# Convolutional Neural Network

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## Understanding 1D Convolutional Neural Networks

- One-dimensional convolutional neural networks can be applied to various types of sequential data, including financial time series, audio signals, and text data.
- A convolutional layer computes its output by performing a convolution operation on the input, adding a bias term ($\beta$), and then applying an activation function.
- For instance, consider a kernel of size three and a stride of one. The output at each position $i$ is computed as follows:

$$h_i = \mathtt{ReLU}\left[\beta + \Sigma_{j=1}^{3} w_j \cdot x_{i+j-2}\right]$$

- Typically, several convolutions are computed in parallel to form multiple channels in the output. Each individual convolution operation contributes to a separate channel.

# Applying CNNs to 2D Image Data

- Convolutional Neural Networks (CNNs) are typically applied to 2D image data.
- For instance, consider a CNN with a 3×3 kernel. The output at each position $(i, j)$ is computed as follows:

$$h_{ij} = \texttt{ReLU}\left[\beta + \Sigma_{m=1}^{3}\Sigma_{n=1}^{3} w_{mn} \cdot x_{i+m-2,j+n-2}\right]$$

# Exploring 2D Convolutional Neural Networks

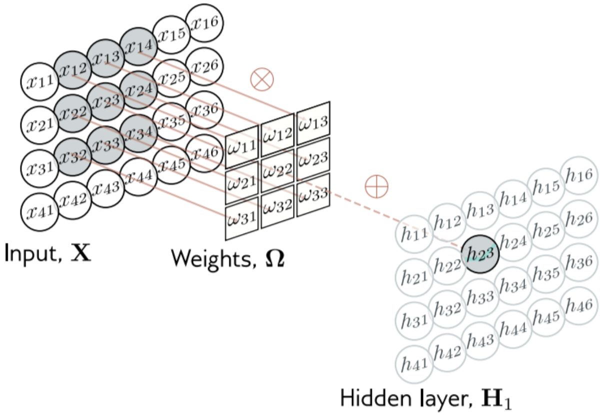


Figure: An Illustration of a 2D Convolutional Neural Network[1]

[1] Adapted from the book "Understanding Deep Learning."

## Understanding Max Pooling in CNNs

Max Pooling is a downsampling technique commonly used in Convolutional Neural Networks (CNNs). It helps to reduce the spatial dimension of features, thereby decreasing computational complexity and preventing overfitting.

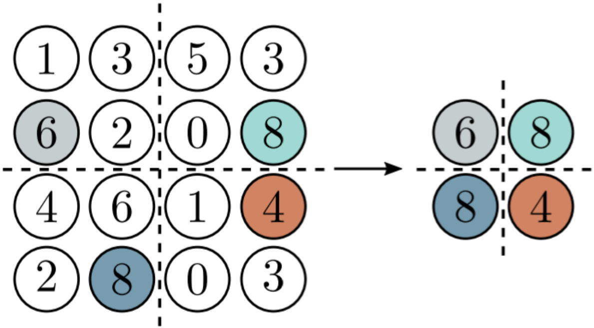


Figure: An Illustration of Max Pooling in CNNs[2]

[2]Adapted from the book "Understanding Deep Learning."