

Logistic Regression

November 10, 2021

1 Logistic Regression Using Gradient Descent

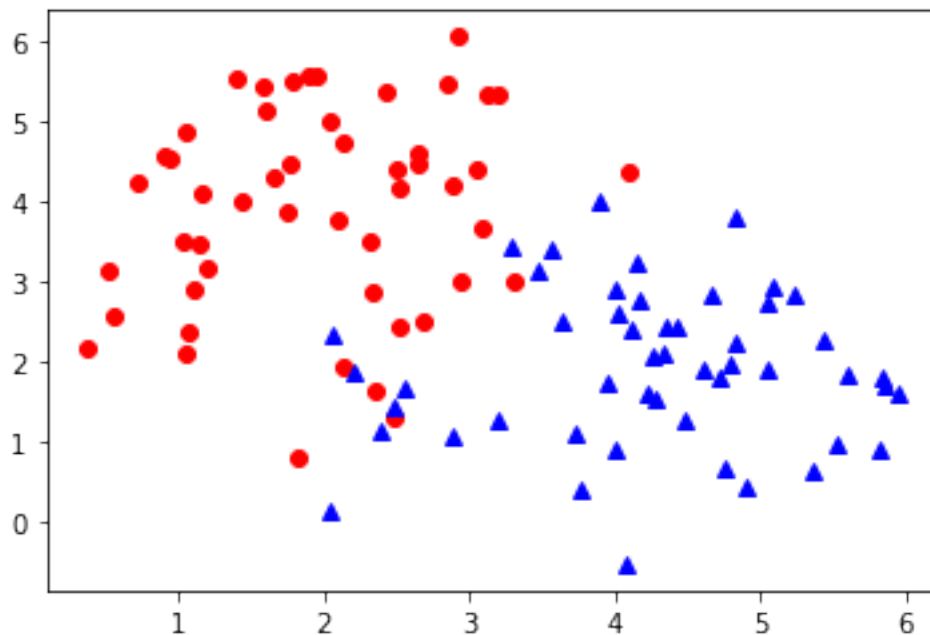
1.0.1 Dataset

```
[16]: import numpy as np  
import matplotlib.pyplot as plt
```

```
[17]: from sklearn.datasets import make_blobs  
X, y = make_blobs(n_samples=100, centers=[[2,4],[4,2]], random_state=20)
```

```
[18]: #Visualize dataset  
plt.plot(X[:,0][y==0],X[:,1][y==0], 'o',color='red')  
plt.plot(X[:,0][y==1],X[:,1][y==1], '^',color='blue')
```

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[18]: [<matplotlib.lines.Line2D at 0x7f7cc24b3610>]
```



```
[19]: print(X.shape)
      print(y.shape)
```

```
(100, 2)
(100,)
```

```
[20]: def sigmoid(z):
      return 1/(1 + np.exp(-z))
```

```
[21]: def predict(W,x):

      z = np.dot(W,x)
      return sigmoid(z)
```

```
[22]: def Cost(W,y,x):
      return -y*np.log(predict(W,x)) + -(1 - y)*np.log(1 - predict(W,x))
```

```
[23]: ''' x is the data vector appended with 1 for bias '''
      ''' y is the label (0,1)'''
      ''' returns a vector of gradient '''
      ''' W is the current Weights '''
      def compute_gradient(x,y,W):
          return x*(predict(W,x) - y)
```

```
[24]: def Gradient_Descent(iterations , X_train , y_train, learning_rate ):
      Weights = []
      Iterations = []
      cost = []
      w = np.random.rand(3)

      for j in range(iterations):
          C = 0
          G = np.zeros(w.shape)
          for i in range(len(X_train)):
              C = C + Cost(w,y_train[i],X_train[i,:])
              G = G + compute_gradient(X_train[i,:],y[i],w)
          C = C/len(X_train)
          G = G/len(X_train)
          w = w - learning_rate * G
          Weights.append(w)
          cost.append(C)
          Iterations.append(j + 1)
```

```

    print("The cost after Iteration {0} is {1}".format(j + 1,C))
    return Weights,cost,w,Iterations

```

```

[25]: X_train = np.zeros((X.shape[0],X.shape[1] + 1))
      X_train[:,0:2] = X
      X_train[:,2] = 1
      #print(X_train)
      #print(X_train.shape)
      y_train = np.copy(y)
      W,C,w,I = Gradient_Descent(1000,X_train,y_train,0.01)

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The cost after Iteration 841 is 0.20515244540115896
The cost after Iteration 842 is 0.20510734734493002
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The cost after Iteration 844 is 0.20501743157603078
The cost after Iteration 845 is 0.20497261328010705
The cost after Iteration 846 is 0.20492788765638284
The cost after Iteration 847 is 0.2048832544162492
The cost after Iteration 848 is 0.20483871327229264

The cost after Iteration 849 is 0.20479426393828962
The cost after Iteration 850 is 0.20474990612919963
The cost after Iteration 851 is 0.2047056395611599
The cost after Iteration 852 is 0.20466146395147788
The cost after Iteration 853 is 0.20461737901862773
The cost after Iteration 854 is 0.2045733844822416
The cost after Iteration 855 is 0.20452948006310503
The cost after Iteration 856 is 0.20448566548315136
The cost after Iteration 857 is 0.2044419404654543
The cost after Iteration 858 is 0.2043983047342241
The cost after Iteration 859 is 0.20435475801480002
The cost after Iteration 860 is 0.20431130003364562
The cost after Iteration 861 is 0.20426793051834197
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The cost after Iteration 868 is 0.20396679830406522
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The cost after Iteration 871 is 0.20383904184314222
The cost after Iteration 872 is 0.20379662778670402
The cost after Iteration 873 is 0.20375429901226078
The cost after Iteration 874 is 0.20371205526142216
The cost after Iteration 875 is 0.20366989627683835
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The cost after Iteration 878 is 0.20354392536262828
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The cost after Iteration 881 is 0.20341870817898391
The cost after Iteration 882 is 0.20337713543876038
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The cost after Iteration 893 is 0.20292524230092454
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The cost after Iteration 897 is 0.20276333643567043
The cost after Iteration 898 is 0.20272305836473214
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The cost after Iteration 900 is 0.2026427386570007
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The cost after Iteration 902 is 0.20256273264638508
The cost after Iteration 903 is 0.20252284670025436
The cost after Iteration 904 is 0.20248303848752044
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The cost after Iteration 912 is 0.2021673439639321
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The cost after Iteration 932 is 0.20139906475510563
The cost after Iteration 933 is 0.20136141495529358
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The cost after Iteration 935 is 0.20128632890804218
The cost after Iteration 936 is 0.2012488922544785
The cost after Iteration 937 is 0.20121152624482228
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The cost after Iteration 939 is 0.2011370053534204
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The cost after Iteration 979 is 0.1997033808774954
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The cost after Iteration 982 is 0.19960004113485064
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The cost after Iteration 986 is 0.19946312381111914
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The cost after Iteration 989 is 0.19936108166512082
The cost after Iteration 990 is 0.19932718974430613
The cost after Iteration 991 is 0.1992933586113656
The cost after Iteration 992 is 0.19925958810156388

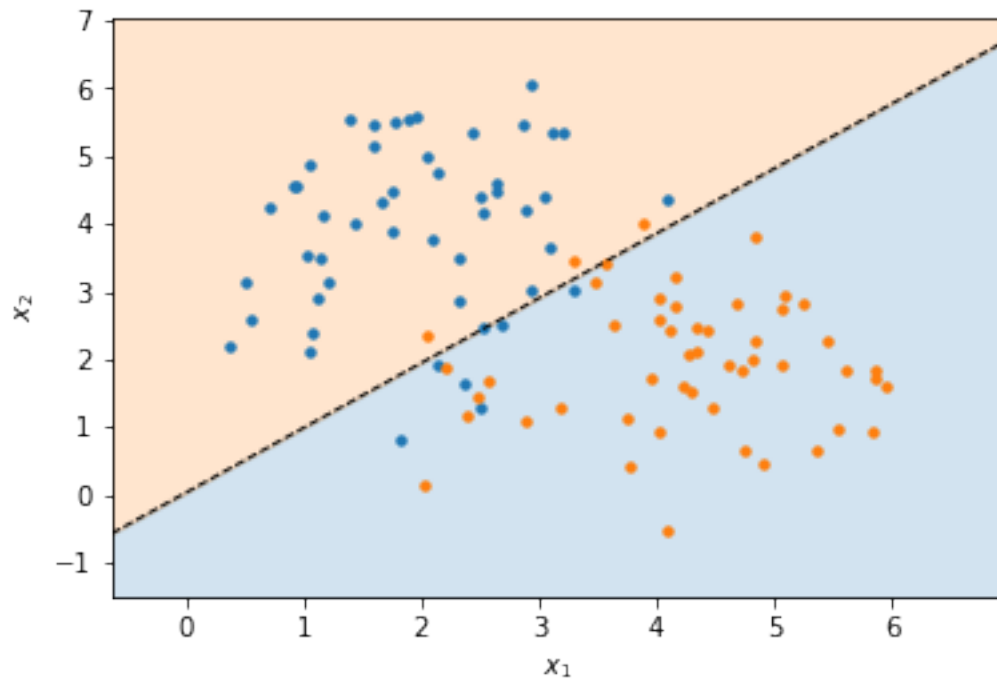
The cost after Iteration 993 is 0.1992258780507571
The cost after Iteration 994 is 0.19919222829539218
The cost after Iteration 995 is 0.19915863867250358
The cost after Iteration 996 is 0.19912510901971023
The cost after Iteration 997 is 0.19909163917521305
The cost after Iteration 998 is 0.19905822897779288
The cost after Iteration 999 is 0.19902487826680715
The cost after Iteration 1000 is 0.19899158688218804

```
[26]: c = -w[2]/w[1]
      m = -w[0]/w[1]

      xmin, xmax = X_train[:, 0].min()-1, X_train[:, 0].max()+1
      ymin, ymax = X_train[:, 1].min()-1, X_train[:, 1].max()+1
      xd = np.array([xmin, xmax])
      yd = m*xd + c
      plt.plot(xd, yd, 'k', lw=1, ls='--')
      plt.fill_between(xd, yd, ymin, color='tab:blue', alpha = 0.2)
      plt.fill_between(xd, yd, ymax, color='tab:orange', alpha = 0.2)

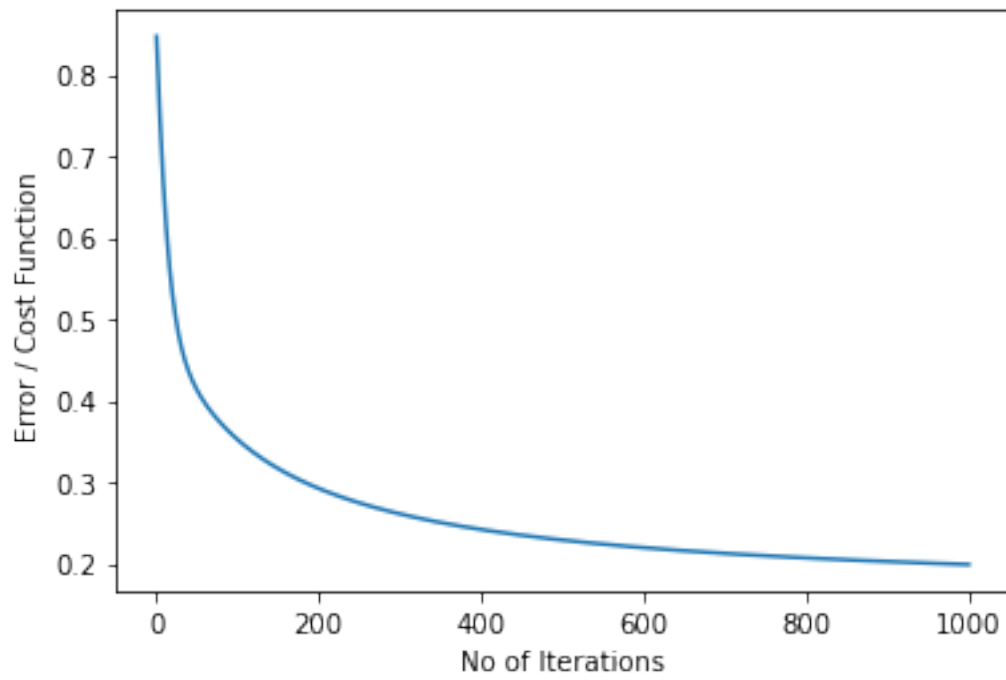
      plt.scatter(*X[y_train == 0 ].T, s=11, alpha= 1)
      plt.scatter(*X[y_train == 1 ].T, s=11, alpha= 1)
      plt.xlim(xmin, xmax)
      plt.ylim(ymin, ymax)
      plt.ylabel(r'$x_2$')
      plt.xlabel(r'$x_1$')

      plt.show()
```

```
[27]: plt.plot(I,C)
      plt.xlabel(" No of Iterations ")
      plt.ylabel("Error / Cost Function ")
```

```
[27]: Text(0, 0.5, 'Error / Cost Function ')
```



[]: