## HU Extension CSCI E-89 Deep Learning

## Assignment 02

### Handed out: 09/12/2025 Due by 1 PM EST on Saturday, 09/20/2025

**Problem 1.** Create a computational graph for the following expression:

Calculate the forward values of all the nodes and function starting with. In the process of calculating every node and every intermediate value, record all partial derivatives of every intermediate value with respect to its inputs. Finally, determine the partial derivatives of with respect to x, y, and z. Please, present your results as a simple graph. You can draw your graph by any means you find convenient, including by hand. Please place forward values above the lines representing propagation of values and backpropagation values (derivatives) below the lines. List clearly the final values of partial derivatives of function with respect to x, y, and z. Do all calculation with pan and paper.

(25%)

**Problem 2**. Find partial derivatives of function as defined in the first problem, with respect to x, y and z by using f.GradientTape(). Compare those values with the ones obtained in Problem 1.

(25%)

**Problem 3.** Please demonstrate that the binary classification example as presented in the lecture notes works as advertised. Please change the color of the upper set of events to green and the lower set of events to red. Change the covariance matrix used to define the shape of two clouds so that the clouds are almost spherical. Instead of the red decision boundary draw a dashed black line. (15%)

**Problem 4.** Please create a synthetic set of 100 data points. Let the independent variable x has a range [0, 8]. For variable x, use uniform distribution. Create dependent variable y by starting with a straight line Subsequently, add normal Gaussian noise of standard deviation equal to 0.2. Let us “solve” the regression problem. We want to find a straight line which has the minimal mean square error from the points in the data set. Formulate the problem as a training loop which adjusts its parameters by the gradient descend method and finds parameters of the best straight line. Please rely on tf.GradientTape() for calculations of your gradients. Please plot your synthetic data points and the best fit line on the same plot.

(35%)

**Problem 5**. Please go through every step of attached notebook: Lab02\_GradTapeBackProp.ipynb. Submit this notebook with all cells ran. Please provide HTML image of this notebook. (25%)

For problems 1 to 4, please submit a Jupyter ipynb file named e89\_YourLastName\_YourFirstName\_02.ipynb. Please submit an HTML image of that notebook as well. Make sure that your Jupyter notebook(s) contains description of all the steps you have taken. Please, present all intermediate and the final steps and their results. Please do not submit only the final numbers as the results of your analysis. We must see every step of your work.

If your notebook(s) contain(s) excessively long outputs, please copy a meaningful and illustrative number of initial and/or final lines and paste those in a markdown (comment) cell. Then, delete the long output(s).