Perceptron

$$a = w^T x$$

$$= w_1 x_1 + w_2 x_2 + \dots + w_n x_n + \underbrace{w_0}_{\substack{\| \\ b \\ \text{"bias"}}} \underbrace{x_0}_{\substack{\| \\ 1}}$$

observe an example in traing (x, y) $y = 1$ — for simplicity we suppose this is a positive example

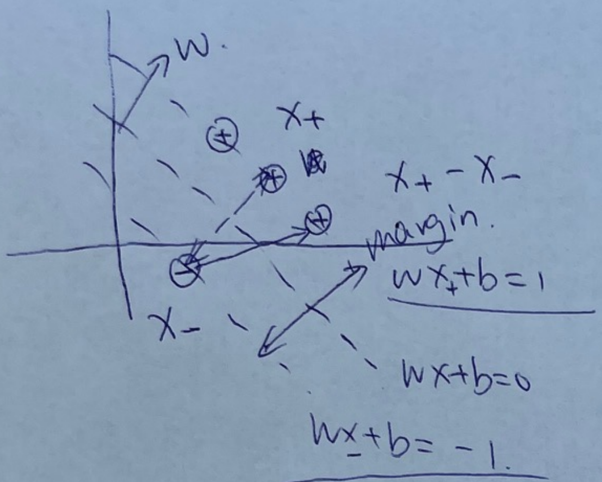
model made a mistake, namely $a < 0$.

so, we make a update $w' = w + x$.

observe this example again

$$a' = w'^T x = (w + x)^T x = \underbrace{w^T x}_{\substack{\| \\ a}} + \underbrace{x^T x}_{\substack{\| \\ \sum_{i=0}^{n} x_i^2 \\ \vee \\ 1 \quad x_0 = 1}} > a + 1$$

SVM



margin

$$= (x_+ - x_-) \cdot \frac{w}{\|w\|_2}$$

unit vector.

$$= \frac{2}{w} \cdot \frac{w}{\|w\|_2}$$

$$x_+ - x_- = \frac{2}{w}$$

$$= \frac{2}{\|w\|_2}$$

$$\sqrt{w_1^2 + w_2^2 + \cdots w_n^2}.$$

$$wx_+ + b = 1$$
$$wx_- + b = -1$$

$$wx_+ - wx_- = 1 - b - (-1 - b) = 2.$$

$$L(x_j, y_j^*) = \underbrace{\boxed{W^T f(x_j, y_j^*)}}_{F} - \log \underbrace{\boxed{\sum_y e^{W^T f(x_j, y)}}}_{E}$$

$$\frac{\partial L}{\partial w_i} = \frac{\partial F}{\partial w_i} - \frac{\partial \log E}{\partial w_i} = \frac{\partial F}{\partial w_i} - \frac{1}{E} \cdot \frac{\partial E}{\partial w_i}$$

i'th feature/weight

$$= f_i(x_j, y_j^*) - \frac{\sum_y f_i(x_j, y^*) \cdot e^{W^T f(x_j, y)}}{\sum_y e^{W^T f(x_j, y)}}$$

(1)

$$F = W^T f(x_j, y_j^*) \qquad W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_i \\ \vdots \end{bmatrix} \qquad f(x_j, y_j^*) = \begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_i \\ \vdots \end{bmatrix}$$

$$\underline{\frac{\partial F}{\partial w_i}} = f_i(x_j, y_j^*)$$

(2)

$$E = \sum_y e^F$$

$$\frac{\partial E}{\partial w_i} = \sum_y \frac{\partial e^F}{\partial w_i} = \sum_y \boxed{\frac{\partial e^F}{\partial F}} \cdot \frac{\partial F}{\partial w_i} = \sum_y \boxed{e^F} \cdot \underline{\frac{\partial F}{\partial w_i}}$$

$$= \sum_y e^{W^T f(x_j, y)} \cdot f_i(x_j, y_j^*)$$

Chain Rule:

$$\frac{\partial f(g(x))}{\partial x} = \frac{\partial f}{\partial g} \cdot \frac{\partial g}{\partial x}$$

$$f(x) = e^x \rightarrow \frac{\partial f}{\partial x} = e^x$$

$$f(x) = \log(x) \rightarrow \frac{\partial f}{\partial x} = \frac{1}{x}$$

$$f(x) = c + x \rightarrow \frac{\partial f}{\partial x} = 1$$