CS 240: Lab 3
Perceptron

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Instructions

- This lab will be **graded**.
- Please read the problem statement and submission guidelines carefully.
- For any doubts or questions, please contact either the TA assigned to your lab group or the TAs involved in making the lab.
- The deadline for this lab is **Thursday, 30 January, 5 pm** but solutions till 5:30 pm will be accepted. Submissions after 5:30 pm will get **no marks**.
- You are not allowed to use any kind of LLM for code generation. You can refer to pseudo codes.
- The submissions will be checked for plagiarism, and any form of cheating will be penalized.

Helper Functions

These are some helper functions that you can use in your code.

- `plot_data`: This function plots the data points. Its inputs are :-
  - `X` (input features) : `np.ndarray` of shape (n, 2).
  - `y` (input labels) : `np.ndarray` of shape (n, 1).
- `plot_decision_boundary`: This function plots the data points and the decision boundary. Its inputs are :-
  - `X` (input features) : `np.ndarray` of shape (n, 2).
  - `y` (input labels) : `np.ndarray` of shape (n, 1).
  - `w` (weights) : `np.ndarray` of shape (3, 1).

Tasks to be Completed

Complete the following tasks in the provided Jupyter Notebook file:

Task 1 - Create data for the NAND and NOR functions (**linearly separable**).

Task 2 - Create data for the XOR and XNOR functions (**not linearly separable**).

Task 3 - Preprocess the above datasets as taught in class.

Task 4 - Implement the perceptron algorithm as taught in class.

Task 5 - Plot the decision boundary for the NAND and NOR functions.

Task 6 - Plot the decision boundary for the XOR and XNOR functions. (In this case, the perceptron algorithm will not converge and in the plot you can see that the decision boundary dosent separate the data points.)

In the following tasks, instead of checking if $x \cdot W > \theta$, we will check that if $sigmoid(x \cdot W - \theta) > 0.9$, y is assigned 1, but if $sigmoid(x \cdot W - \theta) < 0.1$, y is assigned 0. The sigmoid function is defined as follows:-

$$sigmoid(a) = \frac{1}{1 + e^{-a}}$$

Task 7 - Implement the perceptron algorithm with sigmoid.

Task 8 - Plot the decision boundary for the NAND and NOR functions for sigmoid.

Task 9 - Plot the decision boundary for the XOR and XNOR functions for sigmoid. (In this case, the perceptron algorithm will not converge and in the plot you can see that the decision boundary dosent separate the data points.)

Submission

- Submissions should be made on Moodle. Submit the Jupyter Notebook file renamed as `rollnumber1_rollnumber2.ipynb` (the "b" in roll number should be in lowercase).
- The hard deadline for submission is 5:30 pm. No marks will be given after that.
- Only one person per team should submit their solution.