Machine Learning (CS-601)

Deep Architectures

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Introduction

Deep Learning

- Deep Learning isn't a single approach but rather a class of algorithms and topologies that you can apply to a broad spectrum of problems.
- Deep learning is certainly not new, it is experiencing explosive growth because of the intersection of deeply layered neural networks and the use of GPUs to accelerate their execution.
- The number of architectures and algorithms that are used in deep learning is wide and varied.

Introduction

Deep Learning Architectures

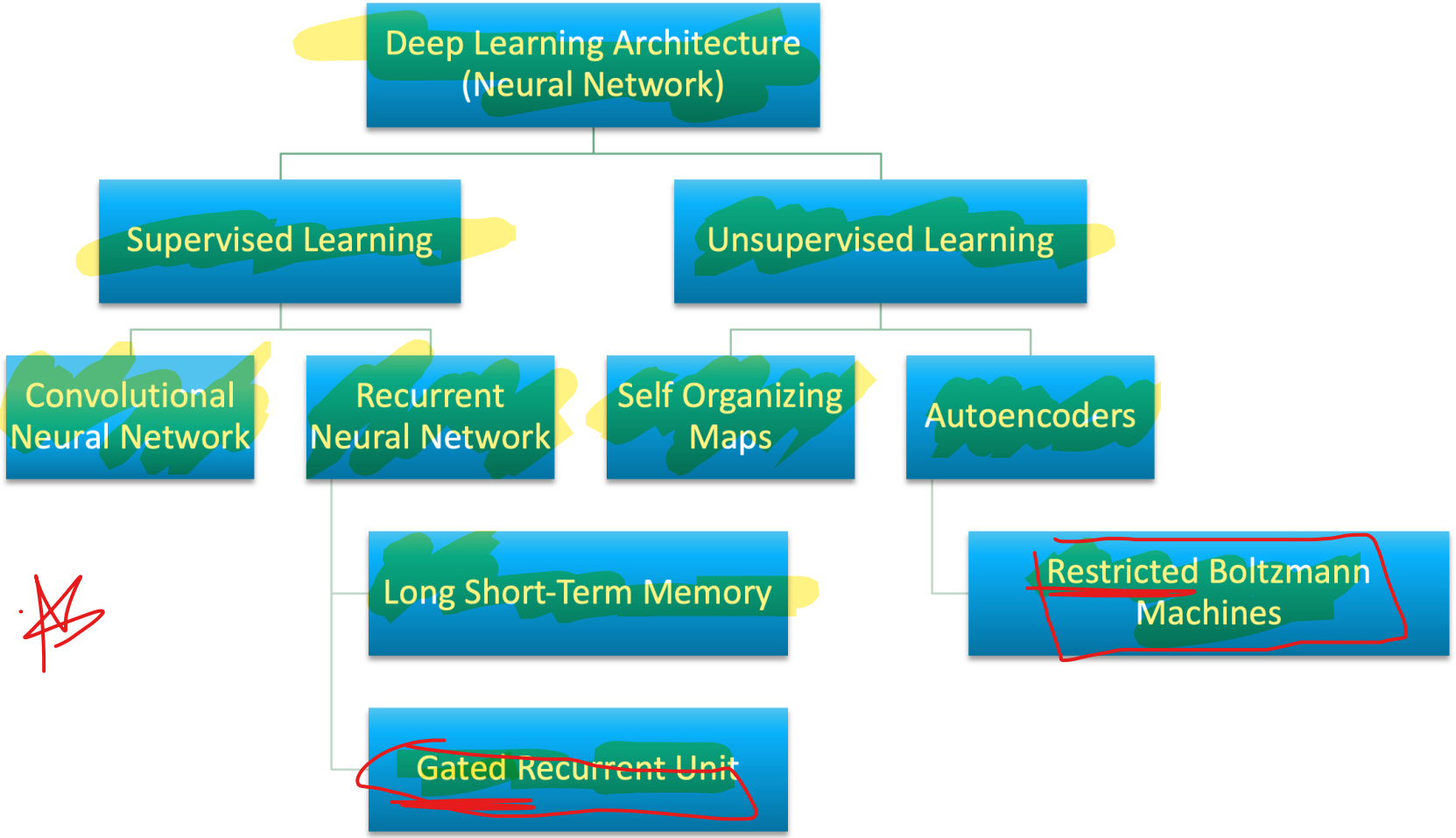

Fig : Deep Architectures

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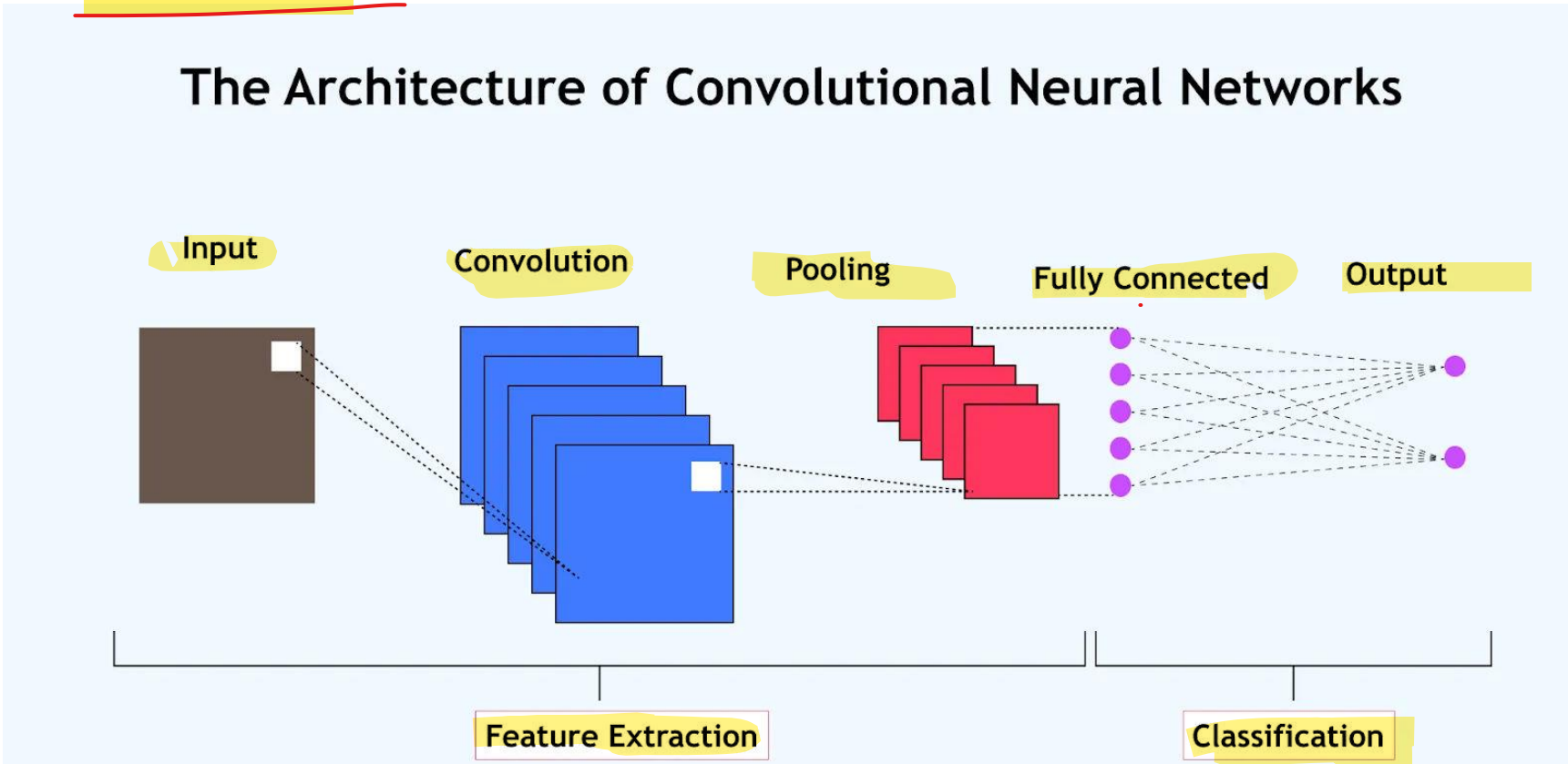
Convolutional Neural Networks

- Early layers recognize features (such as edges), later layers recombine these features into higher-level attributes.



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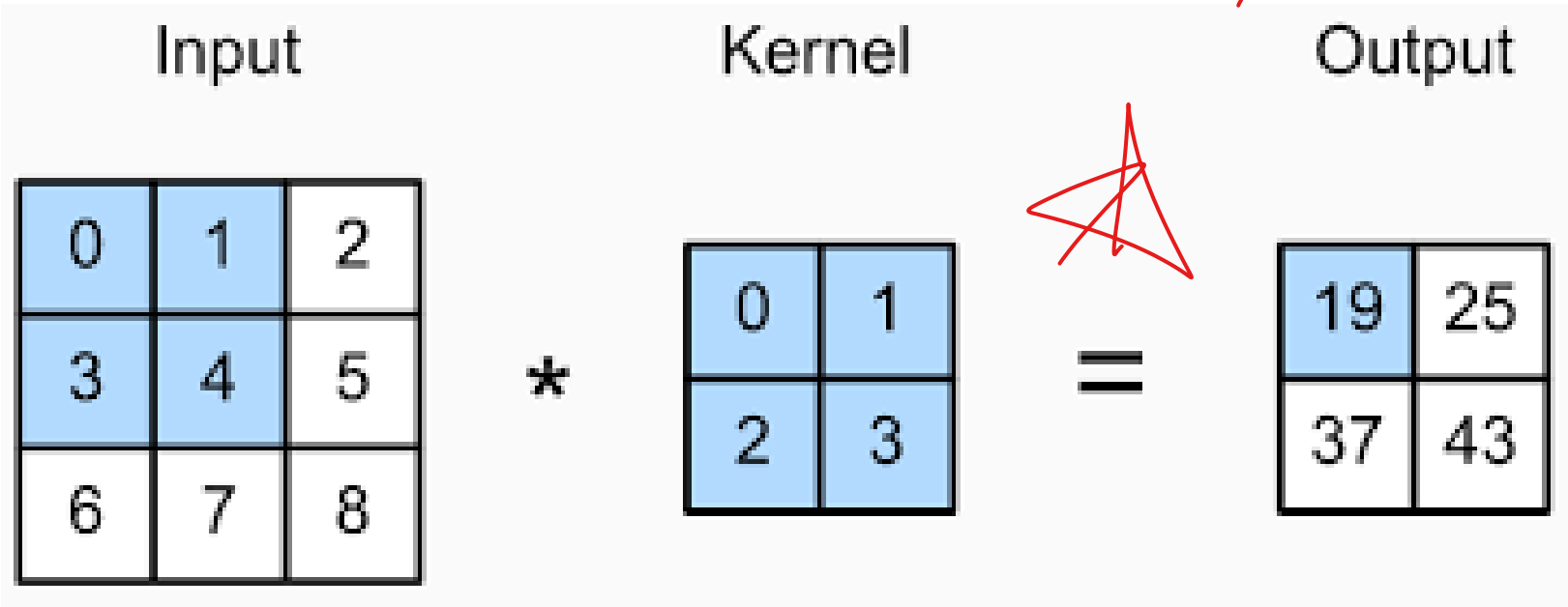
Convolutional Neural Networks

- The **convolution** is used to extract features by applying a filter/kernel to the input.



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Convolutional Neural Networks

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10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0

6 x 6

*

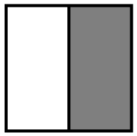
1	0	-1
1	0	-1
1	0	-1

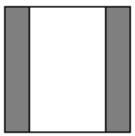
3 x 3

=

-0	30	30	0
0	30	30	0
0	30	30	0
0	30	30	0

4 x 4





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Convolutional Neural Networks

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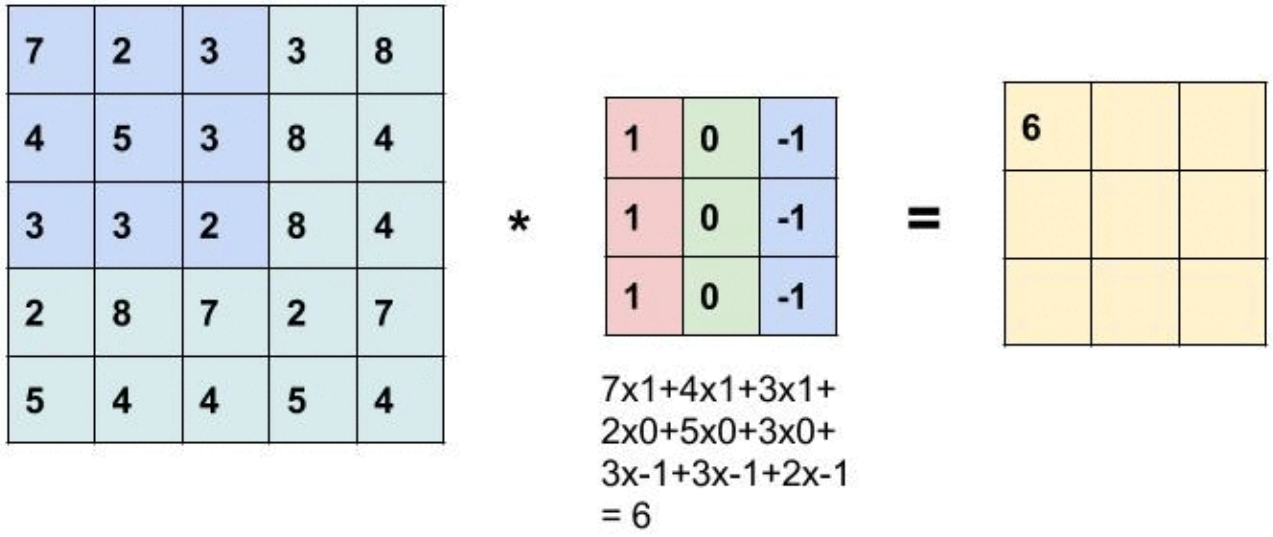

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Convolutional Neural Networks

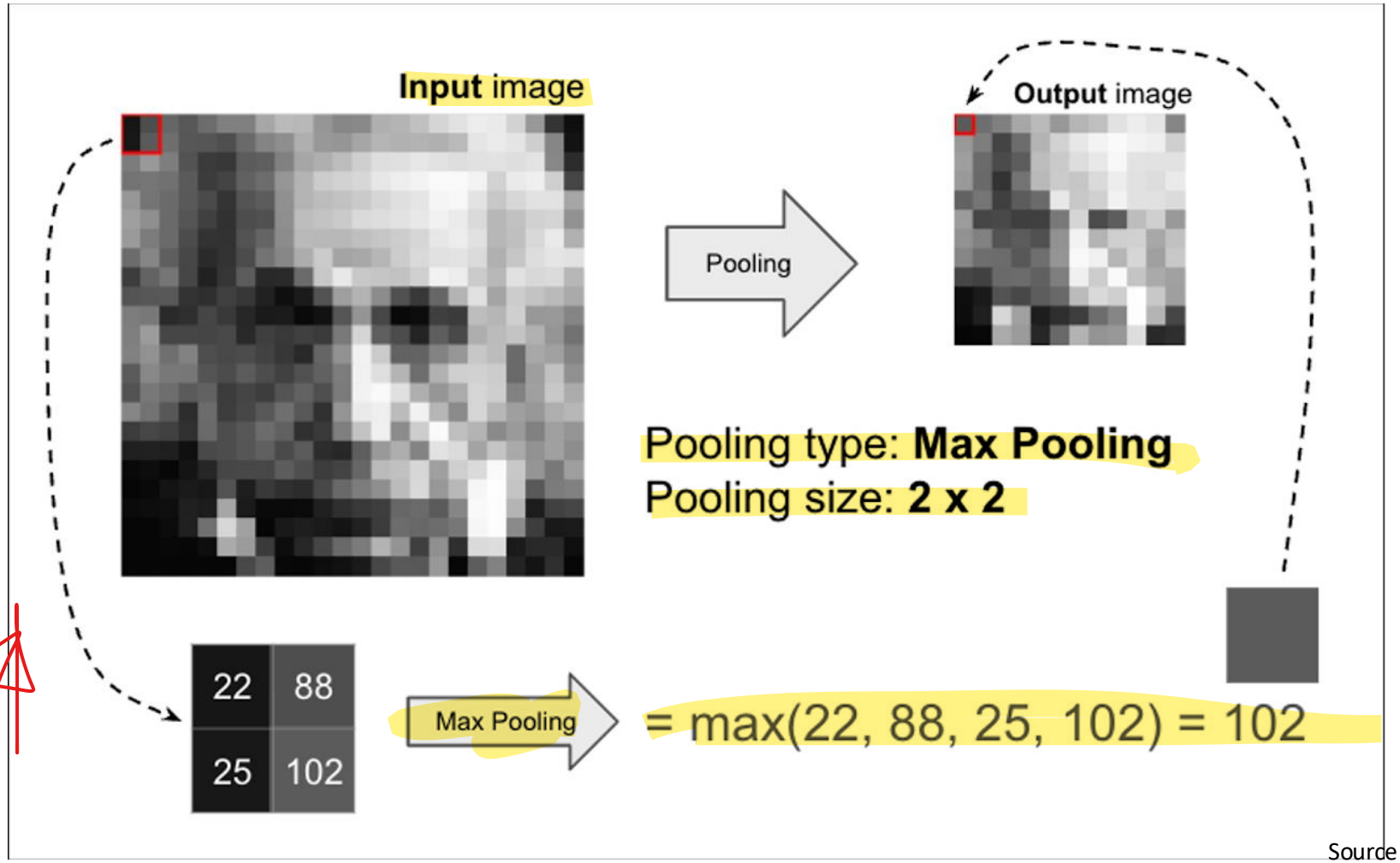
- The **convolution** is used to extract features by applying a filter/kernel to input.

Original	*Gaussian Blur*	*Sharpen*	*Edge Detection*
$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$
			

Source: Internet

Convolutional Neural Networks

- **Pooling** is down sampling to reduce the width and height of features while retaining the information.



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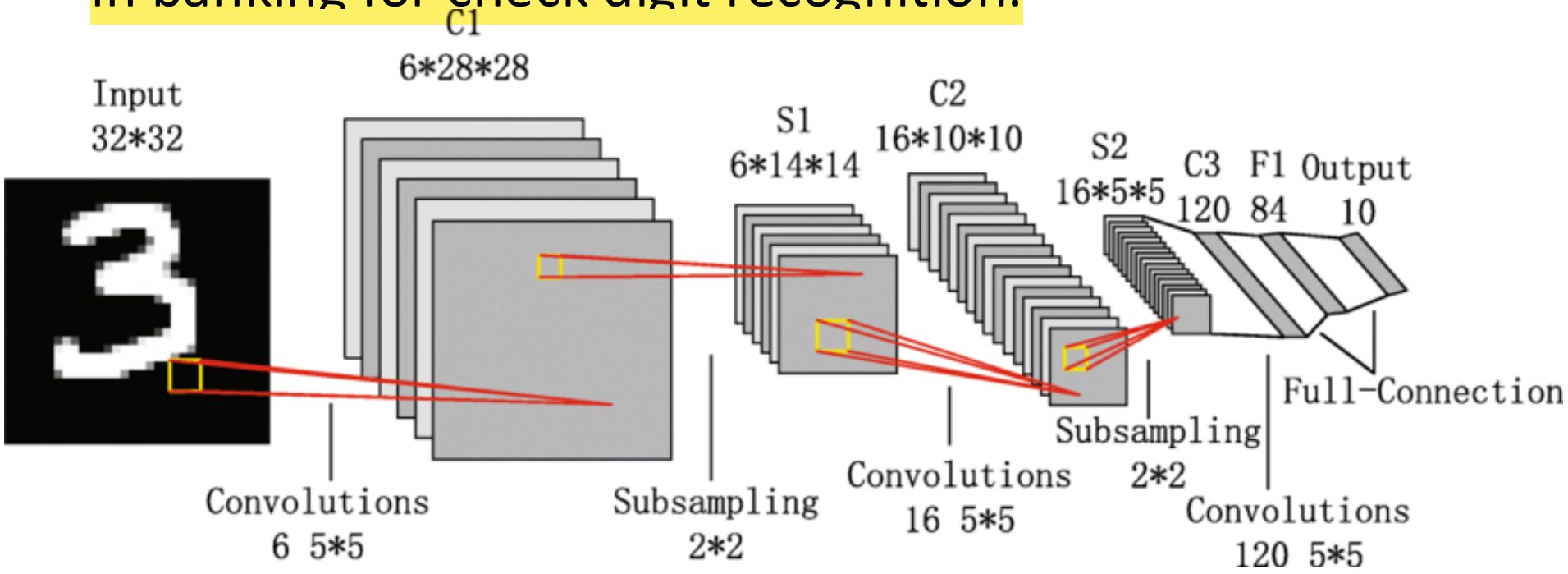
Convolutional Neural Networks

➢ **CNN Variants: LeNet**

LeNet is a CNN that Yann LeCun introduced in 1989.

LeNet-1 (1990) – Early prototype for digit recognition.

LeNet-5 (1998) – The most well-known version, used in banking for check digit recognition.



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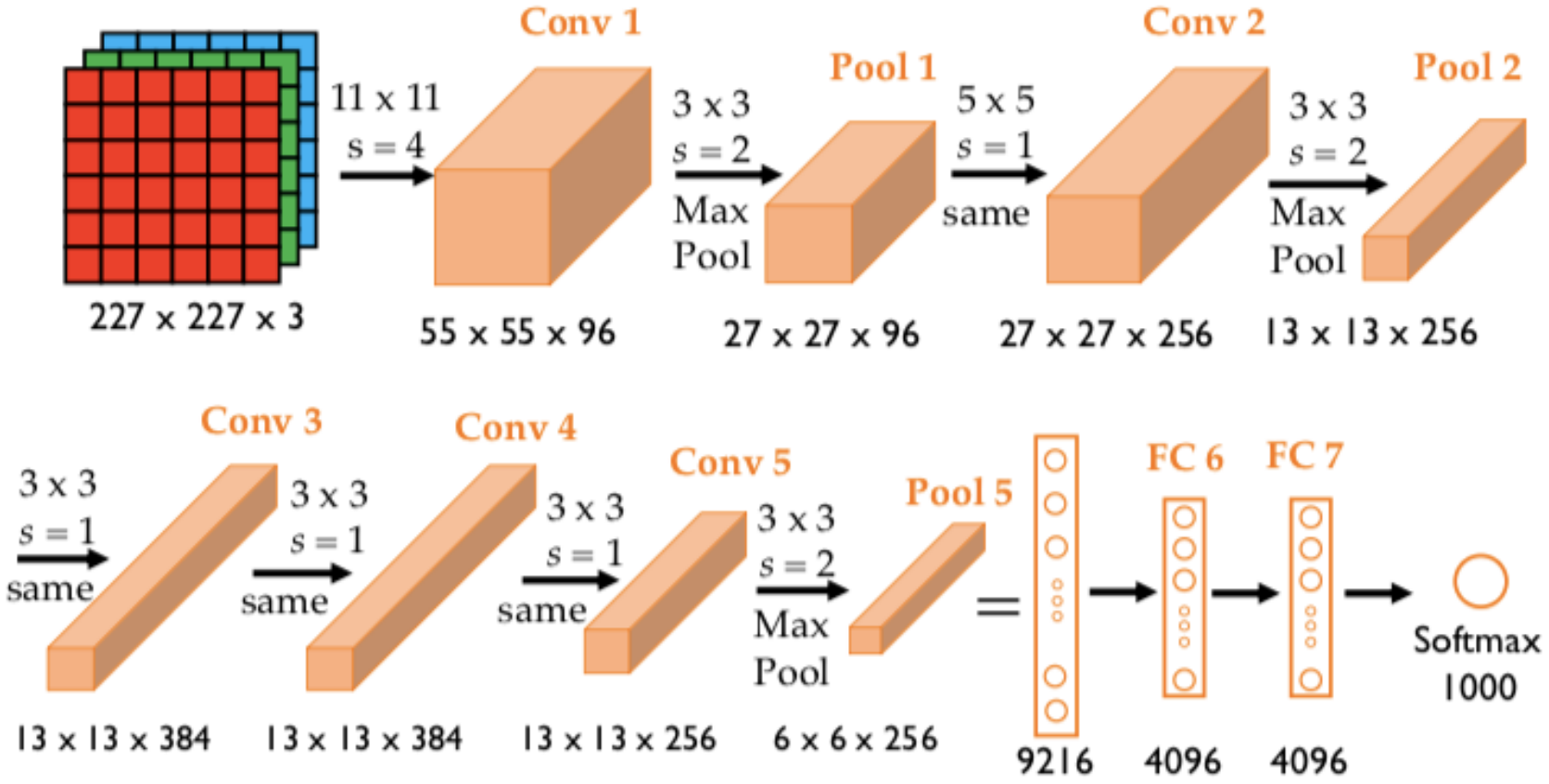
Convolutional Neural Networks

➢CNN Variants: AlexNet

AlexNet introduced in 2012 is a deep CNN that revolutionized computer vision and modern deep learning.



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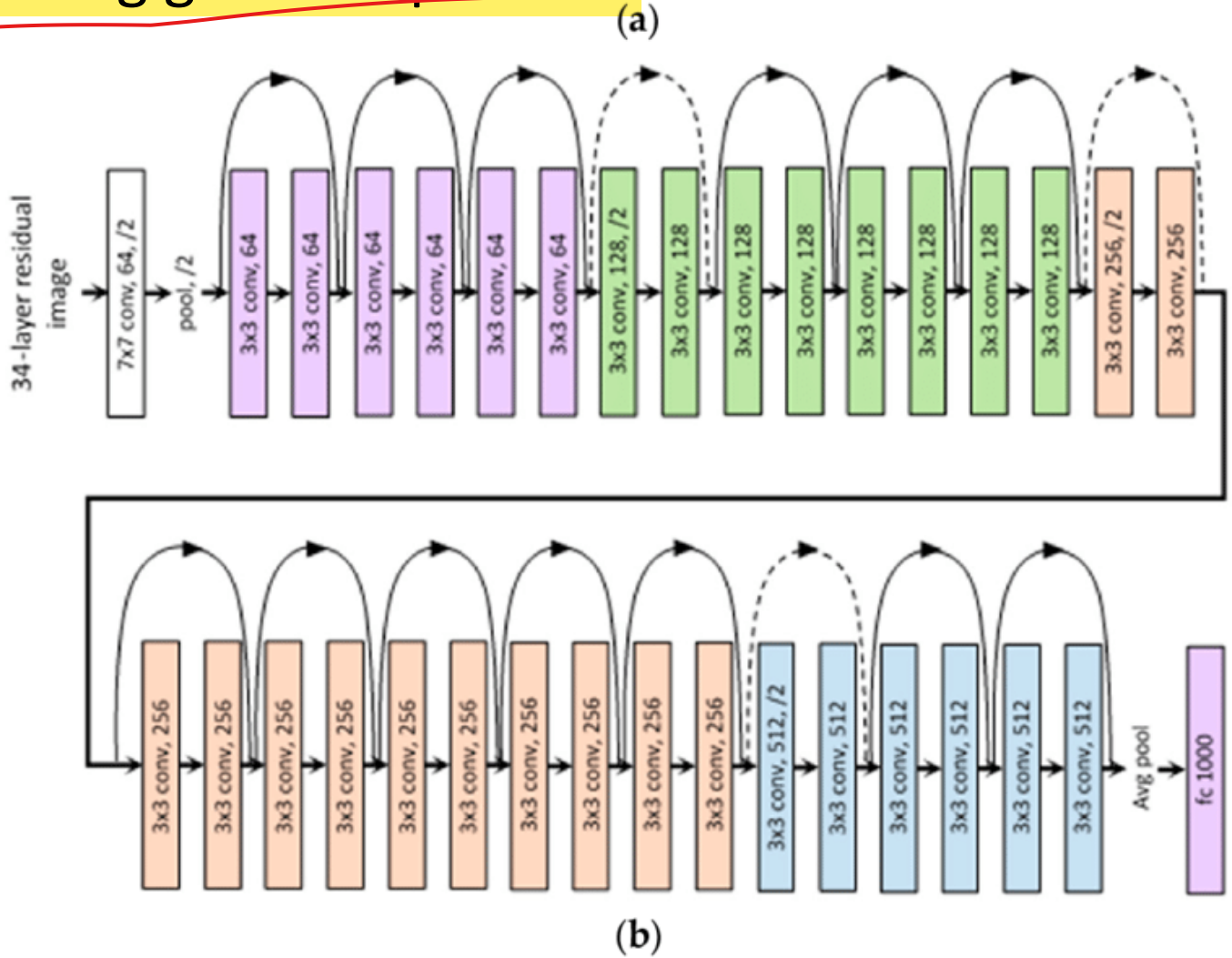
Convolutional Neural Networks

- **CNN Variants: ResNet:** ResNet allows for the training of much deeper networks without suffering from the vanishing gradient problem.



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Recurrent Neural Networks

- A recurrent neural network (RNN) is a deep learning model that is trained to process a sequential data input into sequential data output.
- Sequential data—such as words, sentences, or time-series data—where sequential components are interrelate.
- RNNs have a "memory" that captures information about what has been calculated so far.
- In RNN information is fed back into the system after each step.
- This feedback enables RNNs to remember prior inputs making them ideal for tasks where context is important.

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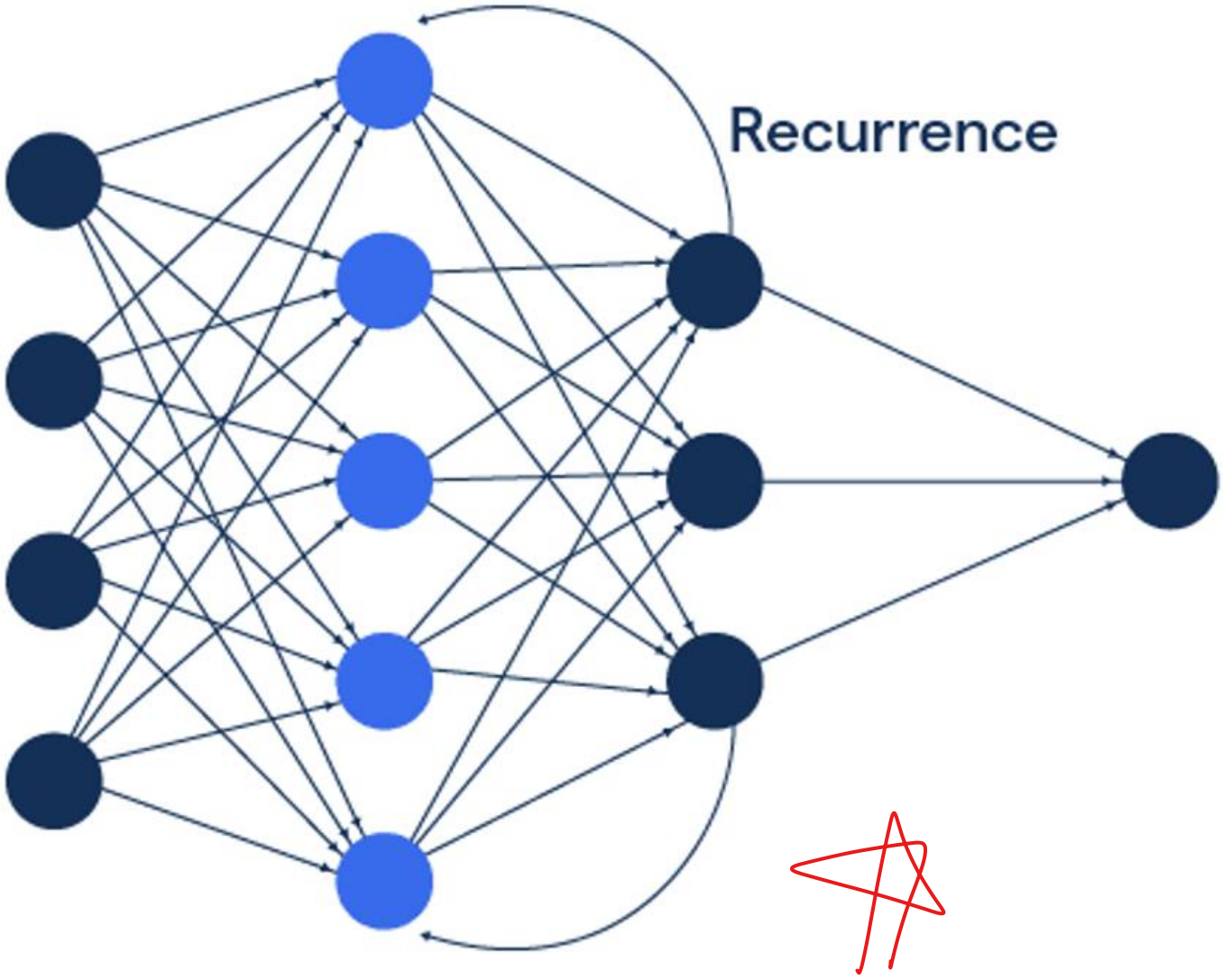
Recurrent Neural Networks



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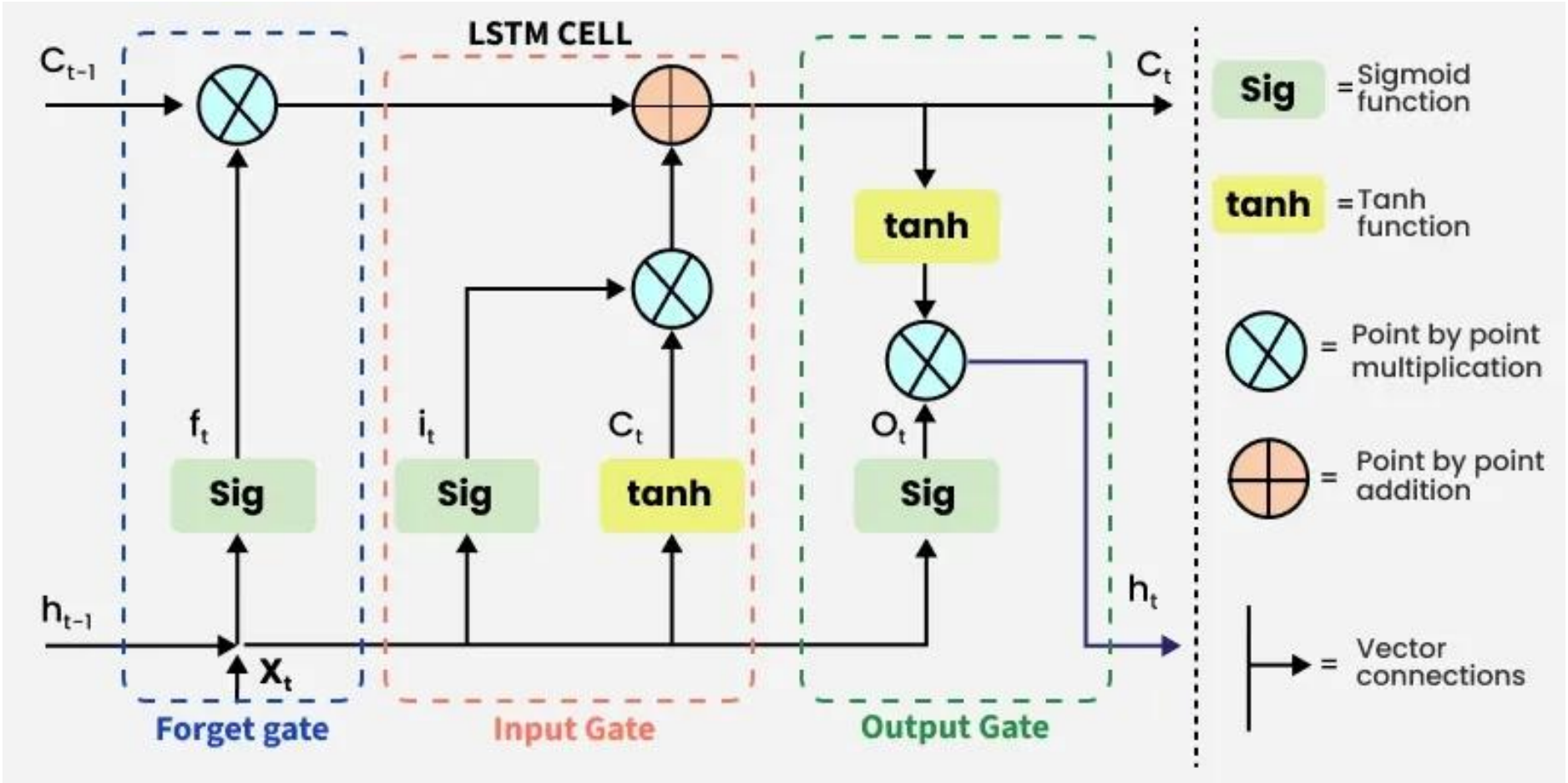
Recurrent Neural Networks

- **RNN Variants: LSTM:** Long Short-Term Memory (LSTM) networks introduce memory cells, which have the ability to retain information over long sequences.



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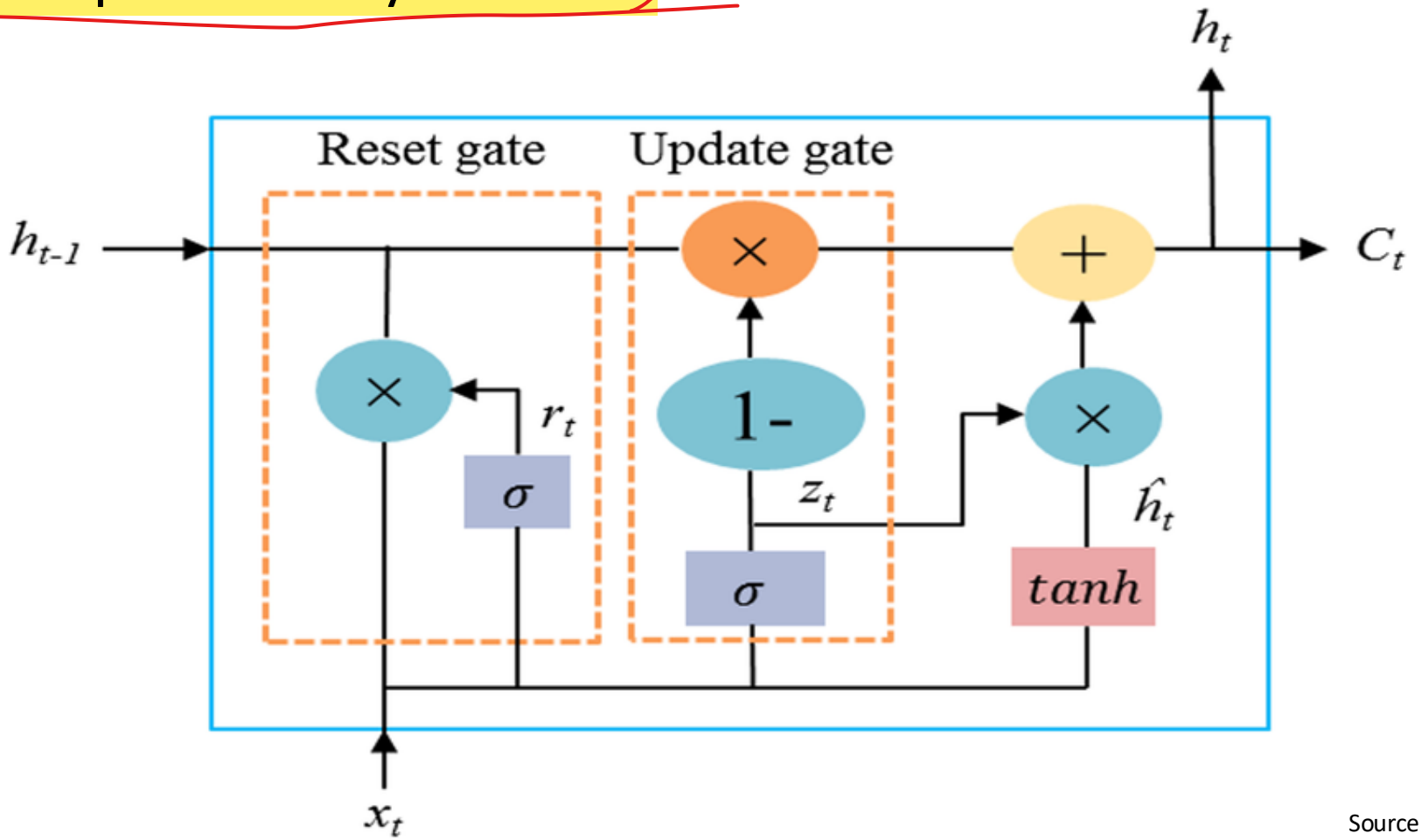
Recurrent Neural Networks

- **RNN Variants: GRU:** Gated Recurrent Unit (GRU) has a simpler architecture than LSTM, with fewer parameters, which can make it easier to train and more computationally efficient.



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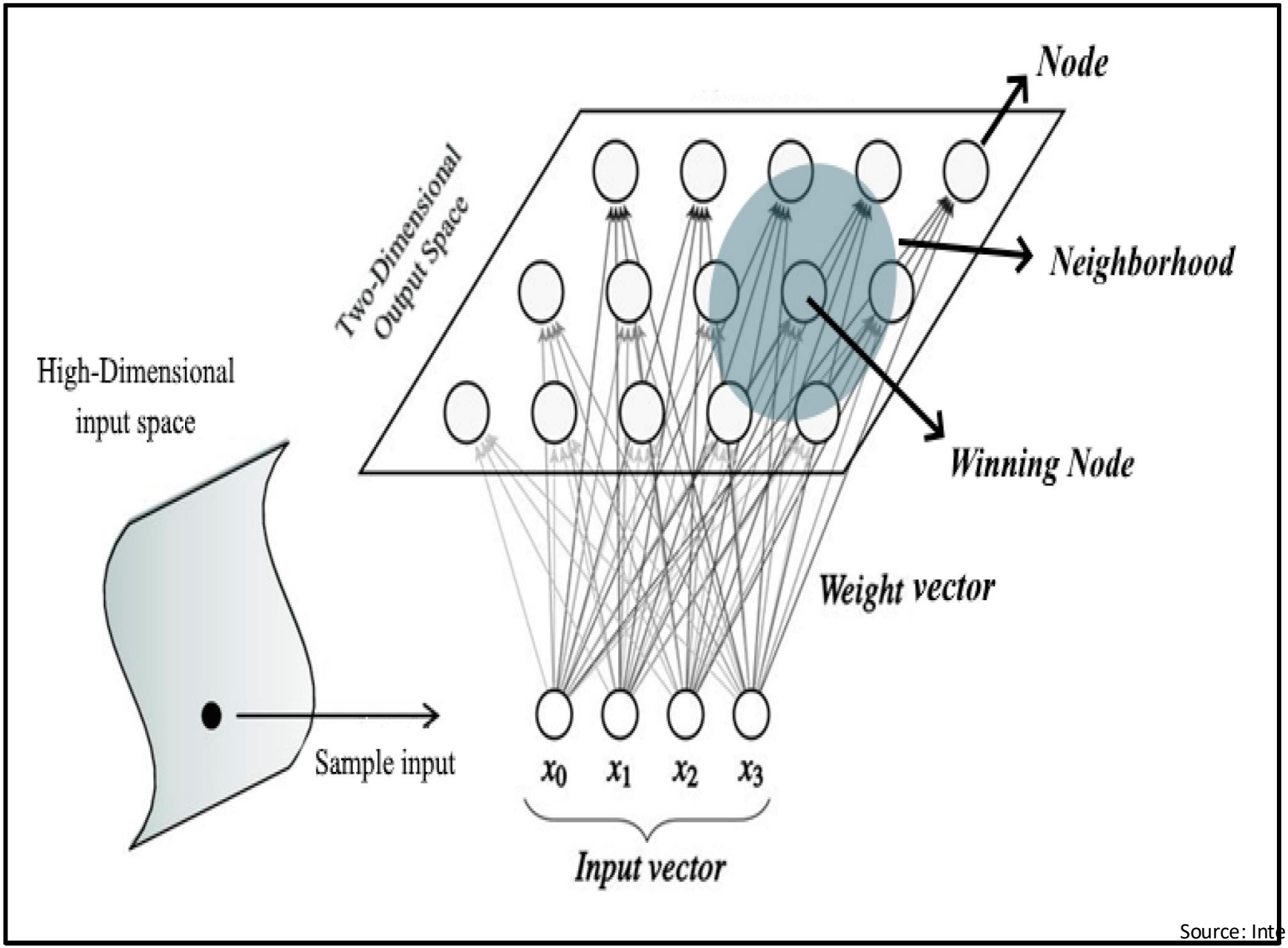
Self-Organizing Maps

- The Self-Organizing Maps (SOMs) are a type of artificial neural network used in machine learning and data analysis.
- It follows an unsupervised learning approach and trained its network through a competitive learning algorithm (CLA).
- CLA is based on the idea of competition between neurons in the network, where each neuron attempts to become the most active or "winning" neuron in response to a given input.
- SOM is used for clustering and dimensionality reduction to map multidimensional data onto lower-dimensions.
- SOMs can be used for image and signal processing, text and data mining, and bioinformatics.

Self-Organizing Maps



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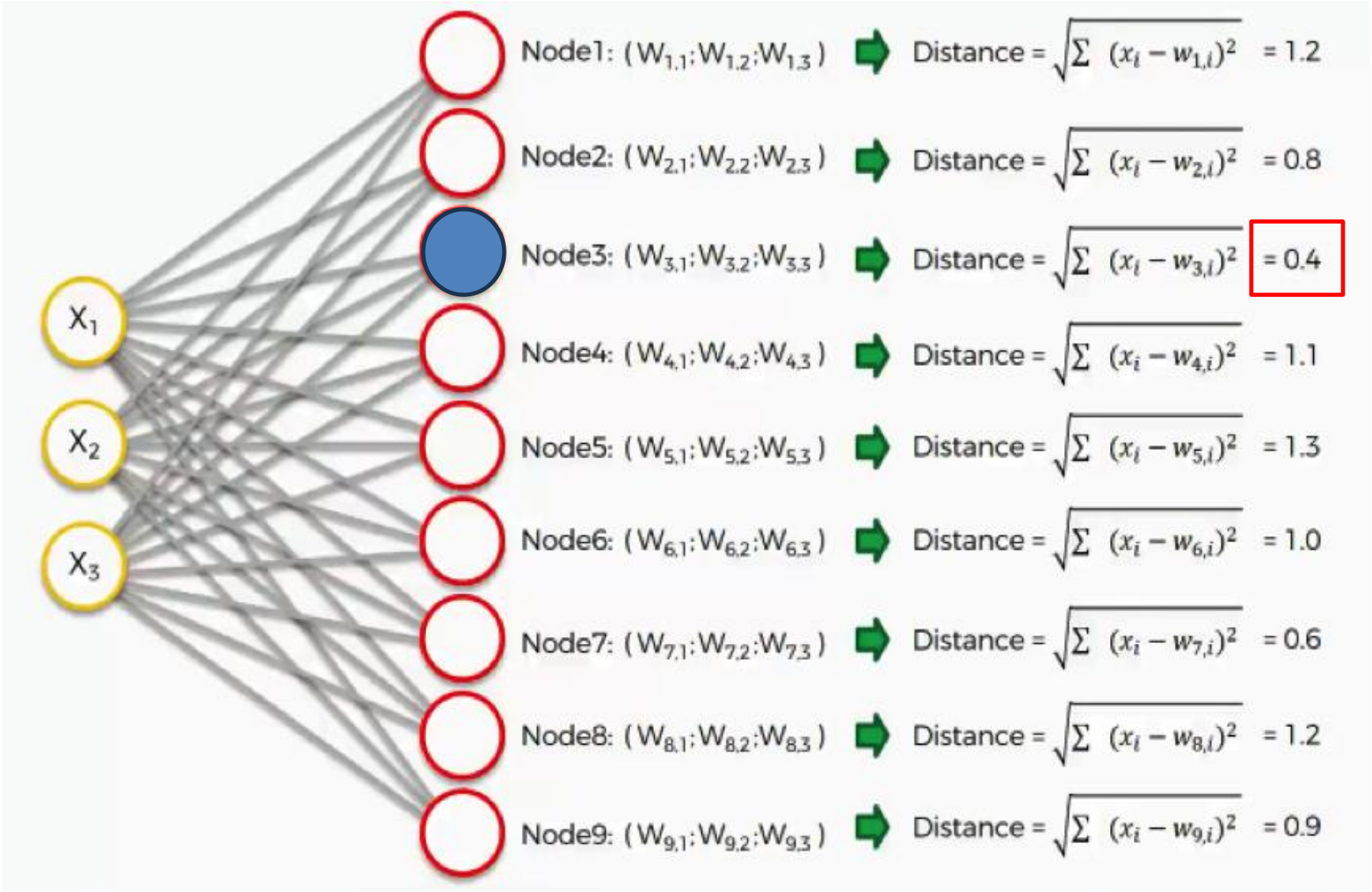
Self-Organizing Maps



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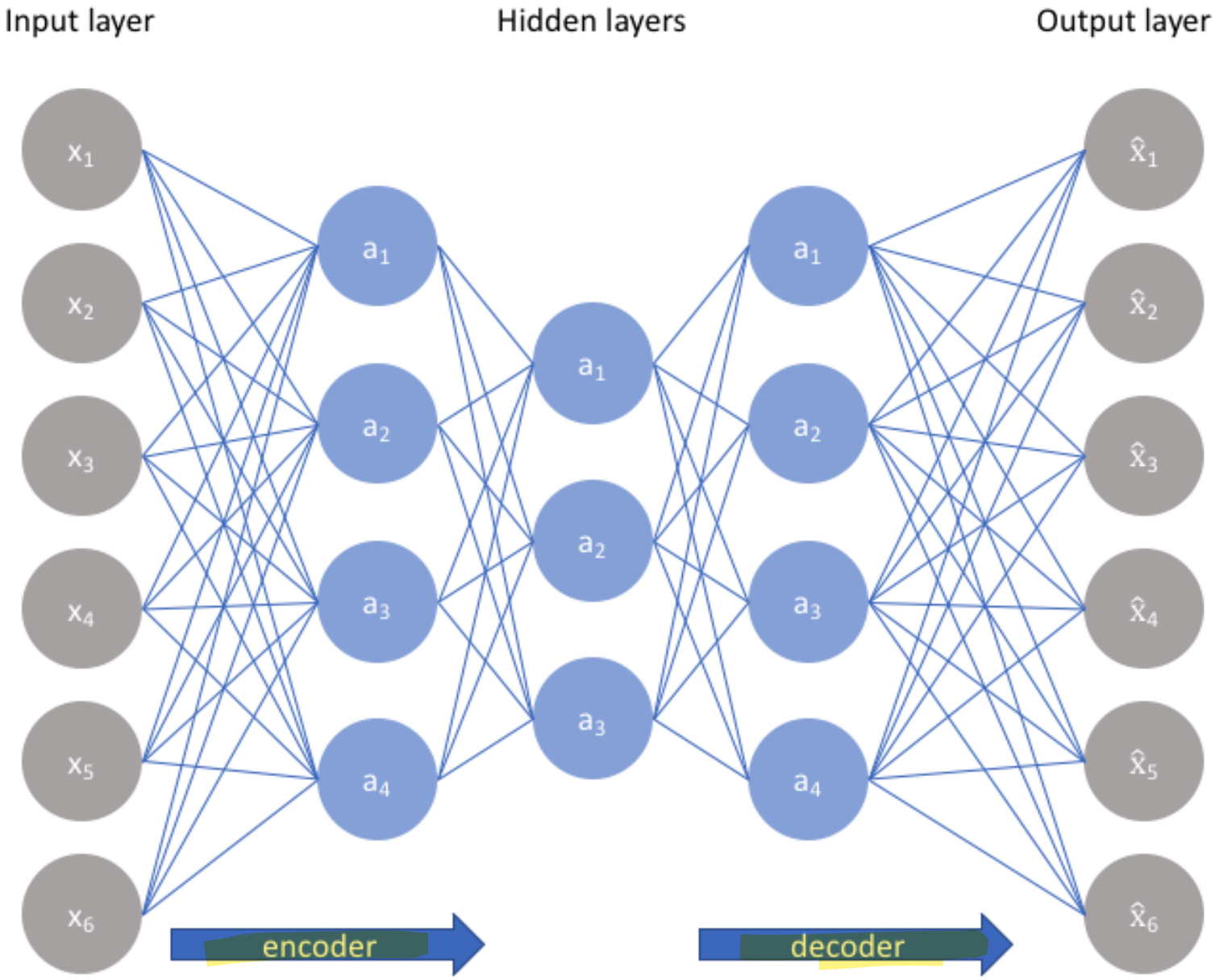
Autoencoders

- The Autoencoders are a special type of unsupervised feedforward neural network.
- Autoencoder learns to represent data in a compressed form and then reconstructs it as closely as possible to the original form.
- For example if the input is a noisy image then the autoencoder can learn to remove noise by compressing the image into a smaller feature set and reconstructing a cleaner version of the original image.
- They are used in applications like image processing, anomaly detection, noise removal and feature extraction.

Autoencoders



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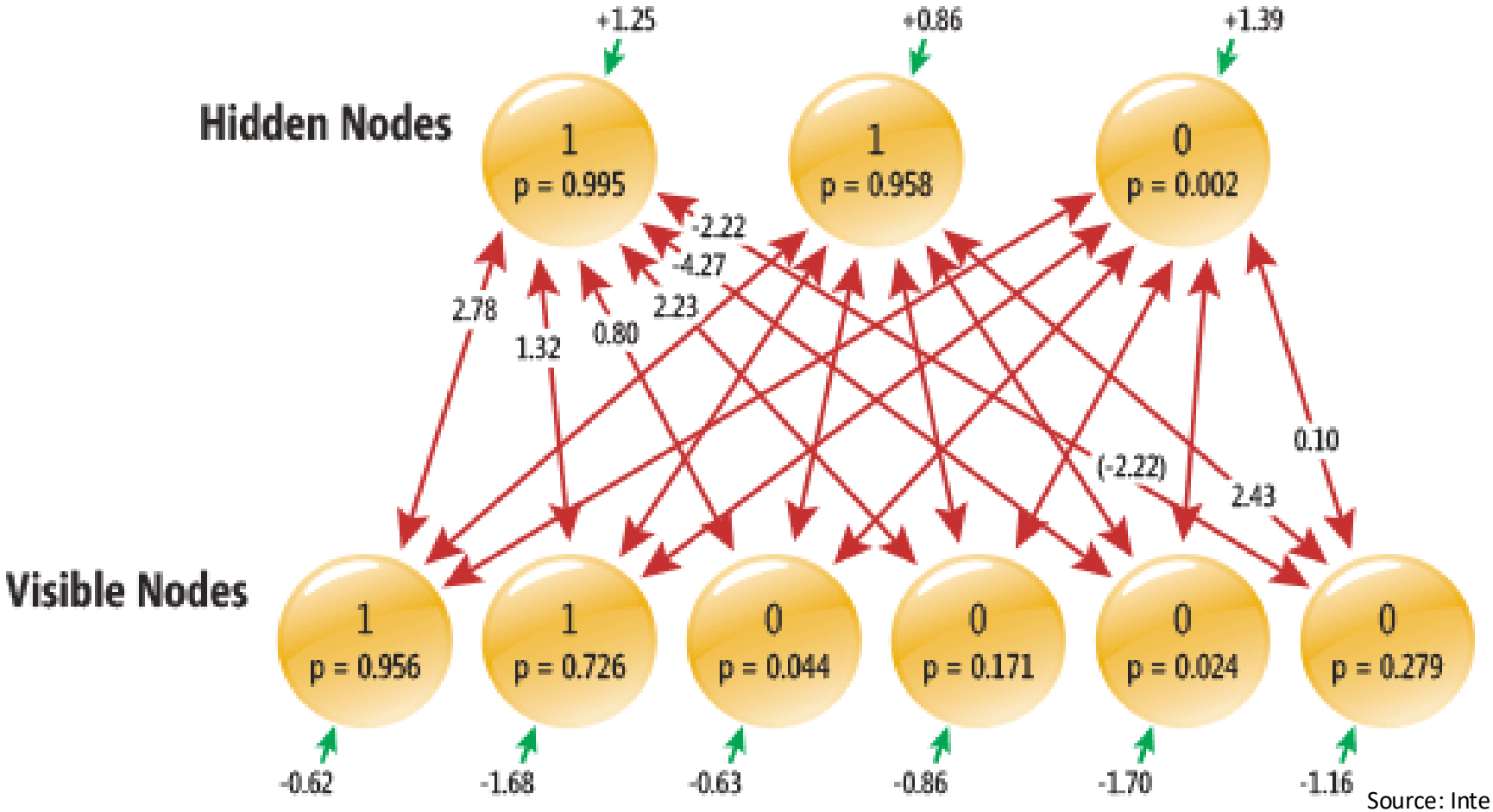
Restricted Boltzmann Machines

- RBMs are generative models that can be trained to build a probabilistic distribution of data by using unsupervised learning techniques.



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