Homework 1 for DTSC740 (Deep Learning)
Due October 21, 2023

Attention: Please submit your own work - Copying will be penalized.

1. (25 points: Practice of scalar-based backpropagation)You are required to calculate the gradients of

$$f(\boldsymbol{x}, \boldsymbol{w}) = \frac{1}{2 + sin^2(x_1 w_1) + cos(x_2 w_2)}$$

with respect to w_1, w_2.
(a) Use computational graph for calculation.
(b) Based on (a), writhe a program to implement the computational graph and verify your answer in (a).

Note: You are free to choose the inputs of your computational graph (values for x_1, x_2, w_1, w_2)

2. (25 points: Practice of vector-based backpropagation). You are required to calculate the gradients of

$$f(\boldsymbol{x}, \boldsymbol{w}) = ||\sigma(\boldsymbol{W}\boldsymbol{x})||^2$$

with respect to $W_{i,j}$.
Here $|| \cdot ||^2$ is the calculation of L_2 loss function, $\boldsymbol{W}$ is 3-by-3 matrix and $\boldsymbol{x}$ is 3-by-1 vector, and $\sigma(\cdot)$ is the sigmoid function that performs *element-wise* sigmoid operation.
(a). Use computational graph for calculation
(b). Based on(a), write a program to implement the computational graph and verify your answer in (a).
(c). (Optional - extra 2 points) Use the vectorized approach in python to simply your codes.

What to submit: a PDF file for this problem, including source codes and print screen results.