## Part 1

You are expected to show/derive each weight update rule in detail and in a step-by-step fashion by utilizing the backpropagation algorithm for both regression and classification problems represented here.

## Regression problem:

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SE(Y,Y') = (Y-Y')2	
$SE(y,y') = (y-y')^{2}$ $O_{0}^{(0)} = 1, O_{1}^{(0)} = 21, O_{2}^{(0)} = 22$	-
$O_{k}^{(1)} = 1$ $O_{k}^{(1)} = \sigma(\Sigma O_{i}^{(0)} \cdot a_{i}^{(0)})$	
0,11 = 0 (1. a01 + X1. a(1) + X2. a(1)	
= 1+e-(a016)+ 2/10/16)+ 2/2 azi(0))	
02 = \sigma(1.a_020) + 24.a_12 + 22.a_2)	
1+e (aoto + 21a1260 + 22a220)	
03(1) = 6(1. a03(0) + 21, a(0) + 21, a(0))	
= 1+e-(ao50)+21,a1500+21,a1500)	
$O_0^{(2)} = \sum_{k=0}^{\infty} O_k^{(1)} \cdot a^{(1)}$	
= 1.a + 0,11. a + 02.a + 03. a	
Weights = 9160 = 0160 - x 85E(y,0,0) 8 (y-0,0)2 = (2(y-0,0)) - 8(0,0)	
8 (y-00)2 = (2(y-01)). 8(000)	
Saik	

D	ate:	-
	a (0) = a (0) - x (2(y-0,11)-50,11)  8 do 1	
1	$A_{01} = A_{01} = A \left( \frac{2(y)}{5(a)} \right)  (a)  (a)$	1
	a (0) = a (0) - x(2(y-0,11)) - 86 (a (0) x (a) + x (a) + x (a) 8 a 01	1
	$a_{01} = a_{01}^{(0)} - \alpha \left(2(y-0,0)\right) - e^{-a_{01}^{(0)} - x_1 a_{11}^{(0)} - x_2 a_{21}^{(0)}}$ $(1+e^{-a_{01}^{(0)} - x_1 a_{11}^{(0)} - x_2 a_{21}^{(0)}})^2$	
	(1+e 201 - x1011 - x2021 )	
	$a_{01}^{(0)} = a_{01}^{(0)} + 2 \times (y - 0, u) \frac{e^{-a_{01}(0)} - x_{1}a_{11}^{(0)} - x_{2}a_{21}^{(0)}}{(1 + e^{-a_{01}(0)} - x_{1}a_{11}^{(0)} - x_{2}a_{21}^{(0)})^{2}}$	
2	an = an (0) + 2 x (y -0, 11) . 50, (1) 50, (1)	
	and = an(0) + 2x (y-0, 11) 2xe - 201(0) - x, an (0) - x2 221(0)	
-	(1+e-a01(0)-x1a11(0)-x2a2(0))2	
- 3	a 10) = a 10) + 2x (y -0,11) . 50,00	
	$a_{21}^{(0)} = a_{21}^{(0)} + 2\alpha \left( y - 0.00 \right) \cdot x_{2} e^{-a_{01}(0)} - x_{1}a_{11}^{(0)} - x_{2}a_{21}^{(0)}$	
	(1+ēao1(0)-x1 A11(0)-x2 a21(0))2	
ч	aoz(0) = aoz(0) + 2 x (y-02(1)). 80,(1)	
	Sao2  (a) (b) (c) (c) (d) -ao2(0) x1012(0) x2022(0)	
	002 = 002(0) + 20(4-02(0))002(0) - X1012(0) - X2022(0)) 2 (1+8 002(0) - X1012(0) - X2022(0)) 2	
		-

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. 5	$a_{12}^{(0)} = a_{12}^{(0)} + 2\alpha (y - O_2^{(1)}) \cdot \delta O_2^{(1)}$ $\delta a_{12}^{(0)}$
	a1260) - a1260 + 2 x (y-02(1)). N1e-a02(0)-21/012(0)-21/0222(0)) 2
	(ITE
6	$a_{12} = a_{12} + 2 \times (y - 0_{2}^{(1)}) \cdot \int 0_{2}^{(1)}$ $\int a_{12}^{(0)} dx = \int 0 \cdot \int 0_{2}^{(0)} dx = \int 0$
	$a_{12}^{(0)} = a_{12}^{(0)} + 2\alpha (y - 0_{2}^{(1)}) \cdot n_{2}e^{-a_{02}^{(0)} - n_{1}a_{12}^{(0)} - n_{2}a_{22}^{(0)}}$ $(1 + e^{-a_{2}^{(0)} - n_{1}a_{12}^{(0)} - n_{2}a_{22}^{(0)})^{2}}$
1	
-	a (0) = a (0) + 2a (y-03(1)). \$03(1) - 8003(0)
	$a_{03}^{(0)} = a_{03}^{(0)} + 2\alpha (y - 0_{2}^{(1)}) - e^{-a_{03}^{(0)} - 24a_{13}^{(0)} - 22a_{23}^{(0)}}$ $(1 + e^{-a_{03}^{(0)} - 2a_{13}^{(0)} - 2a_{23}^{(0)} - 2a_{23}^{(0)}})^{\frac{1}{2}}$
3	a13(0) = a13(0) + 2x (y-07(1)). (03(1) 6a13(0)
	a13(0) = a13(0) + 2 × (y-0,(1)). 36, e - a03(0) - ×1, a13(0) - ×2, a23(0)) 2
9	$a_{23}^{(0)} = a_{23}^{(0)} + 2 \times (y - O_3^{(1)}) \cdot 50_3^{(1)}$ $a_{23}^{(0)} = a_{23}^{(0)} + 2 \times (y - O_3^{(1)}) \cdot \kappa_2 e^{-a_{03}^{(0)} - \kappa_1 a_{13}^{(0)} - \kappa_1 a_{23}^{(0)}} \cdot \frac{1}{(1 + e^{-a_{03}^{(0)} - \kappa_1 a_{13}^{(0)} - \kappa_1 a_{23}^{(0)})^2}}$
1	CIT C

Da	ate:	
		1
- 10	and = and - d (2(4-0(2)). 50(2)	-
	200 = a(1) - d(2(y-0,(2))-1	-
	and = and +2a (4-00 )	!
	(2) - (2)	
1)	a (1) - a (1) + 2a(y-00) , 80,(2) 80,(1)	
	a,000 = a,000 + 2 x (y-0,00). O,00	
	a101 - a101 + 2 a (y - 00(2)). I +e-a01(0)-1911(0)-1922(0)	
12	azo = azo + 2x(y-0.(2)).(00(2))	
	azo = azo +2x (y-00(2), 02(1)	
	azo(1) = azo(1) + 2 x (y-00(2)). 1+e-aoz(0)-21/a12(0)-22/azz(0)	
13	azo(1) = azo(1) + 2 x (y -0, (2)) . 50, (2)	
	$a_{30}^{(1)} = a_{30}^{(1)} + 2\alpha (y - 0.(2)) \cdot 0_{30}^{(1)}$	
	ago(1) = ago(1) + 2x (y-0,01). 1+e-ao3(0)-21a13(0)-22ago	-
	1+ e 203 - 21 x 13 co - 22 ago	

## Classification problem:

	CE(1:1') = - \ t; * log(1;')	
	, ,	
	a (1) = a (1) = N & & CE	
	a (1) = a (1) - x & E (E) & Sa(1)	
	leh .	
	000 = 1 , 0 (0) M1 , 0, (0) - x2	
7137	00 - 1 , 0, = m2 , 02 = x2	
	0(1) (=0.6)	
	OK = 0(50; (0) aix	
	Oo" =1	-
	0,(1) = 0(1.a(0) + n; a(0) + n2.a(0))	
	1+e-(a01'0) + 21, a11(0)+ 21-a1(0))	
	1+e-(ao10)+21,011(1)+22,01)	
18.19		
	02"= 1+e-(a0210)+212a2220)	
	1+e-(aozio)+ 21a,200+2122220)	
W 16 16 16	0(1) 1	
1000	03 = 1+e-(aos(0)+ 11,013(0)+12023(0)).	
	21- (11/11)	
	OCE = - 2 (; log(C')	
	Men	-
Till a	= \(\frac{1}{\ill.}\) \(\frac{\lambda(\lambda')}{\lambda}\)	
	l' San	
1		
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4.50		
1000	CE = 01 = - 3 (; log (0;41))	
	1=0 100 (0)	
	CE = (lo log (O(1)) + l, log (O(1)) + l2 log (O(1)) + l3 log (O(1)))	
1	a 101 = a 101 - x SCE : Saulo	
33	(0) 1/2 1 1 1 1 1	. 7
	= 00 - 00 log(1) + 4 log( 1+e-asito-quasto	-74a 80)
	= a (0) - 2 ( - lo log(1) + 1,109 ( 1+e-2010-14) (1+e-2010-14)	
	+ (3 log (1+ E aos(0)-1/1 ags(0)-1/2 ars(0)))	
1	$a_{01}^{(0)} = a_{01}^{(0)} + x \cdot \left[ e^{a_{01}^{(0)} - x_1 a_{11}^{(0)} - x_2 a_{21}^{(0)}} \right]$ $\frac{1 + e^{a_{01}^{(0)} - x_1 a_{11}^{(0)} - x_2 a_{21}^{(0)}}{1 + e^{a_{01}^{(0)} - x_1 a_{21}^{(0)}}}$	*
	1 + Eao1(0) - 21, AN(0) - 22 An1(0)	
2	a 10 = a (0) + x - 4 My e-a 010) - nran (0) - nran (0) -  1+ e a 0101 - nran (0) - nran (0)	
	1+ Eaglot- Wrall of Marilo	
1000	1 1 2 1 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
3	021 = a21 + x - 61 2/2 e - a01(0) - 21/21(0) - 22/22(0)	
	1 + East - RIAN - 12751	,
	-an2(a) -11, an2(b) -11, an2(b)	
4	a = 00 + 0 . (2 = ao(0) - 10 ao(0) - 20 200)  + e ao(0) - 2   ao(0) - 20 200)	
	+ e ar male male	
	(0)	
5	a12 = a10 + x L221 4 4	-
-13 4		4

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6	$a_{12}^{(0)} = a_{11}^{(0)} + \alpha \underbrace{l_{2} u_{1}}_{1+e^{-\alpha_{0}2^{(0)}} - u_{1}a_{1}z^{(0)} - u_{2}a_{2}z^{(0)}}_{1+e^{-\alpha_{0}2^{(0)}} - u_{1}a_{1}z^{(0)} - u_{2}a_{2}z^{(0)}}$	
7	12 11 (+ e-asz(0) - 21, a/z(0) - 12 azz(0)	
7	$a_{03}^{(0)} = a_{03}^{(0)} + \alpha l_3 e^{-a_{03}^{(0)} - 2i_1a_{13}^{(0)} - 2i_2a_{23}^{(0)}}$ $1 + e^{-a_{03}^{(0)} - 2i_1a_{13}^{(0)} - 2i_2a_{23}^{(0)}}$	
-	1+e-assa- 21, disto- 42, disto	
, 8	a 3 (0) = a 3 (0) + a 13 x, e - a 3 (0) x (a 13 (0) - x 2 (a 23 (0))  1 + e - a 0 3 (0) - x (a 13 (0) - x 2 a 23 (0))	
-	1+ e-203 - 41,213 - 41,223	
9	ans (0) - ans (0) + of by Mae - aes (0) - Mais (0) - Meas (0)  1 + e - mas (0) - mais (0) - mas (0) - mas (0)  1 + e - mas (0) - mas (0) - mas (0) - mas (0)	
	1+e	
	(2) (1) (2) (2) (2)	
	O(2) = softmax (X(1), X(2)) = (x(1)) =	
	$X_0^{(1)} = \sum_{k \neq 0} O_k^{(1)} \cdot a_{kn}^{(1)}$	
	A = C Ok · agen	
	= 00. a0 + 01. a10 + 02. a20 + 04	(1)
	= 000 + 01 , 010 + 02 , 010 70	0 9 30
	x (2) = 000 - a (1) + 0 (1) a (1) + 02 (1) (1) + 01)	
	1 = 0 = 101 + 01 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	31
MEN I	X2 = 000. a + 010. a 12 + 02. a 12 + 09. a 12	
	00 - enon + enon + enon	
	e 20 + e 21 + e 26 12	
	0(2) = 82(2)	
	en +	
	012 = ensure + ensure this 15 012 = ensure + ensure this 15 012 = ensure + ensure Child abuse!	1
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\frac{CE}{-\frac{2}{5}(s \circ \log(O_{5}^{(2)})}

\frac{-(lo \cdot \log e^{n_{0}(x)})}{e^{n_{0}(x)}} + \frac{(log e^{n_{1}(x)})}{e^{n_{0}(x)} + e^{n_{1}(x)}} + \frac{(log e^{n_{1}(x)})}{e^{n_{0}(x)} + e^{n_{1}(x)}}

+ \frac{1}{2} \log e^{n_{3}(x)}

e^{n_{0}(x)} + e^{n_{1}(x)} + e^{n_{1}(x)}

e^{n_{0}(x)} + e^{n_{1}(x)} + e^{n_{1}(x)}

\frac{a_{00}}{a_{00}} = a_{00} + d - on PC
```

```
clc; clear; close all; format long;
%% Variable Definition
syms 00 01 02 03
syms a00 a10 a20 a30 a01 a11 a21 a02 a12 a22 a03 a13 a23 a31 a32
syms x1 x2
syms L0 L1 L2
syms b0 b1 b2 % the softmax function
% Df = diff(f,var) % Derivates the function f with respect to var
%% Equations to Derivate
00 = 1;
01 = 1/(1+exp(-(a01+x1*a11+x2*a21)));
02 = 1/(1+exp(-(a02+x1*a12+x2*a22)));
03 = 1/(1+exp(-(a03+x1*a13+x2*a23)));
b0 = 00*a00+01*a10+02*a20+03*a30;
b1 = 00*a01+01*a11+02*a21+03*a31;
b2 = 00*a02+01*a12+02*a22+03*a32;
C = -( ... 
    +L0*log(exp(b0)/(exp(b0)+exp(b1)+exp(b2))) ...
   +L1*log(exp(b1)/(exp(b0)+exp(b1)+exp(b2))) ...
   +L2*log(exp(b2)/(exp(b0)+exp(b1)+exp(b2))) ...
   );
dC = diff(C,a00);
```

Figure 1 taking the derivative of CE

$\frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} + d\theta$
$12 \cdot exp \left( \frac{a0}{ap_1 - abz - abz + bz} + \frac{a0}{abz} +$
'age <u>menoning mangri proposition of the menoning of the menoning </u>
$c_{2}(a) = \frac{a_{2}}{a_{2}^{2} + a_{1}^{2} - a_{1}^{2} + a_{1}^{2} + a_{1}^{2} - a_{2}^{2} + a_{1}^{2} - a_{1}^{2$
(***) [***] [**] [***] [***] [***] [***] [***] [***] [***] [***] [***] [***] [**] [**] [***] [***] [***] [***] [***] [***] [***] [***] [***] [***] [**] [**] [***] [***] [***] [***] [***] [***] [***] [***] [***] [***] [**] [***] [***] [***] [***] [***] [***] [***] [***] [***] [***] [**] [**] [**] [***] [***] [***] [***] [***] [***] [***] [***] [***] [***] [**] [***
$exp\left(2 \cdot a(0) + exp(-a(1) - a(1) \cdot x) + -a(1) \cdot x(2) + 1\right) \cdot exp(-a(2) - a(2 \cdot x) + 1\right) \cdot exp(-a(2) - a(1) \cdot x) + a(2) \cdot x(2) + 1$
$(qq)(qb) + \frac{db}{(qp)(qb)} - \frac{db}{(qp)(qb)} + \frac{db}{(qp)(qb)} - \frac{db}{(qp)(qb)} - \frac{db}{(qp)(qb)} + \frac{db}{(qp)(qb)} - \frac{db}{(qb)(qb)} -$
$(cq)(d0) + \frac{a(0)}{(q(q(a) + a(1)(a) - a(1)(a))} + (q(a(a) - a(1)(a) - a(1)(a))} + (q(a(a) - a(1)(a) - a(1)(a) - a(1)(a))} + (q(a(a) - a(1)(a) - a(1)(a))} + (q(a) - a(1)(a)(a))} + (q(a) - a(1)(a)(a)(a))} + (q(a) - a(1)(a)(a)(a)(a)(a)(a)} + (q(a) - a(1)(a)(a)(a)(a)(a)(a)(a)(a)(a)(a)(a)(a)(a)$

Tries to derivate and the results are way too long to write down hence probably what am doing is wrong however working makes sense.

if this answer is acceptable then yes we do the same thing for other weights and we get each weight value.