RYERSON UNIVERSITY

Faculty of Engineering, Architecture, and Science

Department of Electrical and Computer Engineering

Course Number	EE8603
Course Title	Neural Networks and Deep Learning
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Instructor	Dr. Kandasamy Illanko

Assignment No. 4

Assignment Title	Back Propagation - the Matrix Version

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1 EXERCISE 8.1.1

Suppose

$$A = \begin{bmatrix} a_1 & a_2 \end{bmatrix}$$

$$W = \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{bmatrix}$$

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$yy = AWx$$

(a) Write out AWx to express yy as a function of a_i's, w_i's j's, and x_i's.

(b) Find all four derivatives $\partial yy/\partial w_{ij}$.

(c) Arrange the derivatives in the appropriate order to obtain $D_{W_{yy}}$.

(d) Express $[xA]^T$ as a function of a_i's and x_i's, and conclude that $D_{W_{yy}} = [xA]^T$.

1.1 ANSWER TO (A)

$$yy = AWx = \begin{bmatrix} a_1 & a_2 \end{bmatrix}_{1\times 2} \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{bmatrix}_{2\times 2} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}_{2\times 1}$$

$$yy = AWx = \begin{bmatrix} a_1 & a_2 \end{bmatrix} \begin{bmatrix} w_{11}x_1 + w_{12}x_2 \\ w_{21}x_1 + w_{22}x_2 \end{bmatrix}$$

$$yy = AWx = \begin{bmatrix} a_1(w_{11}x_1 + w_{12}x_2) + a_2(w_{21}x_1 + w_{22}x_2) \end{bmatrix}$$

OR

$$yy = AWx = w_{11}a_1x_1 + w_{12}a_1x_2 + w_{21}a_2x_1 + w_{22}a_2x_2$$

1.2 ANSWER TO (B)

$$\frac{\partial yy}{\partial w_{11}} = a_1x_1$$

$$\partial yy/\partial w_{12} = a_1x_2$$

$$\partial yy/\partial w_{21} = a_2x_1$$

$$\partial yy/\partial w_{22} = a_2x_2$$

1.3 ANSWER TO (C)

$$D_{W_{yy}} = \begin{bmatrix} a_1x_1 & a_1x_2 \\ a_2x_1 & a_2x_2 \end{bmatrix}$$

1.4 ANSWER TO (D)

$$xA = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}_{2\times 1} \begin{bmatrix} a_1 & a_2 \end{bmatrix}_{1\times 2} = \begin{bmatrix} a_1x_1 & a_2x_1 \\ a_1x_2 & a_2x_2 \end{bmatrix}$$

$$[xA]^T = \begin{bmatrix} a_1x_1 & a_1x_2 \\ a_2x_1 & a_2x_2 \end{bmatrix} = D_{W_{yy}}$$

2 Exercise 8.2.1

3 Exercise 8.2.2

4 Exercise 8.3.1

5 Exercise 8.4.1

6 Exercise 8.4.2

7 Exercise 8.4.3

Submit the code for the 2/6-1 architecture.

8 Exercise 8.5.1

9 Exercise 8.5.2

10 Exercise 8.5.3

Submit the code for each architecture.

11 Exercise 8.5.4

Submit the code for each architecture.

12 Question 11

First read the section on Matlab image related functions in Chapter 7 and play with the scripts given there. For this exercise you will need 30 color images. Each image can contain any object or scenery. You can use your own pictures or get them from the web. Your job is to resize each image to 20 by 30 pixels (20 rows and 30 columns), make a collage and submit a hard copy in an A4 sized paper. Your collage does not need to be in color. Just sent the color images to a black and white printer. Make a collage that contains 5 pictures in each row and 6 pictures in each column. There may be a function in Matlab (or Python) that makes a collage of pictures. If there is such a function, it is up to you to lean about it. Otherwise write your own code that makes the collage. Submit only the code that makes the collage, and the collage in hard copy.