

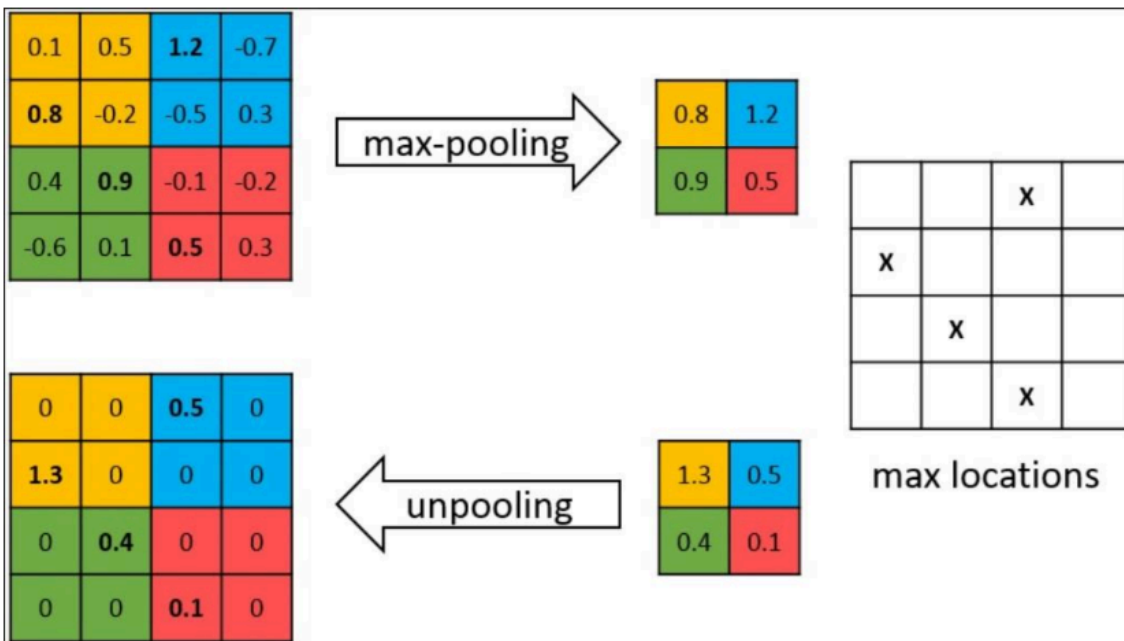
Deep Learning for Perceptron
Lab # 5
Convolution Neural Network

1. Run this notebook

<https://www.kaggle.com/code/kanncaal/convolutional-neural-network-cnn-tutorial>

All tasks below are expected to be written from scratch.

2. Write a code for convolution operation between an image of 5*5 and filter of 2*2. Padding and stride must be passed as a parameter. And your code must work accordingly.
3. Write a code for max pooling and unpooling. You need to store max locations in another matrix.



4. Write a code for full convolution to generate a dL/dX matrix of dimension 3×3 .

`dO= np.array([[1, 2], [3, 4]])` # matrix for Loss Gradient

`filter = np.array([[0, 1], [2, 3]])` // you need to rotate that filter by 180 degree.

Considering if originally $X = \text{np.array}([\text{np.array}([200, 300, 400]), \text{np.array}([100, 200, 300]), \text{np.array}([150, 200, 300])])$, what would be the updated X if learning rate is 0.05.

$$\begin{array}{|c|c|c|} \hline \frac{\partial L}{\partial X_{11}} & \frac{\partial L}{\partial X_{12}} & \frac{\partial L}{\partial X_{13}} \\ \hline \frac{\partial L}{\partial X_{21}} & \frac{\partial L}{\partial X_{22}} & \frac{\partial L}{\partial X_{23}} \\ \hline \frac{\partial L}{\partial X_{31}} & \frac{\partial L}{\partial X_{32}} & \frac{\partial L}{\partial X_{33}} \\ \hline \end{array} = \text{Full Convolution} \left(\begin{array}{|c|c|} \hline F_{22} & F_{21} \\ \hline F_{12} & F_{11} \\ \hline \end{array} \text{Filter F}, \begin{array}{|c|c|} \hline \frac{\partial L}{\partial \theta_{11}} & \frac{\partial L}{\partial \theta_{12}} \\ \hline \frac{\partial L}{\partial \theta_{21}} & \frac{\partial L}{\partial \theta_{22}} \\ \hline \end{array} \text{Loss Gradient } \frac{\partial L}{\partial \theta} \right)$$

$\frac{\partial L}{\partial X}$

$$\frac{\partial L}{\partial X} = \text{Full Convolution} \left(\begin{array}{c} 180^\circ \text{rotated} \\ \text{Filter F} \end{array}, \begin{array}{c} \text{Loss} \\ \text{Gradient } \frac{\partial L}{\partial \theta} \end{array} \right)$$