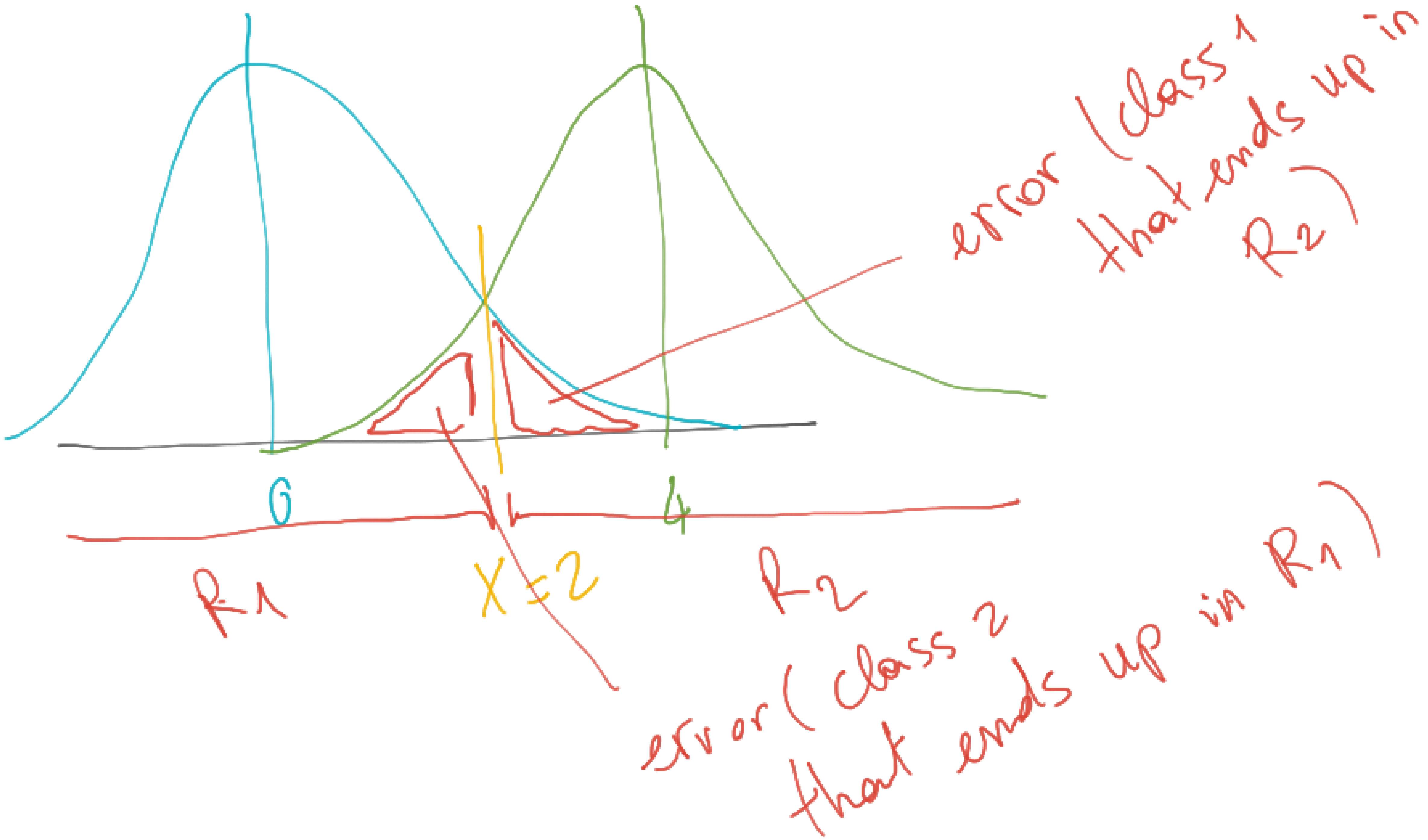
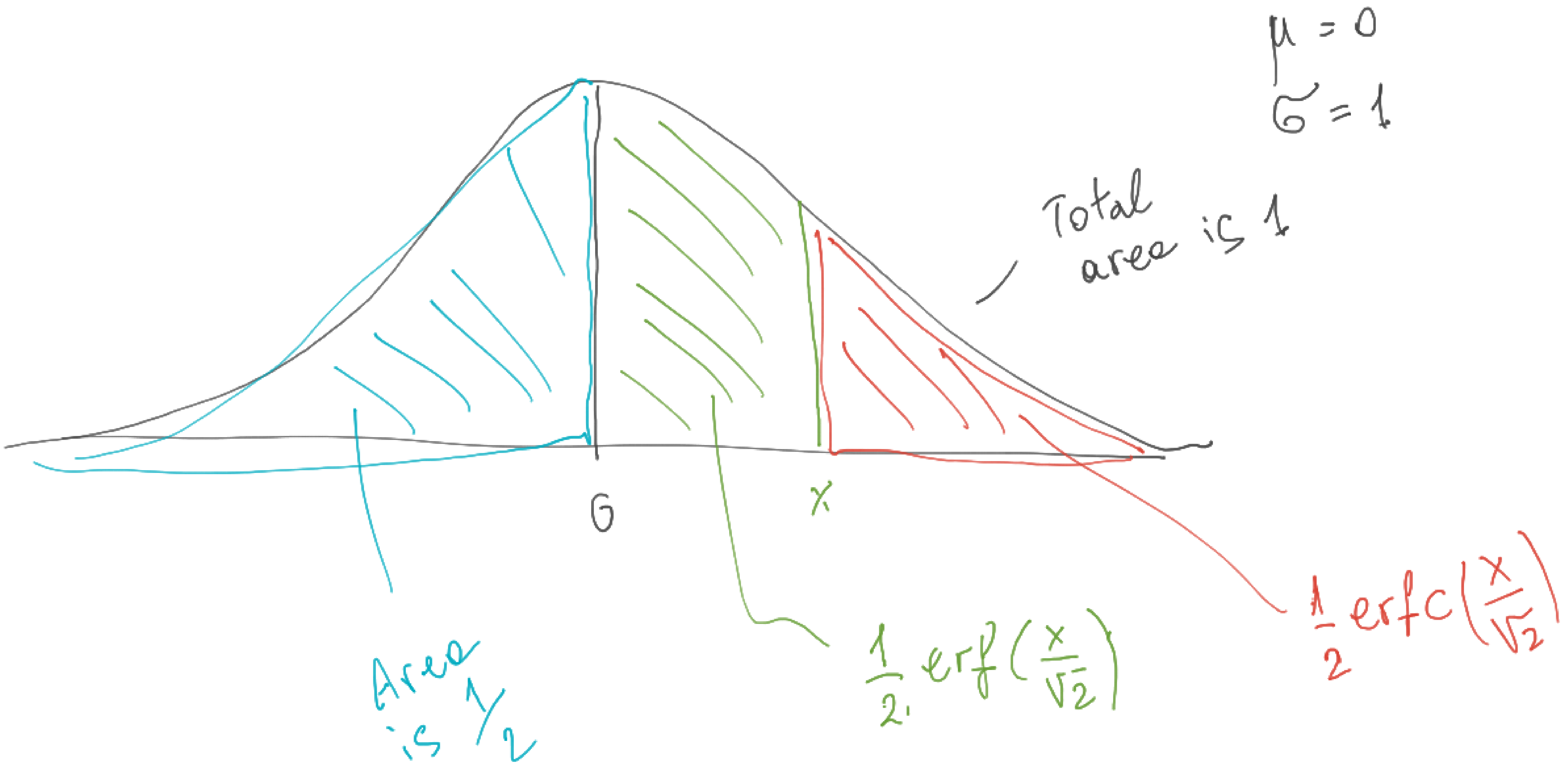
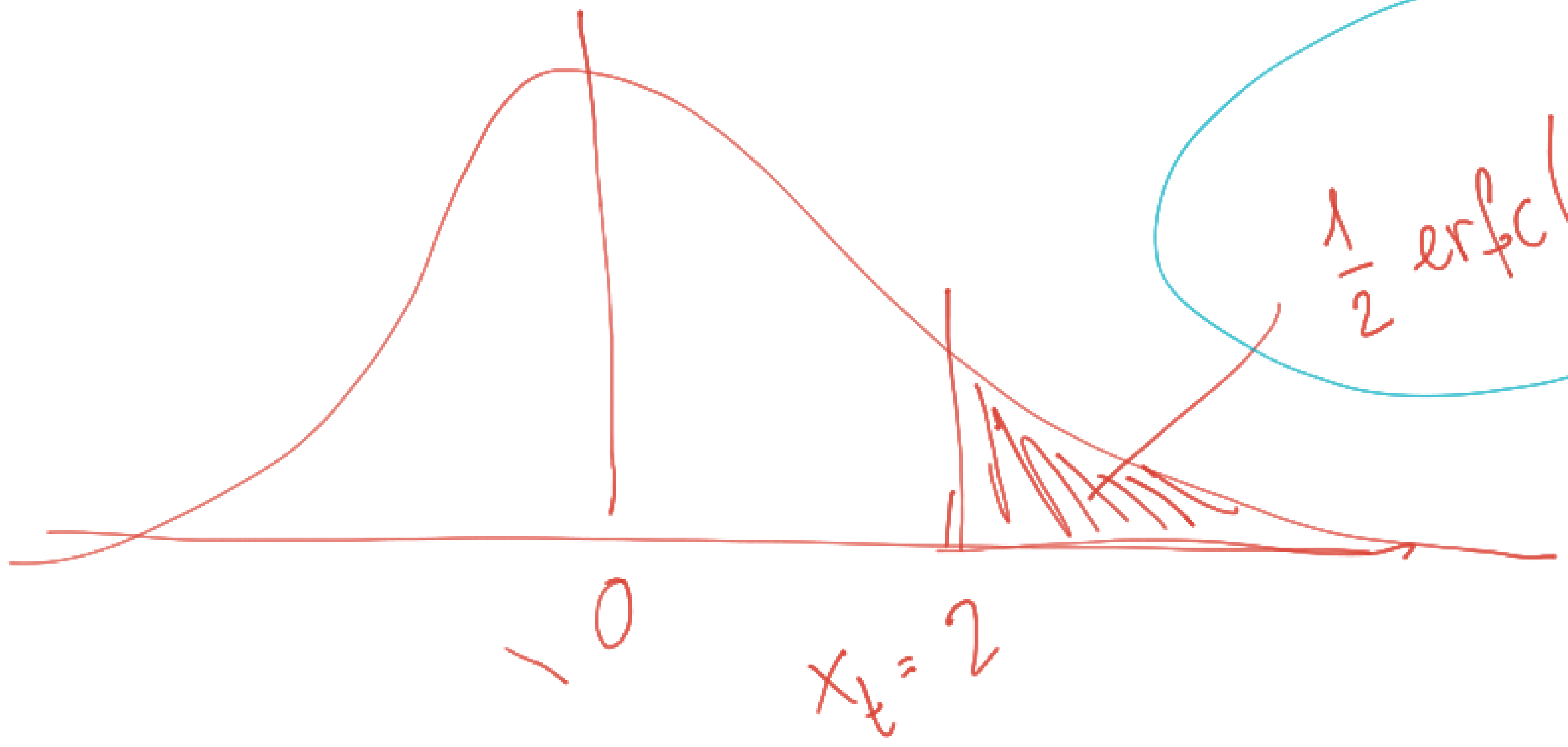


error (class 1 that ends up in R_2)
0
1
4
R_1
$X=2$
R_2
error (class 2 that ends up in R_1)



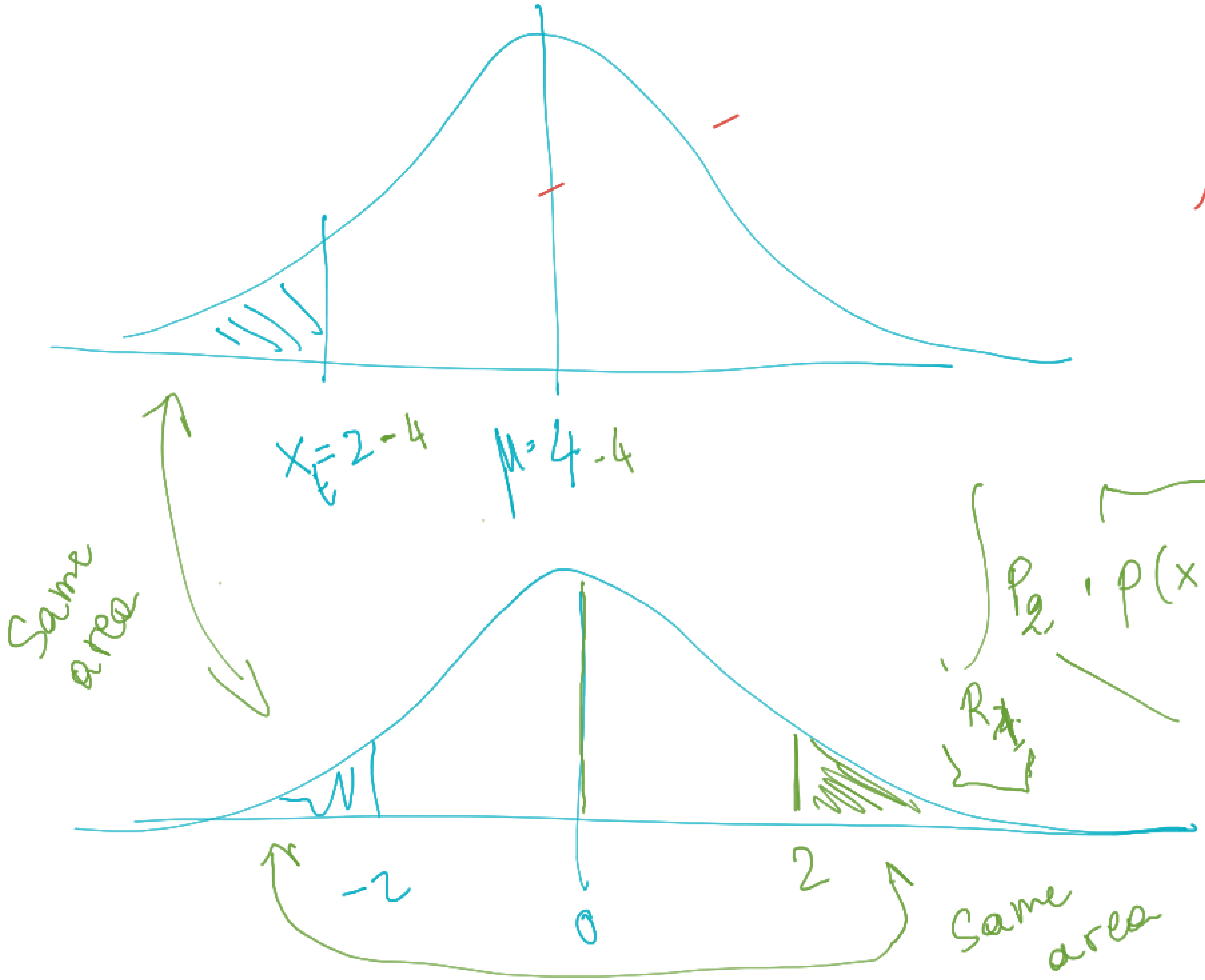
$\mu = 0$
$\sigma = 1$
Total area is 1
0
x
Area is 1/2
$\frac{1}{2}\,\mathrm{erf}\left(\frac{x}{\sqrt{2}}\right)$
$\frac{1}{2}\,\mathrm{erfc}\left(\frac{x}{\sqrt{2}}\right)$



$$\frac{1}{2}\,\mathrm{erfc}\left(\frac{x_t}{\sqrt{2}}\right)$$

$$\int_{R_2} P(\omega|x)\,dx = \int_{R_2} P_1 \cdot p(x|\omega_1)\,dx =$$

$$= \frac{1}{2}\cdot\left(\frac{1}{2}\,\underbrace{\mathrm{erfc}\left(\frac{2}{\sqrt{2}}\right)}_{0.046}\right) = 0.0115$$



$$\frac{1}{2} + \frac{1}{2}\,\mathrm{erf}\left(-\frac{2}{\sqrt{2}}\right)$$

$$\int_{R_1} \overbrace{P_2 \cdot p(x|\omega_2)}\,dx = 0.0115$$

$$\frac{1}{2} \cdot \int_{2}^{+\infty} N(0,1)\,dx$$

μ-4

symmetry!

X_{tr}

$$\begin{array}{c|ccccc} & x_{tr1} & x_{tr2} & x_{tr3} & x_{tr4} & x_{tr5} \\ \hline x_{ts1} & 2.24 & 2.24 & 1.41 & 1.00 & 2.83 \\ & 3.61 & 3.61 & 0.00 & 2.24 & 1.41 \\ & 1.00 & 1.00 & 2.83 & 1.00 & 4.24 \\ & 2.83 & 3.16 & 1.00 & 2.00 & 2.24 \end{array}$$

$\rightarrow \overbrace{x_{tr4}, x_{tr3}}^{k=2}, x_{tr1}, x_{tr2}, x_{tr5}$

y_{tr4}, y_{tr3}

$$\mathbf{y}_{tr} = \begin{bmatrix} 2 \\ 2 \\ 0 \\ 1 \\ 0 \end{bmatrix},$$

$$\begin{array}{cc} y_{tr4} & y_{tr3} \\ \end{array}$$
$$[1, 0]$$

$y_{ts1} = 1$

$y_i \cdot f(x_i)$

$>0 \rightarrow \hat{y}_i = 1$

$<0 \rightarrow \hat{y}_i = -1$ wrong

1

$y_i = -1$ $f(x_i) < 0$ $\hat{y}_i = -1$

correct classif.

$y_i f(x_i) > 0$

wrong classif.

$y_i f(x_i) < 0$

~~inner~~ first term of our loss

$$\nabla \ell_w = -yx$$

$$\nabla \ell_b = -y$$

$$z = y f(x)$$

$$\ell(z) = [\underbrace{\max(0, 1-z)} - \max(0, -z)]$$

-2

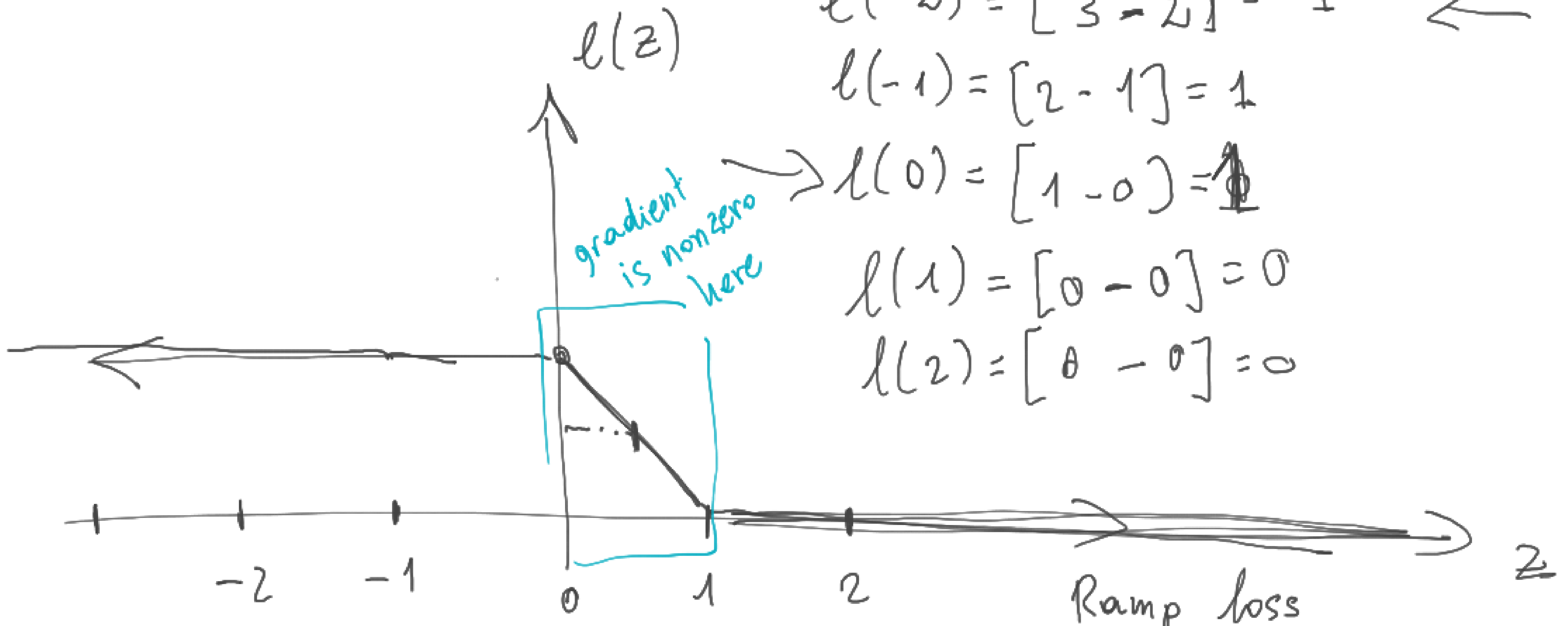
$$\ell(-2) = [3 - 2] = 1$$

$$\ell(-1) = [2 - 1] = 1$$

$$\ell(0) = [1 - 0] = 1$$

$$\ell(1) = [0 - 0] = 0$$

$$\ell(2) = [0 - 0] = 0$$

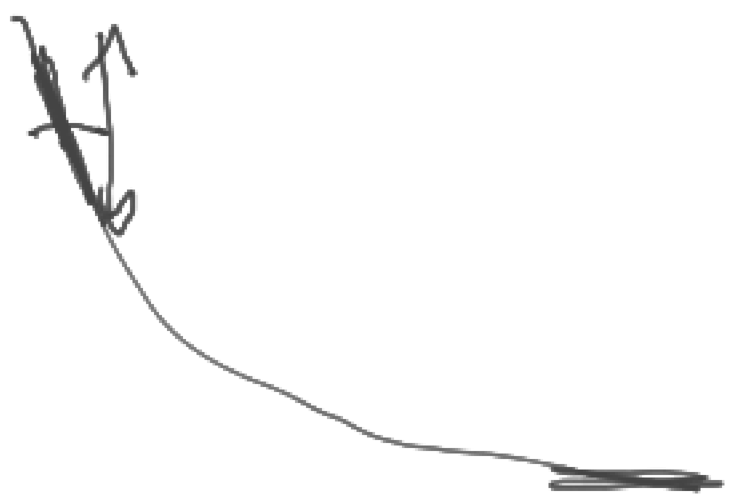


Ramp loss function

while $\|\nabla L_b\|_1 + \|\nabla L_b\|_1$

$$w \to w - \eta \nabla L_w$$

$$b \to b - \eta \nabla L_b$$



$$L = \frac{1}{n}\sum_{i=1}^{N} \underbrace{\left[\max\left(0, 1 - y_i f(x_i)\right) - \max\left(0, -y_i f(x_i)\right)\right]} + \overbrace{\frac{\lambda}{2} w^T w}^{r}$$

$$\left.\begin{array}{l} \nabla l_w = -y_i x_i \\ \nabla l_b = -y_i \end{array}\right\} \begin{array}{l} \text{only when } y_i f(x_i) \text{ in } (0,1) \\ \text{otherwise it's } \emptyset \end{array}$$

$$\nabla r_b = 0$$

$$\nabla r_w = \nabla_w \left[\frac{\lambda}{2} w^T w\right]$$

$$\nabla r_w = \begin{bmatrix} \frac{\partial r}{\partial w_1} \\ \frac{\partial r}{\partial w_2} \end{bmatrix} = \begin{bmatrix} \frac{\lambda}{\cancel{2}} \cdot \cancel{2} w_1 \\ \frac{\lambda}{\cancel{2}} \cancel{2} w_2 \end{bmatrix} = \lambda \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = \lambda \vec{w}$$

$$r = \frac{\lambda}{2} w^T w = \frac{\lambda}{2} \begin{bmatrix} w_1 & w_2 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = \frac{\lambda}{2}\left(w_1^2 + w_2^2\right)$$

$$\nabla_w L = \begin{cases} \frac{1}{n} \sum \left(-y_i \vec{x}_i\right) & \text{if } \left(y_i f(x_i) \text{ in } (0,1)\right) \\ 0 & \text{otherwise} \end{cases} + \lambda \vec{w}$$

$$\nabla_w L = \begin{cases} \frac{1}{n}\sum(-y_i\vec{x}_i) & \text{if } (y_i f(x_i) \text{ in } (0,1) \\ 0 & \text{otherwise} \end{cases} + \lambda\vec{w}$$

$$\nabla_b L = \begin{cases} \frac{1}{n}\sum -y_i & \text{if } f(x_i)\cdot y_i \text{ is in } (0,1) \\ 0 & \text{otherwise} \end{cases} + 0$$

$$\mathbf{x} = \begin{bmatrix} -2 & 0 \\ 0 & -2 \\ -1 & -1 \\ 1 & 2 \\ 1 & 1 \\ 2 & 0 \end{bmatrix}, \quad \mathbf{y} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ -1 \\ -1 \\ -1 \end{bmatrix},$$

$$\underbrace{\mathbf{w} = [0.2, \ -1]^T}_{1\times 2}, \quad b = 0,$$

$$f(x_i) = w^T \cdot \underbrace{x_i}_{6\times 2} + b \qquad 6$$

$$\mathbb{R}^{1\times 2} \times \mathbb{R}^{2\times 6} \to \mathbb{R}^{1\times 6}$$

$$(w^T \cdot X^T) + b$$

$$\begin{bmatrix} 0.2 & -1 \end{bmatrix} \begin{bmatrix} -2 & 0 & -1 & 1 & 1 & 2 \\ 0 & -2 & -1 & 2 & 1 & 0 \end{bmatrix} + 0 = \begin{bmatrix} (0.2)(-2) + (-1)(0) \\ (0.2)(0) + (-1)(-2) \\ (0.2)(-1) + (-1)(-1) \\ (0.2)(1) + (-1)(2) \\ (0.2)(1) + (-1)(1) \\ (0.2)(2) + (-1)(0) \end{bmatrix}^T$$

$$\mathbf{x} = \begin{bmatrix} -2 & 0 \\ 0 & -2 \\ -1 & -1 \\ 1 & 2 \\ 1 & 1 \\ 2 & 0 \end{bmatrix}, \quad \mathbf{y} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ -1 \\ -1 \\ -1 \end{bmatrix}, \qquad \underbrace{\dot{w} = [0.2, \ -1]^T}_{1\times 2}, \ b = 0,$$

$$f(x_i) = w^T \underbrace{x_i}_{6\times 2} + b \qquad 6$$

$$\mathbb{R}^{1\times 2} \times \mathbb{R}^{2\times 6} \to \mathbb{R}^{1\times 6}$$

$$= \begin{bmatrix} (0.2)(-2) + (-1)(0) \\ (0.2)(0) + (-1)(-2) \\ (0.2)(-1) + (-1)(-1) \\ (0.2)(1) + (-1)(2) \\ (0.2)(1) + (-1)(1) \\ (0.2)(2) + (-1)(0) \end{bmatrix}^T = \begin{bmatrix} -0.4 \\ +2 \\ -0.2+1 \\ 0.2-2 \\ 0.2-1 \\ 0.4 \end{bmatrix}^T \to f(x)$$

$$f(x_i) \cdot y_i \begin{bmatrix} 1 \\ 1 \\ 1 \\ -1 \\ -1 \\ -1 \end{bmatrix} \begin{bmatrix} -0.4 & +2 & 0.8 & -1.8 & -0.8 & 0.4 \end{bmatrix} =$$

$\boxed{f(x_i) \cdot y_i:}$

in $(0,1)$

$$= \begin{bmatrix} -0.4 & 2 & 0.8 & 1.8 & 0.8 & -0.4 \end{bmatrix}$$