Загрузка данных

In [230]:

```
from IPython.display import Image
#import graphviz
import numpy as np
import pandas as pd
from typing import Dict, Tuple
from sklearn.datasets import load_iris, load_wine, load_boston
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor, export_graphviz
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.metrics import mean_absolute_error
import matplotlib.pyplot as plt
%matplotlib inline
from IPython.display import Image
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.datasets import load_iris, load_boston
from sklearn.neighbors import KNeighborsRegressor, KNeighborsClassifier
from sklearn.model_selection import cross_val_score, cross_validate
from sklearn.model_selection import KFold, RepeatedKFold, LeaveOneOut, LeavePOut, ShuffleSplit, StratifiedKFold
from sklearn.metrics import accuracy_score, balanced_accuracy_score
from sklearn.metrics import precision_score, recall_score, f1_score, classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import mean_absolute_error, mean_squared_error, mean_squared_log_error, median_absolute_error, r2_score
from sklearn.metrics import roc_curve, roc_auc_score
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV
from sklearn.model_selection import learning_curve, validation_curve
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.set(style="ticks")
```

In [185]:

```
wine = load_wine()
```

In [196]:

```
df_wine = pd.DataFrame(wine.data,columns=wine.feature_names)
df_wine['target'] = pd.Series(wine.target)
df_wine.head()
```

Out[196]:

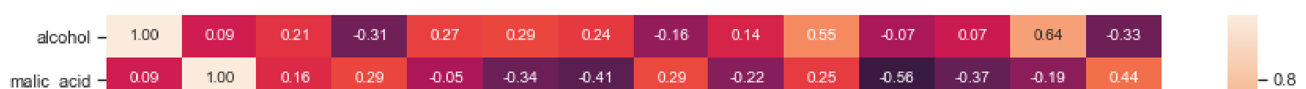
	alcohol	malic_acid	ash	alcalinity_of_ash	magnesium	total_phenols	flavanoids	nonflavanoid_phenols	proanthocyanins	color_intensity	hue	oc
0	14.23	1.71	2.43	15.6	127.0	2.80	3.06	0.28	2.29	5.64	1.04	
1	13.20	1.78	2.14	11.2	100.0	2.65	2.76	0.26	1.28	4.38	1.05	
2	13.16	2.36	2.67	18.6	101.0	2.80	3.24	0.30	2.81	5.68	1.03	
3	14.37	1.95	2.50	16.8	113.0	3.85	3.49	0.24	2.18	7.80	0.86	
4	13.24	2.59	2.87	21.0	118.0	2.80	2.69	0.39	1.82	4.32	1.04	

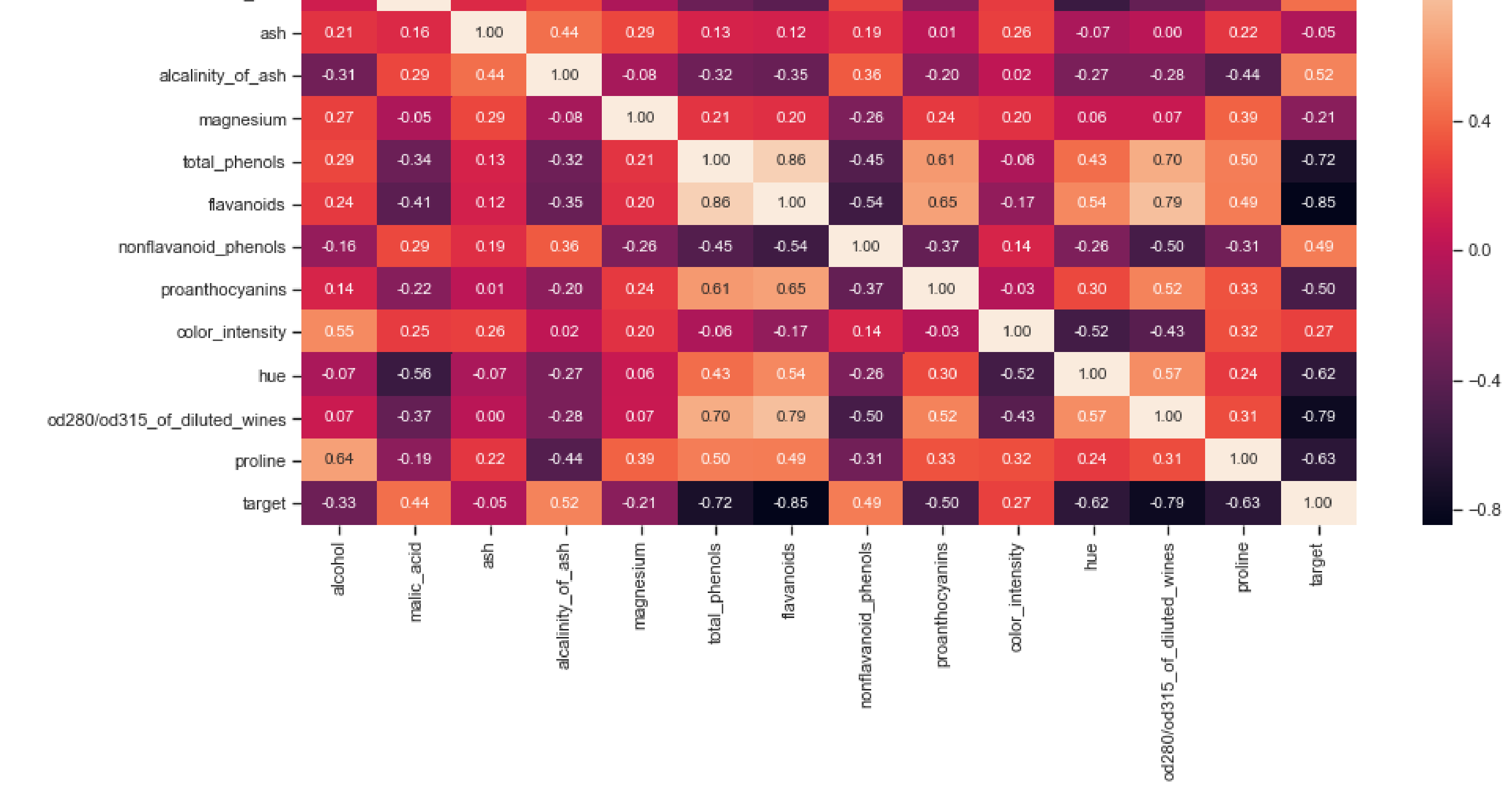
In [198]:

```
fig, ax = plt.subplots(figsize=(15,7))
sns.heatmap(df_wine.corr(method='pearson'), ax=ax, annot=True, fmt='.2f')
```

Out[198]:

<matplotlib.axes._subplots.AxesSubplot at 0x1868fa06cc0>





Деревья решений

In [187]:

```
wine_tree_cl = DecisionTreeClassifier(random_state=1)
wine_tree_cl.fit(wine_x_ds, wine.target)
wine_tree_cl
```

Out[187]:

```
DecisionTreeClassifier(class_weight=None, criterion='gini', 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=False, random_state=1,
            splitter='best')
```

In [188]:

```
wine.target
```

Out[188]:

```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2])
```

In [189]:

```
list(zip(wine_x_ds.columns.values, wine_tree_cl.feature_importances_))
```

Out[189]:

```
[('alcohol', 0.012570564071187309),
 ('malic_acid', 0.014223159778821876),
 ('ash', 0.0),
 ('alcalinity_of_ash', 0.0),
 ('magnesium', 0.0534597951279922),
 ('total_phenols', 0.0),
 ('flavanoids', 0.16704836491408806),
 ('nonflavanoid_phenols', 0.0),
```

```
('proanthocyanins', 0.0),
('color_intensity', 0.0),
('hue', 0.058185091460406506),
('od280/od315_of_diluted_wines', 0.3120425747831769),
('proline', 0.38247044986432716)]
```

In [190]:

```
sum(wine_tree_cl.feature_importances_)
```

Out[190]:

```
1.0
```

In [191]:

```
wine_X_train, wine_X_test, wine_y_train, wine_y_test = train_test_split(
    wine_x_ds, wine.target, test_size=0.5, random_state=1)
wine_X_train.shape, wine_X_test.shape
```

Out[191]:

```
((89, 13), (89, 13))
```

In [192]:

```
wine_tree_cl_feat_1 = DecisionTreeClassifier(random_state=1).fit(wine_X_train, wine_y_train)
wine_y_test_predict = wine_tree_cl_feat_1.predict(wine_X_test)
wine_y_test_predict.shape
```

Out[192]:

```
(89,)
```

In [193]:

```
print_accuracy_score_for_classes(wine_y_test, wine_y_test_predict)
```

```
Метка   Accuracy
0   0.8181818181818182
1   0.8823529411764706
2   0.9545454545454546
```

In [194]:

```
mean_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[194]:

```
0.12359550561797752
```

In [195]:

```
median_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[195]:

```
0.0
```

Линейная зависимость

In [212]:

```
wine_X_train, wine_X_test, wine_y_train, wine_y_test = train_test_split(
    wine.data, wine.target, test_size=0.5, random_state=1)
wine_X_train.shape, wine_X_test.shape
```

Out[212]:

```
((89, 13), (89, 13))
```

In [214]:

```
reg1 = LinearRegression().fit(wine_X_train, wine_y_train)
(b1, reg1.coef_), (b0, reg1.intercept_)
```

Out[214]:

```
((0.20884722950068055,
  array([-0.14363533,  0.01736955, -0.12304724,  0.04618784, -0.00180479,
          0.21048533, -0.37095489, -0.47875276, -0.10163014,  0.09471474,
         -0.37481097, -0.19107785, -0.00077269])),
 (-1.0715116629341392, 3.881691199237158))
```

In [215]:

```
wine_y_test_predict = reg1.predict(wine_X_test)
```

In [218]:

```
mean_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[218]:

```
0.23201284251888057
```

In [219]:

```
median_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[219]:

```
0.2123153564338245
```

Метод опорных векторов

In [220]:

```
# Используем датасет iris с двумя первыми признакам
wine_X = wine.data[:, :2]
wine_y = wine.target
```

In [227]:

```
def make_meshgrid(x, y, h=.02):
    """Create a mesh of points to plot in

    Parameters
    ----------
    x: data to base x-axis meshgrid on
    y: data to base y-axis meshgrid on
    h: stepsize for meshgrid, optional

    Returns
    -------
    xx, yy : ndarray
    """
    x_min, x_max = x.min() - 1, x.max() + 1
    y_min, y_max = y.min() - 1, y.max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h),
                         np.arange(y_min, y_max, h))
    return xx, yy

def plot_contours(ax, clf, xx, yy, **params):
    """Plot the decision boundaries for a classifier.

    Parameters
    ----------
    ax: matplotlib axes object
    clf: a classifier

    xx: meshgrid ndarray
    yy: meshgrid ndarray
    params: dictionary of params to pass to contourf, optional
    """
```

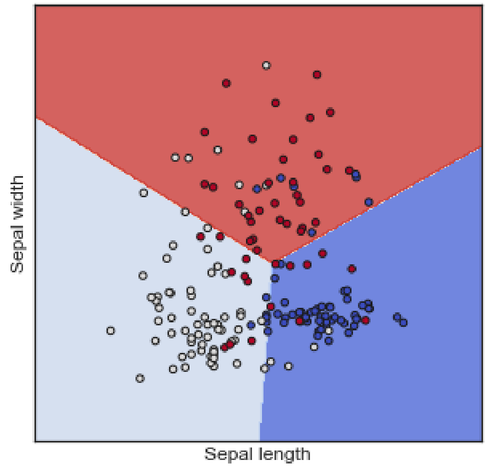
```
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    #Можно проверить все ли метки классов предсказываются
    print(np.unique(Z))
    out = ax.contourf(xx, yy, Z, **params)
    return out


def plot_cl(clf):
    title = clf.__repr__
    clf.fit(wine_X, wine_y)
    fig, ax = plt.subplots(figsize=(5,5))
    X0, X1 = wine_X[:, 0], wine_X[:, 1]
    xx, yy = make_meshgrid(X0, X1)
    plot_contours(ax, clf, xx, yy, cmap=plt.cm.coolwarm, alpha=0.8)
    ax.scatter(X0, X1, c=wine_y, cmap=plt.cm.coolwarm, s=20, edgecolors='k')
    ax.set_xlim(xx.min(), xx.max())
    ax.set_ylim(yy.min(), yy.max())
    ax.set_xlabel('Sepal length')
    ax.set_ylabel('Sepal width')
    ax.set_xticks(())
    ax.set_yticks(())
    ax.set_title(title)
    plt.show()
```

In [228]:

```
plot_cl(LinearSVC(C=1.0, max_iter=10000))
```

[0 1 2]

<bound method BaseEstimator.__repr__ of LinearSVC(C=1.0, class_weight=None, dual=True, fit_intercept=True,
intercept_scaling=1, loss='squared_hinge', max_iter=10000,
multi_class='ovr', penalty='l2', random_state=None, tol=0.0001,
verbose=0)>



Подбор гиперпараметров

In [236]:

```
scores = cross_val_score(LinearRegression(),
                         wine.data, wine.target, cv=3)
scores
```

Out[236]:

array([-73.46648267,   0.   , -6.64995487])

In [238]:

```
scores = cross_val_score(LinearSVC(C=1.0, max_iter=10000),
                         wine.data, wine.target, cv=3)
scores
```

C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\svm\base.py:931: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)
C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\svm\base.py:931: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)

"the number of iterations.", ConvergenceWarning)
C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\svm\base.py:931: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  "the number of iterations.", ConvergenceWarning)

Out[238]:

array([0.93333333, 0.93333333, 0.96551724])

In [239]:

```
scores = cross_val_score(DecisionTreeClassifier(random_state=1),
                         wine.data, wine.target, cv=3)
scores
```

Out[239]:

array([0.85   , 0.83333333, 0.9137931])

In [246]:

```
n_range = np.array(range(5,55,5))
tuned_parameters = [{'DecisionTreeClassifier': n_range}]
tuned_parameters
```

Out[246]:

[{'DecisionTreeClassifier': array([5, 10, 15, 20, 25, 30, 35, 40, 45, 50])}]

In [274]:

```
tree_para = {'criterion':['gini','entropy'],'max_depth':[4,5,6,7,8,9,10,11,12,15,20,30,40,50,70,90]}
clf_gs = GridSearchCV(DecisionTreeClassifier(random_state=1), tree_para, cv = 20, scoring='accuracy')
clf_gs.fit(wine_X_train, wine_y_train)
```

C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\model_selection_search.py:841: DeprecationWarning: The default of the `iid` parameter will change from True to False in version 0.22 and will be removed in 0.24. This will change numeric results when test-set sizes are unequal.
  DeprecationWarning)

Out[274]:

```
GridSearchCV(cv=20, error_score='raise-deprecating',
       estimator=DecisionTreeClassifier(class_weight=None, criterion='gini', 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=False, random_state=1,
            splitter='best'),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'criterion': ['gini', 'entropy'], 'max_depth': [4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 20, 30, 40, 50, 70, 90]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='accuracy', verbose=0)
```

In [275]:

```
clf_gs.best_estimator_
```

Out[275]:

```
DecisionTreeClassifier(class_weight=None, criterion='entropy', 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=False, random_state=1,
            splitter='best')
```

In [276]:

```
clf_gs.best_score_
```

Out[276]:

0.9213483146067416

In [277]:

In [277]:

```
#Параметры для дерева решений
clf_gs.best_params_
```

Out[277]:

```
{'criterion': 'entropy', 'max_depth': 4}
```

In [282]:

```
model = LinearRegression()
parameters = {'fit_intercept':[True,False], 'normalize':[True,False], 'copy_X':[True, False]}
grid = GridSearchCV(model,parameters, cv=None)
grid.fit(wine_X_train, wine_y_train)
```

```
C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\model_selection\_split.py:2053: FutureWarning: You should specify a value for 'cv' instead of rel
ying on the default value. The default value will change from 3 to 5 in version 0.22.
  warnings.warn(CV_WARNING, FutureWarning)
C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:841: DeprecationWarning: The default of the `iid` parameter will ch
ange from True to False in version 0.22 and will be removed in 0.24. This will change numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

Out[282]:

```
GridSearchCV(cv=None, error_score='raise-deprecating',
       estimator=LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'fit_intercept': [True, False], 'normalize': [True, False], 'copy_X': [True, False]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [283]:

```
#Параметры для линейной регрессии
grid.best_params_
```

Out[283]:

```
{'copy_X': True, 'fit_intercept': True, 'normalize': False}
```

In [285]:

```
param_grid = {'C':[1,10,100,1000],'gamma':[1,0.1,0.001,0.0001], 'kernel':['linear','rbf']}
grid = GridSearchCV(SVC(),param_grid,refit = True, verbose=2)
grid.fit(wine_X_train, wine_y_train)
```

```
C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\model_selection\_split.py:2053: FutureWarning: You should specify a value for 'cv' instead of rel
ying on the default value. The default value will change from 3 to 5 in version 0.22.
  warnings.warn(CV_WARNING, FutureWarning)
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.1s remaining:    0.0s
```

```
Fitting 3 folds for each of 32 candidates, totalling 96 fits
[CV] C=1, gamma=1, kernel=linear ....................................
[CV] ..................... C=1, gamma=1, kernel=linear, total=   0.1s
[CV] C=1, gamma=1, kernel=linear ....................................
[CV] ..................... C=1, gamma=1, kernel=linear, total=   0.0s
[CV] C=1, gamma=1, kernel=linear ....................................
[CV] ..................... C=1, gamma=1, kernel=linear, total=   0.1s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=1, kernel=rbf .......................................
[CV] ........................ C=1, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=linear ..................................
[CV] ................... C=1, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=1, gamma=0.1, kernel=linear ..................................
[CV] ................... C=1, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=1, gamma=0.1, kernel=linear ..................................
[CV] ................... C=1, gamma=0.1, kernel=linear, total=   0.1s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.1, kernel=rbf
```

```
[CV] C=1, gamma=0.1, kernel=rbf ......................................
[CV] ....................... C=1, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=linear .................................
[CV] .................. C=1, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=1, gamma=0.001, kernel=linear .................................
[CV] .................. C=1, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=1, gamma=0.001, kernel=linear .................................
[CV] .................. C=1, gamma=0.001, kernel=linear, total=   0.1s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.001, kernel=rbf ....................................
[CV] ..................... C=1, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=linear ................................
[CV] ................. C=1, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=linear ................................
[CV] ................. C=1, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=linear ................................
[CV] ................. C=1, gamma=0.0001, kernel=linear, total=   0.1s
[CV] C=1, gamma=0.0001, kernel=rbf ...................................
[CV] .................... C=1, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=rbf ...................................
[CV] .................... C=1, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1, gamma=0.0001, kernel=rbf ...................................
[CV] .................... C=1, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=1, kernel=linear ....................................
[CV] ..................... C=10, gamma=1, kernel=linear, total=   0.0s
[CV] C=10, gamma=1, kernel=linear ....................................
[CV] ..................... C=10, gamma=1, kernel=linear, total=   0.0s
[CV] C=10, gamma=1, kernel=linear ....................................
[CV] ..................... C=10, gamma=1, kernel=linear, total=   0.1s
[CV] C=10, gamma=1, kernel=rbf .......................................
[CV] ........................ C=10, gamma=1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=1, kernel=rbf .......................................
[CV] ........................ C=10, gamma=1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=1, kernel=rbf .......................................
[CV] ........................ C=10, gamma=1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.1, kernel=linear ..................................
[CV] ................... C=10, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=10, gamma=0.1, kernel=linear ..................................
[CV] ................... C=10, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=10, gamma=0.1, kernel=linear ..................................
[CV] ................... C=10, gamma=0.1, kernel=linear, total=   0.1s
[CV] C=10, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=10, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=10, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.1, kernel=rbf .....................................
[CV] ...................... C=10, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.001, kernel=linear ................................
[CV] ................. C=10, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=10, gamma=0.001, kernel=linear ................................
[CV] ................. C=10, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=10, gamma=0.001, kernel=linear ................................
[CV] ................. C=10, gamma=0.001, kernel=linear, total=   0.1s
[CV] C=10, gamma=0.001, kernel=rbf ...................................
[CV] .................... C=10, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.001, kernel=rbf ...................................
[CV] .................... C=10, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.001, kernel=rbf ...................................
[CV] .................... C=10, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=linear ...............................
[CV] ................ C=10, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=linear ...............................
[CV] ................ C=10, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=linear ...............................
[CV] ................ C=10, gamma=0.0001, kernel=linear, total=   0.1s
[CV] C=10, gamma=0.0001, kernel=rbf ..................................
[CV] ................... C=10, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=rbf ..................................
[CV] ................... C=10, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=10, gamma=0.0001, kernel=rbf ..................................
[CV] ................... C=10, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=1, kernel=linear ...................................
[CV] .................... C=100, gamma=1, kernel=linear, total=   0.0s
[CV] C=100, gamma=1, kernel=linear ...................................
[CV] .................... C=100, gamma=1, kernel=linear, total=   0.0s
[CV] C=100, gamma=1, kernel=linear ...................................
[CV] .................... C=100, gamma=1, kernel=linear, total=   0.1s
[CV] C=100, gamma=1, kernel=rbf ......................................
[CV] ....................... C=100, gamma=1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=1, kernel=rbf ......................................
```

```
[CV] ....................... C=100, gamma=1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=1, kernel=rbf ......................................
[CV] ....................... C=100, gamma=1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.1, kernel=linear .................................
[CV] .................. C=100, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=100, gamma=0.1, kernel=linear .................................
[CV] .................. C=100, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=100, gamma=0.1, kernel=linear .................................
[CV] .................. C=100, gamma=0.1, kernel=linear, total=   0.1s
[CV] C=100, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.1, kernel=rbf ....................................
[CV] ..................... C=100, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=linear ...............................
[CV] ................ C=100, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=100, gamma=0.001, kernel=linear ...............................
[CV] ................ C=100, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=100, gamma=0.001, kernel=linear ...............................
[CV] ................ C=100, gamma=0.001, kernel=linear, total=   0.1s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.001, kernel=rbf ..................................
[CV] ................... C=100, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.0001, kernel=linear ..............................
[CV] ............... C=100, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=100, gamma=0.0001, kernel=linear ..............................
[CV] ............... C=100, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=100, gamma=0.0001, kernel=linear ..............................
[CV] ............... C=100, gamma=0.0001, kernel=linear, total=   0.1s
[CV] C=100, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=100, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=100, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=100, gamma=0.0001, kernel=rbf .................................
[CV] .................. C=100, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=1, kernel=linear ..................................
[CV] ................... C=1000, gamma=1, kernel=linear, total=   0.0s
[CV] C=1000, gamma=1, kernel=linear ..................................
[CV] ................... C=1000, gamma=1, kernel=linear, total=   0.0s
[CV] C=1000, gamma=1, kernel=linear ..................................
[CV] ................... C=1000, gamma=1, kernel=linear, total=   0.1s
[CV] C=1000, gamma=1, kernel=rbf .....................................
[CV] ...................... C=1000, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=1, kernel=rbf .....................................
[CV] ...................... C=1000, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=1, kernel=rbf .....................................
[CV] ...................... C=1000, gamma=1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.1, kernel=linear ................................
[CV] ................. C=1000, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=1000, gamma=0.1, kernel=linear ................................
[CV] ................. C=1000, gamma=0.1, kernel=linear, total=   0.0s
[CV] C=1000, gamma=0.1, kernel=linear ................................
[CV] ................. C=1000, gamma=0.1, kernel=linear, total=   0.1s
[CV] C=1000, gamma=0.1, kernel=rbf ...................................
[CV] .................... C=1000, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.1, kernel=rbf ...................................
[CV] .................... C=1000, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.1, kernel=rbf ...................................
[CV] .................... C=1000, gamma=0.1, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.001, kernel=linear ..............................
[CV] ............... C=1000, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=1000, gamma=0.001, kernel=linear ..............................
[CV] ............... C=1000, gamma=0.001, kernel=linear, total=   0.0s
[CV] C=1000, gamma=0.001, kernel=linear ..............................
[CV] ............... C=1000, gamma=0.001, kernel=linear, total=   0.1s
[CV] C=1000, gamma=0.001, kernel=rbf .................................
[CV] .................. C=1000, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.001, kernel=rbf .................................
[CV] .................. C=1000, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.001, kernel=rbf .................................
[CV] .................. C=1000, gamma=0.001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=linear .............................
[CV] .............. C=1000, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=linear .............................
[CV] .............. C=1000, gamma=0.0001, kernel=linear, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=linear .............................
[CV] .............. C=1000, gamma=0.0001, kernel=linear, total=   0.1s
[CV] C=1000, gamma=0.0001, kernel=rbf ................................
[CV] ................. C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
```

```
[CV] ................ C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=rbf ...............................
[CV] ................ C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
[CV] C=1000, gamma=0.0001, kernel=rbf ...............................
[CV] ................ C=1000, gamma=0.0001, kernel=rbf, total=   0.0s
```

```
[Parallel(n_jobs=1)]: Done  96 out of  96 | elapsed:    7.3s finished
C:\Users\cveto\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:841: DeprecationWarning: The default of the `iid` parameter will ch
ange from True to False in version 0.22 and will be removed in 0.24. This will change numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

Out[285]:

```
GridSearchCV(cv='warn', error_score='raise-deprecating',
       estimator=SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
  kernel='rbf', max_iter=-1, probability=False, random_state=None,
  shrinking=True, tol=0.001, verbose=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [1, 10, 100, 1000], 'gamma': [1, 0.1, 0.001, 0.0001], 'kernel': ['linear', 'rbf']},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=2)
```

In [286]:

```
grid.best_params_
```

Out[286]:

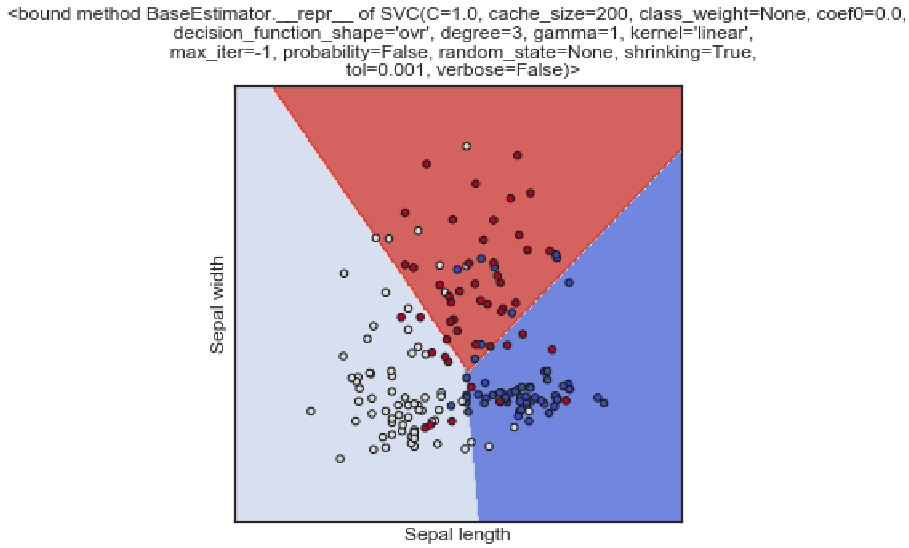
```
{'C': 1, 'gamma': 1, 'kernel': 'linear'}
```

Повторение для найденных оптимальных значений гиперпараметров

In [288]:

```
plot_cl(SVC(C=1.0, gamma = 1, kernel = 'linear'))
```

```
[0 1 2]
```



In [291]:

```
reg1 = LinearRegression(copy_X = True, fit_intercept = True, normalize = False).fit(wine_X_train, wine_y_train)
(b1, reg1.coef_), (b0, reg1.intercept_)
```

Out[291]:

```
((0.20884722950068055,
  array([-0.14363533,  0.01736955, -0.12304724,  0.04618784, -0.00180479,
         0.21048533, -0.37095489, -0.47875276, -0.10163014,  0.09471474,
        -0.37481097, -0.19107785, -0.00077269])),
 (-1.0715116629341392, 3.881691199237158))
```

In [295]:

```
wine_y_test_predict = reg1.predict(wine_X_test)
```

In [296]:

```
mean_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[296]:

0.23201284251888057

In [297]:

```
median_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[297]:

0.2123153564338245

In [294]:

```
wine_tree_cl = DecisionTreeClassifier(criterion = 'entropy', max_depth = 4)
wine_tree_cl.fit(wine_x_ds, wine.target)
wine_tree_cl
```

Out[294]:

```
DecisionTreeClassifier(class_weight=None, criterion='entropy', 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=False, random_state=None,
            splitter='best')
```

In [298]:

```
wine_y_test_predict = wine_tree_cl.predict(wine_X_test)
```

In [299]:

```
print_accuracy_score_for_classes(wine_y_test, wine_y_test_predict)
```

```
Метка   Accuracy
0   1.0
1   1.0
2   1.0
```

In [300]:

```
mean_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[300]:

0.0

In [301]:

```
median_absolute_error(wine_y_test, wine_y_test_predict)
```

Out[301]:

0.0

In [ ]:

```

```

Министерство науки и высшего образования Российской Федерации
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(национальный исследовательский университет)»
(МГТУ им. Н.Э. Баумана)

Факультет «Информатика и системы управления»

Кафедра ИУ5 «Системы обработки информации и управления»

Лабораторная работа №5
по дисциплине «Технология машинного обучения» на тему:

Линейные модели, SVM и деревья решений.

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Проверил:
Ю.Е. Гапанюк
подпись, дата

2020 г.

Задание:

1. Выберите набор данных (датасет) для решения задачи классификации или регресии.
2. В случае необходимости проведите удаление или заполнение пропусков и кодирование категориальных признаков.
3. С использованием метода train_test_split разделите выборку на обучающую и тестовую.
4. Обучите 1) одну из линейных моделей, 2) SVM и 3) дерево решений. Оцените качество моделей с помощью трех подходящих для задачи метрик. Сравните качество полученных моделей.
5. Произведите для каждой модели подбор одного гиперпараметра с использованием GridSearchCV и кросс-валидации.
6. Повторите пункт 4 для найденных оптимальных значений гиперпараметров. Сравните качество полученных моделей с качеством моделей, полученных в пункте 4.