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Assignment 6 – CS 271
Professor Mark Stamp
Problems 1, 2, 4, 6, 8

1.

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$$\frac{dv_2}{dv_0} = -1 \qquad \frac{dz}{dv_1} = -1$$

①
$v_0 = x$ (1)
$v_1 = y$ (2)
$v_2 = -(v_0 + v_1)$ (3)
$v_3 = 1 + e^{v2}.$ (4)
$v_4 = v_0 / v_3$ (5)
$\cancel{z_5} = z = v_4$ (6)

$$\frac{dv_3}{d_2} = e^{v_2}$$

$$\frac{dv_4}{dv_0} = \frac{1}{d_{v_3}.} \qquad \frac{dv_4}{dv_3} = \frac{-v_0}{v_3^2.}$$

$$\frac{d_z}{d_3} = \frac{dz}{\partial v_4} \cdot \frac{\partial v_4}{\partial v_3} = \frac{-v_0}{v_3^{\,2}} \cdot \frac{dz}{\partial v_4}$$

$$\frac{dz}{\partial_2} = \frac{\partial z}{\partial v_3} \cdot \frac{\partial v_3}{\partial v_2} = e^{v2} \cdot \frac{dz}{\partial v_3}.$$

$$\frac{\partial z}{\partial_1} = \frac{\partial z}{\partial v_2} \cdot \frac{\partial v_2}{\partial v_1} = \frac{-1}{1} \cdot \frac{\partial z}{\partial v_2}.$$

$$\frac{\partial z}{\partial v_0} = \frac{\partial z}{\partial v_2} \cdot \frac{\partial v_2}{\partial v_0} + \frac{\partial z}{\partial v_4} \cdot \frac{\partial v_4}{\partial v_0} = \frac{-1}{1} \frac{dz}{\partial v_2} + \frac{1}{v_3} \cdot \frac{dz}{\partial v_4}.$$

$$\frac{\partial z}{\partial v_0} =$$

$\partial z = 1$
$\partial v_4 = \partial z$
$\partial v_3 = -v_0 \, (v_3)^2 \, \partial v_4$

$dv_2 = e^{v_2} \cdot dv_3$
$dv_1 = -\partial v_2$
$\partial v_0 = -dv_2 + 1/v_3 \cdot dv_4$

2.

(2) a) $y = w_4 \, f(w_0 x_0, w_1 x_1) + w_5 \, f(w_1 x_0, w_3 x_1)$

$\Rightarrow \; y = w_4 \max(w_0 x_0 + w_2 x_1, 0) + w_5 \max(w_1 x_0 + w_3 x_1, 0)$

b) $w_0 = +1 \qquad w_2 = -1 \qquad w_4 = 1$

$w_1 = -1 \qquad w_3 = 1 \qquad w_5 = 1$

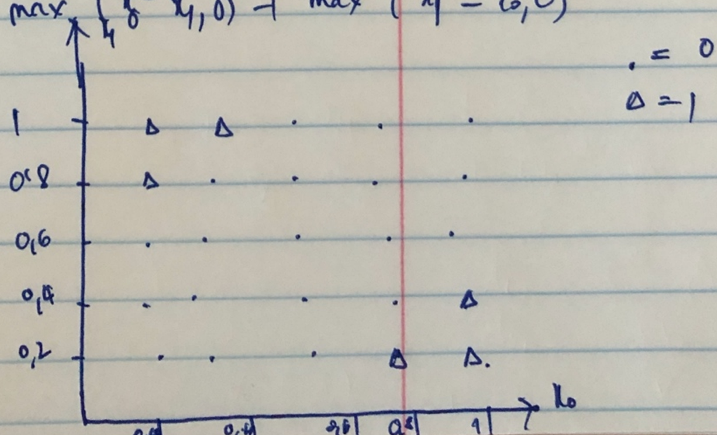
TRUE TABLE

x_0	x_1	max
0	0	$1(1(0) + (-1)(0) + 1(-1(0) + 1(0)) = 0$
0	1	$1 \max(1(0) + (-1)(1) + \max(-1(0) + 1.(1)) = 1$
1	0	$1 \max(1(1) + (-1)(0) + \max(-1)(1)\,(1.(0)) = 1$
1	1	$1 + \max(1(1) + (-1)(1) + \max(-1)(1)(1)(1) = 0.$

PROVE

c) $y = (1)\max((1)(x_0) + (-1)(x_1), 0) + (1)\max((-1)x_0) + (1)(x_1), 0)$

$y = \max(x_0 - x_1, 0) + \max(x_1 - x_0, 0)$



4.

(4)

$y = 4((0,0),2\,1) + 5(1,0\,;3,1)$

$= 4(a(0\,0) + b(2,1)) + 5(a(1;0) + b(3,1))$

$= a(0, w_4 + w_1 w_5)_0 + b(2w_4 + w_3 w_5)_1$

$= A X_0 + b X_1$

. a

Weights ->
0.974789091334698, 4.809937143244501, 0.7444642839954673, 2.441124015206587, -4.183234902756482,
.6388695492322847]

Predicted Value -->

1, 0, 0, 1, 1, 0, 1]

Expected Training Value ->

1, 0, 0, 1, 1, 0, 1]
ccuracy -> 100.00

Predicted Value for Testing Set ->

1, 1, 1, 0, 0, 1, 1, 0, 0, 0]

Predicted value for Training Set ->

1, 0, 1, 0, 0, 1, 1, 0, 1, 0]
ccuracy -> 80.00

. b

Weights ->
0.9872087581119291, 7.0581617869102375, 0.6776821921455273, 1.5217262742577355, -17.50863874737142,
3.356130962546924]

Predicted Value -->

1, 0, 0, 1, 1, 0, 0]

Expected Training Value ->

1, 0, 0, 1, 1, 0, 1]
ccuracy -> 85.71

Predicted Value for Testing Set ->

1, 1, 1, 0, 0, 1, 1, 0, 0, 0]

Predicted value for Training Set ->

1, 0, 1, 0, 0, 1, 1, 0, 1, 0]
ccuracy -> 80.00

8| Forward pass:

1: $v_0 = w_0$

2: $v_1 = w_1$

3: $v_2 = w_2$

4: $v_3 = w_3$

5: $v_4 = w_4$

6: $v_5 = w_5$

7: $v_6 = x_0 v_0 + x_1 v_2$

8: $v_7 = x_0 v_1 + x_1 v_3$

9: $v_8 = 1 + e^{-v_6}$

10: $v_9 = 1 + e^{-v_7}$

11: $v_{10} = v_4 / v_8$

12: $v_{11} = v_5 / v_9$.

13: $v_{12} = (v_{10} + v_{11} - z)^2 / 2$.

14: $v_6' = x_0' v_0 + x_1' v_2$

15: $v_7' = x_0' v_1 + x_1' v_3$

16: $v_8' = 1 + e^{-v_6'}$

17: $v_9' = 1 + e^{-v_7'}$

18: $v_{10}' = v_4 / v_8$.

19: $v_{11}' = v_5 / v_9$

20: $v_{12}' = (v_{10}' + v_{11}' - z)^2 / 2$.

21: $z = v_{12} + v_{12}'$

Backward pass:

1: $d_z = 1$

2: $\partial v_{12} = v'_{12} + 1$

3: $\partial v'_{12} = v_{12} + 1$

4: $\partial v_{11} = v_{10} + v_{11} - z$

5: $\partial v_{10} = v_{10} + x_{11} - z$

6: $\partial v_9 = -v_5 / \frac{2}{9} \; \partial v_{11}$

7: $\partial v_8 = -v_4 / \frac{2}{8} \; \partial v_{10}$

8: $\partial v_7 = -e^{-v_7} \, \partial v_9$

9: $\partial v_6 = -e^{-v_6} \, \partial v_8$

8: $\partial v_5 = \partial v_{11} / v_9 + \partial v'_{11} / v_9$

9: $\partial v_4 = \partial v_{10} / v_8 + \partial v'_{10} / v_8$

10: $\partial v_3 = x_1 \, \partial v_7 + x'_1 \, \partial v'_7$

11: $\partial v_2 = x_1 \, \partial v_6 + x'_1 \, \partial v'_6$

12: $\partial v_1 = x_0 \, \partial v_7 + x'_0 \, \partial v'_7$

13: $\partial v_0 = x_0 \, \partial v_6 + x_0 \, \partial' v_6$

Repeat 4 to 7 for ∂v_{11} to ∂v_6 same v_4 and v_5

Then re-estimate weight $w_i = i = 0, 1, 2 .. 5$.

$w_i = w_i - \alpha \, d v_i$