CSCI323: Modern Artificial Intelligence

Question 1 (4 Marks) You have a loss function:

$$\text{Loss}(x, y, z, w) = 4(x^2y^2 + 3\min\{w, z\} + 2w). \quad (1)$$

Use backpropagation algorithm to compute the gradients for the four variables at x = 4, y = -2, z = 5 and w = -1. Provide the computation graph with the following nodes: addition, square, multiplication, min, multiplication by a constant.

Question 2 (3 Marks) Assume you have two datasets of (x, y):

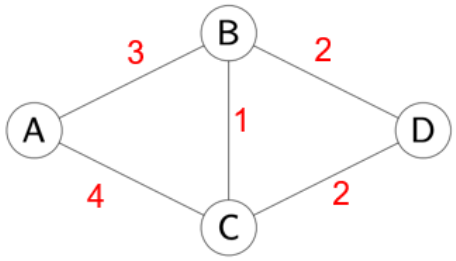
- $D_1 = \{(-1, +1), (0, -1), (1, +1)\}$.
- $D_2 = \{(-1, -1), (0, +1), (1, -1)\}$.

If you use feature $\varphi(x) = x$, neither dataset can be linearly separated. You need to define a two-dimensional feature $\varphi(x)$ to fix this such that:

- A weight vector $\mathbf{w}_1$ can classify D_1 perfectly (i.e., $\mathbf{w}_1 \cdot \varphi(x) > 0$ if x has label +1 and $\mathbf{w}_1 \cdot \varphi(x) < 0$ if x has label −1); and
- A weight vector $\mathbf{w}_2$ can classify D_2 perfectly;

Note the two datasets share the same features $\varphi(x)$ but the weight vectors can be different. $\varphi(x) = x$ normally can be re-written as $\varphi(x) = [1, x]$, which is regarded as one-dimensional feature.

Question 3 (3 Marks) Please use the uniform cost search algorithm to derive the minimum cost path of the following graph. The red numbers near the edge denote the cost between two nodes. For example, the cost(A, B)=3. Note that, besides the minimum cost path, your answer should also include the information about the unexplored, frontier, and explored nodes step by step.



Start state: A, end state: D

Submission:

Due date: **please follow the due date in the moodle site**.

Submit a PDF file to answer all the questions. Structure your answers: paragraphs, bullet points, etc.

Late submission:

5% deduction per day.

Plagiarism:

A plagiarised assignment will receive a zero mark and be penalised according to the university rules. Plagiarism detection software might be used for this assignment.