Artificial Intelligence Lab 6 : Perceptron

The dataset is given by $\mathcal{D}_n = (x_i, y_i)_{i=1}^n$, with $x_i \in \mathbb{R}^d$ the labels $y_i \in \{-1, +1\}$, and it is also known that:

a) the dataset is linearly separable with factor $\gamma > 0$, i.e., there exists $w_* \in \mathbb{R}^d$ such that $\|w_*\|_2 = 1$ and

$$y_i(w_*^\top x_i + b) \geq \gamma, \tag{1}$$

where $b \in \mathbb{R}$ is some bias.

b) the data is bounded i.e., $\|x_i\|_2 = R$.

c) the dataset contains **equal** number of positive and negative examples.

(Q1) Implement a function that takes in d, γ, b and R as input and produces a linearly separable dataset $\mathcal{D}_n, n = 100, 1000$. [25 Marks]

Case I: Data is centered about the origin.

(Q2) For $b = 0$, $d = 1$, create a datasets for $\gamma = 0.1, R = 1, \gamma = 1, R = 10$. Run the perceptron algorithm. How many iterations does it take in each case. [25 Marks]

(Q3) For $b = 0$, $d = 2$, create a datasets for $\gamma = 0.1, R = 1, \gamma = 1, R = 10$. Run the perceptron algorithm. How many iterations does it take in each case. [25 Marks]

Case II: Data is not-centered about origin

(Q4) For $b = 4$, $d = 1$, create a datasets for $\gamma = 0.1, R = 1, \gamma = 1, R = 10$. Run the perceptron algorithm with 1-padding. How many iterations does it take in each case. [15 Marks]

(Q5) For $b = -4$, $d = 2$, create a datasets for $\gamma = 0.1, R = 1, \gamma = 1, R = 10$. Run the perceptron algorithm with 1-padding. How many iterations does it take in each case. [10 Marks]

Display the dataset and $w_t^\top x + b = 0$ each iteration.