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DEEP LEARNING

A Modern Approach to Artificial Intelligence

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|00 INTRODUCTION

Perceptron
Rosenblatt
1958

Perceptrons
Minsky & Seymour
1958

Boltzmann Machine
Hinton
1985

CNN
LeCun
1989

Contrastive Divergence
Hinton
2002

GAN
Goodfellow
2014

1959
Hubel & Wiesel
Cat Visual Cortex

1979
Fukushima
NeoCognitron

1986
Smolenski
Harmonium
Hinton
RBM
Rumelhart, Hinton & Williams
MLP
Jordan
RNN

1997
Hochreiter & Schmidhuber
LSTM
Schuster & Paliwal
BRNN

2012
Hinton
Dropout

2017
Sabour, Frosst & Hinton
Capsule Network

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|00 INTRODUCTION

AlexNet
Krizhevsky, Sutskever & Hinton
2012

ResNet
He, Zhang, Ren & Sun
2015

ResNetXt
Xie, Girshick et al.
2019

2014
Simonyan & Zisserman
VGG

Google
Inception Network

2016
Huang et al.
DenseNet

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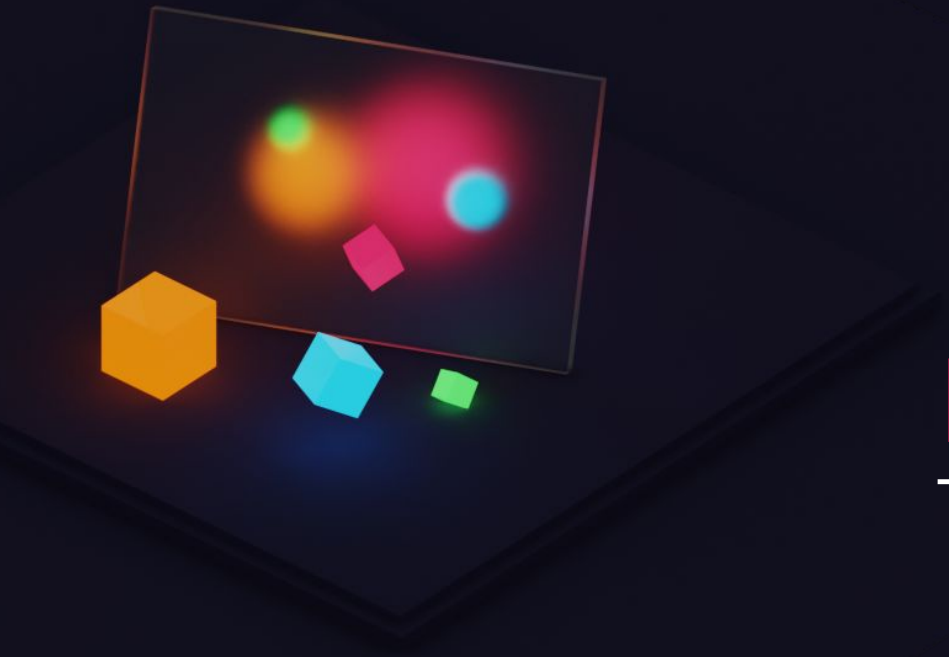

01|

PERCEPTRON

The Beginning and the End

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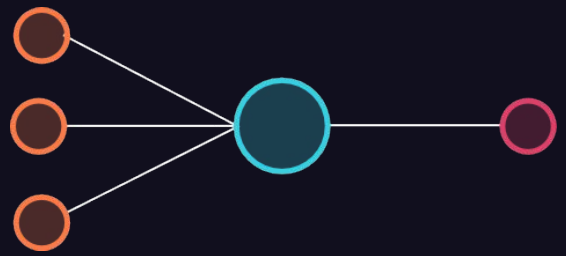
|01 PERCEPTRON



PERCEPTRON

$$\hat{y} = f(wx + b)$$

$$f(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{else} \end{cases}$$

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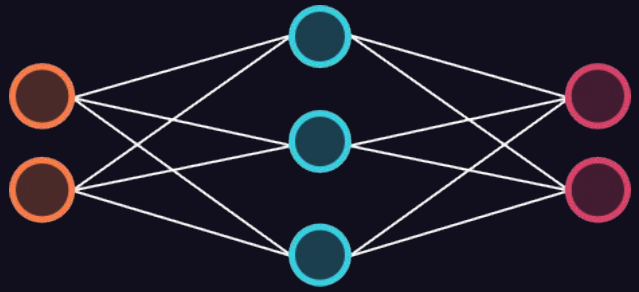
|01 PERCEPTRON



MULTILAYER PERCEPTRON

$$\hat{y} = f(w_2 h + b_2)$$

$$h = f(w_1 x + b_1)$$

$$f(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{else} \end{cases}$$

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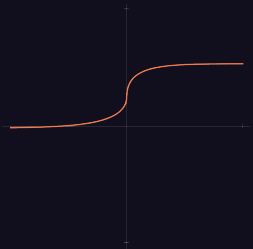
ACTIVATION FUNCTIONS

Step

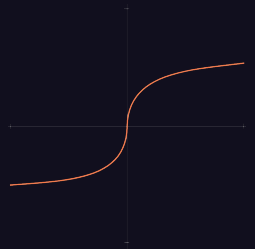
$$f(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{else} \end{cases}$$

Sigmoid



$$\sigma(x) = \frac{1}{1+e^{-x}}$$

Tanh

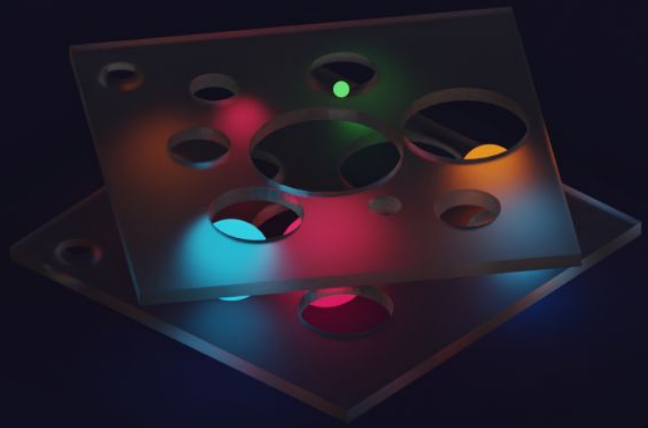


$$\tanh(x) = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}$$

|02

CONVOLUTION

Signal Processing 101



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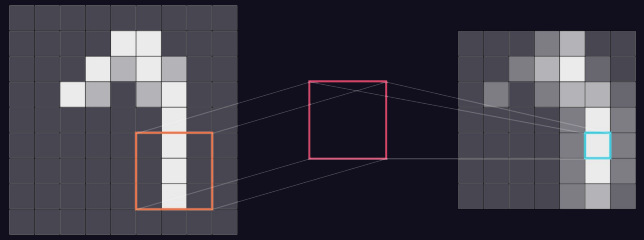
|02 CONVOLUTION



CONVOLUTION
CROSS CORRELATION

$$(f * g)(x) = \int_{-\infty}^{+\infty} f(x)g(x-t)dt$$

Weight Sharing

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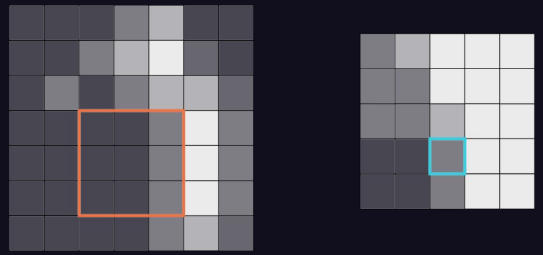
|02 CONVOLUTION

POOLING



Dimensionality Reduction

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|02 CONVOLUTION

CONVOLUTIONAL NEURAL NETWORK

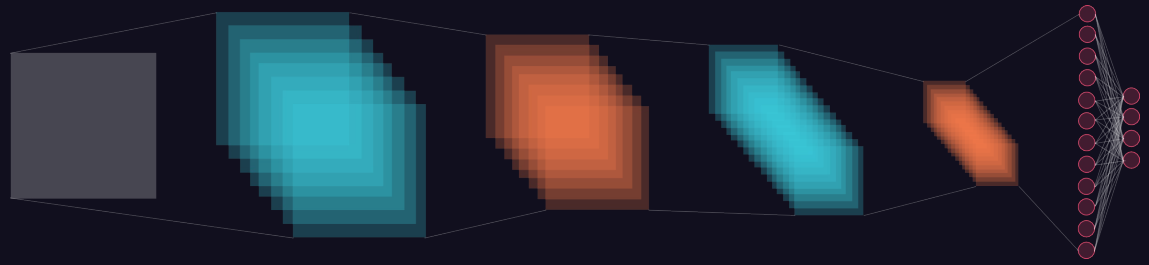

Image Input

Convolution & Pooling

MLP

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03|

RECURRENT

Backprop Through Time

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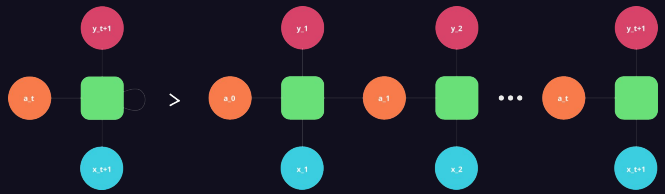
|03 RECURRENT



RECURRENT CELLS

Weight Sharing & Backprop Through Time

$$a_t = g_1(W_{aa}a_{t-1} + W_{ax}x_t + b_a)$$

$$y_t = g_2(W_{ya}a_t + b_y)$$

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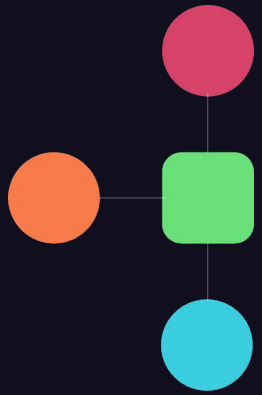
|03 RECURRENT



ARCHITECTURES

One to One

Traditional Neural Network

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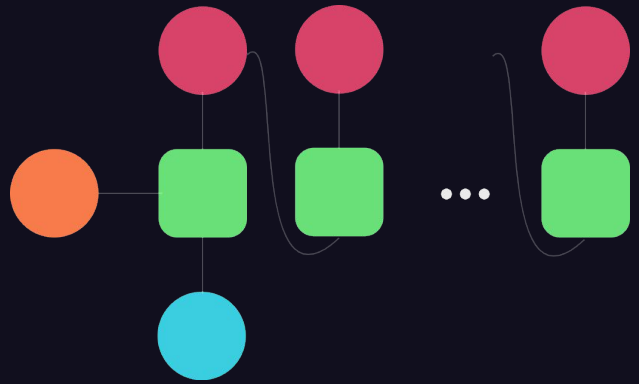

ARCHITECTURES

One to Many

Music Generation

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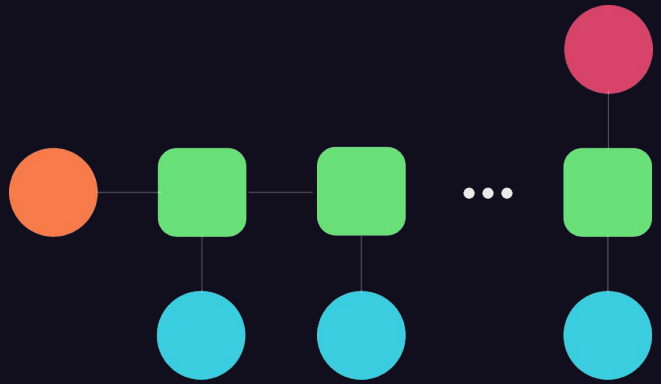

ARCHITECTURES

Many to One

Sentiment Classification

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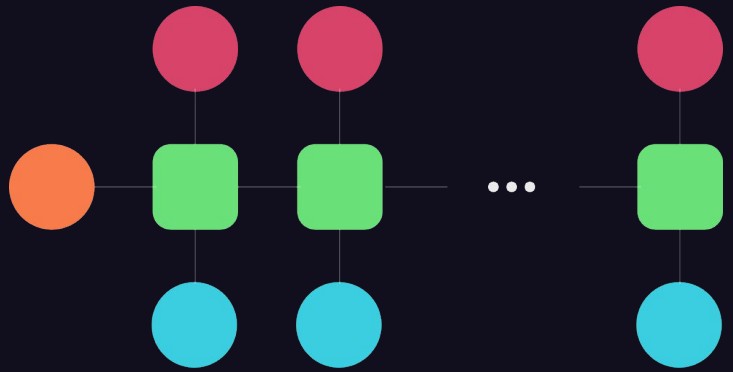

ARCHITECTURES

Many to Many

Name Entity Recognition

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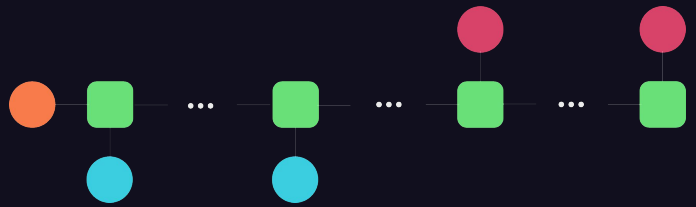

ARCHITECTURES

Many to Many

Machine Translation

|03 RECURRENT

ADVANTAGES

Infinite Input Length
Model **Size Invariant**
Historical Information
Weight Sharing Through Time

DRAWBACKS

Computationally **Slow**
Long Time **Dependency Lost** Over Time
Future Input not Considered
Vanishing/Exploding Gradient

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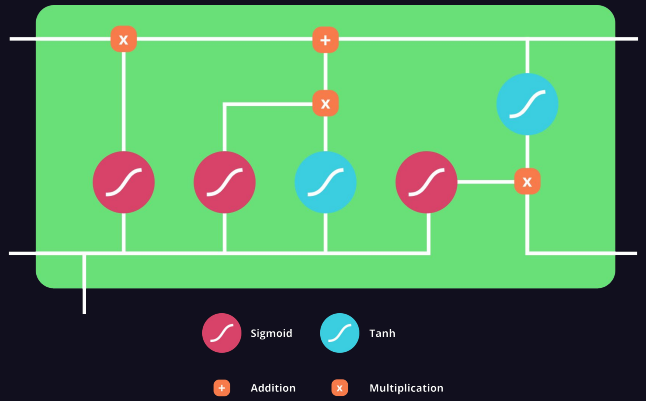
|03 RECURRENT



LSTM

Gates	I/O
Forget Gate	**Previous** Input
Update Gate	**Cell State**
Output Gate	**Output** State

Still **Suffers** from **Exploding Gradient**

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