test_addition

April 18, 2025

[1]:
```
import numpy as np
import matplotlib.pyplot as plt
```

[2]:
```
import random
```

1 1. Preparing a dataset

[3]:
```
rangeData=20
lenData =1000
testProportion = 0.3
testEnd = round(lenData * testProportion)
```

Now generate a random number

[4]:
```
dataIn = np.random.randint(-rangeData,rangeData+1,size=(lenData,2))

print(dataIn)
```

```
[[ -5  -6]
 [ -8  -7]
 [  6  15]
 …
 [ 10   9]
 [  5  20]
 [ -6 -11]]
```

[5]:
```
dataOut=dataIn[:,0] + dataIn[:,1]

print(dataOut)
```

```
[-11 -15  21  -2 -16   5  18  -4  12 -11 -23   6 -13 -18 -16  -5  11  13
  22 -26 -27  13  10  10 -11 -26  -1   8 -18 -19 -19  -1  24  -2  38  -7
 -10  13   3 -32  10   3   5  -4 -19  23  -1 -10  -5  16 -30  14  12  11
  22 -12  19  28 -12 -10  -2 -19 -25  29  16   5  29 -10   5   7   7   7
   8   1   8  30  11  -1  28   6 -12   3   3  -9   1 -26 -28 -33  20  -7
 -16   2 -30 -13  14   7  29  -1 -14   7   1 -11 -36  24  23   7   8 -19
   1  -3 -31  -5  33 -28  19   8  28  -5 -23   7 -31   0 -28   6   3  17
```

35	17	13	-1	-5	-3	-17	-22	-29	31	-6	16	-6	-13	-20	-21	-17	-24
-2	-24	9	6	-6	-17	-3	31	-35	-5	-16	-11	29	-23	31	9	15	0
25	10	-20	-3	9	29	-1	12	-2	8	-11	-18	-6	-8	-9	-11	14	4
-3	11	-9	6	5	-4	-3	-1	39	1	29	15	-25	28	-1	-18	13	23
-10	-10	12	-1	23	-17	1	11	-23	5	19	-40	-30	30	-2	15	10	2
-12	9	19	13	29	16	4	-21	32	-18	-15	-4	-14	3	-17	-6	7	5
13	15	-20	-19	7	14	1	-18	-11	2	16	14	-31	29	-9	-3	-15	2
7	-27	35	-19	-26	-20	17	1	22	-25	-24	7	-16	15	-13	-7	-2	14
21	-8	7	-11	35	-21	0	-9	5	5	20	-17	8	-8	-8	-27	6	30
2	-4	2	5	-3	-17	0	-3	11	17	6	-13	-14	-1	-19	-10	7	-7
8	24	-10	31	6	29	-32	7	16	11	-9	-14	-23	15	11	-18	-19	25
8	18	1	-29	-5	-14	29	-25	12	1	15	7	4	-3	3	8	-3	10
10	-4	13	-4	16	-28	-3	-12	-12	-12	-6	-20	-9	5	5	-26	-10	-18
19	-8	-17	-6	6	28	-39	3	-3	15	-6	8	11	-25	-20	18	-6	-30
37	-9	-1	5	4	-7	-1	0	25	21	27	-13	26	30	15	29	-2	2
-11	-21	-14	-18	5	22	-20	16	14	23	-12	-2	22	-2	-7	19	-25	6
-16	4	1	32	-2	-10	-17	19	-4	-26	-1	-18	36	3	13	-4	-18	1
4	-19	-37	33	-2	17	-23	-10	-1	11	-32	12	-10	-3	-16	11	-15	4
18	38	-9	-16	-6	3	36	11	0	-13	-17	-28	-18	-23	18	-25	10	25
-27	15	-1	-12	12	1	7	16	15	20	3	10	-17	-30	7	10	3	-8
-8	23	-3	-12	7	18	-1	-2	-2	-15	-28	-5	-12	-1	-3	-31	6	-7
-15	-12	33	-5	-26	-31	7	-19	4	9	8	-14	2	-15	-19	-6	10	17
-16	32	29	28	-37	-15	-11	-25	-13	-7	16	-33	-14	5	17	-14	1	-5
8	3	8	-21	-8	-7	-13	-35	-3	-1	6	-5	9	10	-8	-4	1	38
-25	-28	-12	-8	21	12	4	-18	-9	36	6	9	20	13	7	2	-16	-35
15	5	2	24	-27	-28	17	-6	4	-13	-2	-24	-10	-8	-26	33	-10	-12
-22	-18	-9	12	12	13	-18	-11	-14	19	-32	5	-8	16	1	6	-5	-20
20	24	6	20	5	8	-25	-2	10	8	3	-13	-4	-20	-20	30	25	4
3	-15	2	2	10	11	15	-6	-8	-25	21	-6	12	19	-15	-10	21	30
-2	-15	35	-5	11	24	15	-22	33	11	-24	28	-28	-5	14	-8	-4	-14
-9	-5	-27	1	20	13	16	24	16	1	-2	-26	-8	22	17	-6	-13	13
19	25	9	-14	-20	-28	-13	23	-22	-11	-6	27	-9	-26	-10	-11	-3	-1
6	-13	1	-5	24	24	-3	0	9	-9	4	7	7	9	2	15	-8	0
-15	9	-30	-8	-16	-1	-10	2	5	-17	3	2	7	10	12	4	-10	4
9	12	3	-15	25	-5	12	-26	-26	30	-17	0	-12	4	22	32	19	11
-7	-18	36	-26	8	2	-4	1	-24	0	25	2	20	-21	25	13	2	29
33	-3	8	-6	-21	25	-20	-18	1	8	10	-6	-14	-28	-13	-8	-5	5
-27	10	17	-20	-1	1	-5	-4	-18	6	-17	-18	18	-29	-16	-10	28	0
23	-37	7	13	11	-2	-21	5	-17	-17	-10	17	-7	-18	0	-14	-4	15
0	40	-32	4	-23	31	21	5	22	26	3	18	-4	1	-22	-4	2	-32
-23	38	19	20	-4	-18	1	5	35	-12	17	-11	-2	23	-5	1	21	1
0	-5	-32	19	-7	-3	11	-12	-10	4	2	-11	-12	4	10	11	34	1
4	2	21	-26	8	-2	-19	1	-6	4	-3	10	3	-1	30	-1	6	-20
-10	16	-16	3	12	20	21	11	20	27	-24	11	-23	4	17	26	2	-28
-3	10	5	-28	-1	6	4	-19	19	7	10	11	5	-2	10	18	-12	-5
15	13	7	24	-21	-5	4	27	-31	32	-10	5	-27	-3	20	18	-33	14
-12	-15	8	-26	20	4	26	-19	-10	8	9	-4	26	-15	-8	-5	35	-23
-28	-12	-23	19	12	-19	31	10	23	6	30	5	24	3	-7	13	34	23

```
 -20  36 -15  -3  -9  -1  -7  19  25 -17]
```

[6]:
```
# It creates a column vector of ones: np.ones([lenData, 1])

# Then it horizontally concatenates this with dataIn:


dataIn = np.concatenate( [     np.ones([lenData,1])    ,
                               dataIn
                        ] ,
                         axis=1
                       )

# dataIn = np.concatenate([np.ones([lenData,1]), dataIn], axis=1)
```

In NumPy:

axis=0 refers to rows (vertical stacking)

axis=1 refers to columns (horizontal stacking)

[7]:
```
a = np.array([[1, 2],
              [3, 4]])

b = np.array([[5],
              [6]])

np.concatenate([a, b], axis=1)
```

[7]:
```
array([[1, 2, 5],
       [3, 4, 6]])
```

Now, making the final dataset.

[8]:
```
print(testEnd)
print(f"Testing = 0 : {testEnd} and training is {testEnd+1} : {lenData}")
print(f"Also we have Input and Output : in Testing and Training ")
print("------------------")
print(f"Normally 70% in training and 30% in testing")

testingIn = dataIn[0:testEnd]
testingOut = dataOut[0:testEnd]

trainingIn = dataIn[testEnd:]
trainingOut=dataOut[testEnd:]
```

```
300
Testing = 0 : 300 and training is 301 : 1000
```

```
Also we have Input and Output : in Testing and Training
-----------------
Normally 70% in training and 30% in testing
```

[9]:
```python
print(testingIn[0])
print(testingOut[0])

print(trainingIn[0])
print(trainingOut[0])
```

```
[ 1. -5. -6.]
-11
[  1.   0. -14.]
-14
```

2 2. Setting up Neural Network

[10]:
```python
# Only one input layer ----> Length = 3 (1 bias + 2 numbers )
# Output layer lenth = 1 (result)

# setting a random weight in the range of -2 to 2
weights = 4*np.random.rand(3)-2

print(weights)
```

```
[-0.2769033  -1.75657219 -0.80155973]
```

[11]:
```python
# No need of activation function

# Output of neural network is DOT PRODUCT of two vectors.

def calculateOut(x,w):
    # x = input
    # w = weights
    return np.dot(x,w)
```

[12]:
```python
testIndex=10

calculateOut(trainingIn[testIndex] , weights)
```

[12]: -11.771348918645202

[13]:
```python
print(trainingIn[testIndex])
one = trainingIn[testIndex]

print(weights)
two = weights
```

```python
print(np.dot(one,two))
```

```
[ 1.  7. -1.]
[-0.2769033  -1.75657219 -0.80155973]
-11.771348918645202
```

[14]:
```python
# Since we are giving only index, so we need to check everything as our output␣
↪matches or not
#
calculateOut(testingIn,weights)
```

[14]:
```
array([ 13.31531606,  19.38659237, -22.83973247,  16.6064155 ,
        23.05318949,   9.08547245, -31.89520277,   9.61442284,
       -18.49073224,  -0.05485836,  29.61912008, -10.81633646,
         8.23334832,  25.61132141,  29.7382767 ,  -5.81922922,
       -11.95909775,  -8.78715493, -27.46134204,  32.97881174,
        29.96032164,  -9.74216739, -17.84262523, -16.88761277,
        17.1353659 ,  39.66389895,  -2.34038095, -23.87960543,
        18.9262342 ,  17.81776902,  15.9077441 ,  16.75986823,
       -28.10944905,  -9.17892088, -47.92639745,  13.92912696,
        20.153856  ,  -5.92211755,  -7.4566448 ,  41.60821998,
         0.30261148,   4.95851716, -12.8798141 ,   8.65941038,
        32.1429559 , -23.48783948,   9.11976856,   2.96363174,
        -1.04416693, -22.65198363,  39.05008805, -26.77893892,
        -9.89562011, -18.64418496, -21.73126729,   1.70171383,
       -31.74175005, -34.18072536,   5.52176367,  20.153856  ,
        18.51644042,  20.68280639,  27.40218971, -32.11724772,
       -29.33707085,  -0.46465214, -35.93729755,  23.97390583,
       -16.69986394,  -6.8428339 , -22.12303324,   6.52734052,
       -21.01456806,  15.15674876,   1.90573095, -35.78384483,
       -14.82413513,  10.07478102, -32.27070044, -20.36646105,
        25.5770253 ,   3.04849225,   5.91352962,   8.84715922,
         3.69659926,  32.02379928,  33.62691875,  38.58972988,
       -31.58829732,  23.47925155,  12.54805244,  15.31020148,
        36.18505068,  23.51354766, -12.45375204, -21.16802078,
       -37.84732247,   6.25473118,  11.89994543, -17.34797095,
        -4.89851287,  26.68549048,  43.85944646, -29.06446151,
       -26.35287685,  -4.93280898, -10.50943101,  22.59283131,
       -14.44863746,  17.40797524,  43.67169762,  -7.72925414,
       -44.87361124,  35.53694367, -30.78673759,  -2.86933134,
       -38.95578765,  20.92111962,  28.66410762,   6.52734052,
        36.98661041,  14.04828358,  31.71689383,  -6.99628663,
       -12.23170709, -33.00366796, -45.52171825, -24.40855583,
       -14.51722968, -17.62058029,  -2.95419185,  -5.51232377,
        14.30462463,  20.22244822,  35.38349094, -39.45044194,
        -8.83771932, -32.20210822,  -6.9276944 ,   7.27833586,
```

```
 31.03449071,  28.97101307,  20.98971184,  33.28571719,
  5.146266  ,  25.64561752, -10.35597829,  -1.26621187,
 -4.06265703,  27.67479905,  15.49795032, -39.45044194,
 44.01289918,   0.86585799,  18.27812719,   5.67521639,
-39.75734739,  21.97902041, -40.4054544 ,  -1.76086616,
-17.07536161,   7.36319637, -29.86602124, -24.52771244,
 32.94451563,  12.63291294, -17.0410655 , -32.11724772,
 16.75986823, -13.71566995,  -7.26889596,  -5.73436872,
  8.54025377,  17.01620928,  -6.9276944 ,   4.22554965,
  7.89214676,  15.22534098, -10.54372712,  10.84204464,
 10.72288803, -13.86912267,   5.98212184, -13.68137384,
  9.08547245,  17.25452251,   9.76787557, -11.89050553,
-49.68296964,  -0.12345058, -36.89231001, -18.03037407,
 24.53715234, -30.36067552,  10.07478102,  17.01620928,
 -4.96710509, -33.99297652,  21.10886846,   1.05360682,
-10.85063257,  -4.25040586, -31.12793915,  20.03469938,
-12.53861254,  -7.18403546,  27.70909516,  -5.23971443,
-31.74175005,  50.88573523,  37.14006314, -37.69386974,
  2.28122862, -30.44553603, -18.79763769, -14.29518474,
  9.3418135 , -18.95109041, -17.41656317, -19.29229197,
-41.6673723 , -16.92190888,   8.93201972,  24.19595078,
-38.34197675,  17.01620928,  30.84674188, -10.44083879,
 20.49505756,  -7.4566448 ,  26.7197866 ,  16.94761706,
-24.03305816,  -6.19472689,  -5.92211755, -31.40054849,
 24.3494035 ,  18.77278148,  -9.70787128,  -6.72367729,
  8.47166155,  22.74628404,  20.00040327,   8.62511427,
-11.19183413, -23.91390154,  38.89663533, -38.80233493,
 18.39728381,  -1.69227394,   7.92644287,  -9.52012244,
-11.61789619,  29.96032164, -42.65668087,  21.63781885,
 26.29372453,  27.21444088, -13.90341878,  -2.0334755 ,
-24.59630466,  35.99730184,  23.7355926 ,   6.52734052,
 12.54805244, -23.76044882,  10.14337324,   4.37900237,
 -3.44884613, -26.77893892, -26.6597823 ,   5.18056211,
 -9.70787128,   9.49526623, -46.47673071,  28.01600061,
 15.95830849,  25.08237102, -14.78983902, -10.96978918,
-22.03817274,  30.53983643, -16.23950576,  13.77567424,
  3.27053719,  29.00530918,   8.28391271, -43.4239445 ,
  1.94002706,  -5.6657765 , -13.34017228, -20.51991377,
 -7.42234869,  20.98971184,   6.40818391,  20.27301261,
-18.64418496, -11.03838141, -23.23149842,  17.78347291])
```

[15]:
```
# Testing the accuracy

# For that , we only aim to calculated how many is correct ;

# If TestingOutput - CalculateOutput = 0 ; Then it is correct
# Else the calculation is incorrect
```

```
# So,  (TestingOutput - CalculateOutput) > o ----Then represent is as +1
# And
# So,  (TestingOutput - CalculateOutput) < o ----Then represent is as -1

# Then we will get the output as -1 , -1 , 1 , 0 , 1, 1 like this

# Since all +1 and -1 are the incorrect values; else we would have got (0)

# Therefore, makking all error as (1) and correct as (0). And on calculating␣
↪total, we would get the total incorrect values
```

[16]:
```
testingOut-calculateOut(testingIn,weights)
np.round(testingOut-calculateOut(testingIn,weights))
np.sign(np.round(testingOut-calculateOut(testingIn,weights)))
np.abs(np.sign(np.round(testingOut-calculateOut(testingIn,weights))))
np.sum(np.abs(np.sign(np.round(testingOut-calculateOut(testingIn,weights)))))

np.sum(np.abs(np.sign(np.round(testingOut-calculateOut(testingIn,weights))))) /␣
↪testEnd

1- np.sum(np.abs(np.sign(np.
↪round(testingOut-calculateOut(testingIn,weights))))) / testEnd
```

[16]: 0.01666666666666672

[17]:
```
def manual_accuracy(testingIn, testingOut, weights):
    predictions = calculateOut(testingIn, weights)
    error = testingOut - predictions

    # Convert error to 1 or -1 based on sign
    for i in range(len(error)):
        if error[i] > 0:
            error[i] = 1
        elif error[i] < 0:
            error[i] = -1
        else:
            error[i] = 0  # optional: handle case where prediction == actual

    # Count correct predictions (i.e., where error == 0)
    correct = 0
    for i in range(len(error)):
        if error[i] == 0:
            correct += 1

    # Calculate accuracy as a percentage
    return correct / len(error)
```

[18]:
```python
def accuracy(testingIn,testingOut,weights):
    return 1-np.sum(np.abs(np.sign(np.
↪round(testingOut-calculateOut(testingIn,weights))))) / testEnd
```

[19]:
```python
accuracy(testingIn,testingOut,weights)
```

[19]: 0.01666666666666672

2.0.1 Now, for the neural network, the accuracy means how much it is write or wrong;

But this means nothing for the learining. Only the error helps in learning

So with the help of error function, we can improve the network.

2.0.2 Error

[20]:
```python
def error(predictedValues,corectValues):
    return np.sum((predictedValues-corectValues)**2)
```

[21]:
```python
# error(calculateOut,testingOut)

# error(calculateOut(trainingIn,weights),trainingOut)

error(calculateOut(trainingIn[testIndex],weights),trainingOut[testIndex])
```

[21]: 315.820842388232

Accuracy is used with the testing Dataset while

Error is used with the training dataset

---

3 Now with the error minimization

3.1 Gradient of Error

[22]:
```python
def gradientSlow(x,w,correctValues):
    return np.array([  2 * (calculateOut(x,w) - correctValues) * x[indexWeight]␣
↪for indexWeight in range(3) ])
```

[23]:
```python
gradientSlow(trainingIn[testIndex],weights,testingOut[testIndex])

# it is giving three output of weights : w1, w2 and w3
```

[23]: array([22.45730216, 157.20111514, -22.45730216])

[24]:
```
def gradient(x,w,correctValues):
    return 2 * (calculateOut(x,w) - correctValues) * x
```

[25]:
```
gradient(trainingIn[testIndex],weights,testingOut[testIndex])
```

[25]:
```
array([ 22.45730216, 157.20111514, -22.45730216])
```

3.2 Learning Rate

[26]:
```
iterations = 100000

learningRate = 0.0001

# weights = weights - learningRate * gradient()


# For documentation ; making a list
errorlist = [error(calculateOut(trainingIn[testIndex],weights) ,␣
↪trainingOut[testIndex] )]
weight_list = [weights]
```

[27]:
```
for i in range(iterations):
    # pick random input
    index = np.random.randint(lenData-testEnd)
    # update weight
    weights = weights - learningRate *␣
↪gradient(trainingIn[index],weights,trainingOut[index])
    weight_list.append(weights)
    # Calculate error
    er = (error(calculateOut(trainingIn[index],weights),trainingOut[index]))
    errorlist.append(er)
```

[28]:
```
errorlist
```

[28]:
```
[315.820842388232,
 518.1792001346853,
 4750.934483074319,
 896.6774794212665,
 408.1249681440157,
 2237.57616025153,
 53.49986955008886,
 648.2500240443367,
 3180.104285453929,
 278.2280542671019,
 77.35380806959002,
 118.74050431240813,
```

209.78873866595575,
136.45534070745117,
833.7499367590063,
3.3402347960360705,
237.73788471825384,
1864.9275994191519,
995.6070716746941,
556.596516085255,
2.687690147294702,
994.9129282477743,
270.74256282299393,
9.975395088293801,
5.882393809266465,
101.12844128521463,
191.5436318444525,
84.12325658872653,
41.781627129805486,
40.995575991693926,
51.795001884338205,
227.59709808343936,
700.0548308401964,
152.16615420259467,
297.8817749067755,
156.63296637993423,
84.28725511849161,
3.3560036255355654,
45.623476240708456,
12.995061579678142,
1.2818258527253135,
38.079272518928136,
23.736956802853587,
3.200336098018333,
0.6945041101482481,
39.40767185025295,
4.880661236200896,
0.2951393917012479,
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…]
```

[30]:
```
print(weights)
print(er)
```

```
[-5.38857708e-10  1.00000000e+00  1.00000000e+00]
1.8418196179133608e-19
```

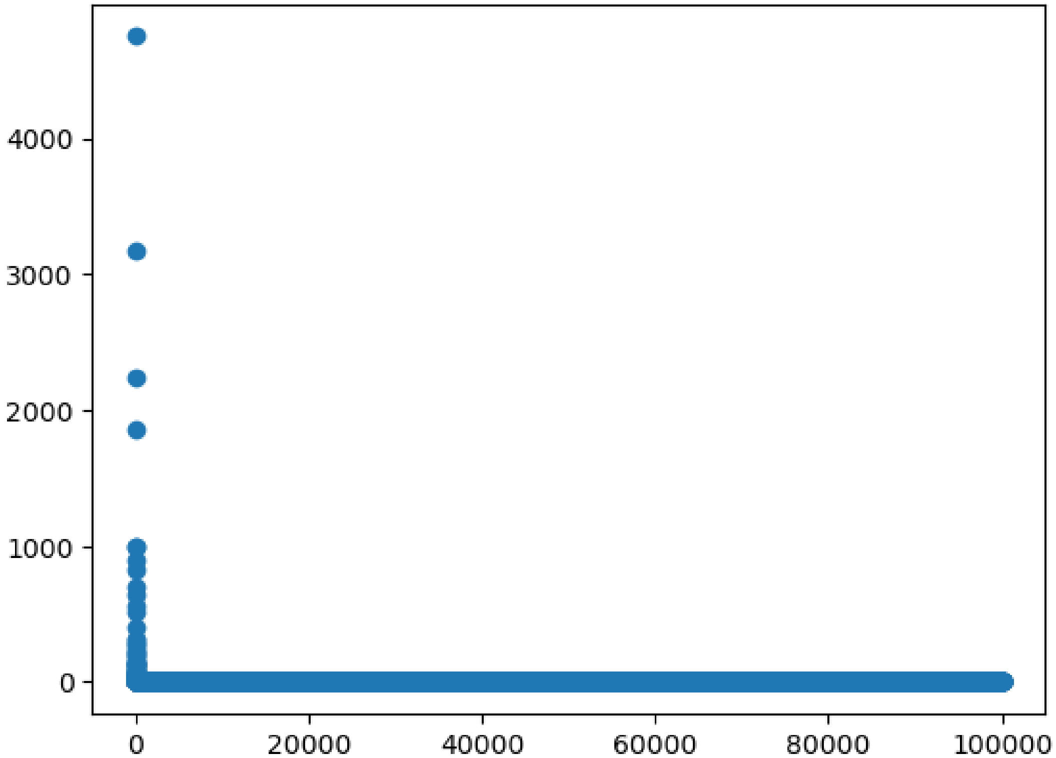
[31]:
```
print(len(errorlist))
```

```
100001
```

4 Plotting the plot of error (convergence rate)

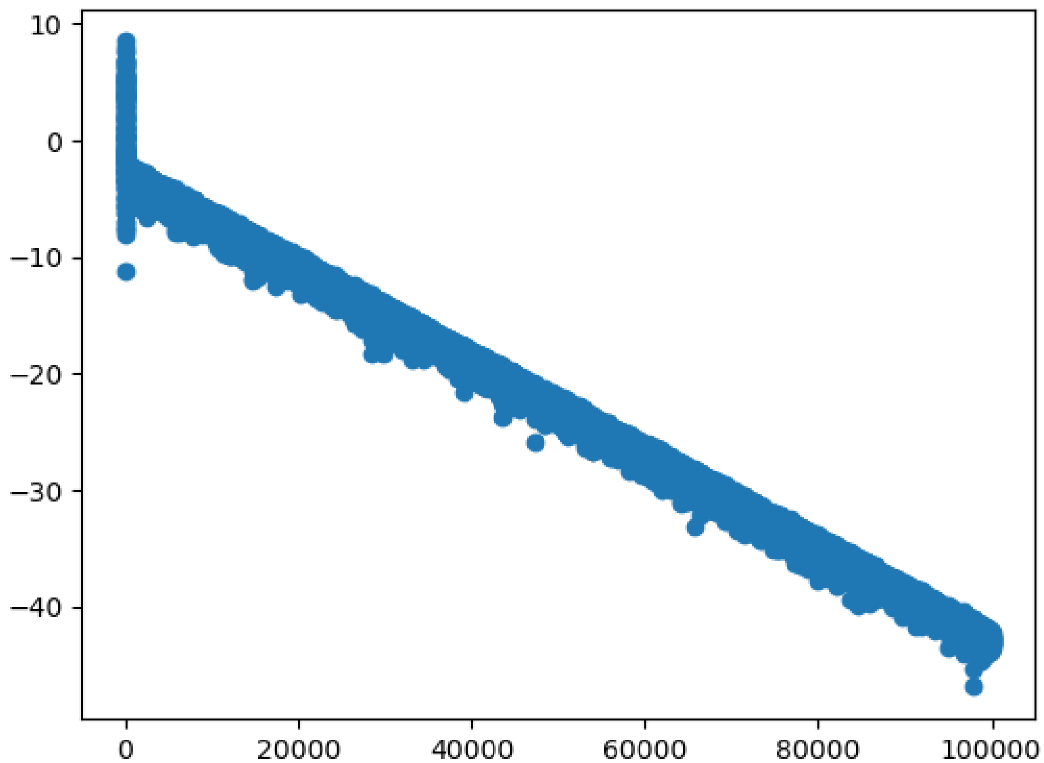
[32]:
```
plt.scatter(range(iterations+1),errorlist)
```

[32]:
```
<matplotlib.collections.PathCollection at 0x7baa8d534a30>
```

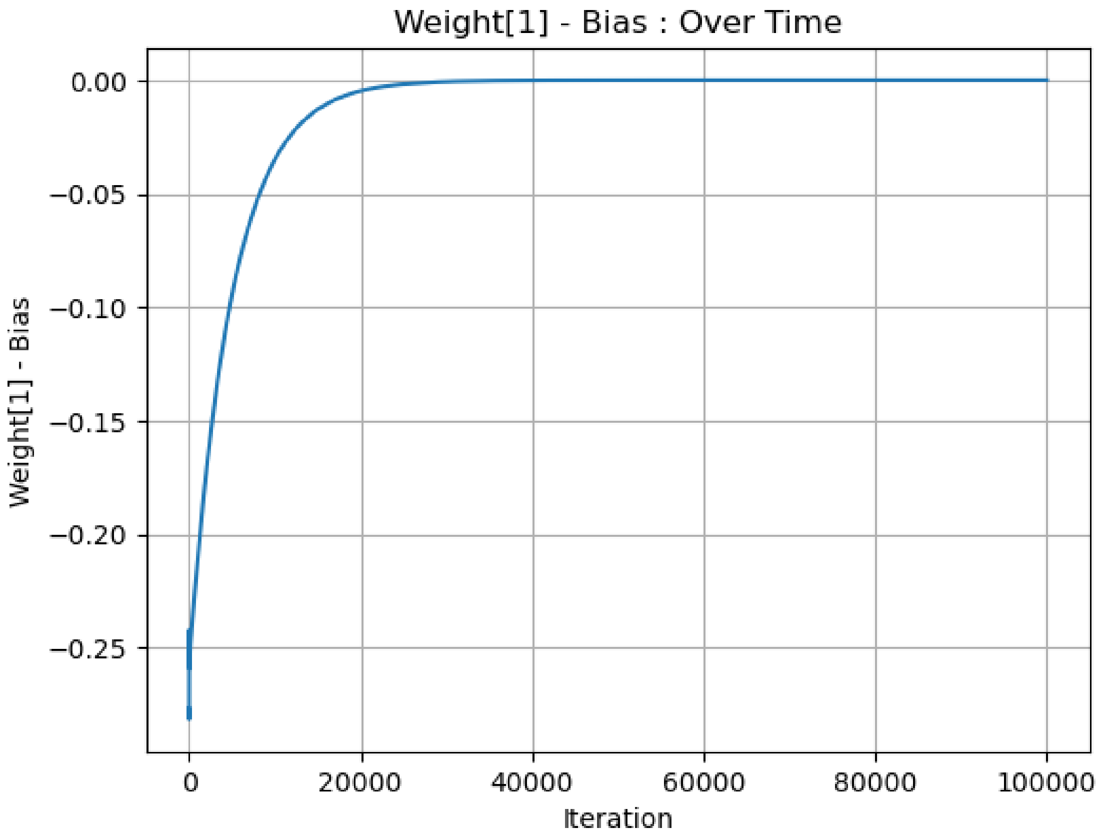


[33]:
```
plt.scatter(range(iterations+1),np.log(errorlist))
```

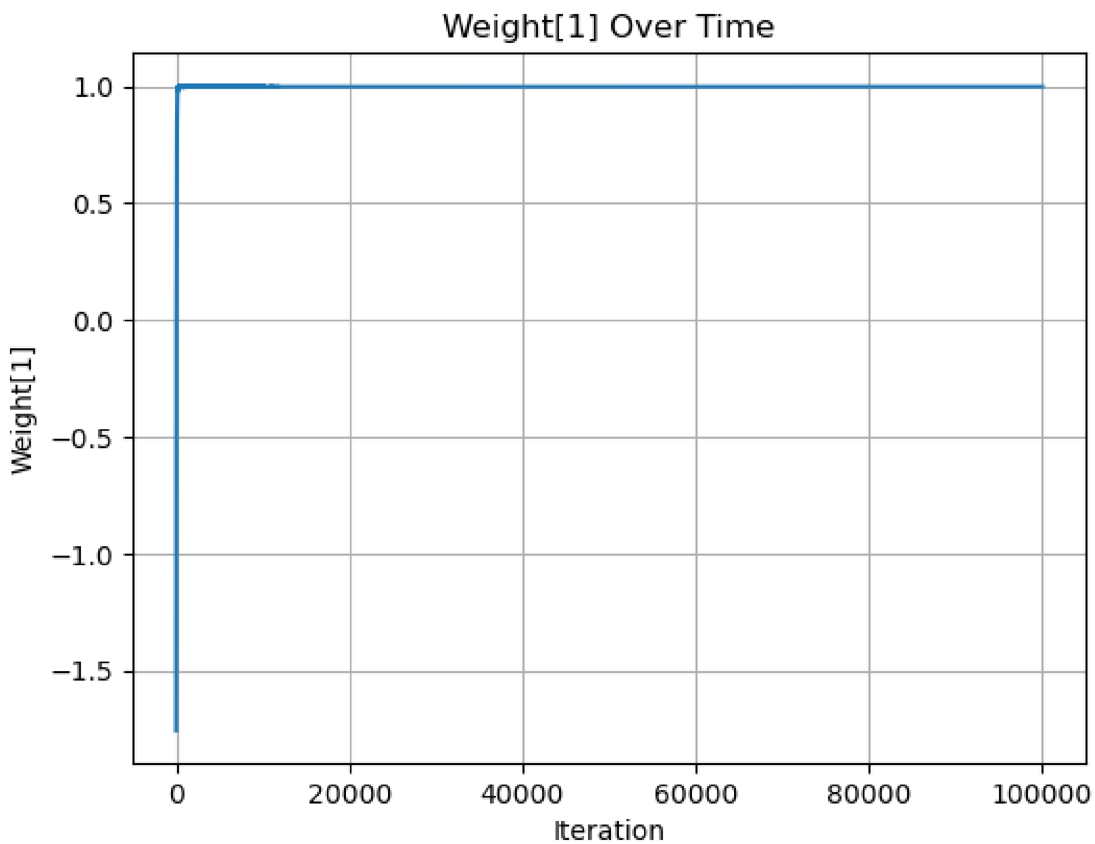
[33]: <matplotlib.collections.PathCollection at 0x7baa6f5fefb0>



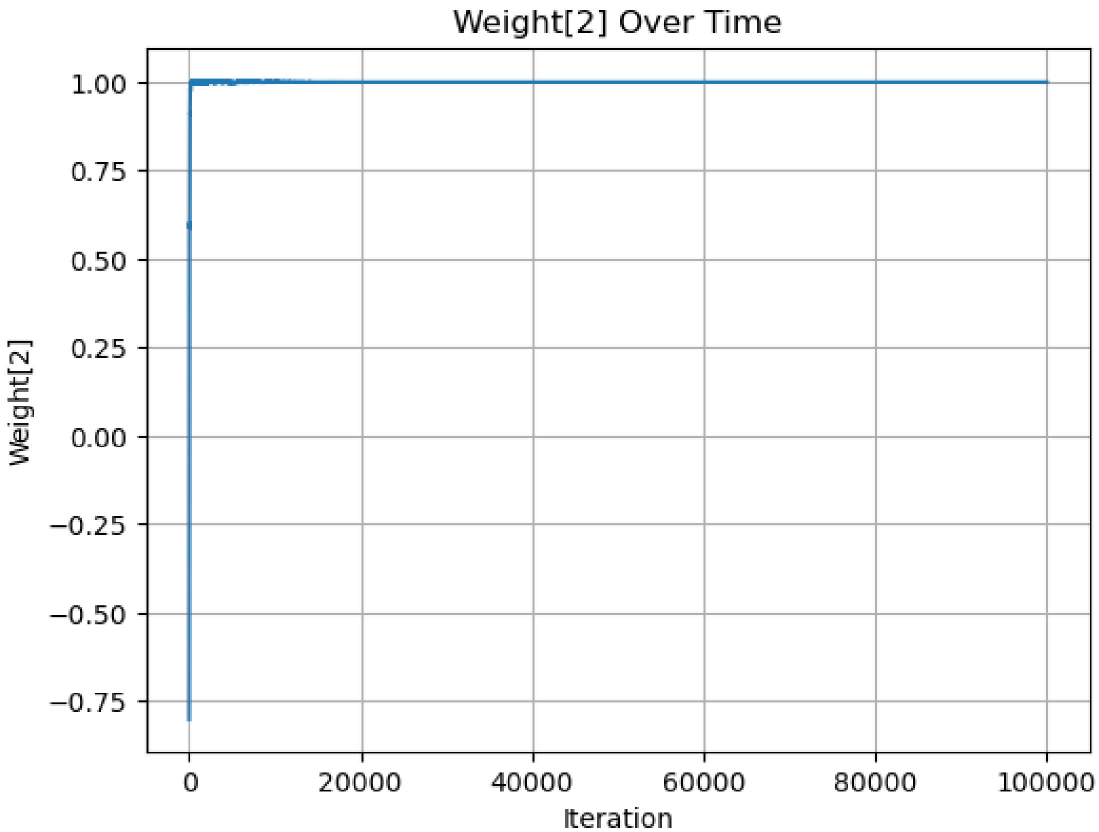
[42]:
```
weights_array = np.array(weight_list)  # shape: (iterations+1, num_weights)
plt.plot(range(len(weights_array)), weights_array[:, 0])  # first weight
plt.xlabel("Iteration")
plt.ylabel("Weight[1] - Bias")
plt.title("Weight[1] - Bias : Over Time")
plt.grid(True)
plt.show()
```



[38]:
```
weights_array = np.array(weight_list)  # shape: (iterations+1, num_weights)
plt.plot(range(len(weights_array)), weights_array[:, 1])  # second weight
plt.xlabel("Iteration")
plt.ylabel("Weight[1]")
plt.title("Weight[1] Over Time")
plt.grid(True)
plt.show()
```

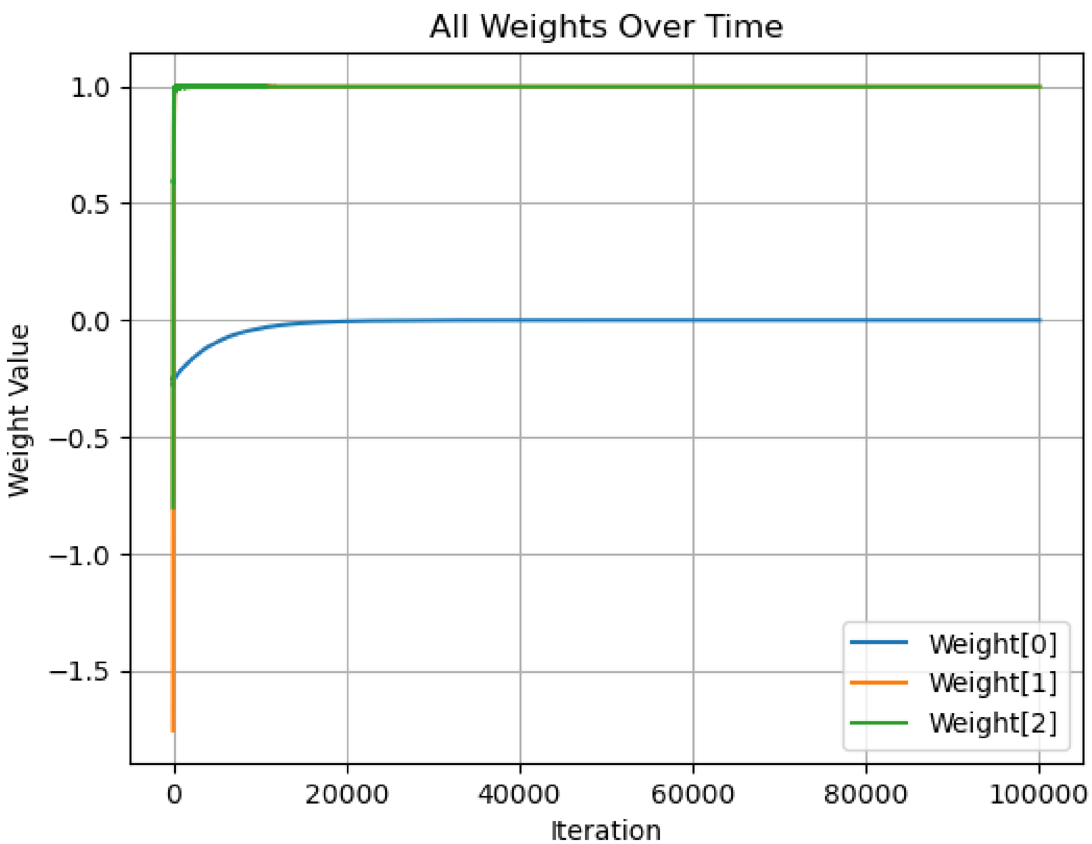


[39]:
```
weights_array = np.array(weight_list)  # shape: (iterations+1, num_weights)
plt.plot(range(len(weights_array)), weights_array[:, 2])  # third weight
plt.xlabel("Iteration")
plt.ylabel("Weight[2]")
plt.title("Weight[2] Over Time")
plt.grid(True)
plt.show()
```



[40]:
```
for i in range(weights_array.shape[1]):
    plt.plot(weights_array[:, i], label=f'Weight[{i}]')

plt.xlabel("Iteration")
plt.ylabel("Weight Value")
plt.title("All Weights Over Time")
plt.legend()
plt.grid(True)
plt.show()
```



5 Now what to do with those 300 testing dataset?

Those 300 datasets are quite untouched so far

So, the network does not know this dataset, and this network has not learned from this (testing) dataset.

Now, it is a good dataset (testing) to verify that the network has actually learned and that it has not just memorized the input data from the trainingg.

But that it can also apply its capabilities to a new testing dataset.

[43]:
```
testingOut
```

[43]:
```
array([-11, -15,  21,  -2, -16,   5,  18,  -4,  12, -11, -23,   6, -13,
       -18, -16,  -5,  11,  13,  22, -26, -27,  13,  10,  10, -11, -26,
        -1,   8, -18, -19, -19,  -1,  24,  -2,  38,  -7, -10,  13,   3,
       -32,  10,   3,   5,  -4, -19,  23,  -1, -10,  -5,  16, -30,  14,
        12,  11,  22, -12,  19,  28, -12, -10,  -2, -19, -25,  29,  16,
         5,  29, -10,   5,   7,   7,   7,   8,   1,   8,  30,  11,  -1,
        28,   6, -12,   3,   3,  -9,   1, -26, -28, -33,  20,  -7, -16,
```

```
 2, -30, -13,  14,   7,  29,  -1, -14,   7,   1, -11, -36,  24,
23,   7,   8, -19,   1,  -3, -31,  -5,  33, -28,  19,   8,  28,
-5, -23,   7, -31,   0, -28,   6,   3,  17,  35,  17,  13,  -1,
-5,  -3, -17, -22, -29,  31,  -6,  16,  -6, -13, -20, -21, -17,
-24,  -2, -24,   9,   6,  -6, -17,  -3,  31, -35,  -5, -16, -11,
29, -23,  31,   9,  15,   0,  25,  10, -20,  -3,   9,  29,  -1,
12,  -2,   8, -11, -18,  -6,  -8,  -9, -11,  14,   4,  -3,  11,
-9,   6,   5,  -4,  -3,  -1,  39,   1,  29,  15, -25,  28,  -1,
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22, -25, -24,   7, -16,  15, -13,  -7,  -2,  14,  21,  -8,   7,
-11,  35, -21,   0,  -9,   5,   5,  20, -17,   8,  -8,  -8, -27,
 6,  30,   2,  -4,   2,   5,  -3, -17,   0,  -3,  11,  17,   6,
-13])
```

6 This is what we want to receive from our network

[45]:
```
calculateOut(testingIn,weights)

np.round(calculateOut(testingIn,weights))
```

[45]:
```
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        10.,  10., -11., -26.,  -1.,   8., -18., -19., -19.,  -1.,  24.,
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       -19.,  23.,  -1., -10.,  -5.,  16., -30.,  14.,  12.,  11.,  22.,
       -12.,  19.,  28., -12., -10.,  -2., -19., -25.,  29.,  16.,   5.,
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        20.,  -7., -16.,   2., -30., -13.,  14.,   7.,  29.,  -1., -14.,
         7.,   1., -11., -36.,  24.,  23.,   7.,   8., -19.,   1.,  -3.,
       -31.,  -5.,  33., -28.,  19.,   8.,  28.,  -5., -23.,   7., -31.,
        -0., -28.,   6.,   3.,  17.,  35.,  17.,  13.,  -1.,  -5.,  -3.,
       -17., -22., -29.,  31.,  -6.,  16.,  -6., -13., -20., -21., -17.,
       -24.,  -2., -24.,   9.,   6.,  -6., -17.,  -3.,  31., -35.,  -5.,
       -16., -11.,  29., -23.,  31.,   9.,  15.,  -0.,  25.,  10., -20.,
        -3.,   9.,  29.,  -1.,  12.,  -2.,   8., -11., -18.,  -6.,  -8.,
        -9., -11.,  14.,   4.,  -3.,  11.,  -9.,   6.,   5.,  -4.,  -3.,
        -1.,  39.,   1.,  29.,  15., -25.,  28.,  -1., -18.,  13.,  23.,
       -10., -10.,  12.,  -1.,  23., -17.,   1.,  11., -23.,   5.,  19.,
       -40., -30.,  30.,  -2.,  15.,  10.,   2., -12.,   9.,  19.,  13.,
        29.,  16.,   4., -21.,  32., -18., -15.,  -4., -14.,   3., -17.,
        -6.,   7.,   5.,  13.,  15., -20., -19.,   7.,  14.,   1., -18.,
```

```
 -11.,   2.,  16.,  14., -31.,  29.,  -9.,  -3., -15.,   2.,   7.,
 -27.,  35., -19., -26., -20.,  17.,   1.,  22., -25., -24.,   7.,
 -16.,  15., -13.,  -7.,  -2.,  14.,  21.,  -8.,   7., -11.,  35.,
 -21.,  -0.,  -9.,   5.,   5.,  20., -17.,   8.,  -8.,  -8., -27.,
   6.,  30.,   2.,  -4.,   2.,   5.,  -3., -17.,  -0.,  -3.,  11.,
  17.,   6., -13.])
```

7 Now check the accuracy

[47]:
```
accuracy(testingIn,testingOut,weights)

# previously on the top, the accuracy was 0.016666666666666672
```

[47]:
```
1.0
```

Now its 100% perfect of time .

It is able to predict all 300 out of 300 perfectly.

These dataset(testing) was not seen by the network but now did task ; very correctly.

8 Now you can check (or perform addition with the neural network)

[48]:
```
calculateOut([50, 90,90 ],weights)
```

[48]:
```
179.99999997372225
```

[52]:
```
np.round(calculateOut([50, 170,90 ],weights))
```

[52]:
```
260.0
```