$$f(x) = \cos\left(\left((x_1+x_2)^3 + \frac{1}{(x_3/x_4)}\right) - x_5\right) \qquad \vec{x} = (-3,-3,1,-1,4)$$

Forward step:

$a = x_1 + x_2 = -6$

$b = \frac{1}{-1} = -1$
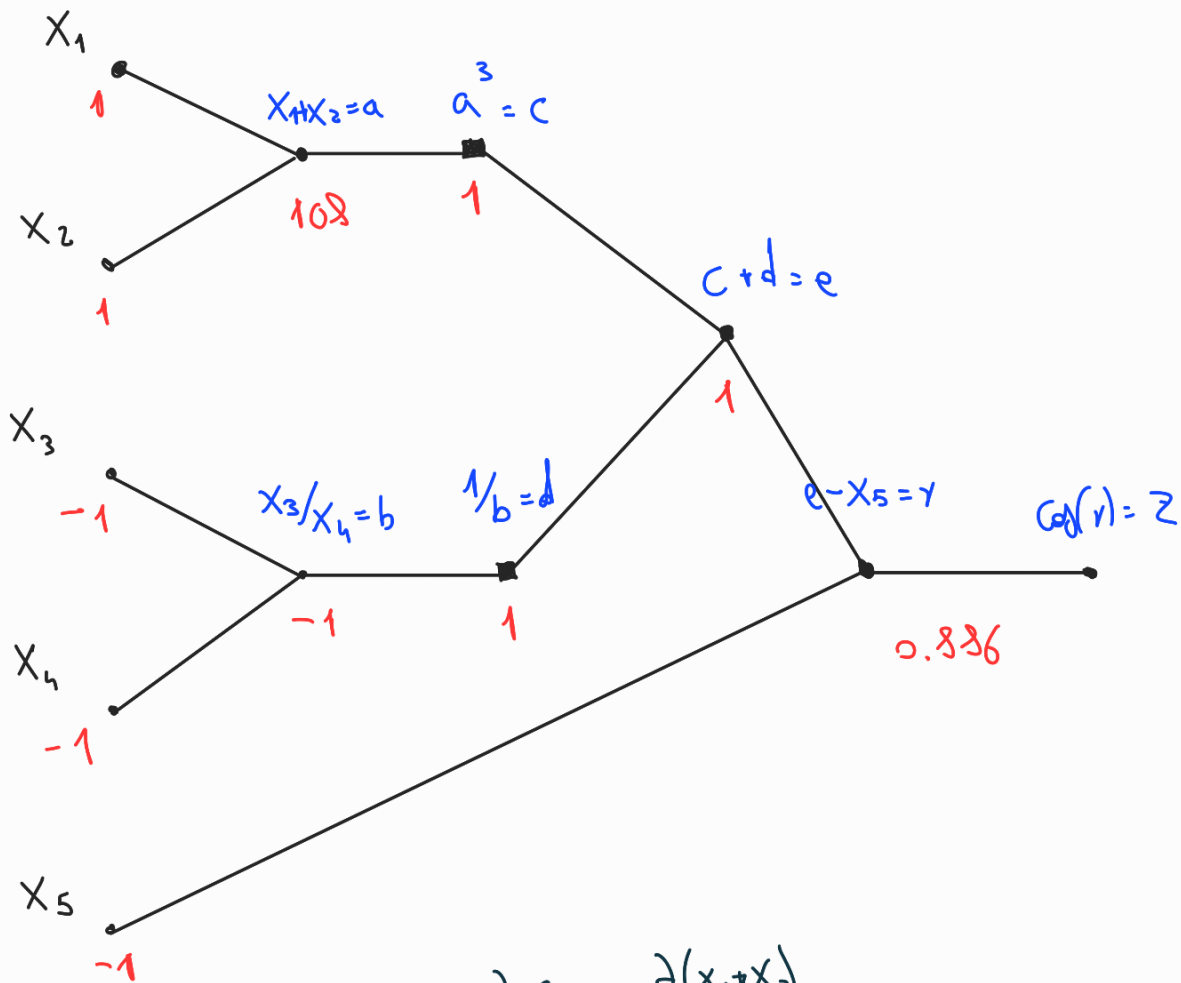
$c = a^3 = -216$

$d = \frac{1}{b} = -1$

$e = c + d = -217$

$y = e - x_5 = -221$

$z = \cos(y) \approx 0.464$

X_1 — 1

X_2 — 1

$x_1+x_2 = a$ — 108

$a^3 = c$ — 1

$c+d=e$ — 1

X_3 — -1

$x_3/x_4 = b$ — -1

$\frac{1}{b} = d$ — 1

$e - x_5 = y$ — 0.836

$\cos(y) = z$

X_4 — -1

X_5 — -1

Backward step

$$\frac{\partial z}{\partial y} = \frac{\partial \cos(y)}{\partial y} = -\sin(y) = 0.886$$

$$\frac{\partial y}{\partial e} = \frac{\partial(e - x_5)}{\partial e} = 1$$

$$\frac{\partial e}{\partial c} = \frac{\partial(c+d)}{\partial c} = 1$$

$$\frac{\partial e}{\partial d} = \frac{\partial(c+d)}{\partial d} = 1$$

$$\frac{\partial c}{\partial a} = \frac{\partial(a^3)}{\partial a} = 3a^2 = 108$$

$$\frac{\partial a}{\partial x_1} = \frac{\partial(x_1+x_2)}{\partial x_1} = 1$$

$$\frac{\partial a}{\partial x_2} = \frac{\partial(x_1+x_2)}{\partial x_2} = 1$$

$$\frac{\partial d}{\partial b} = \frac{\partial(\frac{1}{b})}{\partial b} = -\frac{1}{b^2} = -1$$

$$\frac{\partial b}{\partial x_3} = \frac{\partial(x_3/x_4)}{\partial x_3} = \frac{1}{x_4} = -1$$

$$\frac{\partial b}{\partial x_4} = \frac{\partial(x_3/x_4)}{\partial x_4} = -\frac{x_3}{x_4^2} = -1$$

$$\frac{\partial y}{\partial x_5} = \frac{\partial(e - x_5)}{\partial x_5} = -1$$

$$\frac{\partial z}{\partial x_1} = 1 \cdot 108 \cdot 1 \cdot 1 \cdot 0.886 = 95.68$$

$$\frac{\partial z}{\partial x_2} = 1 \cdot 108 \cdot 1 \cdot 1 \cdot 0.086 = 95.68$$

$$\frac{\partial \bar{z}}{\partial x_3} = (-1)(-1) \cdot 1 \cdot 1 \cdot 0.886 = 0.886$$

$$\frac{\partial z}{\partial x_4} = -1 \cdot (-1) \cdot 1 \cdot 1 \cdot 0.886 = 0.886$$

$$\frac{\partial z}{\partial x_5} = -1 \cdot 0.886 = -0.886$$