C=1, epsilon=0.4 ................................................
[CV] ................................. C=1, epsilon=0.4, total=   0.0s
[CV] C=1, epsilon=0.4 ................................................
[CV] ................................. C=1, epsilon=0.4, total=   0.0s
[CV] C=1, epsilon=0.4 ................................................
[CV] ................................. C=1, epsilon=0.4, total=   0.0s
[CV] C=1, epsilon=0.4 ................................................
[CV] ................................. C=1, epsilon=0.4, total=   0.0s
[CV] C=1, epsilon=0.5 ................................................
[CV] ................................. C=1, epsilon=0.5, total=   0.0s
[CV] C=1, epsilon=0.5 ................................................
[CV] ................................. C=1, epsilon=0.5, total=   0.0s
[CV] C=1, epsilon=0.5 ................................................
[CV] ................................. C=1, epsilon=0.5, total=   0.0s
[CV] C=1, epsilon=0.5 ................................................
[CV] ................................. C=1, epsilon=0.5, total=   0.0s
[CV] C=1, epsilon=0.5 ................................................
[CV] ................................. C=1, epsilon=0.5, total=   0.0s
[CV] C=1, epsilon=0.6 ................................................
[CV] ................................. C=1, epsilon=0.6, total=   0.0s
[CV] C=1, epsilon=0.6 ................................................
[CV] ................................. C=1, epsilon=0.6, total=   0.0s
[CV] C=1, epsilon=0.6 ................................................
[CV] ................................. C=1, epsilon=0.6, total=   0.0s
[CV] C=1, epsilon=0.6 ................................................
[CV] ................................. C=1, epsilon=0.6, total=   0.0s
[CV] C=1, epsilon=0.6 ................................................
[CV] ................................. C=1, epsilon=0.6, total=   0.0s
[CV] C=1, epsilon=0.7 ................................................
[CV] ................................. C=1, epsilon=0.7, total=   0.0s
[CV] C=1, epsilon=0.7 ................................................
[CV] ................................. C=1, epsilon=0.7, total=   0.0s
[CV] C=1, epsilon=0.7 ................................................
[CV] ................................. C=1, epsilon=0.7, total=   0.0s
[CV] C=1, epsilon=0.7 ................................................
[CV] ................................. C=1, epsilon=0.7, total=   0.0s
[CV] C=1, epsilon=0.7 ................................................
[CV] ................................. C=1, epsilon=0.7, total=   0.0s
[CV] C=1, epsilon=0.8 ................................................
```

```
[CV] ................................. C=1, epsilon=0.8, total=   0.0s
[CV] C=1, epsilon=0.8 ................................................
[CV] ................................. C=1, epsilon=0.8, total=   0.0s
[CV] C=1, epsilon=0.8 ................................................
[CV] ................................. C=1, epsilon=0.8, total=   0.0s
[CV] C=1, epsilon=0.8 ................................................
[CV] ................................. C=1, epsilon=0.8, total=   0.0s
[CV] C=1, epsilon=0.8 ................................................
[CV] ................................. C=1, epsilon=0.8, total=   0.0s
[CV] C=1, epsilon=0.9 ................................................
[CV] ................................. C=1, epsilon=0.9, total=   0.0s
[CV] C=1, epsilon=0.9 ................................................
[CV] ................................. C=1, epsilon=0.9, total=   0.0s
[CV] C=1, epsilon=0.9 ................................................
[CV] ................................. C=1, epsilon=0.9, total=   0.0s
[CV] C=1, epsilon=0.9 ................................................
[CV] ................................. C=1, epsilon=0.9, total=   0.0s
[CV] C=1, epsilon=0.9 ................................................
[CV] ................................. C=1, epsilon=0.9, total=   0.0s
[CV] C=1, epsilon=1.0 ................................................
[CV] ................................. C=1, epsilon=1.0, total=   0.0s
[CV] C=1, epsilon=1.0 ................................................
[CV] ................................. C=1, epsilon=1.0, total=   0.0s
[CV] C=1, epsilon=1.0 ................................................
[CV] ................................. C=1, epsilon=1.0, total=   0.0s
[CV] C=1, epsilon=1.0 ................................................
[CV] ................................. C=1, epsilon=1.0, total=   0.0s
[CV] C=1, epsilon=1.0 ................................................
[CV] ................................. C=1, epsilon=1.0, total=   0.0s
[CV] C=10, epsilon=0.1 ...............................................
[CV] ................................ C=10, epsilon=0.1, total=   0.0s
[CV] C=10, epsilon=0.1 ...............................................
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
```

```
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done 200 out of 200 | elapsed:    0.4s finished
```

```
[CV] ................................ C=10, epsilon=0.1, total=   0.0s
[CV] C=10, epsilon=0.1 ...............................................
[CV] ................................ C=10, epsilon=0.1, total=   0.0s
[CV] C=10, epsilon=0.1 ...............................................
[CV] ................................ C=10, epsilon=0.1, total=   0.0s
[CV] C=10, epsilon=0.1 ...............................................
[CV] ................................ C=10, epsilon=0.1, total=   0.0s
[CV] C=10, epsilon=0.2 ...............................................
[CV] ................................ C=10, epsilon=0.2, total=   0.0s
[CV] C=10, epsilon=0.2 ...............................................
[CV] ................................ C=10, epsilon=0.2, total=   0.0s
[CV] C=10, epsilon=0.2 ...............................................
[CV] ................................ C=10, epsilon=0.2, total=   0.0s
[CV] C=10, epsilon=0.2 ...............................................
[CV] ................................ C=10, epsilon=0.2, total=   0.0s
[CV] C=10, epsilon=0.2 ...............................................
[CV] ................................ C=10, epsilon=0.2, total=   0.0s
[CV] C=10, epsilon=0.3 ...............................................
[CV] ................................ C=10, epsilon=0.3, total=   0.0s
[CV] C=10, epsilon=0.3 ...............................................
[CV] ................................ C=10, epsilon=0.3, total=   0.0s
[CV] C=10, epsilon=0.3 ...............................................
[CV] ................................ C=10, epsilon=0.3, total=   0.0s
[CV] C=10, epsilon=0.3 ...............................................
[CV] ................................ C=10, epsilon=0.3, total=   0.0s
[CV] C=10, epsilon=0.3 ...............................................
[CV] ................................ C=10, epsilon=0.3, total=   0.0s
[CV] C=10, epsilon=0.4 ...............................................
[CV] ................................ C=10, epsilon=0.4, total=   0.0s
[CV] C=10, epsilon=0.4 ...............................................
[CV] ................................ C=10, epsilon=0.4, total=   0.0s
[CV] C=10, epsilon=0.4 ...............................................
[CV] ................................ C=10, epsilon=0.4, total=   0.0s
[CV] C=10, epsilon=0.4 ...............................................
[CV] ................................ C=10, epsilon=0.4, total=   0.0s
[CV] C=10, epsilon=0.4 ...............................................
[CV] ................................ C=10, epsilon=0.4, total=   0.0s
[CV] C=10, epsilon=0.5 ...............................................
[CV] ................................ C=10, epsilon=0.5, total=   0.0s
[CV] C=10, epsilon=0.5 ...............................................
[CV] ................................ C=10, epsilon=0.5, total=   0.0s
[CV] C=10, epsilon=0.5 ...............................................
[CV] ................................ C=10, epsilon=0.5, total=   0.0s
[CV] C=10, epsilon=0.5 ...............................................
[CV] ................................ C=10, epsilon=0.5, total=   0.0s
[CV] C=10, epsilon=0.5 ...............................................
[CV] ................................ C=10, epsilon=0.5, total=   0.0s
[CV] C=10, epsilon=0.6 ...............................................
[CV] ................................ C=10, epsilon=0.6, total=   0.0s
[CV] C=10, epsilon=0.6 ...............................................
[CV] ................................ C=10, epsilon=0.6, total=   0.0s
[CV] C=10, epsilon=0.6 ...............................................
[CV] ................................ C=10, epsilon=0.6, total=   0.0s
[CV] C=10, epsilon=0.6 ...............................................
[CV] ................................ C=10, epsilon=0.6, total=   0.0s
[CV] C=10, epsilon=0.6 ...............................................
[CV] ................................ C=10, epsilon=0.6, total=   0.0s
[CV] C=10, epsilon=0.7 ...............................................
[CV] ................................ C=10, epsilon=0.7, total=   0.0s
[CV] C=10, epsilon=0.7 ...............................................
[CV] ................................ C=10, epsilon=0.7, total=   0.0s
[CV] C=10, epsilon=0.7 ...............................................
[CV] ................................ C=10, epsilon=0.7, total=   0.0s
[CV] C=10, epsilon=0.7 ...............................................
[CV] ................................ C=10, epsilon=0.7, total=   0.0s
[CV] C=10, epsilon=0.7 ...............................................
[CV] ................................ C=10, epsilon=0.7, total=   0.0s
[CV] C=10, epsilon=0.8 ...............................................
[CV] ................................ C=10, epsilon=0.8, total=   0.0s
[CV] C=10, epsilon=0.8 ...............................................
[CV] ................................ C=10, epsilon=0.8, total=   0.0s
[CV] C=10, epsilon=0.8 ...............................................
[CV] ................................ C=10, epsilon=0.8, total=   0.0s
```

```
[CV] ................................ C=10, epsilon=0.8, total=   0.0s
[CV] C=10, epsilon=0.8 ...............................................
[CV] ................................ C=10, epsilon=0.8, total=   0.0s
[CV] C=10, epsilon=0.8 ...............................................
[CV] ................................ C=10, epsilon=0.8, total=   0.0s
[CV] C=10, epsilon=0.9 ...............................................
[CV] ................................ C=10, epsilon=0.9, total=   0.0s
[CV] C=10, epsilon=0.9 ...............................................
[CV] ................................ C=10, epsilon=0.9, total=   0.0s
[CV] C=10, epsilon=0.9 ...............................................
[CV] ................................ C=10, epsilon=0.9, total=   0.0s
[CV] C=10, epsilon=0.9 ...............................................
[CV] ................................ C=10, epsilon=0.9, total=   0.0s
[CV] C=10, epsilon=0.9 ...............................................
[CV] ................................ C=10, epsilon=0.9, total=   0.0s
[CV] C=10, epsilon=1.0 ...............................................
[CV] ................................ C=10, epsilon=1.0, total=   0.0s
[CV] C=10, epsilon=1.0 ...............................................
[CV] ................................ C=10, epsilon=1.0, total=   0.0s
[CV] C=10, epsilon=1.0 ...............................................
[CV] ................................ C=10, epsilon=1.0, total=   0.0s
[CV] C=10, epsilon=1.0 ...............................................
[CV] ................................ C=10, epsilon=1.0, total=   0.0s
[CV] C=10, epsilon=1.0 ...............................................
[CV] ................................ C=10, epsilon=1.0, total=   0.0s
[CV] C=100, epsilon=0.1 ..............................................
[CV] ............................... C=100, epsilon=0.1, total=   0.0s
[CV] C=100, epsilon=0.1 ..............................................
[CV] ............................... C=100, epsilon=0.1, total=   0.0s
[CV] C=100, epsilon=0.1 ..............................................
[CV] ............................... C=100, epsilon=0.1, total=   0.0s
[CV] C=100, epsilon=0.1 ..............................................
[CV] ............................... C=100, epsilon=0.1, total=   0.0s
[CV] C=100, epsilon=0.1 ..............................................
[CV] ............................... C=100, epsilon=0.1, total=   0.0s
[CV] C=100, epsilon=0.2 ..............................................
[CV] ............................... C=100, epsilon=0.2, total=   0.0s
[CV] C=100, epsilon=0.2 ..............................................
[CV] ............................... C=100, epsilon=0.2, total=   0.0s
[CV] C=100, epsilon=0.2 ..............................................
[CV] ............................... C=100, epsilon=0.2, total=   0.0s
[CV] C=100, epsilon=0.2 ..............................................
[CV] ............................... C=100, epsilon=0.2, total=   0.0s
[CV] C=100, epsilon=0.2 ..............................................
[CV] ............................... C=100, epsilon=0.2, total=   0.0s
[CV] C=100, epsilon=0.3 ..............................................
[CV] ............................... C=100, epsilon=0.3, total=   0.0s
[CV] C=100, epsilon=0.3 ..............................................
[CV] ............................... C=100, epsilon=0.3, total=   0.0s
[CV] C=100, epsilon=0.3 ..............................................
[CV] ............................... C=100, epsilon=0.3, total=   0.0s
[CV] C=100, epsilon=0.3 ..............................................
[CV] ............................... C=100, epsilon=0.3, total=   0.0s
[CV] C=100, epsilon=0.3 ..............................................
[CV] ............................... C=100, epsilon=0.3, total=   0.0s
[CV] C=100, epsilon=0.4 ..............................................
[CV] ............................... C=100, epsilon=0.4, total=   0.0s
[CV] C=100, epsilon=0.4 ..............................................
[CV] ............................... C=100, epsilon=0.4, total=   0.0s
[CV] C=100, epsilon=0.4 ..............................................
[CV] ............................... C=100, epsilon=0.4, total=   0.0s
[CV] C=100, epsilon=0.4 ..............................................
[CV] ............................... C=100, epsilon=0.4, total=   0.0s
[CV] C=100, epsilon=0.4 ..............................................
[CV] ............................... C=100, epsilon=0.4, total=   0.0s
[CV] C=100, epsilon=0.5 ..............................................
[CV] ............................... C=100, epsilon=0.5, total=   0.0s
[CV] C=100, epsilon=0.5 ..............................................
[CV] ............................... C=100, epsilon=0.5, total=   0.0s
[CV] C=100, epsilon=0.5 ..............................................
[CV] ............................... C=100, epsilon=0.5, total=   0.0s
[CV] C=100, epsilon=0.5 ..............................................
[CV] ............................... C=100, epsilon=0.5, total=   0.0s
[CV] C=100, epsilon=0.5 ..............................................
[CV] ............................... C=100, epsilon=0.5, total=   0.0s
[CV] C=100, epsilon=0.6 ..............................................
[CV] ............................... C=100, epsilon=0.6, total=   0.0s
[CV] C=100, epsilon=0.6 ..............................................
```

```
[CV] C=100, epsilon=0.6 ..............................................
[CV] ............................... C=100, epsilon=0.6, total=   0.0s
[CV] C=100, epsilon=0.6 ..............................................
[CV] ............................... C=100, epsilon=0.6, total=   0.0s
[CV] C=100, epsilon=0.6 ..............................................
[CV] ............................... C=100, epsilon=0.6, total=   0.0s
[CV] C=100, epsilon=0.6 ..............................................
[CV] ............................... C=100, epsilon=0.6, total=   0.0s
[CV] C=100, epsilon=0.7 ..............................................
[CV] ............................... C=100, epsilon=0.7, total=   0.0s
[CV] C=100, epsilon=0.7 ..............................................
[CV] ............................... C=100, epsilon=0.7, total=   0.0s
[CV] C=100, epsilon=0.7 ..............................................
[CV] ............................... C=100, epsilon=0.7, total=   0.0s
[CV] C=100, epsilon=0.7 ..............................................
[CV] ............................... C=100, epsilon=0.7, total=   0.0s
[CV] C=100, epsilon=0.7 ..............................................
[CV] ............................... C=100, epsilon=0.7, total=   0.0s
[CV] C=100, epsilon=0.8 ..............................................
[CV] ............................... C=100, epsilon=0.8, total=   0.0s
[CV] C=100, epsilon=0.8 ..............................................
[CV] ............................... C=100, epsilon=0.8, total=   0.0s
[CV] C=100, epsilon=0.8 ..............................................
[CV] ............................... C=100, epsilon=0.8, total=   0.0s
[CV] C=100, epsilon=0.8 ..............................................
[CV] ............................... C=100, epsilon=0.8, total=   0.0s
[CV] C=100, epsilon=0.8 ..............................................
[CV] ............................... C=100, epsilon=0.8, total=   0.0s
[CV] C=100, epsilon=0.9 ..............................................
[CV] ............................... C=100, epsilon=0.9, total=   0.0s
[CV] C=100, epsilon=0.9 ..............................................
[CV] ............................... C=100, epsilon=0.9, total=   0.0s
[CV] C=100, epsilon=0.9 ..............................................
[CV] ............................... C=100, epsilon=0.9, total=   0.0s
[CV] C=100, epsilon=0.9 ..............................................
[CV] ............................... C=100, epsilon=0.9, total=   0.0s
[CV] C=100, epsilon=0.9 ..............................................
[CV] ............................... C=100, epsilon=0.9, total=   0.0s
[CV] C=100, epsilon=1.0 ..............................................
[CV] ............................... C=100, epsilon=1.0, total=   0.0s
[CV] C=100, epsilon=1.0 ..............................................
[CV] ............................... C=100, epsilon=1.0, total=   0.0s
[CV] C=100, epsilon=1.0 ..............................................
[CV] ............................... C=100, epsilon=1.0, total=   0.0s
[CV] C=100, epsilon=1.0 ..............................................
[CV] ............................... C=100, epsilon=1.0, total=   0.0s
[CV] C=100, epsilon=1.0 ..............................................
[CV] ............................... C=100, epsilon=1.0, total=   0.0s
```

```
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/svm/_base.py:947:
ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
```

Out[47]:

```
GridSearchCV(cv=None, error_score=nan,
             estimator=LinearSVR(C=1.0, dual=True, epsilon=0.0,
                                 fit_intercept=True, intercept_scaling=1.0,
                                 loss='epsilon_insensitive', max_iter=1000,
                                 random_state=None, tol=0.0001, verbose=0),
             iid='deprecated', n_jobs=None,
             param_grid={'C': [0.1, 1, 10, 100],
                         'epsilon': [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8,
                                     0.9, 1.0]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=2)
```

In [48]:

```
grid.best_estimator_
```

Out[48]:

```
(LinearSVR(C=10, dual=True, epsilon=0.1, fit_intercept=True,
           intercept_scaling=1.0, loss='epsilon_insensitive', max_iter=1000,
           random_state=None, tol=0.0001, verbose=0),
           random_state=None, tol=0.0001, verbose=0),
 0.7034991070076)
```

In [49]:

```
grid.best_score_, grid.best_params_
```

Out[49]:

```
(0.7034991070076, {'C': 10, 'epsilon': 0.1})
```

In [50]:

```
parameters = {"alpha_1": np.logspace(-13,-5,10),
              "alpha_2": np.logspace(-9,-3,10),
              "lambda_1": np.logspace(-10,-5,10),
              "lambda_2": np.logspace(-11,-4,10)}

grid_regr = GridSearchCV(BayesianRidge(), parameters, cv=3, n_jobs=-1)
grid_regr.fit(x.reshape(-1, 1), y)
```

Out[50]:

```
GridSearchCV(cv=3, error_score=nan,
             estimator=BayesianRidge(alpha_1=1e-06, alpha_2=1e-06,
                                     alpha_init=None, compute_score=False,
                                     copy_X=True, fit_intercept=True,
                                     lambda_1=1e-06, lambda_2=1e-06,
                                     lambda_init=None, n_iter=300,
                                     normalize=False, tol=0.001,
                                     verbose=False),
             iid='deprecated', n_jobs=-1,
             param_grid={'alpha_1': array([1.00000000e-13, 7.74263683e-13, 5.99484250e-...
                         'lambda_1': array([1.00000000e-10, 3.59381366e-10, 1.29154967e-09,
4.64158883e-09,
       1.66810054e-08, 5.99484250e-08, 2.15443469e-07, 7.74263683e-07,
       2.78255940e-06, 1.00000000e-05]),
                         'lambda_2': array([1.00000000e-11, 5.99484250e-11, 3.59381366e-10,
2.15443469e-09,
       1.29154967e-08, 7.74263683e-08, 4.64158883e-07, 2.78255940e-06,
       1.66810054e-05, 1.00000000e-04])},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [51]:

```
grid_regr.best_estimator_
```

Out[51]:

```
BayesianRidge(alpha_1=1e-05, alpha_2=1e-09, alpha_init=None,
              compute_score=False, copy_X=True, fit_intercept=True,
              lambda_1=1e-10, lambda_2=0.0001, lambda_init=None, n_iter=300,
              normalize=False, tol=0.001, verbose=False)
```

In [52]:

```
grid_regr.best_score_, grid_regr.best_params_
```

Out[52]:

```
(0.7342007111758907,
 {'alpha_1': 1e-05, 'alpha_2': 1e-09, 'lambda_1': 1e-10, 'lambda_2': 0.0001})
```

In [53]:

```
reg = BayesianRidge(
    fit_intercept=True, alpha_1=1e-05, alpha_2=1e-09, lambda_1=1e-10, lambda_2=0.0001
).fit(
    x.reshape(-1, 1), y.reshape(-1, 1)
)
y_tt = reg.predict(x.reshape(-1, 1))
```

```
lin_SVR = LinearSVR(C=1.0, max_iter=10000, epsilon=1.0)
lin_SVR.fit(x.reshape(-1, 1), y)
predict = lin_SVR.predict(x.reshape(-1, 1))

dec_tree = DecisionTreeRegressor(random_state=1, max_depth=3)
dec_tree.fit(data, data["Chance of Admit "])
dec_predict = dec_tree.predict(data)
```

```
/Users/alexandr/Учеба/Мага/mmo/env/lib/python3.7/site-packages/sklearn/utils/validation.py:760: Da
taConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the
shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [54]:

```
print("Метрики для линейной модели:\n")
print("Средняя абсолютная ошибка: ", mean_absolute_error(y, y_tt))
print("Средняя квадратичная ошибка: ", mean_squared_error(y, y_tt))
print("Коэффициент детерминации: ", r2_score(y, y_tt))

print("\n\nМетрики для SVM-модели:\n")
print("Средняя абсолютная ошибка: ", mean_absolute_error(y, predict))
print("Средняя квадратичная ошибка: ", mean_squared_error(y, predict))
print("Коэффициент детерминации: ", r2_score(y, predict))


print("\n\nМетрики для Decision Tree:\n")
print("Средняя абсолютная ошибка: ", mean_absolute_error(y, dec_predict))
print("Средняя квадратичная ошибка: ", mean_squared_error(y, dec_predict))
print("Коэффициент детерминации: ", r2_score(y, dec_predict))
```

```
Метрики для линейной модели:

Средняя абсолютная ошибка:  0.05104503964708347
Средняя квадратичная ошибка:  0.004815356104829768
Коэффициент детерминации:  0.762633391224825


Метрики для SVM-модели:

Средняя абсолютная ошибка:  0.72435
Средняя квадратичная ошибка:  0.5449695
Коэффициент детерминации:  -25.86355054222429


Метрики для Decision Tree:

Средняя абсолютная ошибка:  0.018912063108038904
Средняя квадратичная ошибка:  0.0004848476125557749З
Коэффициент детерминации:  0.9761000783618737
```

In [ ]: