**Московский государственный технический университет им. Н.Э. Баумана**

Кафедра «Системы обработки информации и управления»

**Лабораторная работа №5**

**по курсу «Методы машинного обучения»**

**на тему**

**«Линейные модели, SVM и деревья решений.»**

**Выполнил:**

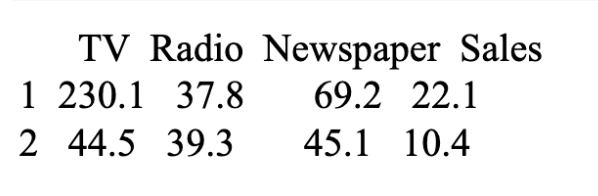
**Хотин П.Ю.**

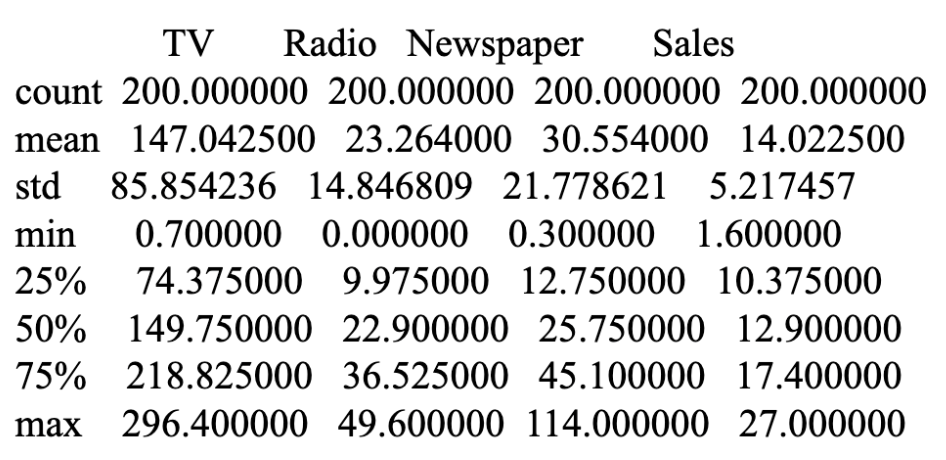
**ИУ5-24М**

Москва, 2020 год

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  
%matplotlib inline   
sns.set(style="ticks")  
  
import warnings  
warnings.filterwarnings('ignore')

data = pd.read\_csv("advertising.csv")

data.head(2)

data.describe()

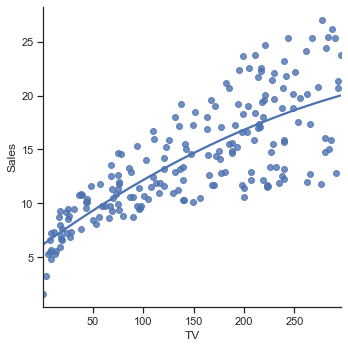
data.info()

<class 'pandas.core.frame.DataFrame'>  
Int64Index: 200 entries, 1 to 200  
Data columns (total 4 columns):  
 # Column Non-Null Count Dtype   
--- ------ -------------- -----   
 0 TV 200 non-null float64  
 1 Radio 200 non-null float64  
 2 Newspaper 200 non-null float64  
 3 Sales 200 non-null float64  
dtypes: float64(4)  
memory usage: 7.8 KB

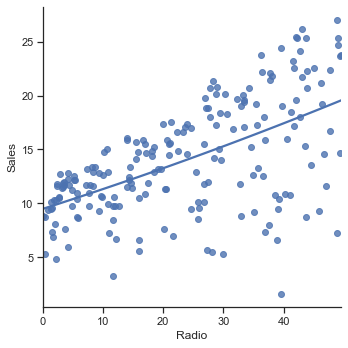
data.columns

Index(['TV', 'Radio', 'Newspaper', 'Sales'], dtype='object')

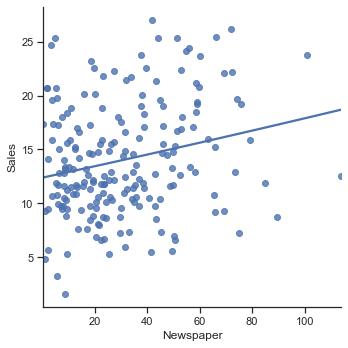
sns.lmplot(x="TV", y="Sales", data=data, order=2, ci=None)

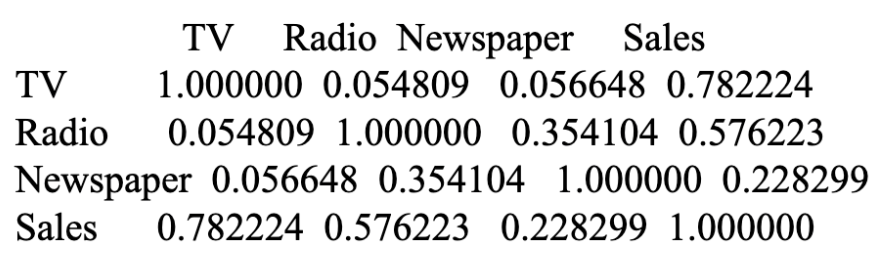
<seaborn.axisgrid.FacetGrid at 0x133706f10>

sns.lmplot(x="Radio", y="Sales", data=data, order=2, ci=None)

<seaborn.axisgrid.FacetGrid at 0x1357f9d90>

sns.lmplot(x="Newspaper", y="Sales", data=data, order=2, ci=None)

<seaborn.axisgrid.FacetGrid at 0x135878550>

data.corr()

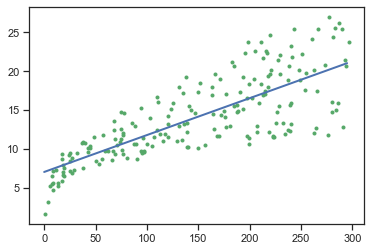
Между TV и Sales есть корреляция 0.78

x = data["TV"].values  
y = data["Sales"].values  
  
reg = BayesianRidge(fit\_intercept=True).fit(x.reshape(-1, 1), y.reshape(-1, 1))  
reg.coef\_  
reg.intercept\_

7.054854152265513

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

x\_t = list(range(0, 300, 5))  
y\_t = [func(reg.coef\_[0], reg.intercept\_, x) for x in x\_t]  
y\_tt = reg.predict(x.reshape(-1, 1))

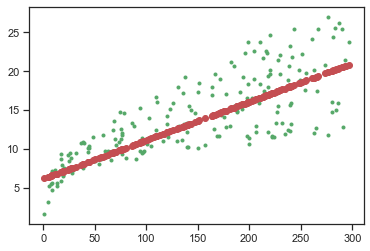
plt.plot(x, y, 'g.')  
plt.plot(x\_t, y\_t, 'b', linewidth=2.0)  
plt.show()

Модель линейной регрессии дала неплохой результат

SVM

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

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')

[<matplotlib.lines.Line2D at 0x13e5a9b10>]

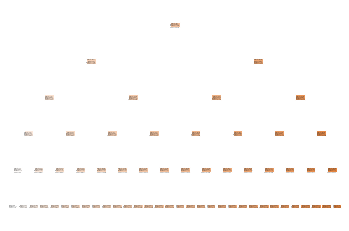
Деревья решений

dec\_tree = DecisionTreeRegressor(random\_state=1, max\_depth=5)  
dec\_tree.fit(data, data["Sales"])  
dec\_tree

DecisionTreeRegressor(ccp\_alpha=0.0, criterion='mse', max\_depth=5,  
 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')

dec\_predict = dec\_tree.predict(data)

from sklearn import tree  
tree.plot\_tree(dec\_tree, filled=True)

[Text(167.4, 199.32, 'X[3] <= 15.1\nmse = 27.086\nsamples = 200\nvalue = 14.023'),  
 Text(83.7, 163.07999999999998, 'X[3] <= 10.0\nmse = 7.31\nsamples = 125\nvalue = 10.67'),  
 Text(41.85, 126.83999999999999, 'X[3] <= 7.45\nmse = 3.527\nsamples = 45\nvalue = 7.767'),  
 Text(20.925, 90.6, 'X[0] <= 4.75\nmse = 2.173\nsamples = 18\nvalue = 5.872'),  
 Text(10.4625, 54.359999999999985, 'X[3] <= 2.4\nmse = 0.64\nsamples = 2\nvalue = 2.4'),  
 Text(5.23125, 18.119999999999976, 'mse = 0.0\nsamples = 1\nvalue = 1.6'),  
 Text(15.693750000000001, 18.119999999999976, 'mse = -0.0\nsamples = 1\nvalue = 3.2'),  
 Text(31.387500000000003, 54.359999999999985, 'X[3] <= 6.25\nmse = 0.669\nsamples = 16\nvalue = 6.306'),  
 Text(26.15625, 18.119999999999976, 'mse = 0.108\nsamples = 7\nvalue = 5.443'),  
 Text(36.61875, 18.119999999999976, 'mse = 0.075\nsamples = 9\nvalue = 6.978'),  
 Text(62.775000000000006, 90.6, 'X[3] <= 9.0\nmse = 0.442\nsamples = 27\nvalue = 9.03'),  
 Text(52.3125, 54.359999999999985, 'X[3] <= 8.25\nmse = 0.18\nsamples = 12\nvalue = 8.375'),  
 Text(47.081250000000004, 18.119999999999976, 'mse = 0.052\nsamples = 4\nvalue = 7.825'),  
 Text(57.54375, 18.119999999999976, 'mse = 0.017\nsamples = 8\nvalue = 8.65'),  
 Text(73.2375, 54.359999999999985, 'X[3] <= 9.55\nmse = 0.034\nsamples = 15\nvalue = 9.553'),  
 Text(68.00625000000001, 18.119999999999976, 'mse = 0.013\nsamples = 7\nvalue = 9.386'),  
 Text(78.46875, 18.119999999999976, 'mse = 0.008\nsamples = 8\nvalue = 9.7'),  
 Text(125.55000000000001, 126.83999999999999, 'X[3] <= 12.55\nmse = 2.031\nsamples = 80\nvalue = 12.302'),  
 Text(104.625, 90.6, 'X[3] <= 11.1\nmse = 0.487\nsamples = 48\nvalue = 11.317'),  
 Text(94.16250000000001, 54.359999999999985, 'X[3] <= 10.55\nmse = 0.083\nsamples = 19\nvalue = 10.558'),  
 Text(88.93125, 18.119999999999976, 'mse = 0.024\nsamples = 9\nvalue = 10.3'),  
 Text(99.39375, 18.119999999999976, 'mse = 0.023\nsamples = 10\nvalue = 10.79'),  
 Text(115.0875, 54.359999999999985, 'X[3] <= 11.85\nmse = 0.127\nsamples = 29\nvalue = 11.814'),  
 Text(109.85625, 18.119999999999976, 'mse = 0.034\nsamples = 17\nvalue = 11.565'),  
 Text(120.31875000000001, 18.119999999999976, 'mse = 0.047\nsamples = 12\nvalue = 12.167'),  
 Text(146.475, 90.6, 'X[3] <= 13.8\nmse = 0.703\nsamples = 32\nvalue = 13.781'),  
 Text(136.01250000000002, 54.359999999999985, 'X[3] <= 13.05\nmse = 0.091\nsamples = 17\nvalue = 13.047'),  
 Text(130.78125, 18.119999999999976, 'mse = 0.014\nsamples = 9\nvalue = 12.789'),  
 Text(141.24375, 18.119999999999976, 'mse = 0.017\nsamples = 8\nvalue = 13.338'),  
 Text(156.9375, 54.359999999999985, 'X[3] <= 14.45\nmse = 0.094\nsamples = 15\nvalue = 14.613'),  
 Text(151.70625, 18.119999999999976, 'mse = 0.022\nsamples = 4\nvalue = 14.175'),  
 Text(162.16875000000002, 18.119999999999976, 'mse = 0.026\nsamples = 11\nvalue = 14.773'),  
 Text(251.10000000000002, 163.07999999999998, 'X[3] <= 20.45\nmse = 10.081\nsamples = 75\nvalue = 19.611'),  
 Text(209.25, 126.83999999999999, 'X[3] <= 17.8\nmse = 2.413\nsamples = 47\nvalue = 17.519'),  
 Text(188.32500000000002, 90.6, 'X[3] <= 16.35\nmse = 0.603\nsamples = 27\nvalue = 16.348'),  
 Text(177.8625, 54.359999999999985, 'X[3] <= 15.65\nmse = 0.084\nsamples = 14\nvalue = 15.657'),  
 Text(172.63125, 18.119999999999976, 'mse = 0.023\nsamples = 7\nvalue = 15.4'),  
 Text(183.09375, 18.119999999999976, 'mse = 0.013\nsamples = 7\nvalue = 15.914'),  
 Text(198.7875, 54.359999999999985, 'X[3] <= 17.05\nmse = 0.095\nsamples = 13\nvalue = 17.092'),  
 Text(193.55625, 18.119999999999976, 'mse = 0.026\nsamples = 5\nvalue = 16.76'),  
 Text(204.01875, 18.119999999999976, 'mse = 0.025\nsamples = 8\nvalue = 17.3'),  
 Text(230.175, 90.6, 'X[3] <= 19.1\nmse = 0.505\nsamples = 20\nvalue = 19.1'),  
 Text(219.7125, 54.359999999999985, 'X[3] <= 18.7\nmse = 0.162\nsamples = 10\nvalue = 18.5'),  
 Text(214.48125000000002, 18.119999999999976, 'mse = 0.043\nsamples = 6\nvalue = 18.2'),  
 Text(224.94375, 18.119999999999976, 'mse = 0.002\nsamples = 4\nvalue = 18.95'),  
 Text(240.63750000000002, 54.359999999999985, 'X[3] <= 19.75\nmse = 0.128\nsamples = 10\nvalue = 19.7'),  
 Text(235.40625, 18.119999999999976, 'mse = 0.039\nsamples = 6\nvalue = 19.45'),  
 Text(245.86875, 18.119999999999976, 'mse = 0.027\nsamples = 4\nvalue = 20.075'),  
 Text(292.95, 126.83999999999999, 'X[3] <= 23.45\nmse = 3.285\nsamples = 28\nvalue = 23.121'),  
 Text(272.02500000000003, 90.6, 'X[3] <= 21.75\nmse = 0.581\nsamples = 16\nvalue = 21.744'),  
 Text(261.5625, 54.359999999999985, 'X[3] <= 21.0\nmse = 0.149\nsamples = 8\nvalue = 21.088'),  
 Text(256.33125, 18.119999999999976, 'mse = 0.002\nsamples = 4\nvalue = 20.725'),  
 Text(266.79375, 18.119999999999976, 'mse = 0.032\nsamples = 4\nvalue = 21.45'),  
 Text(282.4875, 54.359999999999985, 'X[3] <= 22.5\nmse = 0.153\nsamples = 8\nvalue = 22.4'),  
 Text(277.25625, 18.119999999999976, 'mse = 0.042\nsamples = 5\nvalue = 22.16'),  
 Text(287.71875, 18.119999999999976, 'mse = 0.08\nsamples = 3\nvalue = 22.8'),  
 Text(313.875, 90.6, 'X[3] <= 25.05\nmse = 0.984\nsamples = 12\nvalue = 24.958'),  
 Text(303.4125, 54.359999999999985, 'X[3] <= 24.0\nmse = 0.133\nsamples = 6\nvalue = 24.1'),  
 Text(298.18125000000003, 18.119999999999976, 'mse = 0.002\nsamples = 3\nvalue = 23.767'),  
 Text(308.64375, 18.119999999999976, 'mse = 0.042\nsamples = 3\nvalue = 24.433'),  
 Text(324.33750000000003, 54.359999999999985, 'X[3] <= 25.85\nmse = 0.361\nsamples = 6\nvalue = 25.817'),  
 Text(319.10625, 18.119999999999976, 'mse = 0.002\nsamples = 4\nvalue = 25.425'),  
 Text(329.56875, 18.119999999999976, 'mse = 0.16\nsamples = 2\nvalue = 26.6')]

Метрики качества

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: 2.550919383216356  
Средняя квадратичная ошибка: 10.512821002854928  
Коэффициент детерминации: 0.6118688451058344  
  
  
Метрики для SVM-модели:  
  
Средняя абсолютная ошибка: 2.5708683334350892  
Средняя квадратичная ошибка: 10.859652690875892  
Коэффициент детерминации: 0.5990638916505333  
  
  
Метрики для Decision Tree:  
  
Средняя абсолютная ошибка: 0.14353164841694266  
Средняя квадратичная ошибка: 0.03201810934980053  
Коэффициент детерминации: 0.9988178980926156

Подбор гиперпараметров. Кросс-валидация

from sklearn.model\_selection import cross\_validate

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

{'fit\_time': array([0.00085902, 0.00085711, 0.00055289]),  
 'score\_time': array([0.00140524, 0.00080299, 0.00078702]),  
 'test\_mean': array([-2.51215213, -2.46200408, -2.76711466]),  
 'test\_square': array([-10.83437466, -9.33658309, -11.90833409]),  
 'test\_r2': array([0.61497417, 0.65311667, 0.53715304])}

scores\_svm = cross\_validate(LinearSVR(C=1.0, max\_iter=10000),   
 x.reshape(-1, 1), y, cv=3, scoring=scoring)  
scores\_svm

{'fit\_time': array([0.03139281, 0.02713585, 0.02338099]),  
 'score\_time': array([0.00076604, 0.00061393, 0.00054908]),  
 'test\_mean': array([-2.54098772, -2.37148251, -3.1291242 ]),  
 'test\_square': array([-11.0231287 , -9.81978964, -15.84997398]),  
 'test\_r2': array([0.60826634, 0.63516403, 0.38395142])}

scores\_dec = cross\_validate(DecisionTreeRegressor(random\_state=1, max\_depth=3),   
 data, data["Sales"], cv=5, scoring=scoring)  
scores\_dec

{'fit\_time': array([0.00271297, 0.0020709 , 0.00206208, 0.00199294, 0.00195193]),  
 'score\_time': array([0.0018599 , 0.00148034, 0.00148678, 0.00142694, 0.0014143 ]),  
 'test\_mean': array([-0.72293478, -0.7307461 , -0.66116873, -0.85487267, -0.91550049]),  
 'test\_square': array([-0.64975012, -0.70991464, -0.63349151, -1.4104023 , -1.08449788]),  
 'test\_r2': array([0.97486214, 0.97589358, 0.97175881, 0.95176776, 0.95938815])}

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 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: -2.580423621885709  
Средняя квадратичная ошибка: -10.693097277894969  
Коэффициент детерминации: 0.601747959666948  
  
  
Метрики для SVM-модели:  
  
Средняя абсолютная ошибка: -2.6805314771806956  
Средняя квадратичная ошибка: -12.23096410841425  
Коэффициент детерминации: 0.5424605962417798  
  
  
Метрики для Decision Tree:  
  
Средняя абсолютная ошибка: -0.7770445553321956  
Средняя квадратичная ошибка: -0.8976112886827845  
Коэффициент детерминации: 0.9667340888852873

Оптимизация с помощью решетчатого поиска

from sklearn.model\_selection import GridSearchCV

n\_range = np.array(range(1,10,1))  
tuned\_parameters = [{'max\_depth': n\_range}]  
tuned\_parameters

[{'max\_depth': array([1, 2, 3, 4, 5, 6, 7, 8, 9])}]

%%time  
clf\_gs = GridSearchCV(DecisionTreeRegressor(), tuned\_parameters, cv=5, scoring='r2')  
clf\_gs.fit(x.reshape(-1, 1), y)

CPU times: user 48.9 ms, sys: 1.26 ms, total: 50.2 ms  
Wall time: 49.2 ms  
  
  
  
  
  
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)

# Лучшая модель  
clf\_gs.best\_estimator\_

DecisionTreeRegressor(ccp\_alpha=0.0, criterion='mse', 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, presort='deprecated',  
 random\_state=None, splitter='best')

clf\_gs.best\_score\_

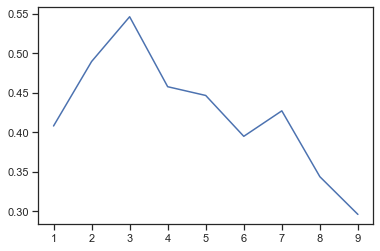
0.5464056968965096

clf\_gs.best\_params\_

{'max\_depth': 3}

plt.plot(n\_range, clf\_gs.cv\_results\_['mean\_test\_score'])

[<matplotlib.lines.Line2D at 0x1365b10d0>]



Оптимизация SVM

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]}

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 ..............................................  
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[CV] C=1, epsilon=0.1 ................................................  
  
  
[Parallel(n\_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.  
[Parallel(n\_jobs=1)]: Done 1 out of 1 | elapsed: 0.0s remaining: 0.0s  
  
  
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[CV] ................................. C=1, epsilon=0.1, total= 0.0s  
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[CV] ................................. C=1, epsilon=0.4, total= 0.0s  
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[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, 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  
  
  
[Parallel(n\_jobs=1)]: Done 200 out of 200 | elapsed: 0.8s finished  
  
  
  
  
  
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)

grid.best\_estimator\_

LinearSVR(C=10, dual=True, epsilon=1.0, fit\_intercept=True,  
 intercept\_scaling=1.0, loss='epsilon\_insensitive', max\_iter=1000,  
 random\_state=None, tol=0.0001, verbose=0)

grid.best\_score\_

0.5440492644611755

grid.best\_params\_

{'C': 10, 'epsilon': 1.0}

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)

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)

grid\_regr.best\_estimator\_

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)

grid\_regr.best\_score\_

0.6017531508217578

grid\_regr.best\_params\_

{'alpha\_1': 1e-05, 'alpha\_2': 1e-09, 'lambda\_1': 1e-10, 'lambda\_2': 0.0001}

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["Sales"])  
dec\_predict = dec\_tree.predict(data)

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: 2.5508292802546  
Средняя квадратичная ошибка: 10.512794897173503  
Коэффициент детерминации: 0.6118698089221382  
  
  
Метрики для SVM-модели:  
  
Средняя абсолютная ошибка: 2.5996867264932724  
Средняя квадратичная ошибка: 11.18839596468356  
Коэффициент детерминации: 0.586926758668624  
  
  
Метрики для Decision Tree:  
  
Средняя абсолютная ошибка: 0.7095532407407409  
Средняя квадратичная ошибка: 0.7222188657407407  
Коэффициент детерминации: 0.9733358303760538

После подбора параметров модели показали лучший результат, чем без подбора.