DATA ANALYSIS AND PREPROCESSING

```
In [1]:   import numpy as np
          import pandas as pd
          from sklearn.preprocessing import LabelEncoder
          import matplotlib.pyplot as plt
          import seaborn as sns
```

```
In [2]:   main_df = pd.read_csv("ionosphere.data",header=None)
```

```
In [3]:   main_df
```

Out[3]:

	0	1	2	3	4	5	6	7	8	9	...	25	26	
0	1	0	0.99539	-0.05889	0.85243	0.02306	0.83398	-0.37708	1.00000	0.03760	...	-0.51171	0.41078	-0.461
1	1	0	1.00000	-0.18829	0.93035	-0.36156	-0.10868	-0.93597	1.00000	-0.04549	...	-0.26569	-0.20468	-0.184
2	1	0	1.00000	-0.03365	1.00000	0.00485	1.00000	-0.12062	0.88965	0.01198	...	-0.40220	0.58984	-0.221
3	1	0	1.00000	-0.45161	1.00000	1.00000	0.71216	-1.00000	0.00000	0.00000	...	0.90695	0.51613	1.000
4	1	0	1.00000	-0.02401	0.94140	0.06531	0.92106	-0.23255	0.77152	-0.16399	...	-0.65158	0.13290	-0.532
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
346	1	0	0.83508	0.08298	0.73739	-0.14706	0.84349	-0.05567	0.90441	-0.04622	...	-0.04202	0.83479	0.001
347	1	0	0.95113	0.00419	0.95183	-0.02723	0.93438	-0.01920	0.94590	0.01606	...	0.01361	0.93522	0.049
348	1	0	0.94701	-0.00034	0.93207	-0.03227	0.95177	-0.03431	0.95584	0.02446	...	0.03193	0.92489	0.025
349	1	0	0.90608	-0.01657	0.98122	-0.01989	0.95691	-0.03646	0.85746	0.00110	...	-0.02099	0.89147	-0.077
350	1	0	0.84710	0.13533	0.73638	-0.06151	0.87873	0.08260	0.88928	-0.09139	...	-0.15114	0.81147	-0.048

351 rows × 35 columns

```
In [4]:   main_df.isna().sum()
```

Out[4]:
```
0       0
1       0
2       0
3       0
4       0
5       0
6       0
7       0
8       0
9       0
10      0
11      0
12      0
13      0
14      0
15      0
16      0
17      0
18      0
```

```
19    0
20    0
21    0
22    0
23    0
24    0
25    0
26    0
27    0
28    0
29    0
30    0
31    0
32    0
33    0
34    0
dtype: int64
```

In [5]:
```python
(main_df == 0).sum()
```

Out[5]:
```
0      38
1     351
2      25
3      30
4      38
5      46
6      37
7      39
8      32
9      39
10     28
11     37
12     31
13     37
14     39
15     45
16     25
17     30
18     24
19     34
20     36
21     37
22     27
23     32
24     24
25     27
26      0
27      4
28     30
29     33
30     31
31     36
32     48
33     51
34      0
dtype: int64
```

In [6]:
```python
main_df.drop(main_df.columns[[1]], axis=1, inplace=True) #dropping the second column by i
main_df
```

Out[6]:

	0	2	3	4	5	6	7	8	9	10	...	25	26
0	1	0.99539	-0.05889	0.85243	0.02306	0.83398	-0.37708	1.00000	0.03760	0.85243	...	-0.51171	0.41078

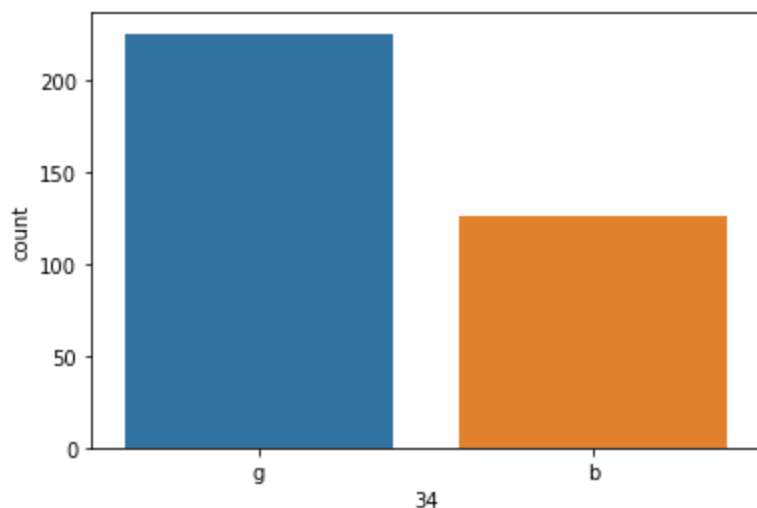|	0	2	3	4	5	6	7	8	9	10	...	25	26
1	1	1.00000	-0.18829	0.93035	-0.36156	-0.10868	-0.93597	1.00000	-0.04549	0.50874	...	-0.26569	-0.20468
2	1	1.00000	-0.03365	1.00000	0.00485	1.00000	-0.12062	0.88965	0.01198	0.73082	...	-0.40220	0.58984
3	1	1.00000	-0.45161	1.00000	1.00000	0.71216	-1.00000	0.00000	0.00000	0.00000	...	0.90695	0.51613
4	1	1.00000	-0.02401	0.94140	0.06531	0.92106	-0.23255	0.77152	-0.16399	0.52798	...	-0.65158	0.13290
...	...	...	...	...	...	...	...	...	...	...	...	...	...
346	1	0.83508	0.08298	0.73739	-0.14706	0.84349	-0.05567	0.90441	-0.04622	0.89391	...	-0.04202	0.83479
347	1	0.95113	0.00419	0.95183	-0.02723	0.93438	-0.01920	0.94590	0.01606	0.96510	...	0.01361	0.93522
348	1	0.94701	-0.00034	0.93207	-0.03227	0.95177	-0.03431	0.95584	0.02446	0.94124	...	0.03193	0.92489
349	1	0.90608	-0.01657	0.98122	-0.01989	0.95691	-0.03646	0.85746	0.00110	0.89724	...	-0.02099	0.89147
350	1	0.84710	0.13533	0.73638	-0.06151	0.87873	0.08260	0.88928	-0.09139	0.78735	...	-0.15114	0.81147

351 rows × 34 columns

In [7]:
```python
main_df[3]
```

Out[7]:
```
0      -0.05889
1      -0.18829
2      -0.03365
3      -0.45161
4      -0.02401
         ...
346     0.08298
347     0.00419
348    -0.00034
349    -0.01657
350     0.13533
Name: 3, Length: 351, dtype: float64
```

In [8]:
```python
sns.countplot(x=main_df[34],data=main_df)
```

Out[8]:
```
<AxesSubplot:xlabel='34', ylabel='count'>
```


In [9]:
```python
main_df[34].unique()
```

Out[9]:
```
array(['g', 'b'], dtype=object)
```

```
In [10]:   main_df[34].head()
```

Out[10]:
```
0    g
1    b
2    g
3    b
4    g
Name: 34, dtype: object
```

```
In [11]:   #Encoding the output class
           main_df[34]=main_df[34].astype('category')
           encoding={'g':1,'b':0}
           main_df[34].replace(encoding,inplace=True)
           main_df
```
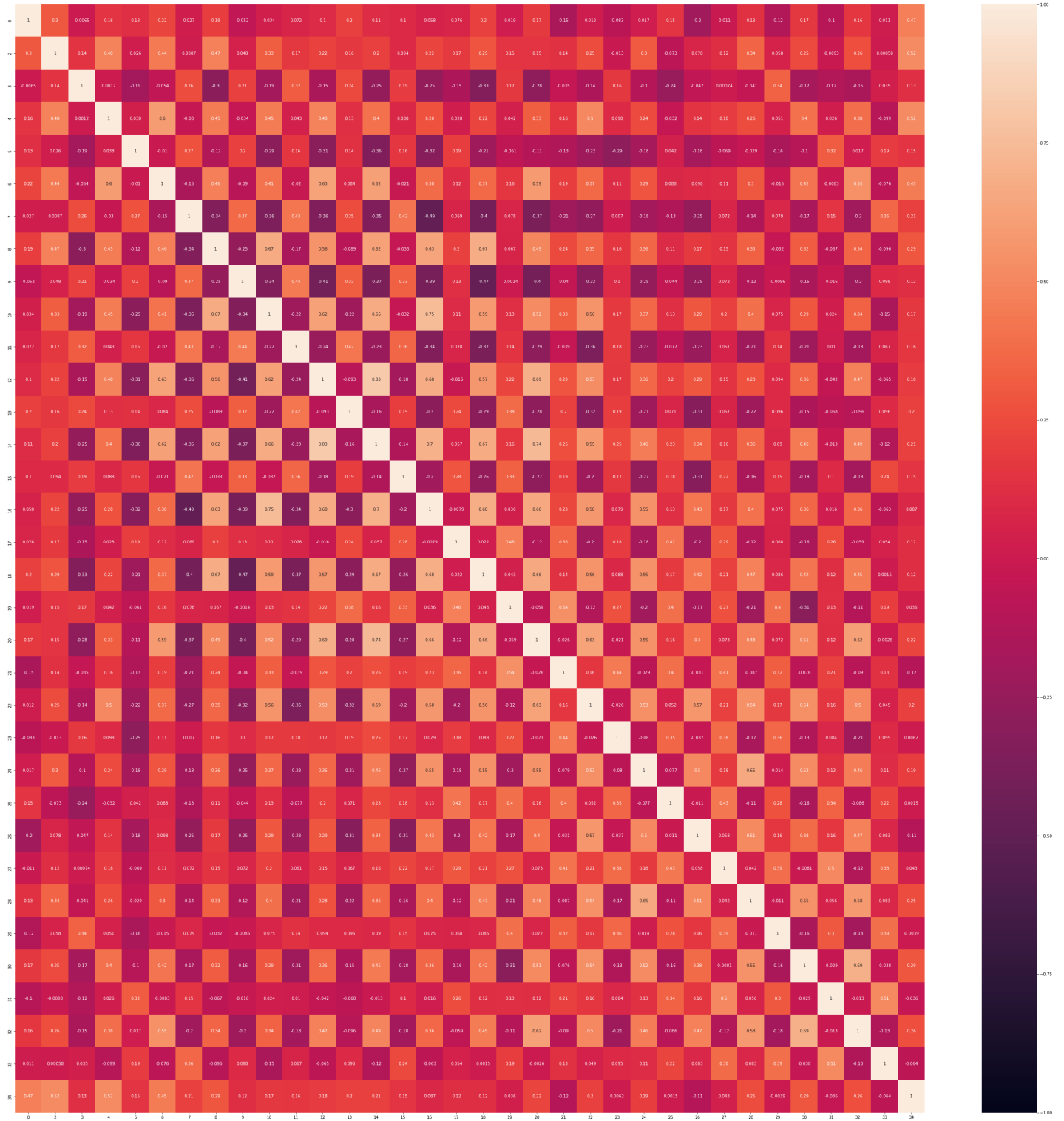
Out[11]:

	0	2	3	4	5	6	7	8	9	10	...	25	26
0	1	0.99539	-0.05889	0.85243	0.02306	0.83398	-0.37708	1.00000	0.03760	0.85243	...	-0.51171	0.41078
1	1	1.00000	-0.18829	0.93035	-0.36156	-0.10868	-0.93597	1.00000	-0.04549	0.50874	...	-0.26569	-0.20468
2	1	1.00000	-0.03365	1.00000	0.00485	1.00000	-0.12062	0.88965	0.01198	0.73082	...	-0.40220	0.58984
3	1	1.00000	-0.45161	1.00000	1.00000	0.71216	-1.00000	0.00000	0.00000	0.00000	...	0.90695	0.51613
4	1	1.00000	-0.02401	0.94140	0.06531	0.92106	-0.23255	0.77152	-0.16399	0.52798	...	-0.65158	0.13290
...	...	...	...	...	...	...	...	...	...	...	...	...	...
346	1	0.83508	0.08298	0.73739	-0.14706	0.84349	-0.05567	0.90441	-0.04622	0.89391	...	-0.04202	0.83479
347	1	0.95113	0.00419	0.95183	-0.02723	0.93438	-0.01920	0.94590	0.01606	0.96510	...	0.01361	0.93522
348	1	0.94701	-0.00034	0.93207	-0.03227	0.95177	-0.03431	0.95584	0.02446	0.94124	...	0.03193	0.92489
349	1	0.90608	-0.01657	0.98122	-0.01989	0.95691	-0.03646	0.85746	0.00110	0.89724	...	-0.02099	0.89147
350	1	0.84710	0.13533	0.73638	-0.06151	0.87873	0.08260	0.88928	-0.09139	0.78735	...	-0.15114	0.81147

351 rows × 34 columns

```
In [12]:   plt.figure(figsize=(50,50))
           sns.heatmap(main_df.corr(), vmin=-1, annot=True)
```

Out[12]:   <AxesSubplot:>

In [13]: `main_df.corr()`

Out[13]:

	0	2	3	4	5	6	7	8	9	10	...
0	1.000000	0.302034	-0.006529	0.156152	0.127606	0.221867	0.027079	0.189242	-0.051883	0.034138	...
2	0.302034	1.000000	0.143365	0.476587	0.025768	0.440254	0.008717	0.471614	0.047916	0.325016	...
3	-0.006529	0.143365	1.000000	0.001152	-0.190308	-0.054030	0.255003	-0.302317	0.207697	-0.190090	...
4	0.156152	0.476587	0.001152	1.000000	0.038323	0.597075	-0.029794	0.450454	-0.034236	0.449829	...
5	0.127606	0.025768	-0.190308	0.038323	1.000000	-0.010227	0.274747	-0.120712	0.200080	-0.291447	...
6	0.221867	0.440254	-0.054030	0.597075	-0.010227	1.000000	-0.150424	0.461889	-0.090268	0.412876	...
7	0.027079	0.008717	0.255003	-0.029794	0.274747	-0.150424	1.000000	-0.336013	0.373567	-0.364003	...

	0	2	3	4	5	6	7	8	9	10	...
8	0.189242	0.471614	-0.302317	0.450454	-0.120712	0.461889	-0.336013	1.000000	-0.251950	0.670813	...	
9	-0.051883	0.047916	0.207697	-0.034236	0.200080	-0.090268	0.373567	-0.251950	1.000000	-0.337374	...	-(
10	0.034138	0.325016	-0.190090	0.449829	-0.291447	0.412876	-0.364003	0.670813	-0.337374	1.000000	...	(
11	0.072216	0.169981	0.315877	0.042896	0.163933	-0.020395	0.429146	-0.167705	0.441505	-0.217968	...	-(
12	0.102558	0.217597	-0.149216	0.482118	-0.307197	0.631060	-0.355875	0.562072	-0.406358	0.619217	...	(
13	0.199230	0.164550	0.236604	0.127217	0.135206	0.083657	0.253740	-0.088988	0.323813	-0.216747	...	(
14	0.113622	0.198306	-0.253150	0.398878	-0.359342	0.615407	-0.352216	0.618461	-0.374908	0.664243	...	(
15	0.100474	0.094301	0.185872	0.087992	0.157740	-0.021493	0.419673	-0.032689	0.334135	-0.031705	...	(
16	0.057783	0.221446	-0.251143	0.277932	-0.316705	0.379737	-0.491863	0.633574	-0.392047	0.748290	...	(
17	0.076019	0.172002	-0.147451	0.027588	0.188073	0.115927	0.068717	0.200786	0.130752	0.107085	...	(
18	0.200237	0.285280	-0.332213	0.221532	-0.208571	0.372572	-0.400523	0.673490	-0.471665	0.590598	...	(
19	0.019230	0.150800	0.167244	0.041959	-0.061261	0.158917	0.077624	0.067314	-0.001418	0.128132	...	(
20	0.173828	0.149374	-0.281084	0.326223	-0.114966	0.586627	-0.370473	0.492411	-0.404818	0.518041	...	(
21	-0.153902	0.138065	-0.035401	0.163663	-0.132422	0.190805	-0.212007	0.237322	-0.040414	0.325267	...	(
22	0.011772	0.250832	-0.143719	0.502878	-0.215778	0.373186	-0.270624	0.352218	-0.318463	0.561689	...	(
23	-0.082586	-0.012570	0.164196	0.098274	-0.286541	0.112717	0.007045	0.161258	0.101850	0.172768	...	(
24	0.016717	0.304898	-0.104632	0.243063	-0.177576	0.286749	-0.179928	0.356564	-0.254785	0.365821	...	-(
25	0.149789	-0.073202	-0.236987	-0.032254	0.041787	0.087734	-0.133023	0.107478	-0.043680	0.131849	...	
26	-0.203100	0.077911	-0.046910	0.140899	-0.175433	0.097566	-0.254130	0.172210	-0.250947	0.292281	...	-(
27	-0.010725	0.123345	0.000743	0.184517	-0.068775	0.109391	0.072373	0.146817	0.072018	0.197369	...	(
28	0.133632	0.344459	-0.041090	0.257646	-0.029392	0.300632	-0.139725	0.329813	-0.123296	0.396851	...	-(
29	-0.121415	0.057890	0.342301	0.051068	-0.158090	-0.015158	0.078585	-0.031983	-0.008578	0.074600	...	(
30	0.167031	0.246653	-0.172276	0.399840	-0.100240	0.415216	-0.166682	0.316021	-0.155661	0.294646	...	-(
31	-0.100914	-0.009332	-0.122788	0.025681	0.316802	-0.008323	0.152381	-0.067499	-0.015640	0.023922	...	(
32	0.162962	0.263343	-0.153964	0.383467	0.016899	0.545881	-0.200860	0.344814	-0.203629	0.339506	...	-(
33	0.010788	0.000584	0.034608	-0.099478	0.185215	-0.076460	0.360610	-0.095597	0.098104	-0.152225	...	(
34	0.465614	0.519145	0.125884	0.516477	0.149099	0.450429	0.207544	0.294852	0.120634	0.167908	...	(

34 rows × 34 columns

In [14]:
```python
#selecting the columns with high co-relation with output column for multivariate logistic
res_df=main_df[[0,2,4,6,34]]
res_df=res_df.drop_duplicates(keep='first')
res_df
```

Out[14]:

	0	2	4	6	34
0	1	0.99539	0.85243	0.83398	1
1	1	1.00000	0.93035	-0.10868	0
2	1	1.00000	1.00000	1.00000	1

	0	2	4	6	34
3	1	1.00000	1.00000	0.71216	0
4	1	1.00000	0.94140	0.92106	1
...	...	...	...	...	...
346	1	0.83508	0.73739	0.84349	1
347	1	0.95113	0.95183	0.93438	1
348	1	0.94701	0.93207	0.95177	1
349	1	0.90608	0.98122	0.95691	1
350	1	0.84710	0.73638	0.87873	1

294 rows × 5 columns

In [15]:
```python
#train_test split
train = res_df.sample(frac = 0.80, random_state= 100)
test = res_df.drop(train.index)
train = train.to_numpy()
test = test.to_numpy()
train_x = train[:,0:4]
train_y = train[:,4:5]
test_x = test[:,0:4]
test_y = test[:,4:5]
train_x=train_x.T
train_y=train_y.reshape(1,train_x.shape[1])
test_x=test_x.T
test_y=test_y.reshape(1,test_x.shape[1])
```

In [16]:
```python
print("Shape of train_x : ", train_x.shape)
print("Shape of train_y : ", train_y.shape)
print("Shape of test_x : ", test_x.shape)
print("Shape of test_y : ", test_y.shape)
```

```
Shape of train_x :  (4, 235)
Shape of train_y :  (1, 235)
Shape of test_x :  (4, 59)
Shape of test_y :  (1, 59)
```

LOGISTIC REGRESSION

In [17]:
```python
def sigmoid(x):
    res = 1/(1+np.exp(-x))
    return res
```

In [18]:
```python
def Logistic_Regression(X, Y):

    k=.003 #learning rate
    m = X.shape[1] #No. of training samples
    n = X.shape[0] #No. of features
    W = np.zeros((n,1)) #Initializing weights
    B = 0               #Initializing bias
    cost_val = []      #for keeping track of the cost values at each iteration

    for i in range(30000):
```

```
        y_pred = sigmoid(np.dot(W.T, X) + B)
        cost = -(1/m)*np.sum( Y*np.log(y_pred) + (1-Y)*np.log(1-y_pred))        # cost func
        cost_val.append(cost)
        print("cost after ", i, "iteration is : ", cost)

        # Gradient Descent
        d_wrt_W = (1/m)*np.dot(y_pred-Y, X.T)
        d_wrt_B = (1/m)*np.sum(y_pred - Y)
        W = W - k*d_wrt_W.T
        B = B - k*d_wrt_B

    return W, B, cost_val
```

In [19]:
```
W, B, cost_val=Logistic_Regression(train_x, train_y)
```

```
cost after  0 iteration is :   0.6931471805599453
cost after  1 iteration is :   0.6925690149914489
cost after  2 iteration is :   0.6919932813160913
cost after  3 iteration is :   0.6914199685512581
cost after  4 iteration is :   0.6908490657567229
cost after  5 iteration is :   0.6902805620346065
cost after  6 iteration is :   0.6897144465293329
cost after  7 iteration is :   0.6891507084275834
cost after  8 iteration is :   0.6885893369582495
cost after  9 iteration is :   0.6880303213923844
cost after  10 iteration is :   0.6874736510431521
cost after  11 iteration is :   0.686919315265775
cost after  12 iteration is :   0.6863673034574812
cost after  13 iteration is :   0.6858176050574472
cost after  14 iteration is :   0.6852702095467424
cost after  15 iteration is :   0.6847251064482701
cost after  16 iteration is :   0.6841822853267068
cost after  17 iteration is :   0.6836417357884417
cost after  18 iteration is :   0.6831034474815131
cost after  19 iteration is :   0.6825674100955437
cost after  20 iteration is :   0.6820336133616749
cost after  21 iteration is :   0.6815020470524996
cost after  22 iteration is :   0.6809727009819933
cost after  23 iteration is :   0.680445565005444
cost after  24 iteration is :   0.6799206290193814
cost after  25 iteration is :   0.6793978829615034
cost after  26 iteration is :   0.678877316810602
cost after  27 iteration is :   0.6783589205864894
cost after  28 iteration is :   0.6778426843499201
cost after  29 iteration is :   0.6773285982025138
cost after  30 iteration is :   0.6768166522866762
cost after  31 iteration is :   0.6763068367855195
cost after  32 iteration is :   0.6757991419227809
cost after  33 iteration is :   0.6752935579627396
cost after  34 iteration is :   0.6747900752101345
cost after  35 iteration is :   0.6742886840100787
cost after  36 iteration is :   0.6737893747479742
cost after  37 iteration is :   0.6732921378494255
cost after  38 iteration is :   0.6727969637801511
cost after  39 iteration is :   0.6723038430458959
cost after  40 iteration is :   0.6718127661923402
cost after  41 iteration is :   0.671323723850105
cost after  42 iteration is :   0.6708367065091869
cost after  43 iteration is :   0.67035170496981
cost after  44 iteration is :   0.6698687098913895
cost after  45 iteration is :   0.6693877120179071
cost after  46 iteration is :   0.6689087021327242
cost after  47 iteration is :   0.6684316710584832
cost after  48 iteration is :   0.6679566096570124
```

```
cost after  49 iteration is :  0.6674835088292272
cost after  50 iteration is :  0.6670123595150321
cost after  51 iteration is :  0.6665431526932216
cost after  52 iteration is :  0.6660758793813791
cost after  53 iteration is :  0.6656105306357774
cost after  54 iteration is :  0.6651470975512762
cost after  55 iteration is :  0.66468557126122
cost after  56 iteration is :  0.6642259429373355
cost after  57 iteration is :  0.6637682037896279
cost after  58 iteration is :  0.6633123450662757
cost after  59 iteration is :  0.6628583580535273
cost after  60 iteration is :  0.6624062340755945
cost after  61 iteration is :  0.6619559644945457
cost after  62 iteration is :  0.6615075407102006
cost after  63 iteration is :  0.6610609541600213
cost after  64 iteration is :  0.6606161963190061
cost after  65 iteration is :  0.6601732586995789
cost after  66 iteration is :  0.6597321328514817
cost after  67 iteration is :  0.6592928103616649
cost after  68 iteration is :  0.6588552828541765
cost after  69 iteration is :  0.658419541990052
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cost after    1762 iteration is :    0.5076716646724374
cost after    1763 iteration is :    0.5076455039050527
cost after    1764 iteration is :    0.5076193548696587
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cost after  1765 iteration is :  0.5075932175546227
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cost after   2028 iteration is :   0.5010950517873497
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cost after  2226 iteration is :  0.4966405233888593
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cost after   3023 iteration is :   0.481659217024068
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cost after   3134 iteration is :   0.47988269189148414
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cost after  3395 iteration is :  0.4759536180771779
cost after  3396 iteration is :  0.47593919789281985
cost after  3397 iteration is :  0.4759247823626609
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cost after  3408 iteration is :  0.47576651813138865
cost after  3409 iteration is :  0.4757521582944453
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cost after  3411 iteration is :  0.47572345250266185
cost after  3412 iteration is :  0.4757091065438128
cost after  3413 iteration is :  0.47569476520698806
cost after  3414 iteration is :  0.47568042849018566
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cost after  3416 iteration is :   0.47565176890864586
cost after  3417 iteration is :   0.4756374460399102
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cost after  3480 iteration is :   0.47474432063711264
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cost after    3546 iteration is :   0.4738277653447447
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cost after   3744 iteration is :   0.47119004582704455
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cost after   3807 iteration is :   0.4703843946879881
cost after   3808 iteration is :   0.4703717326850594
cost after   3809 iteration is :   0.47035907458739484
cost after   3810 iteration is :   0.4703464203933611
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cost after   4601 iteration is :   0.46143672706798644
cost after   4602 iteration is :   0.46142671229 48113
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cost after   4603 iteration is :   0.46141670035179827
cost after   4604 iteration is :   0.4614066912378349
cost after   4605 iteration is :   0.4613966849518093
cost after   4606 iteration is :   0.4613866814926103
cost after   4607 iteration is :   0.461376680859127
cost after   4608 iteration is :   0.4613666830502494
cost after   4609 iteration is :   0.4613566880648677
cost after   4610 iteration is :   0.46134669590187277
cost after   4611 iteration is :   0.46133670656015585
cost after   4612 iteration is :   0.46132672003860886
cost after   4613 iteration is :   0.46131673633612413
cost after   4614 iteration is :   0.46130675545159455
cost after   4615 iteration is :   0.4612967773839138
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cost after   4617 iteration is :   0.4612768296946741
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cost after   4621 iteration is :   0.461236968069746684
cost after   4622 iteration is :   0.46122700968906616
cost after   4623 iteration is :   0.46121705411639996
cost after   4624 iteration is :   0.46120710135064674
cost after   4625 iteration is :   0.46119715139070494
cost after   4626 iteration is :   0.4611872042354737
cost after   4627 iteration is :   0.4611772598838529
cost after   4628 iteration is :   0.4611673183347424
cost after   4629 iteration is :   0.461157379587043
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cost after   4636 iteration is :   0.4610878867004255
cost after   4637 iteration is :   0.46107797032450193
cost after   4638 iteration is :   0.461068056740011886
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cost after   4640 iteration is :   0.4610482379415983
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cost after   4648 iteration is :   0.4609690741905585
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cost after   4651 iteration is :   0.4609394336761888
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cost after   4653 iteration is :   0.4609196872164343
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cost after   4659 iteration is :   0.4608605143807328
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cost after   4663 iteration is :   0.460821121189812
cost after   4664 iteration is :   0.4608112798029329
cost after   4665 iteration is :   0.46080144117823185
cost after   4666 iteration is :   0.4607916053146282
cost after   4667 iteration is :   0.4607817722110424
cost after   4668 iteration is :   0.46077194186639486
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cost after  4669 iteration is :  0.4607621142796069
cost after  4670 iteration is :  0.4607522894496
cost after  4671 iteration is :  0.4607424673752963
cost after  4672 iteration is :  0.46073264805561864
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cost after  4674 iteration is :  0.46071301767583434
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cost after  4719 iteration is :  0.46027422751570524
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cost after  4733 iteration is :  0.4601388360896322
cost after  4734 iteration is :  0.4601291854735947
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cost after   4743 iteration is :   0.46004245075312777
cost after   4744 iteration is :   0.46003282696770653
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cost after   4782 iteration is :   0.4596690975501739
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cost after   4798 iteration is :   0.4595170912483526
cost after   4799 iteration is :   0.45950761318317170
cost after   4800 iteration is :   0.45949813773879505
```

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cost after   4801 iteration is :   0.45948866649142084
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cost after   4865 iteration is :   0.4588878072464823
cost after   4866 iteration is :   0.4588785025548792
```

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cost after   4867 iteration is :   0.45886920004171504
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cost after   4931 iteration is :   0.4582791309920586
cost after   4932 iteration is :   0.45826999276768293
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cost after   4933 iteration is :   0.4582608570332509
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cost after   4942 iteration is :   0.45817874731360075
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cost after   4948 iteration is :   0.45812411916250145
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cost after   4968 iteration is :   0.4579426676109985
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cost after   4993 iteration is :   0.457717233737691
cost after   4994 iteration is :   0.45770824810281274
cost after   4995 iteration is :   0.4576992648995697
cost after   4996 iteration is :   0.4576902841270349
cost after   4997 iteration is :   0.45768130578428619
cost after   4998 iteration is :   0.457672329870385
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cost after  4999 iteration is :  0.45766335638441813
cost after  5000 iteration is :  0.45765438532545462
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cost after  5004 iteration is :  0.45761852534117027
cost after  5005 iteration is :  0.45760956640337055
cost after  5006 iteration is :  0.45760060988703366
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cost after  5008 iteration is :  0.45758270411505987
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cost after  5063 iteration is :  0.4570940613450461
cost after  5064 iteration is :  0.45708524370930077
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cost after   5129 iteration is :   0.45651713547030026
cost after   5130 iteration is :   0.4565084722005886
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cost after  5196 iteration is :  0.4559417610574076
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cost after    5263 iteration is :   0.45537649991158063
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cost after   5329 iteration is :   0.45482931978020696
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cost after  5460 iteration is :  0.45377069284673033
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cost after   7042 iteration is :   0.44333690002376186
cost after   7043 iteration is :   0.44333143023041277
cost after   7044 iteration is :   0.44332596161859356
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cost after   7110 iteration is :   0.4429676264863035
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cost after   7437 iteration is :   0.4412645074030174
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cost after   7439 iteration is :   0.44125444552092563
cost after   7440 iteration is :   0.4412494161413117
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cost after    7505 iteration is :    0.44092472345521355
cost after    7506 iteration is :    0.44091976205185374
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cost after   7901 iteration is :   0.439036551424573
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cost after   9880 iteration is :   0.4314364013821742
cost after   9881 iteration is :   0.4314331762702596
cost after   9882 iteration is :   0.4314299516725106
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cost after  9948 iteration is :  0.431218258264034
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cost after   10277 iteration is :   0.43019508617288454
cost after   10278 iteration is :   0.43019205494946733
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cost after   12718 iteration is :   0.42393578197113874
cost after   12719 iteration is :   0.42393360297247473
cost after   12720 iteration is :   0.4239314242334314
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cost after   14766 iteration is :   0.4199464302320161
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cost after  15556 iteration is :  0.4186169446718593
cost after  15557 iteration is :  0.41861532285001163
cost after  15558 iteration is :  0.4186137011751069
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cost after   15624 iteration is :   0.4185069941777188
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cost after   16020 iteration is :   0.4178797700961457
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cost after   17998 iteration is :   0.415037661087682
cost after   17999 iteration is :   0.41503633138430224
cost after   18000 iteration is :   0.41503500177790026
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cost after  19189 iteration is :  0.41351867501515 85
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cost after   19647 iteration is :   0.4129662894417402
cost after   19648 iteration is :   0.4129651011281112
cost after   19649 iteration is :   0.41296391289021
cost after   19650 iteration is :   0.41296272472802553
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cost after   19716 iteration is :   0.41288447289490676
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```

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cost after  20046 iteration is :   0.4124980540048337
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cost after  20904 iteration is :  0.4115290090020035
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cost after   21695 iteration is :   0.41067739083436483
cost after   21696 iteration is :   0.4106763377806762
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cost after  26911 iteration is :  0.40583023781886324
cost after  26912 iteration is :  0.40582941120297383
cost after  26913 iteration is :  0.4058285846199389
cost after  26914 iteration is :  0.40582775806975546
cost after  26915 iteration is :  0.4058269315524204
cost after  26916 iteration is :  0.40582610506793076
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cost after  26918 iteration is :  0.40582445219747576
cost after  26919 iteration is :  0.40582362581150444
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cost after  26921 iteration is :  0.40582197313805907
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cost after  26974 iteration is :  0.40577822506370415
cost after  26975 iteration is :  0.40577740051180433
cost after  26976 iteration is :  0.40577657599257105
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cost after   26977 iteration is :   0.40577557515060011
cost after   26978 iteration is :   0.40577492705209156
cost after   26979 iteration is :   0.4057741026308394
cost after   26980 iteration is :   0.40577327824224418
cost after   26981 iteration is :   0.40577245388862957
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cost after   26983 iteration is :   0.4057708052723461
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cost after   26996 iteration is :   0.4057600924632684
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cost after   27002 iteration is :   0.40575514994867407
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cost after   27041 iteration is :   0.4057230521697812
cost after   27042 iteration is :   0.4057222297999808
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cost after   27043 iteration is :   0.40572140746626489
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cost after  27175 iteration is :  0.40561314279942957
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cost after   27241 iteration is :   0.40555922049515114
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cost after   27307 iteration is :   0.40550543711702025
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cost after  29997 iteration is :  0.40342255067691646
cost after  29998 iteration is :  0.40342181311012
cost after  29999 iteration is :  0.4034210755687244
```
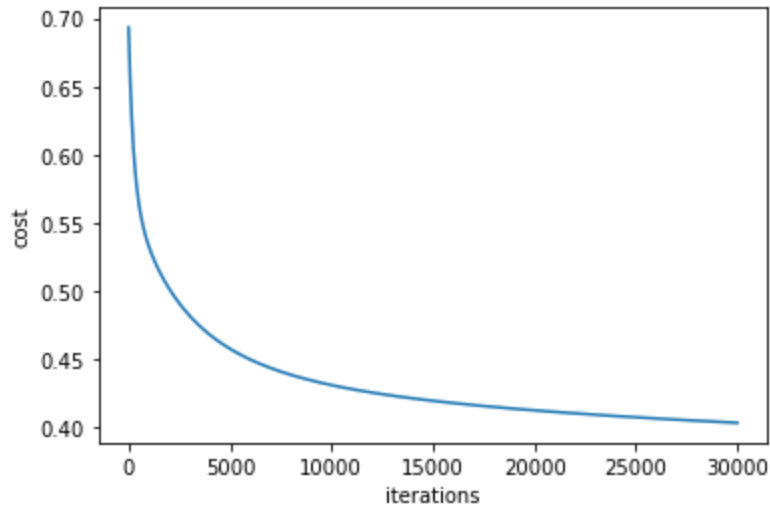
In [20]:
```python
W
```

Out[20]:
```
array([[0.57635478],
       [1.61016273],
       [1.58147715],
       [0.60585038]])
```

In [21]:
```python
plt.plot(list(range(30000)),cost_val)
plt.ylabel('cost')
```

```
plt.xlabel('iterations')
plt.show()
```


In [22]:
```python
def prediction(X,W,B):
    y_p = np.dot(W.T, X) + B
    y_pred = sigmoid(y_p)
    for i in range(y_pred.shape[1]):
        if (y_pred[0,i]<0.5):
            y_pred[0,i]=0
        else:
            y_pred[0,i]=1
    return y_pred
```

In [23]:
```python
def accuracy(X, Y, W, B):
    y_pred = prediction(X,W,B)
    acc = (1 - np.sum(np.absolute(y_pred - Y))/Y.shape[1])*100
    print("Accuracy of the model is : ",acc, "%")
```
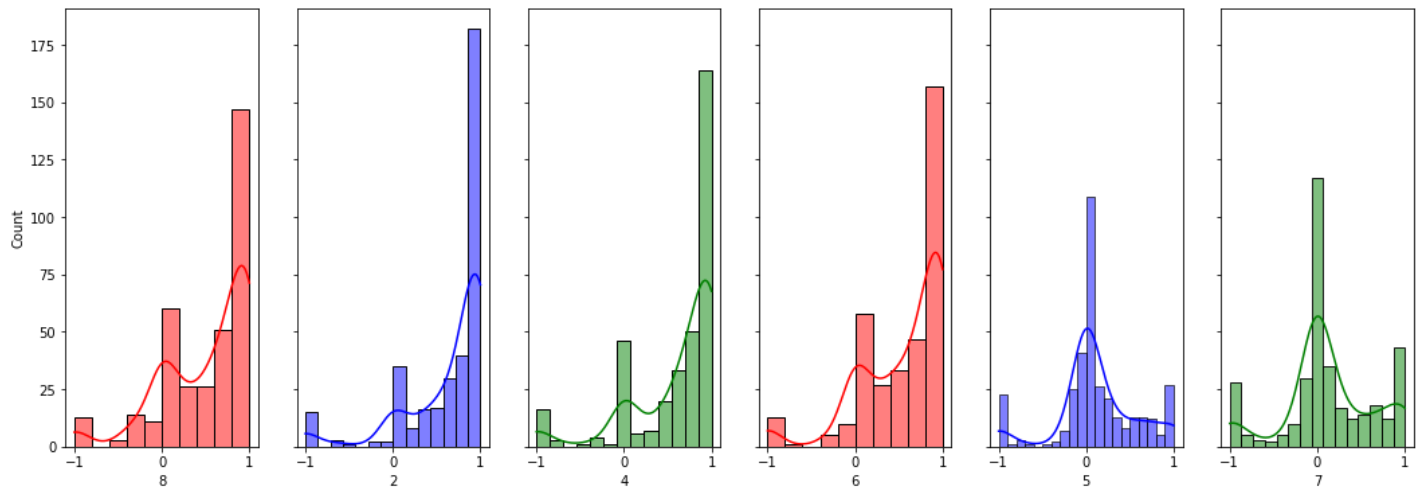
In [24]:
```python
accuracy(test_x, test_y, W, B)
```

Accuracy of the model is : 88.13559322033898 %

NAIVE BAYES

In [25]:
```python
#checking the distribution of the features
fig, axes = plt.subplots(1, 6, figsize=(18,6), sharey=True)
sns.histplot(main_df, ax=axes[0], x=8, kde=True, color='r')
sns.histplot(main_df, ax=axes[1], x=2, kde=True, color='b')
sns.histplot(main_df, ax=axes[2], x=4, kde=True, color='g')
sns.histplot(main_df, ax=axes[3], x=6, kde=True, color='r')
sns.histplot(main_df, ax=axes[4], x=5, kde=True, color='b')
sns.histplot(main_df, ax=axes[5], x=7, kde=True, color='g')
```

Out[25]:
<AxesSubplot:xlabel='7', ylabel='Count'>

```
In [26]:    #Only selecting the 5 and 7 as input features for their gaussian like distribution
            df = main_df[[5,7,34]]
            df=df.drop_duplicates(keep='first') # Dropping the duplicate rows
            df
```

Out[26]:

	5	7	34
0	0.02306	-0.37708	1
1	-0.36156	-0.93597	0
2	0.00485	-0.12062	1
3	1.00000	-1.00000	0
4	0.06531	-0.23255	1
...	...	...	...
346	-0.14706	-0.05567	1
347	-0.02723	-0.01920	1
348	-0.03227	-0.03431	1
349	-0.01989	-0.03646	1
350	-0.06151	0.08260	1

285 rows × 3 columns

```
In [27]:    #train-test split
            train = df.sample(frac = 0.80, random_state= 150)
            test = df.drop(train.index)
            X_test = test.iloc[:,:-1].values
            Y_test = test.iloc[:,-1].values
```

```
In [28]:    train.shape
```

Out[28]:   (228, 3)

```
In [29]:    X_test.shape
```

Out[29]:   (57, 2)

```
In [30]:   Y_test

Out[30]:   array([0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1,
                  0, 0, 1, 1, 1, 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], dtype=int64)

In [31]:   def prior_probability(data, Y):
               classes = sorted(list(data[Y].unique()))
               prior_probabilities = []
               for i in classes:
                   m=len(data[data[Y]==i])
                   n=len(data)
                   prior_probabilities.append(m/n)
               return prior_probabilities
```

Fitting Normal Distribution

```
In [32]:   def likelihood_calculation(data, attribute, attribute_val, Y, prob):
               data = data[data[Y]==prob]
               mean = data[attribute].mean()
               std = data[attribute].std()
               likelihood = (1 / (np.sqrt(2 * np.pi) * std)) *  np.exp(-((attribute_val-mean)**2 / (2
               return likelihood
```

```
In [36]:   def naive_bayes(data, X, Y):
               attributes = list(data.columns)[:-1]
               prior = prior_probability(data, Y)
               Y_pred = []
               for x in X:
                   classes = sorted(list(data[Y].unique()))
                   likelihood = [1]*len(classes)
                   for j in range(len(classes)):
                       for i in range(len(attributes)):
                           likelihood[j] = likelihood[j]*likelihood_calculation(data, attributes[i],

                   # calculation of posterior probability
                   post_prob = [1]*len(classes)
                   for j in range(len(classes)):
                       post_prob[j] = likelihood[j] * prior[j]
                   Y_pred.append(np.argmax(post_prob))
               Y_pred=np.array(Y_pred)
               return Y_pred
```

```
In [37]:   Y_pred = naive_bayes(train, X=X_test, Y=34)
```

```
In [38]:   Y_pred
```

```
Out[38]:   array([1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
                  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], dtype=int64)
```

```
In [39]:   acc = (1 - np.sum(np.absolute(Y_pred - Y_test))/57)*100
           acc
```

```
Out[39]:   85.96491228070175
```

RESULT ANALYSIS

S.No.	Model	ACCURACY
1	LOGISTIC REGRESSION	88.13559322033898 %
2	NAIVE BAYES	85.96491228070175 %

S.No.	Model	ACCURACY
1	LOGISTIC REGRESSION	88.13559322033898 %
2	NAIVE BAYES	85.96491228070175 %