Hands-on session 1

Linear regression

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APL 745: Deep Learning for Mechanics

January 10, 2024

Submission due on January 24, 2024

Instructions:

(i) You are allowed to discuss in a group; however, you must submit your own handwritten homework copy (no computer-typed submission will be accepted). Further, copying homework from your friends is forbidden. If found copied, the homework submission will be considered invalid for all the students involved and will be graded zero.

(ii) Write all the steps, including your reasoning and the formulae you referred to, if any. If sufficient reasoning is not provided and steps are unclear, step marks will not be given.

(iii) For practical submissions, the codes are accepted in *.ipynb* or *.py* format.

(iv) Unless mentioned otherwise, only *numpy*, *pytorch* and *matplotlib* libraries may be used. Direct commands for algorithms to be implemented are not allowed.

(v) The *.rar* file containing all submission related files shall be named in the format, **Name_Entrynumber.rar**

Question 1. [10×5 = 50 Marks] The dataset given in LINK, relates the deflection δ of a simply supported beam with its elastic modulus E, load P, length L, width b and height h.

1. Select suitable basis functions using the given data and perform linear regression using,
   - Ordinary least square method.
   - Least square algorithm with lasso regularization.
   - Least square algorithm with ridge regularization.
2. Select suitable basis functions using the given data and perform linear regression using the gradient descent method.
   - Write the code for gradient descent using *numpy* library and/or *pytorch* library's basic functions.
   - Use *pytorch* library's gradient descent function and verify results obtained in the previous step.

Show final results (mean square error) for the test dataset in all cases. Also, plot the predicted and true deflections. Use 80:20 as the train: test ratio for the given dataset.

Hint: $\delta = \dfrac{PL^3}{C_1 EI}$ and $I = \dfrac{bh^3}{C_2}$, where C_1 and C_2 are constants.