# Classification

$y \in \mathbb{R}$ $-\infty, \infty$ $0, \infty$

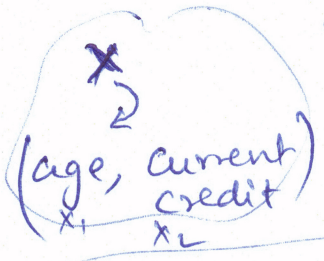
X y } y is categorical

y is a class label

We will assume that y takes only 2 values.

$y \in \{-1, +1\}$

## Credit card approval system:

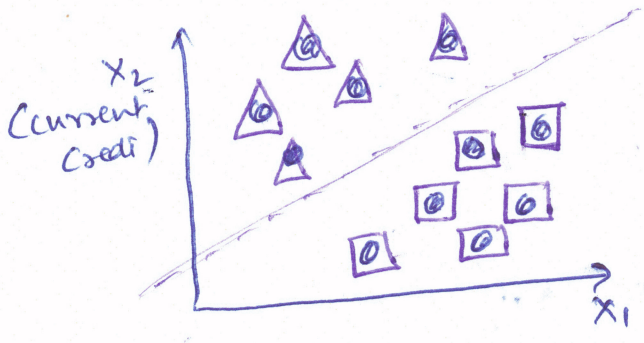




Some function $f$ : $f(x) = y$

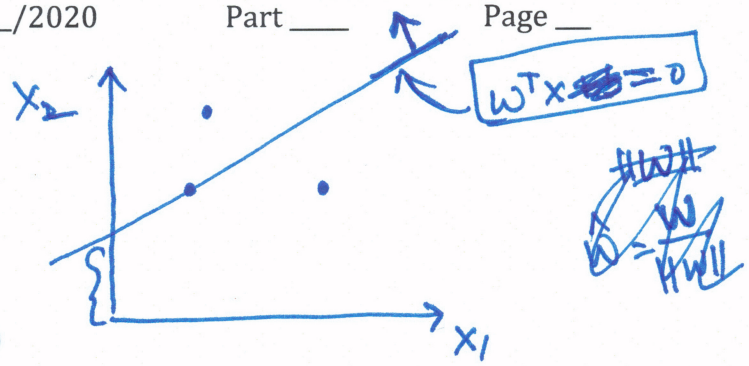
decision function

Inductive bias : f is a line




△ - reject
□ - accept.

↳ linear classifiers




$x_2 = m x_1 + c$

$-c - m x_1 + x_2 = 0$

$(-c) \cdot 1 + (-m) x_1 + (1) x_2 = 0$ are the same

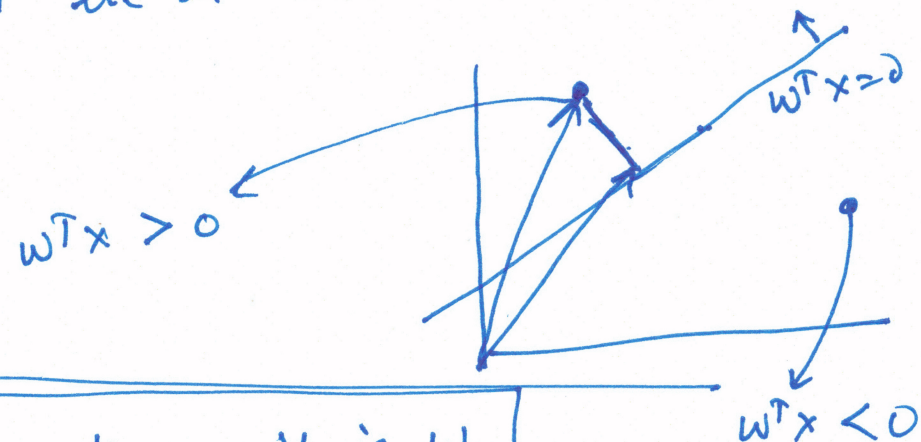
$$\begin{bmatrix} -c \\ -m \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ x_1 \\ x_2 \end{bmatrix} = 0$$

we have absorbed intercept term into $w$ and $x$

$w^T x = 0$

If $x$ lies on the line: $w^T x = 0$

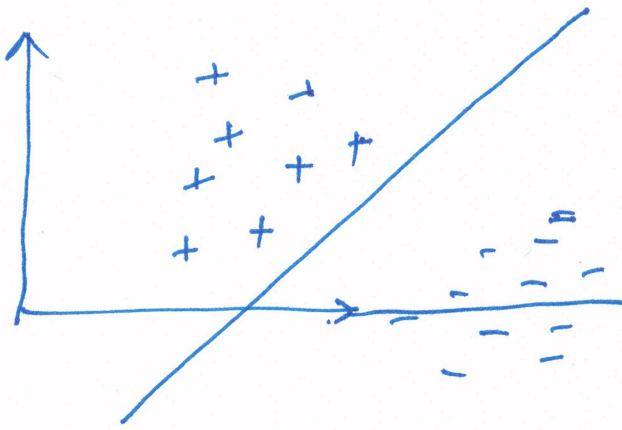
If $x$ does not lie on the line: $w^T x \neq 0$

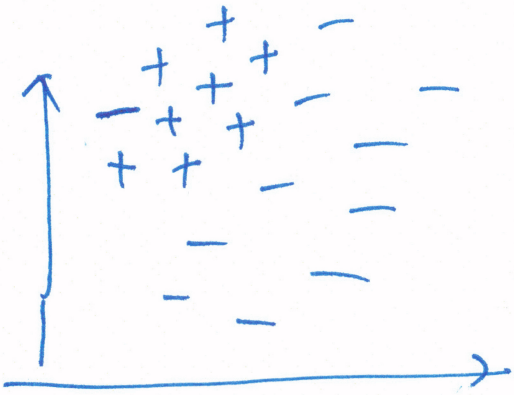



If $w^T x \geq 0$ then $y$ is $+1$

If $w^T x < 0$ then $y$ is $-1$

How do we learn $w$?





NBT

Define an objective fn. $J(w)$ using $X, y$

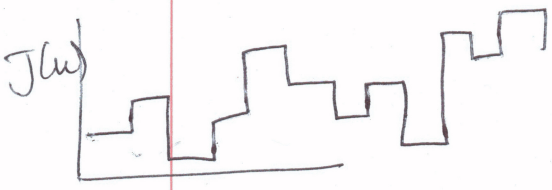
Depending on $J$ →
- Perceptron
- Logistic Regression.
- Support Vector Machine

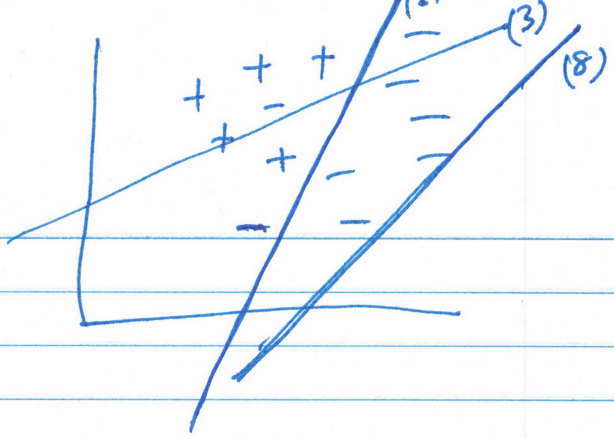
Ideal objective fn.

$$J(w) = \sum_{i=1}^{N} \mathbb{I}\left[y_i (w^T x_i) < 0\right]$$

0-1 loss.

counting number of mistakes.




## Perceptron

$$J(w) = \frac{1}{2} \sum_{i=1}^{N} (y_i - w^T x_i)^2$$

squared loss.