

## Spring 2022 Introduction to Deep Learning

### Homework Assignment 2

Due dates: March 6<sup>th</sup>

**Problem 1 (Practice of scalar-based backpropagation).** You are required to calculate the gradients of  $f(\mathbf{x}, \mathbf{w}) = \frac{1}{2 + \sin^2(x_1 w_1) + \cos(x_2 w_2)}$  with respect to  $x_i$  and  $w_i$ .

- (a) Use computational graph for calculation
- (b) Based on(a), write 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.

**Problem 2 (Practice of vector-based backpropagation).** You are required to calculate the gradients of  $f(x, w) = \|\sigma(\mathbf{W}\mathbf{x})\|^2$  with respect to  $x_i$  and  $W_{i,j}$ . Here  $\|\cdot\|^2$  is the calculation of L2 loss,  $\mathbf{W}$  is 3-by-3 matrix and  $\mathbf{x}$  is 3-by-1 vector, and  $\sigma(\cdot)$  is 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). *You can use vectorized approach to simplify your codes.*

**Note:** You are free to choose the inputs of your computational graph.