# Symbolic 2D Nested Convolution

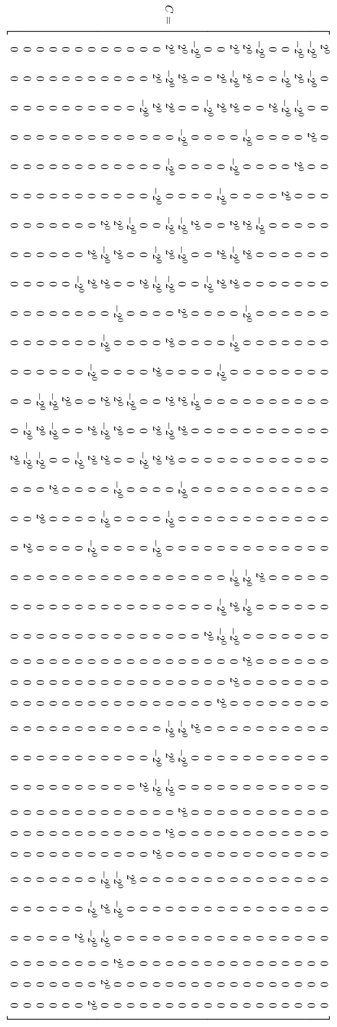
Fast-Convolution Python Library

October 24, 2024

$$x = (a_1^T \otimes a_2^T)[(b_1 \otimes b_2)(c_1 \otimes c_2)]d$$

$$a_1 = \begin{bmatrix} a_{11} & a_{12} \end{bmatrix} \quad a_2 = \begin{bmatrix} a_{21} & a_{22} & a_{23} \end{bmatrix} \quad d = \begin{bmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \\ d_{31} & d_{32} \end{bmatrix}$$

$$b_1 = \begin{bmatrix} b_{11} & b_{12} \end{bmatrix} \quad b_2 = \begin{bmatrix} b_{21} & b_{22} & b_{23} \end{bmatrix} \quad c_1 = \begin{bmatrix} c_{11} & c_{12} \end{bmatrix} \quad c_2 = \begin{bmatrix} c_{21} & c_{22} & c_{23} \end{bmatrix}$$

$$G = (a_1 \otimes b_1)(a_2 \otimes b_2)^T$$

$$\begin{bmatrix} x_0 \\ x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix} = \begin{bmatrix} g_0 & g_1 & g_2 \\ g_3 & g_4 & g_5 \\ g_6 & g_7 & g_8 \\ g_9 & g_{10} & g_{11} \\ g_{12} & g_{13} & g_{14} \\ g_{15} & g_{16} & g_{17} \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \\ 10 & 11 & 12 \\ 13 & 14 & 15 \\ 16 & 17 & 18 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \\ 10 & 11 & 12 \\ 13 & 14 & 15 \\ 16 & 17 & 18 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}