CMSC 436: Artificial Intelligence

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Project 1

CMSC 436: Artificial Intelligence
Project No. 1
Due Wednesday, September 17, 2025 noon

Student Certification:
Student certification:
Team member 1:
Print Name: _____ *Date:* _____
*I have contributed by doing the following:*_____
Signed: _____ *(you can sign/scan or use e-signature)*

Team member 2:
Print Name: _____ *Date:* _____
*I have contributed by doing the following:*_____
Signed: _____ *(you can sign/scan or use e-signature)*

Team member 3:
Print Name: _____ *Date:* _____
*I have contributed by doing the following:*_____
Signed: _____ *(you can sign/scan or use e-signature)*

Team member 4:
Print Name: _____ *Date:* _____
*I have contributed by doing the following:*_____
Signed: _____ *(you can sign/scan or use e-signature)*

Part 1:

A) Understand and explore a data set (10 pts)

Three data sets (set A, B, and C) have been created following normally distributed classes. These data sets provide examples of car models where:

- The first column represents the price in USD.
- The second column represents the weight in pounds.
- The third (last) column corresponds to the type (0 for small, 1 for big car).

Each data set contains 3,000 samples.

For each data set, do the following:

1. Normalize the data first. Then, visualize the points on a 2D graph (for two vehicle types). (2 points)) (resource to understand data normalization)

2. Estimate a separation line and draw it manually (by hand) on that plot. This line will be a linear separator, which separates "small" cars from "big" cars. At this time, no running algorithm is needed (we will do that in the next assignment). (1 point)
3. Determine the mathematical definition of this linear separator. Based on this linear separator (equation), determine the inequality that selects "big" cars. What are the weights and thresholds? Comment. (2 points)
    a. Important: inequality defines neuron's functionality (think of the inequality we covered in Session 04 & 05). Inequality "makes" the decision (chooses a portion of xOy space here). Deciding on inequality means determining weights and threshold of a neuron.
4. Provide a confusion matrix (false positives, false negatives, etc.) (1 point)
5. Calculate accuracy, error, true positive rate and true negative rate, false-positive rate, and false-negative rate. (Note: the true positive rate is different from the true positive). (2 points)
6. Compare results for each data set and explain the differences. How are these datasets different? Why was data normalization helpful? (2 points)

Note: An example of true positive: the class is "it is a big car" and prediction is "big car"

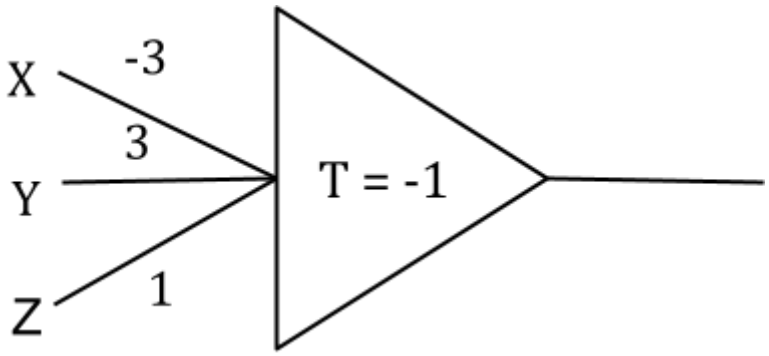
B) McCulloch-Pitts neurons (5 pts)

1. Create a truth table for the artificial neuron defined below. Based on its truth table, identify the logic function this neuron represents. Justify your answer using Boolean expressions. (3 points)
2. Given the same set of weights and the determined logic function of the neuron**, what would be the range of possible values for threshold**? (2 points)

Note: Use a unipolar hard threshold activation function (inputs/outputs are 0 & 1). Begin by defining the net and output formula.

Hint: The truth table (like the one in class) should present inequalities that will evidence the functionality of a neuron (prove that it works as promised).

Neuron Diagram:



Compile all your deliverables into a single PDF report.

Archive/zip the report along with any code, data, or other files.

Submit your file (Canvas). Please name the zip file as GroupName_Project1.zip.