Train 49000
Validation 1000
Test 1000

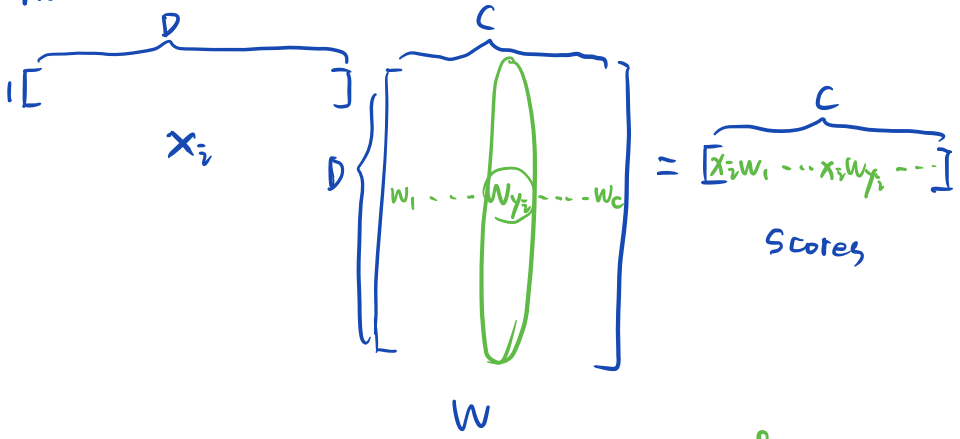
preprocessing : Substract the mean image.

⇒ SVM Loss (a.k.a Hinge Loss)

$$L_i = \sum_{j \neq y_i} [\max(0, x_i W_j - x_i W_{y_i} + \Delta)]$$

- y_i: the index of the correct class of x_i
- j: iterates over all C classes
- $j \neq y_i$: iterates over all N examples
- Δ: margin parameter

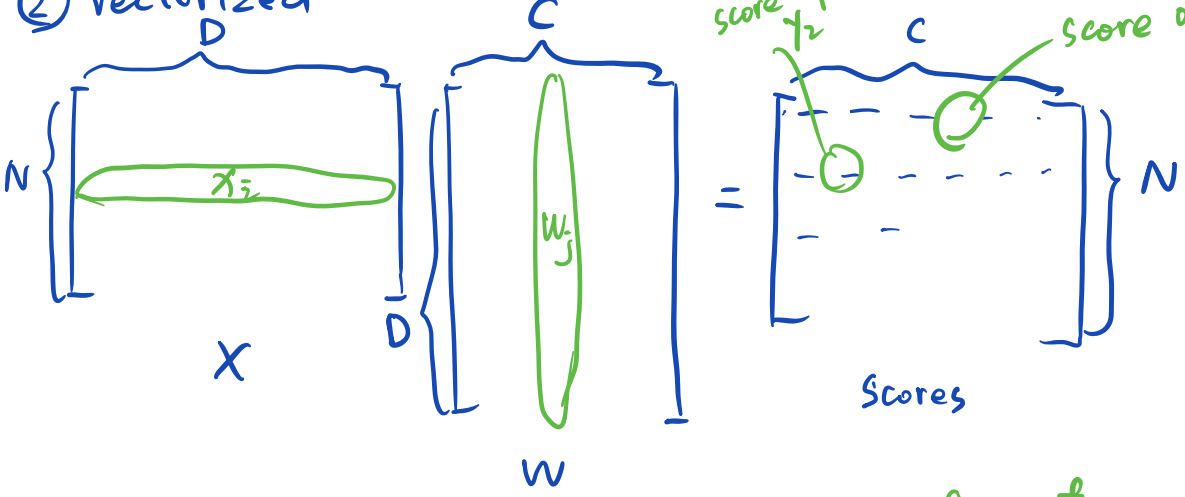
① naive



$$\text{if } (x_i w_j - x_i W_{y_i} + \Delta) > 0$$

$$\begin{cases} \dfrac{dL_i}{dw_j} = x_i \\ \dfrac{dL_i}{dW_{y_i}} = -x_i \end{cases}$$

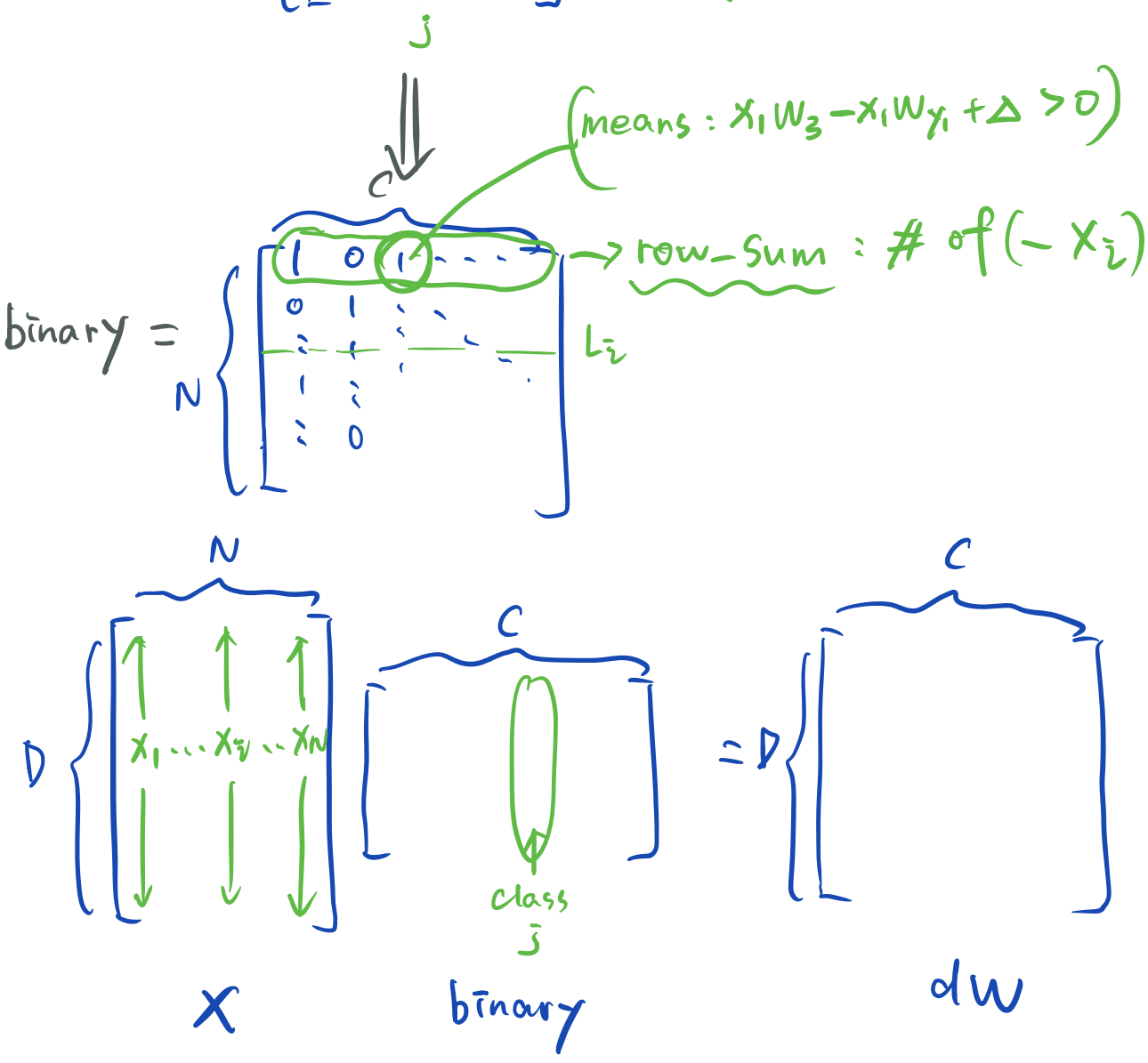
② vectorized



$$\text{margins} = \max\left(0, (XW - \underbrace{XW[[1,\ldots,N], y]}_{\text{Score of correct class}} + \Delta)\right)$$

$[1,\ldots,N]$: (arange)

XW: $(N \times C)$ $\quad$ $XW[\ldots, y]$: $(N \times 1)$


j
(means : $x_i W_j - x_i W_{y_i} + \Delta > 0$)
row_sum : # of ($-x_i$)
binary =
N
L_i

N
D
$x_1 \cdots x_i \cdots x_N$
C
class j
= D
C
X
binary
dW