$$\frac{\partial loss}{\partial kernel_1} = \text{Convolution}(\text{Input } X, \text{ Loss gradient } \frac{\partial loss}{\partial O})$$

$$\frac{\partial loss}{\partial X} = \text{Full Convolution}(180^\circ \text{ ratated Fitter kernel}, \text{ Loss gradient } \frac{\partial Loss}{\partial O})$$

$$\frac{\partial Loss}{\partial kernel_1} = \text{con}(result1, 2(result2 - reference)) \quad \frac{\partial loss}{result2}$$

$$= \begin{bmatrix} 0 & 1 & 1 \\ -1 & 0 & 1 \\ -1 & -1 & 0 \end{bmatrix} \cdot 2 \cdot \begin{bmatrix} 0 & 2 \\ -2 & 0 \end{bmatrix} = 2 \cdot \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix} = \begin{bmatrix} 8 & 4 \\ 4 & 8 \end{bmatrix}.$$

$$\begin{cases} \dfrac{\partial Loss}{\partial kernel2} = \text{con}(\text{Input}X, \dfrac{\partial loss}{\partial result1}) \\[2ex] \dfrac{\partial Loss}{\partial result1} = \text{Full Con}(180^\circ \text{ kernel2}, \dfrac{\partial loss}{\partial result2}) \\[2ex] \dfrac{\partial Loss}{\partial result2} = 2(result2 - reference) \end{cases}$$

$$\therefore \frac{\partial Loss}{\partial result} = 2 \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & -2 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}_{180^\circ} = 2 \cdot \begin{bmatrix} 0 & 2 & 0 \\ -2 & 0 & 2 \\ 0 & -2 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 4 & 0 \\ -4 & 0 & 4 \\ 0 & -4 & 0 \end{bmatrix}$$

$$\therefore \frac{\partial Loss}{\partial kernel2} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 & 4 & 0 \\ -4 & 0 & 4 \\ 0 & -4 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -8 & 0 \\ 8 & 0 & -8 \\ 0 & 8 & 0 \end{bmatrix}.$$