BacK propagation

Report on Back Propagation

Course Name: CSE-837 Machine Learning

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Contents

[Problem Statement 3](#_Toc62644556)

[Calculations 3](#_Toc62644557)

[1st iteration 4](#_Toc62644558)

[Forward Pass 4](#_Toc62644559)

[Error Calculation: 4](#_Toc62644560)

[Backward Pass 4](#_Toc62644561)

[Adjusting 3rd year CGPA(w3): 4](#_Toc62644562)

[Adjusting up to 3rd year CGPA(w4): 5](#_Toc62644563)

[Adjusting bias SPL2(b2) 5](#_Toc62644564)

[Adjusting 1st year CGPA(w1) 6](#_Toc62644565)

[Adjusting 2nd year CGPA (w2) 6](#_Toc62644566)

[Adjusting bias SPL1(b1) 7](#_Toc62644567)

[2nd iteration 8](#_Toc62644568)

[Forward Pass 8](#_Toc62644569)

[Error Calculation: 8](#_Toc62644570)

[Backward Pass 9](#_Toc62644571)

[Adjusting 3rd year CGPA (w3) 9](#_Toc62644572)

[Adjusting up to 3rd year CGPA (w4) 9](#_Toc62644573)

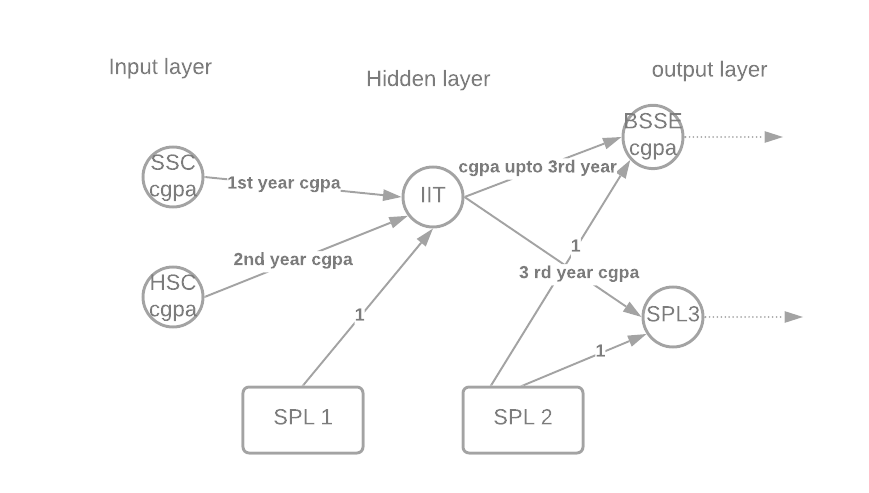
[Adjusting bias SPL2(b2) 10](#_Toc62644574)

[Adjusting 1st year CGPA (w1) 10](#_Toc62644575)

[Adjusting 2nd year CGPA(w2) 11](#_Toc62644576)

[Adjusting bias SPL2(b1) 11](#_Toc62644577)

Back Propagation



Problem Statement:

Calculate the updated value for all parameters (weights and biases) two times using two iterations of back propagation

# Calculations

Let,

Here ***i***= iteration, ***b***=bias, ***w***=weight, ***o***= output, ***h***= hidden layer

|  |  |  |
| --- | --- | --- |
| **Weight and bias** | **Expression** | **Value** |
| 1st year CGPA | w1 | 3.56/4=0.89 |
| 2nd year CGPA | w2 | 3.40/4=0.85 |
| 3rd year CGPA | w3 | 3.46/4=0.87 |
| upto 3rd year CGPA | w4 | 0.852 |
| SPL1 | b1 | 3.5/4=0.88 |
| SPL2 | b2 | 3.75/4=0.9375 |

SSC CGPA = ***i1*** = 1, HSC CGPA = ***i2***=1

IIT = ***h***, SPL3 = ***o1***, BSSE CGPA = ***o2***

Output,

***Actualo1***= 1, ***Actualo2*** = 1  
Learning rate, ***ƞ*** = 0.01  
Here, all the values have been converted in the range of 0 to 1.

# 1st iteration

## Forward Pass

𝒏𝒆𝒕𝒉/*netIIT* = (SSC CGPA\* 1st year CGPA + HSC CGPA\*2nd year CGPA+SPL1\*1)

= 𝒊𝟏 ∗ 𝒘𝟏 + 𝒊𝟐 ∗ 𝒘𝟐 + 𝒃𝟏 ∗ 𝟏 = (1 \* 0.89) + (1 \* 0.85) + (0.88 \* 1) = 2.62  
𝒐𝒖𝒕𝒉 = = = 0.932  
  
𝒏𝒆𝒕𝒐𝟏 = 𝒐𝒖𝒕𝒉 ∗ 𝒘𝟑 + 𝒃𝟐 ∗ 𝟏 = 0.932 \* 0.86 + 0.9375\* 1 = 1.73902

𝒐𝒖𝒕𝒐𝟏 = = = 0.85  
𝒏𝒆𝒕𝒐𝟐 = 𝒐𝒖𝒕𝒉 ∗ 𝒘𝟒 + 𝒃𝟐 ∗ 𝟏 = 0.932\* 0.852+ 0.9375 \* 1 = 1.73156  
  
𝒐𝒖𝒕𝒐𝟐 = ==0.85

## Error Calculation:

E total =

= (Actualo1-outo1)2 + (Actualo2-outo2)2

= (1-0.85)2+(1-0.85)2

=0.045

## Backward Pass

### Adjusting 3rd year CGPA(w3):

Considering w3 to know how much a change in w3 affects the total error.

Now,

= -𝟐(***Actual𝒐𝟏*** - 𝒐𝒖𝒕𝒐𝟏) = -2(1 - 0.85) = -0.30

= 𝒐𝒖𝒕𝒐𝟏(𝟏 - 𝒐𝒖𝒕𝒐𝟏) = 0.85(1 - 0.85) = 0.1275

=𝒐𝒖𝒕𝒉 = 0.932

So,

= (-0.30) \*0.1275\*0.932= -0.0356

So, we get, 𝒘𝟑+ = 𝒘𝟑- ***ƞ\****

= 0.87 – 0.01\*(-0.0356) = 0.8703

Adjusting up to 3rd year CGPA(w4):

Considering w4 to know how much a change in w4 affects the total error.

= -2 (***Actual𝒐2*** – 𝒐𝒖𝒕𝒐2) = -2(1 - 0.85) = -0.30

= 𝒐𝒖𝒕𝒐2(𝟏 – 𝒐𝒖𝒕𝒐2) = 0.85(1 - 0.85) = 0.1275

**=** 𝒐𝒖𝒕𝒉 = 0.932

= (-0.30) \*0.1275\*0.932= -0.0356

So, we get, 𝒘4+ = 𝒘4- ***ƞ\****

= 0.852 – 0.01\*(-0.0356) = 0.8523

### Adjusting bias SPL2(b2)

Considering w4 to know how much a change in w4 affects the total error.

=( +()

= -1 = -1

𝒐𝒖𝒕𝒐𝟏(𝟏 - 𝒐𝒖𝒕𝒐𝟏) = 0.85(1 - 0.85) = 0.1275 𝒐𝒖𝒕𝒐2(𝟏 – 𝒐𝒖𝒕𝒐2) =0.1275

**=** 1 **=**1

= -0.255

So, we get, **b2**+ = **b2**- ***ƞ\****

= 0.9375 – 0.01\*(-0.255) = 0.8703 = 0.94005

### Adjusting 1st year CGPA(w1)

Considering w1 to know how much a change in w1 affects the total error.

**=**

**= (**-1**)** \*0.1275\*w3 = -0.1275\* 0.87 = -0.1089

== (-1) \*0.1275\*w4= -0.1275\*0.852= -0.1086

= 𝒐𝒖𝒕𝒉 (𝟏 - 𝒐𝒖𝒕𝒉) = 0.932\*(1-0.932) =0.063

**=*i1*** = 1

Now,

= -0.0137

So, we get, **w1**+ =w1- ***ƞ\****

= 0.89 – 0.01\*(-0.0137) = 0.890137

### Adjusting 2nd year CGPA (w2)

Considering w2 to know how much a change in w2 affects the total error.

**=**

**= (**-1**)** \*0.1275\*w3 = -0.1275\* 0.87 = -0.1089

== (-1) \*0.1275\*w4= -0.1275\*0.852= -0.1086

= 𝒐𝒖𝒕𝒉 (𝟏 - 𝒐𝒖𝒕𝒉) = 0.932\*(1-0.932) =0.063

**=*i2*** = 1

Now,

= -0.0137

So, we get, **w2**+ =w2- ***ƞ\****

= 0.85 – 0.01\*(-0.0137) = 0.850137

### Adjusting bias SPL1(b1)

Considering b1 to know how much a change in b1 affects the total error.

**=**

**= (**-1**)** \*0.1275\*w3 = -0.1275\* 0.87 = -0.1089

== (-1) \*0.1275\*w4= -0.1275\*0.852= -0.1086

= 𝒐𝒖𝒕𝒉 (𝟏 - 𝒐𝒖𝒕𝒉) = 0.932\*(1-0.932) =0.063

= 1

Now,

= -0.0137

So, we get, **b1**+ =b1- ***ƞ\****

= 0.88– 0.01\*(-0.0137) = 0.880137

After 1st iteration adjusted values are –

|  |  |  |
| --- | --- | --- |
| **Weight and bias** | **Expression** | **Value** |
| 1st year CGPA | w1 | 0.890137 |
| 2nd year CGPA | w2 | 0.850137 |
| 3rd year CGPA | w3 | 0.8703 |
| upto 3rd year CGPA | w4 | 0.8523 |
| SPL1 | b1 | 0.880137 |
| SPL2 | b2 | 0.94005 |

SSC CGPA = ***i1*** = 1, HSC CGPA = ***i2*** = 1,

IIT = ***h***, SPL3 = ***o1***, BSSE CGPA = ***o2  
Actualo1*** = 1, ***Actualo2*** = 1  
Learning rate, ***ƞ*** = 0.01  
These values will be used to adjust the weights and biases for 2nd iteration.

# 2nd iteration

## Forward Pass

𝒏𝒆𝒕𝒉 = (SSC CGPA\* 1st year CGPA + HSC CGPA\*2nd year CGPA+SPL1\*1)

= 𝒊𝟏 ∗ 𝒘𝟏 + 𝒊𝟐 ∗ 𝒘𝟐 + 𝒃𝟏 ∗ 𝟏 = (1 \* 0. 890137) + (1 \* 0. 850137) + (0. 880137 \* 1) = 2.6204  
𝒐𝒖𝒕𝒉 = = = 0.932163  
  
𝒏𝒆𝒕𝒐𝟏 = 𝒐𝒖𝒕𝒉 ∗ 𝒘𝟑 + 𝒃𝟐 ∗ 𝟏 = 0.932 \* 0.8703 + 0.94005\* 1 = 1.7513

𝒐𝒖𝒕𝒐𝟏 = = = 0.852  
𝒏𝒆𝒕𝒐𝟐 = 𝒐𝒖𝒕𝒉 ∗ 𝒘𝟒 + 𝒃𝟐 ∗ 𝟏 = 0.8523\* 0.852+ 0.94005\* 1 = 1.67  
  
𝒐𝒖𝒕𝒐𝟐 = ==0.84

## Error Calculation:

E total =

= (Actual**o1**-out**o1**)2 + (Actual**o2**-out**o2**)2

= (1-0.852)2+(1-0.84)2

=0.0475

## Backward Pass

### Adjusting 3rd year CGPA (w3)

Considering w3 to know how much a change in w3 affects the total error.

Now,

= -𝟐(***Actual𝒐𝟏*** - 𝒐𝒖𝒕𝒐𝟏) = -2(1 - 0.852) = -0.30

= 𝒐𝒖𝒕𝒐𝟏(𝟏 - 𝒐𝒖𝒕𝒐𝟏) = 0.852(1 - 0.852) = 0.1261

=𝒐𝒖𝒕𝒉 = 0.932163

So,

= (-0.30) \*0.1261\*0.932163= -0.0353

So, we get, 𝒘𝟑+ = 𝒘𝟑- ***ƞ\****

= 0.8703 – 0.01\*(-0.0353) = 0.8707

### Adjusting up to 3rd year CGPA (w4)

Considering w4 to know how much a change in w4 affects the total error.

= -2 (***Actual𝒐2*** – 𝒐𝒖𝒕𝒐2) = -2(1 - 0.84) = -0.32

= 𝒐𝒖𝒕𝒐2(𝟏 – 𝒐𝒖𝒕𝒐2) = 0.84(1 - 0.84) = 0.1344

**=** 𝒐𝒖𝒕𝒉 = 0.932163

= (-0.32) \*0.1344\*0.932153= -0.0401

So, we get, 𝒘4+ = 𝒘4- ***ƞ\****

= 0.8523 – 0.01\*(-0.0401) = 0.8527

### Adjusting bias SPL2(b2)

Considering wb2 to know how much a change in b2 affects the total error.

=( +()

= -1 = -1

𝒐𝒖𝒕𝒐𝟏(𝟏 - 𝒐𝒖𝒕𝒐𝟏) = 0.1261 𝒐𝒖𝒕𝒐2(𝟏 – 𝒐𝒖𝒕𝒐2) =0.1344

**=** 1 **=**1

= -0.2605

So, we get, **b2**+ = **b2**- ***ƞ\****

= 0.94005 – 0.01\*(-0.2605) = 0.94266

### Adjusting 1st year CGPA (w1)

Considering w1 to know how much a change in w1 affects the total error.

**=**

**= (**-1**)** \*0.1261\*w3 = -0.1261\* 0.8703 = -0.1097

== (-1) \*0.1344\*w4= -0.1344\*0.8523= -0.1145

= 𝒐𝒖𝒕𝒉 (𝟏 - 𝒐𝒖𝒕𝒉) = 0.932\*(1-0.932) =0.063

**=i1** = 1

Now,

= -0.0141

So, we get, **w1**+ =w1- ***ƞ\****

= 0. 890137– 0.01\*(-0.0141) = 0.8903

### Adjusting 2nd year CGPA(w2)

Considering w2 to know how much a change in w2 affects the total error.

**=**

**= (**-1**)** \*0.1261\*w3 = -0.1261\* 0.8703 = -0.1097

== (-1) \*0.1344\*w4= -0.1344\*0.8523= -0.1145

= 𝒐𝒖𝒕𝒉 (𝟏 - 𝒐𝒖𝒕𝒉) = 0.932\*(1-0.932) =0.063

**=*i2*** = 1

Now,

= -0.0141

So, we get, **w2**+ =w2- ***ƞ\****

= 0.850137– 0.01\*(-0.0141) = 0.8503

### Adjusting bias SPL2(b1)

Considering b1 to know how much a change in b1 affects the total error.

**=**

**= (**-1**)** \*0.1261\*w3 = -0.1261\* 0.8703 = -0.1097

== (-1) \*0.1344\*w4= -0.1344\*0.8523= -0.1145

= 𝒐𝒖𝒕𝒉 (𝟏 - 𝒐𝒖𝒕𝒉) = 0.932\*(1-0.932) =0.063

= 1

Now,

= -0.0141

So, we get, **b1**+ =b1- ***ƞ\****

= 0.880137– 0.01\*(-0.0141) = 0.8803

After 2nd iteration adjusted values are -

|  |  |  |
| --- | --- | --- |
| **Weight and bias** | **Expression** | **Value** |
| 1st year CGPA | w1 | 0.8903 |
| 2nd year CGPA | w2 | 0.8503 |
| 3rd year CGPA | w3 | 0.8707 |
| upto 3rd year CGPA | w4 | 0.8527 |
| SPL1 | b1 | 0.8803 |
| SPL2 | b2 | 0.9427 |