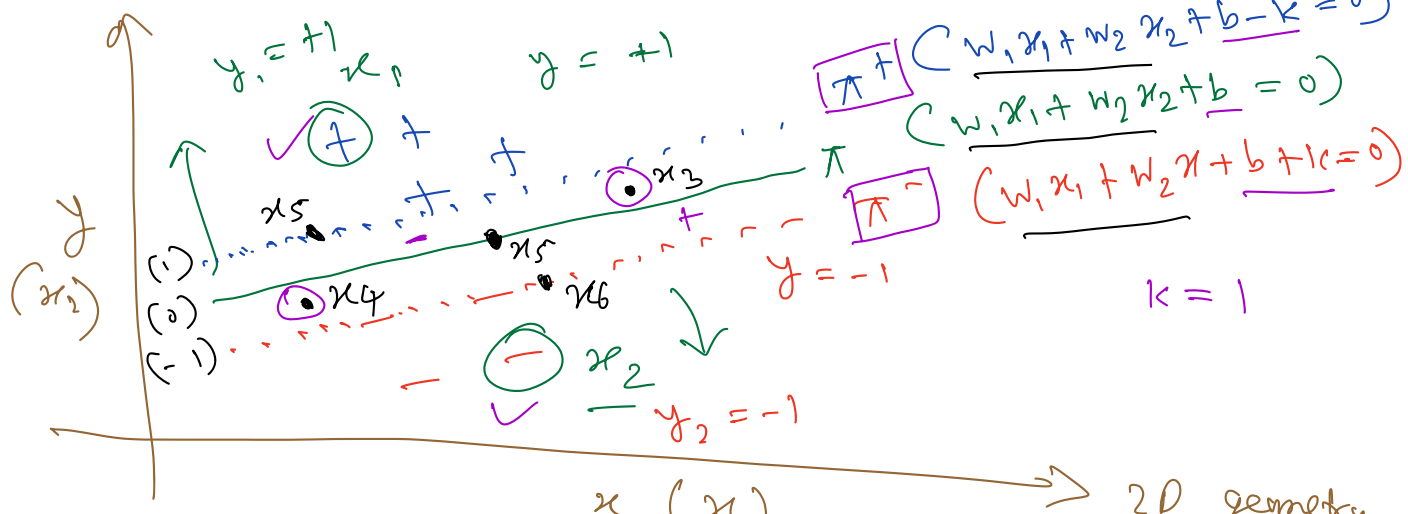
Previous Class (Sept 20)

1) Recap + Quizzes
2) XGBoost & Optimization
3) XGBoost Hyper-params
4) Code walkthrough of XGBoost
5) Light GBM & Optimization
6) Code walkthrough of Light GBM
7) Stacking
8) Cascading

Today's class

1) Problem Statement
2) Geometric Intuition of SVM
3) Hard Margin SVM
4) Soft Margin SVM
5) Algebraic Intuition of SVM
6) Hinge loss
7) SVM Imbalance
8) Code implementation



$\pi^+ : w^T x + b = 1$

$\boxed{w^T x + b - 1 = 0}$

$\pi : w^T x + b = 0$

$\pi^- : \boxed{w^T x + b + 1 = 0}$

$\rightarrow w^T x + b = -1$

$\boxed{w^T x_1 + b \geq 1}$, $\boxed{w^T x_2 + b \leq -1}$

$\boxed{0 < w^T x_3 + b < 1}$

$\boxed{-1 < w^T x_4 + b < 0}$

$x + y + 1 = 0$

$\boxed{x + y = -1}$

$0.5x + 0.5y + 1 = 0$

$\Rightarrow 0.5x + 0.5y = -1$

$\Rightarrow \boxed{x + y = -2}$

$y_1 = +1,\ w^T x_1 + b \geq 1$

$y_2 = -1,\ w^T x_2 + b \leq -1$

$\times$

$\boxed{y_1 (w^T x_1 + b) \geq 1}$

If $y_2 = +1$,

$y_2 (w^T x_2 + b) \leq -1$

$\boxed{y_2 (w^T x_2 + b) \geq 1}$ ✓

$\because y_2 = -1$

$m \times (-1) \geq 1$

$m \leq -1$

$m = -2$

$m \times (-1) = -2 \times -1 = 2$

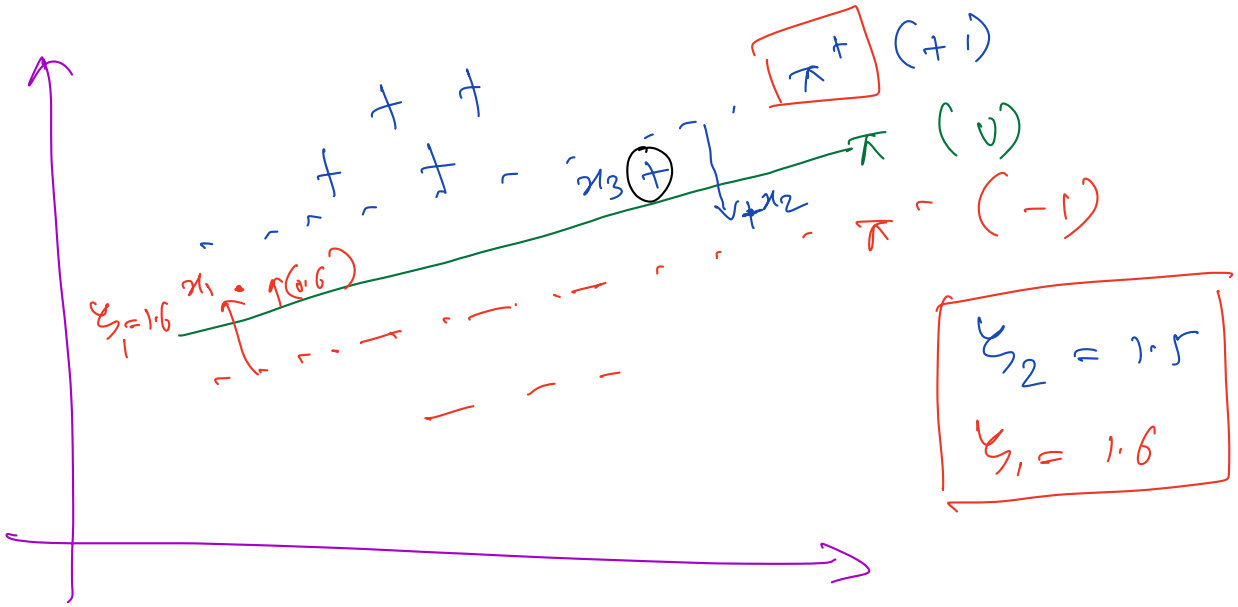
$$y_i \left(w^T x_i + b \right) \geq 1$$

$$w^T x_s + b = 1 \quad , \quad y_s = +1$$

$$y_s \left(w^T x_s + b \right) = 1$$

$$w^T x_6 + b = -1 \quad , \quad y_6 = -1$$

$$y_6 \left(w^T x_6 + b \right) = +1$$



$\|w\| = 1$ unit

x_2 $\quad y_2 \left(w^T x_2 + b \right) = -0.5$

$y_2 = +1$ $\quad = 1 - 1.5$

$\hookrightarrow \xi_2$

$$y_i \left(w^T x_i + b \right) \geq 1 - \xi_i$$

$y_1 \left(w^T x_1 + b \right) = -0.6$

$\hookrightarrow -1$ $\quad = 1 - 1.6$ ξ_1

log reg $\Sigma(\log\text{-loss}) + \lambda \Sigma |w_j|^2$

SVM $\frac{\Sigma |w_j|^2}{2} + C \Sigma \xi_i$

Similar $\frac{1}{C}$ $\frac{\Sigma |w_j|^2}{2} + \Sigma(\xi_i)$

$\frac{1}{C}$ → regularization

$\Sigma(\xi_i)$ → loss / error

param

λ

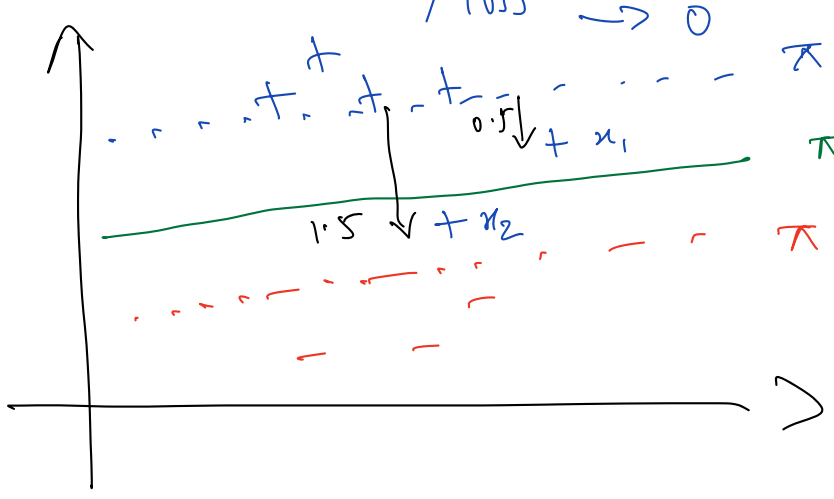
$C \uparrow$, $\frac{1}{C} \downarrow$ → less regularization → overfit

$C \downarrow$, $\frac{1}{C} \uparrow$ → more regularization → underfit

Correctly classified points : $y_i(w^T x_i + b) \geq 1$

$\xi_i \geq 1$

→ error / loss → 0



$\xi_1 = y_i(w^T x_i + b)$

$+1 \quad \downarrow 0.5$

$= 0.5 \quad (1 - 0.5)$

$\xi_1 = 0.5$

$\xi_1 = 1 - \xi_1$

$$z_2 = y_2 (w^T x_2 + b)$$

$$(+1) \quad x - 0.5$$

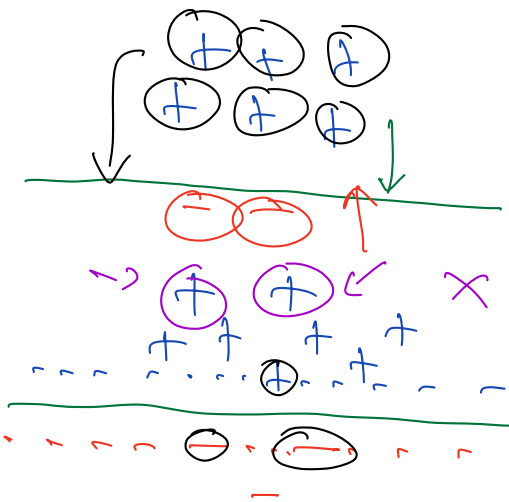
$$= -0.5 \quad (1 - 1.5)$$

$$\zeta_2 = 1.5$$

$z_2 = 1 - \zeta_2$

$z_i = 1 - \zeta_i$

points with non-zero errors



Log Reg [closer to minority class]

SVM

+ve → 100, nSV → 2 possible

-ve → 10, nSV → 3 possible

rbf = x_1, x_2

$$e^{-\left(\frac{|x_1 - x_2|^2}{\sigma}\right)}$$

σ → gamma

↳ exp dist between x_1 & x_2