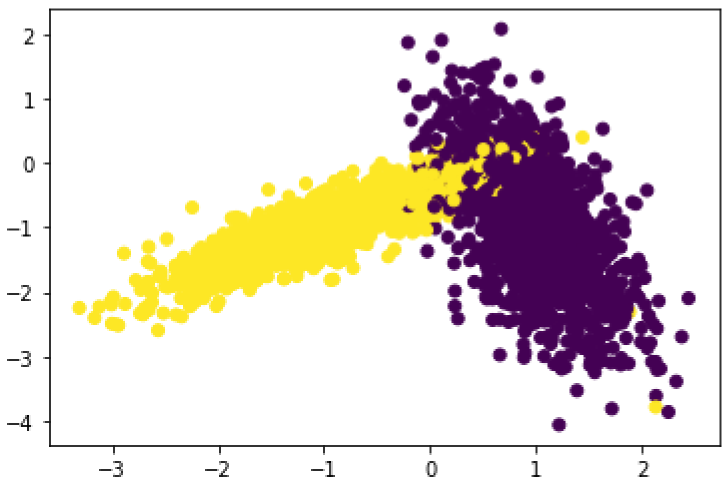
In [6]:
```
from sklearn.datasets import make_classification
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
import numpy
from tqdm import tqdm
import numpy as np
from sklearn.metrics.pairwise import euclidean_distances


x,y = make_classification(n_samples=10000, n_features=2, n_informative=2, n_redundant=
X_train, X_test, y_train, y_test = train_test_split(x,y,stratify=y,random_state=42)

# del X_train,X_test
```

In [24]:
```
%matplotlib inline
import matplotlib.pyplot as plt
# colors = {0:'red', 1:'blue'}
plt.scatter(X_test[:,0], X_test[:,1],c=y_test)
plt.show()
```



Implementing Custom RandomSearchCV

```
def RandomSearchCV(x_train,y_train,classifier, param_range, folds):
    # x_train: its numpy array of shape, (n,d)
    # y_train: its numpy array of shape, (n,) or (n,1)
    # classifier: its typically KNeighborsClassifier()
    # param_range: its a tuple like (a,b) a < b
    # folds: an integer, represents number of folds we need to devide the
data and test our model


    #1.generate 10 unique values(uniform random distribution) in the
given range "param_range" and store them as "params"
    # ex: if param_range = (1, 50), we need to generate 10 random numbers
in range 1 to 50
    #2.devide numbers ranging from  0 to len(X_train) into groups= folds
    # ex: folds=3, and len(x_train)=100, we can devide numbers from 0 to
100 into 3 groups
```

```
        group 1: 0-33, group 2:34-66, group 3: 67-100
    #3.for each hyperparameter that we generated in step 1:
        # and using the above groups we have created in step 2 you will
do cross-validation as follows

        # first we will keep group 1+group 2 i.e. 0-66 as train data and
group 3: 67-100 as test data, and find train and
          test accuracies

        # second we will keep group 1+group 3 i.e. 0-33, 67-100 as train
data and group 2: 34-66 as test data, and find
          train and test accuracies

        # third we will keep group 2+group 3 i.e. 34-100 as train data
and group 1: 0-33 as test data, and find train and
          test accuracies
        # based on the 'folds' value we will do the same procedure

        # find the mean of train accuracies of above 3 steps and store in
a list "train_scores"
        # find the mean of test accuracies of above 3 steps and store in
a list "test_scores"
    #4. return both "train_scores" and "test_scores"

#5. call function RandomSearchCV(x_train,y_train,classifier, param_range,
folds) and store the returned values into "train_score", and "cv_scores"
#6. plot hyper-parameter vs accuracy plot as shown in reference notebook
and choose the best hyperparameter
#7. plot the decision boundaries for the model initialized with the best
hyperparameter, as shown in the last cell of reference notebook
```

In [35]:

```
from sklearn.metrics import accuracy_score

def get_test_indices_set(x_train,block_size,j):

    if  j==1:
        test_index = [*range(1,int(block_size*len(x_train)))    ]   #first block of CV
    else:
        test_index = [*range( int( block_size*(j-1)  *len(x_train)) , int ((block_size*

    return test_index


def RandomSearchCV(x_train,y_train,classifier, params, folds):
    trainscores = []
    testscores  = []

    par_range = params['n_neighbors']  #range of parameters K
    rand_params = []

    for i in range (10):
        rand_params.append(random.randrange(par_range[0] , par_range[1]+1))  #generatin
        rand_params = sorted(rand_params)   #sorted list of random parameters

    for k in tqdm(rand_params):
```

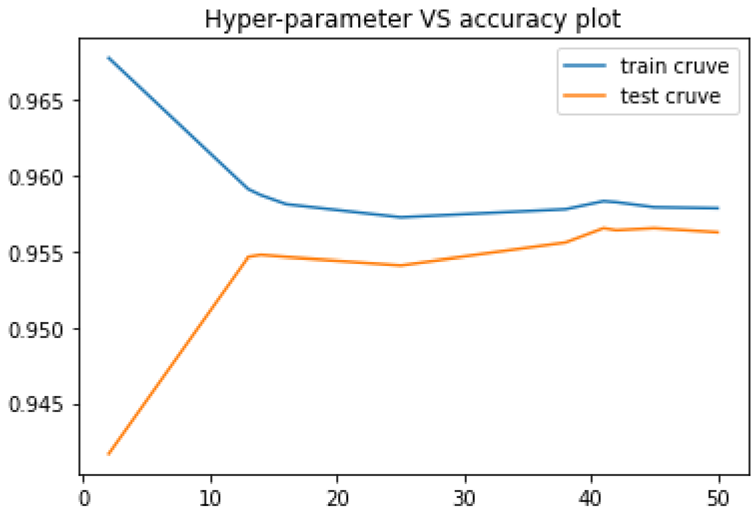
```
        trainscores_folds = []
        testscores_folds  = []

        block_size = round(float(100/(folds*100)),2)      #block size , length of each


        for j in range(0, folds):


            test_indices  = get_test_indices_set(x_train,block_size,j+1)    #getting te
            train_indices = list(set(list(range(1, len(x_train)))) - set(test_indices))


            # selecting the data points based on the train_indices and test_indices
            X_train = x_train[train_indices]  # train set x

            Y_train = y_train[train_indices]  # train set y

            X_test  = x_train[test_indices]   #CV

            Y_test  = y_train[test_indices]   #CV

            classifier.n_neighbors = k          #hyperparameter k

            classifier.fit(X_train,Y_train)       #fit to model

            Y_predicted = classifier.predict(X_test)   #predict CV

            testscores_folds.append(accuracy_score(Y_test, Y_predicted))    #accuracy s

            Y_predicted = classifier.predict(X_train)   #predict train

            trainscores_folds.append(accuracy_score(Y_train, Y_predicted))  #accuracy s

        trainscores.append(np.mean(np.array(trainscores_folds))) #average train set sco

        testscores.append(np.mean(np.array(testscores_folds)))  #average CV set scores

    return trainscores,testscores, rand_params
```

In [37]:

```
from sklearn.metrics import accuracy_score
from sklearn.neighbors import KNeighborsClassifier
import matplotlib.pyplot as plt
import random
import warnings
warnings.filterwarnings("ignore")


neigh = KNeighborsClassifier()

params_range = {'n_neighbors':(1,50)}
folds = 3

trainscores,testscores,rand_params = RandomSearchCV(X_train, y_train, neigh, params_ran

print(rand_params)
plt.plot(rand_params,trainscores, label='train cruve')
plt.plot(rand_params,testscores, label='test cruve')
plt.title('Hyper-parameter VS accuracy plot')
plt.legend()
```

```
plt.show()

#K=45 has the highest test accuracy and distance to the train curve is shortest
```

```
100%|██████████████████████████████████████████████████| 10/10 [00:10<00:00,  1.10s/it]
[2, 13, 14, 16, 25, 38, 41, 42, 45, 50]
```

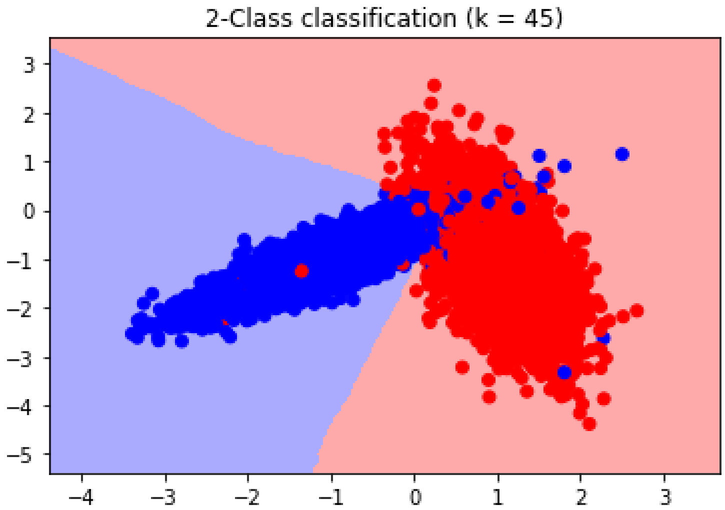


In [38]:

```
# understanding this code line by line is not that importent
def plot_decision_boundary(X1, X2, y, clf):
        # Create color maps
    cmap_light = ListedColormap(['#FFAAAA', '#AAFFAA', '#AAAAFF'])
    cmap_bold = ListedColormap(['#FF0000', '#00FF00', '#0000FF'])

    x_min, x_max = X1.min() - 1, X1.max() + 1
    y_min, y_max = X2.min() - 1, X2.max() + 1

    xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.02), np.arange(y_min, y_max, 0.02))
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)

    plt.figure()
    plt.pcolormesh(xx, yy, Z, cmap=cmap_light)
    # Plot also the training points
    plt.scatter(X1, X2, c=y, cmap=cmap_bold)

    plt.xlim(xx.min(), xx.max())
    plt.ylim(yy.min(), yy.max())
    plt.title("2-Class classification (k = %i)" % (clf.n_neighbors))
    plt.show()
```

In [39]:

```
from matplotlib.colors import ListedColormap
neigh = KNeighborsClassifier(n_neighbors = 45)
neigh.fit(X_train, y_train)
plot_decision_boundary(X_train[:, 0], X_train[:, 1], y_train, neigh)
```


2-Class classification (k = 45)
3
2
1
0
−1
−2
−3
−4
−5
−4
−3
−2
−1
0
1
2
3