CS 1390-01: Introduction to Machine Learning

HW 1 (Given September 7, 2020; Due September 14, 2020)

Your answers must be entered in Google Classroom by midnight of the day it is due. If the question requires a textual response, you can create a PDF and upload that. The PDF might be generated from MS-WORD, LaTeX, the image of a handwritten response, or using any other mechanism. Code must be uploaded and may require demonstration to the TA. Numbers in the parentheses indicate points allocated to the question.

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1. Write the Taylor series expansion of,
   (a) Write the Taylor series expansion of e^x. **(10 points)**
   (b) Write a small program to plot what happens as you progressively take higher order terms i.e. the approximation when you only take the linear term, the approximation when you also include the second order term, the approximation when you include the third order term, and the approximation when you include the fourth order term. Plot these in different colors overlaid on e^x and assume an expansion about $x = 0$. **(20 points)**
2. Assume an error function to be minimized is given by,
$$J(w) = \frac{1}{2}\left[(w_2 - w_1)^2 + (1 - w_1)^2\right] \tag{1}$$
   (a) Plot the contour map of this error function. **(10 points)**
   (b) Find analytically the gradient vector,
$$\nabla(w) = \begin{bmatrix} \frac{\partial J}{\partial w_1} \\ \\ \frac{\partial J}{\partial w_2} \end{bmatrix} \tag{2}$$
   (10 points)
   (c) Identify on the plot you obtained in part (a) using the expression you obtained in part (b), the gradient vector at three arbitrary locations. **(10 points)**
   (d) Find analytically the weight vector that minimizes the error function such that $\nabla(w) = 0$. **(10 points)**