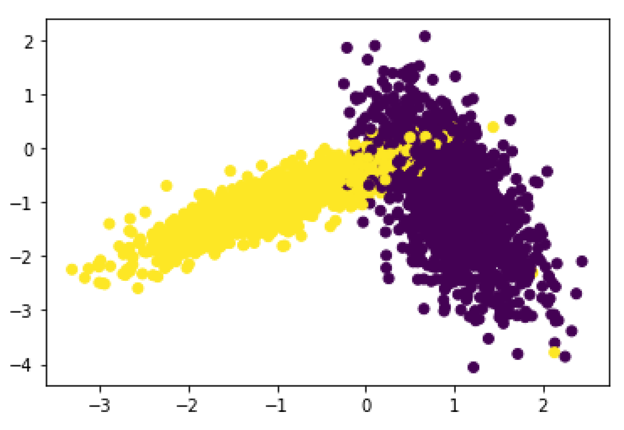
```
In [2]: !pip install tqdm
        from sklearn.datasets import make_classification
        from sklearn.model_selection import train_test_split
        from sklearn.preprocessing import StandardScaler
        import numpy
        from tqdm import tqdm
        import numpy as np
        from sklearn.metrics.pairwise import euclidean_distances


        x,y = make_classification(n_samples=10000, n_features=2, n_informative=2, n_redundant= 0, n_
        clusters_per_class=1, random_state=60)
        X_train, X_test, y_train, y_test = train_test_split(x,y,stratify=y,random_state=42)

        # del X_train,X_test
```

```
WARNING: pip is being invoked by an old script wrapper. This will fail in a future version of
pip.
Please see https://github.com/pypa/pip/issues/5599 for advice on fixing the underlying issue.
To avoid this problem you can invoke Python with '-m pip' instead of running pip directly.
Collecting tqdm
  Downloading tqdm-4.45.0-py2.py3-none-any.whl (60 kB)
     |████████████████████████████████| 60 kB 2.5 MB/s eta 0:00:011
Installing collected packages: tqdm
Successfully installed tqdm-4.45.0
```

```
In [3]: %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 tes
t our model


    #1.generate 10 unique values(uniform random distribution) in the given range "para
m_range" and store them as "params"
    # ex: if param_range = (1, 50), we need to generate 10 random numbers in range 1 t
o 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 gr
oups
      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-valid
ation as follows

        # first we will keep group 1+group 2 i.e. 0-66 as train data and group 3: 67-1
00 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 grou
p 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 "trai
n_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 s
tore the returned values into "train_score", and "cv_scores"
#6. plot hyper-parameter vs accuracy plot as shown in reference notebook and choose th
e best hyperparameter
#7. plot the decision boundaries for the model initialized with the best hyperparamete
r, as shown in the last cell of reference notebook
```

Generating 10 number numbers

```
In [4]: def generate_10_random_numbers(a):
          if a[0] < a[1]:
            r = np.random.uniform(a[0],a[1],10)
            r = list(r.astype(int))
            r.sort()
            if len(r) == len(set(r)):
              return r
            else:
              r = generate_10_random_numbers(a)
              return r
          else:
            print('Error: param_range: its a tuple like (a,b) a < b ')
            return 0
```

divide numbers ranging from 0 to len(X_train) into 3 folds

```
In [5]: def divide_training_dataset_to_k_folds(x_train,y_train,folds):
            temp = len(x_train)/folds
            x_train = x_train.tolist()
            y_train = y_train.tolist()
            group = []
            label = []
            end = 0.0
            while end < len(x_train):
              group.append(x_train[int(end):int(end + temp)])
              label.append(y_train[int(end):int(end + temp)])
              end += temp
            return group,label
```

defining RandomSearch Function

```
In [6]: from sklearn.metrics import accuracy_score
        def RandomSearchCV(x_train,y_train,classifier, param_range, folds):

            #Generate 10 unique values(uniform random distribution) in the given range "param_range"
        and store them as "params"

            params = generate_10_random_numbers(param_range)
            if params == 0:
              exit()


            # divide numbers ranging from  0 to len(X_train) into groups= folds

            temp = len(x_train)/folds
            temp = int(temp)
            groups,labels = divide_training_dataset_to_k_folds(x_train,y_train,folds)

            train_scores = []
            test_scores  = []
            for k in tqdm(params):
              for i in range(folds):
                trainscores_folds = []
                testscores_folds  = []
                X_train = [groups[iter] for iter in range(folds) if iter != i]
                X_train = [j for sublist in X_train for j in sublist]
                Y_train = [labels[iter] for iter in range(folds) if iter != i]
                Y_train = [j for sublist in Y_train for j in sublist]
                X_test  = groups[i]
                Y_test  = labels[i]

                classifier.n_neighbors = k
                #print(np.asarray(Y_train))
                classifier.fit(X_train,Y_train)

                Y_predicted = classifier.predict(X_test)

                testscores_folds.append(accuracy_score(Y_test, Y_predicted))

                Y_predicted = classifier.predict(X_train)
                trainscores_folds.append(accuracy_score(Y_train, Y_predicted))
              train_scores.append(np.mean(np.array(trainscores_folds)))
              test_scores.append(np.mean(np.array(testscores_folds)))

            #4. return both "train_scores" and "test_scores"
            return train_scores, test_scores,params
```

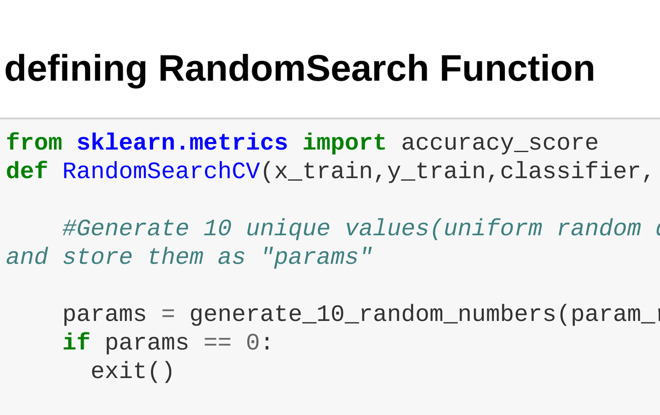
call function RandomSearchCV

```
In [7]: ## call function RandomSearchCV(x_train,y_train,classifier, param_range, folds) and store th
        e returned values into "train_score", and "cv_scores"
        from sklearn.metrics import accuracy_score
        from sklearn.neighbors import KNeighborsClassifier
        import matplotlib.pyplot as plt
        import random
        import warnings
        warnings.filterwarnings("ignore")

        classifier = KNeighborsClassifier()
        param_range = (1,50)
        folds = 3

        trainscores,testscores,params = RandomSearchCV(X_train,y_train,classifier, param_range, fold
        s)
```

```
100%|██████████| 10/10 [00:08<00:00,  1.18it/s]
```

hyper-parameter vs accuracy plot

```
In [8]: # 6. plot hyper-parameter vs accuracy plot as shown in reference notebook and choose the bes
        t hyperparameter
        plt.plot(params,trainscores, label='train cruve')
        plt.plot(params,testscores, label='test cruve')
        plt.title('Hyper-parameter VS accuracy plot')
        plt.legend()
        plt.show()
```

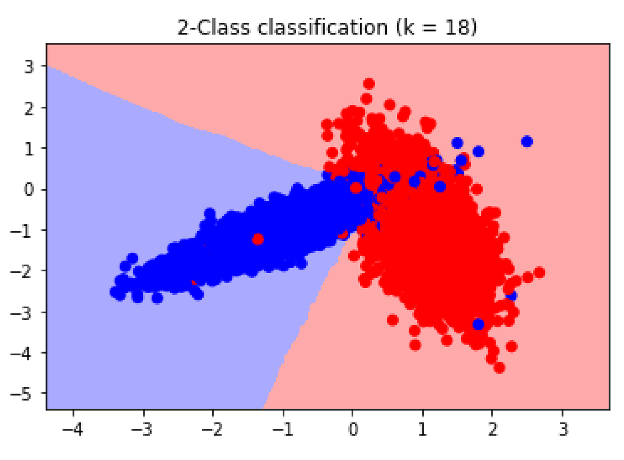



```
In [9]: params
Out[9]: [1, 2, 3, 6, 7, 11, 18, 25, 46, 47]
```

Plotting the decision boundaries

```
In [11]: # 7. plot the decision boundaries for the model initialized with the best hyperparameter, as
         shown in the last cell of reference notebook
         # 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 [12]: from matplotlib.colors import ListedColormap
         neigh = KNeighborsClassifier(n_neighbors = 18)
         neigh.fit(X_train, y_train)
         plot_decision_boundary(X_train[:, 0], X_train[:, 1], y_train, neigh)
```



Reference

Mail of randomsearch provided by appliedai

GridSearchCV coding in Assignment 4 reference