In [16]:

```
import numpy as np
import math
from IPython.display import Markdown as md
from math import *
from matplotlib import pyplot as plt
from sklearn.metrics import accuracy_score
from sklearn.metrics import mean_squared_error
```

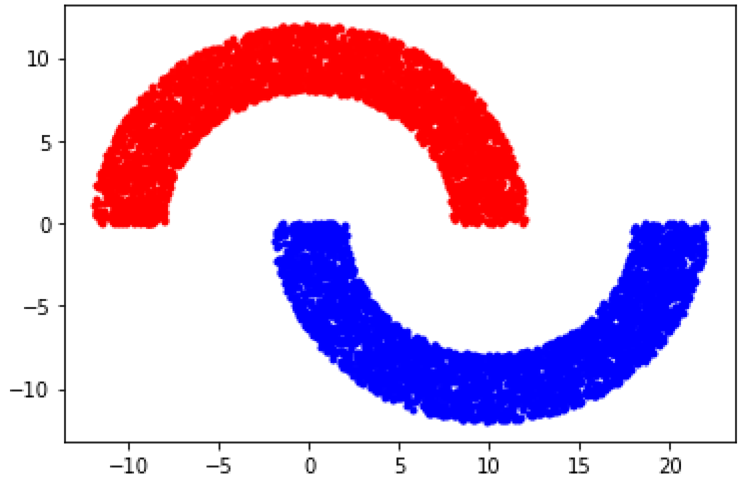
In [26]:

```
def make_half_moons(n_samples, radius, width, distance):

    """
    The function make_half_moons takes as input:
    n_samples = number of data samples to be generated
    radius = central radius of the half-moon
    width = width of the half-moon
    distance = distance between the two half-moons

    and returns as output the dataset generated and shuffled
    data_set = the shuffled and combined dataset with 3 rows (as x_cord, y_cord
               and labels) and n_samples columns
    """

    # Initialise dummy variables
    num_rows = 3
    num_cols = n_samples
    r = radius
    w = width
    d = distance
    n = [0 for i in range(n_samples)]
    m = [0 for i in range(n_samples)]




    # Check for boundary conditions
    if(r < w/2):
        print("\nError: Radius should atleast be larger than half the width.")

    if(num_cols%2 != 0):
        print("\nError: Number of samples should be even.")
        num_cols -= 1

    # Create random 2D array of floats between 0.0 and 1.0
    a = np.random.rand(num_rows, num_cols//2)

    # Define rad for first half of records
    rad = (r - w/2) + w*a[0][:]

    # Define theta for second half of records
    theta = np.pi*a[1][:]

    # Create data-set
    # First half-moon data
    x1 = np.multiply(rad, np.cos(theta))
    y1 = np.multiply(rad, np.sin(theta))
    label1 = 1*np.ones((1, len(x1)), dtype=int)
    label1 = np.hstack(label1)
   # print(label1)

    # Second half-moon data
    x2 = np.multiply(rad, np.cos(-theta)) + r
    y2 = np.multiply(rad, np.sin(-theta)) - d
    label2 = 0*np.ones((1, len(x2)), dtype=int)
    label2 = np.hstack(label2)
   # print(label2)
```

```
# Create dataset by combining all values of x's and y's and
# labels, and shuffling them randomly.
x = np.concatenate((x1, x2))
y = np.concatenate((y1, y2))
labels = np.concatenate((label1, label2))
#print(x)
#print(x1)

def sigmoid(b):
    return 1 / (1 + math.exp(-b))
sigmoid_v = np.vectorize(sigmoid)







# Create coordinate-type dataset from individual values
# so that we have a dataset of type Xi = [[x, y], label]
X = np.zeros((len(x), 2))



k = 0
for i, j in zip(x, y):
    X[k][0] = i
    X[k][1] = j

    k += 1


data_set = [X, labels]
#print(label1)


# Plot a half-moon graph for given dataset
plt.plot(x1, y1, "r.", x2, y2, "b.")
plt.show()


#int(data_set)
#print(x1)
# print(y1)
#print("printing labels")
#print(labels[0])
alpha=0.01  #----------------------------------------------------------------initializin

weights = np.zeros((1,2), dtype=float) #initializing weights
error_lms = 0
error_lms_Sig = 0
threshold = 0.2192254930413396 #---------------------------------------------THRESHold
#threshold_1= 0.21442857142857144 #--------------------------------------------------

actual_result = 0
l = 0
epoch = 50
for j in range(epoch):
    for i in range (0,1999):                          # training 2000 data
```

```
            actual_result = weights[0][0]*X[i][0] + weights[0][1]*X[i][1]
            #actual_result = np.dot(weights[0][k],X[i])
           # print(sigmoid_v(actual_result))
       #  print(sigmoid(actual_result))
            #print(actual_result)
            actual_result = sigmoid_v(actual_result)
         #print(actual_result)

        # print(label1[i])

            if actual_result > 0.5:
                fx = 1
           # print("greater than 0.5")
            if actual_result <= 0.5:
                fx = 0
            #print("less than 0.5")



            if fx != labels[i]:
                error = labels[i] - fx



                weights[0][0] = weights[0][0] + alpha*error*X[i][0]
                weights[0][1] = weights[0][1] + alpha*error*X[i][1]

            #print(weights[:])
            #print (labels)

                #print("learning")
            else:
                if fx == labels[i]:
                    weights[0][0] = weights[0][0]
                    weights[0][1] = weights[0][1]
                    #print("no error")

            n[i]=fx                                                     #storing val
            m[i]=actual_result                                          #storing val
        error_lms = mean_squared_error(labels[:], m[:]) #-----------------------using least
        if(error_lms<threshold):
            break
        print("printing least mean square error without sigmoid epoch number", + j, ":", +
       # error_lms_sig = mean_squared_error(labels[:], n[:])
       # if(error_lms<threshold_1): #-------------------------------------------using lea
         #   break
        #print("printing least mean square error with sigmoid epoch number", + j ,":", + er
        print(" ")


    for j in range(epoch):
        for i in range (2000,7000):                                    # testing the


            actual_result = weights[0][0]*X[i][0] + weights[0][1]*X[i][1]
            actual_result = sigmoid_v(actual_result)
            if actual_result > 0.5:
                fx = 1
              # print("greater than 0.5")
            if actual_result <= 0.5:
```

```
                fx = 0
                #print("less than 0.5")


          # n[i]=fx #storing value of fx in list
          #m[i]=actual_result
      #  error_lms = mean_squared_error(labels[:], m[:])
      #  print("printing least mean square error without sigmoid epoch number", + j, ":", +
      #  error_lms_sig = mean_squared_error(labels[:], n[:])
       # print("printing least mean square error with sigmoid epoch number", + j ,":", + er
        #print(" ")


    acc = accuracy_score(labels[:],n[:])
    print ("Accuracy",+accuracy_score(labels[:],n[:])) #finding accuracy
    print('\033[1m',  (accuracy_score(labels[:],n[:]) *100),'%' , '\033[0m')


    #return data_set



make_half_moons(7000, 10, 4, 0)
```




```
printing least mean square error without sigmoid epoch number 0 : 0.22560398
166858026

printing least mean square error without sigmoid epoch number 1 : 0.22090430
444546996

printing least mean square error without sigmoid epoch number 2 : 0.21987785
982667735

printing least mean square error without sigmoid epoch number 3 : 0.21946882
662968878

Accuracy 0.7825714285714286
 78.25714285714285 %
```

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