Dr. MAHALINGAM MCET
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds

Deep2Neuron Tech Academy

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Convolutional Neural Networks

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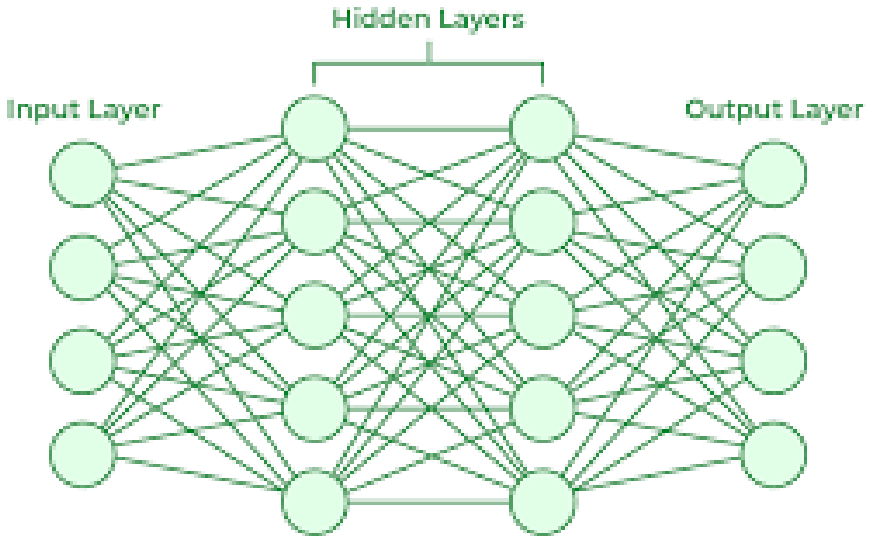
Contents

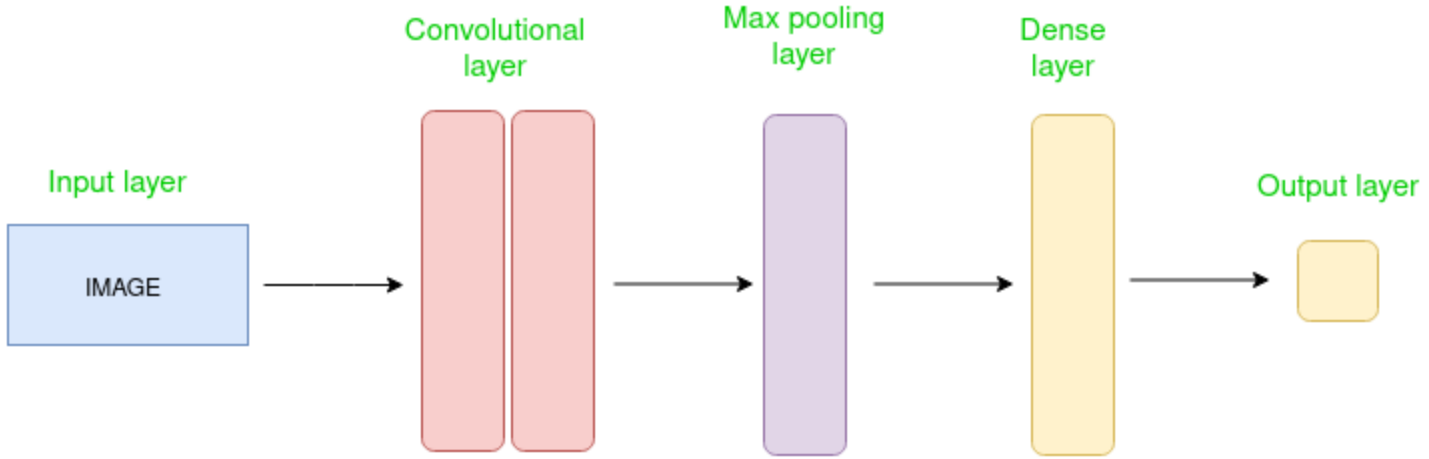
Neural Networks

- Artificial systems inspired by biological neural networks
- Recognize underlying relationships in a dataset
- Deep Learning
- Layers: Input layer, Hidden layers, Output layer



Convolutional Neural Networks

- Deep learning algorithm
- Designed for analyzing visual data
- Capture local pattern and spatial dependencies within data
- Building blocks : Convolutional layers – extract features



Convolutional Layer

- Extract features from the dataset
- Applies set of learnable filters – kernels
- Filters – usually smaller matrices of 2x2, 3x3, or 5x5 shape
- Slide over input layer
- Dot product between kernel weight and corresponding input image patch
- Output – Feature maps

- Let convolutional layer have 12 filters then,
  Output volume dimension : 32x32x12

Activation Layer

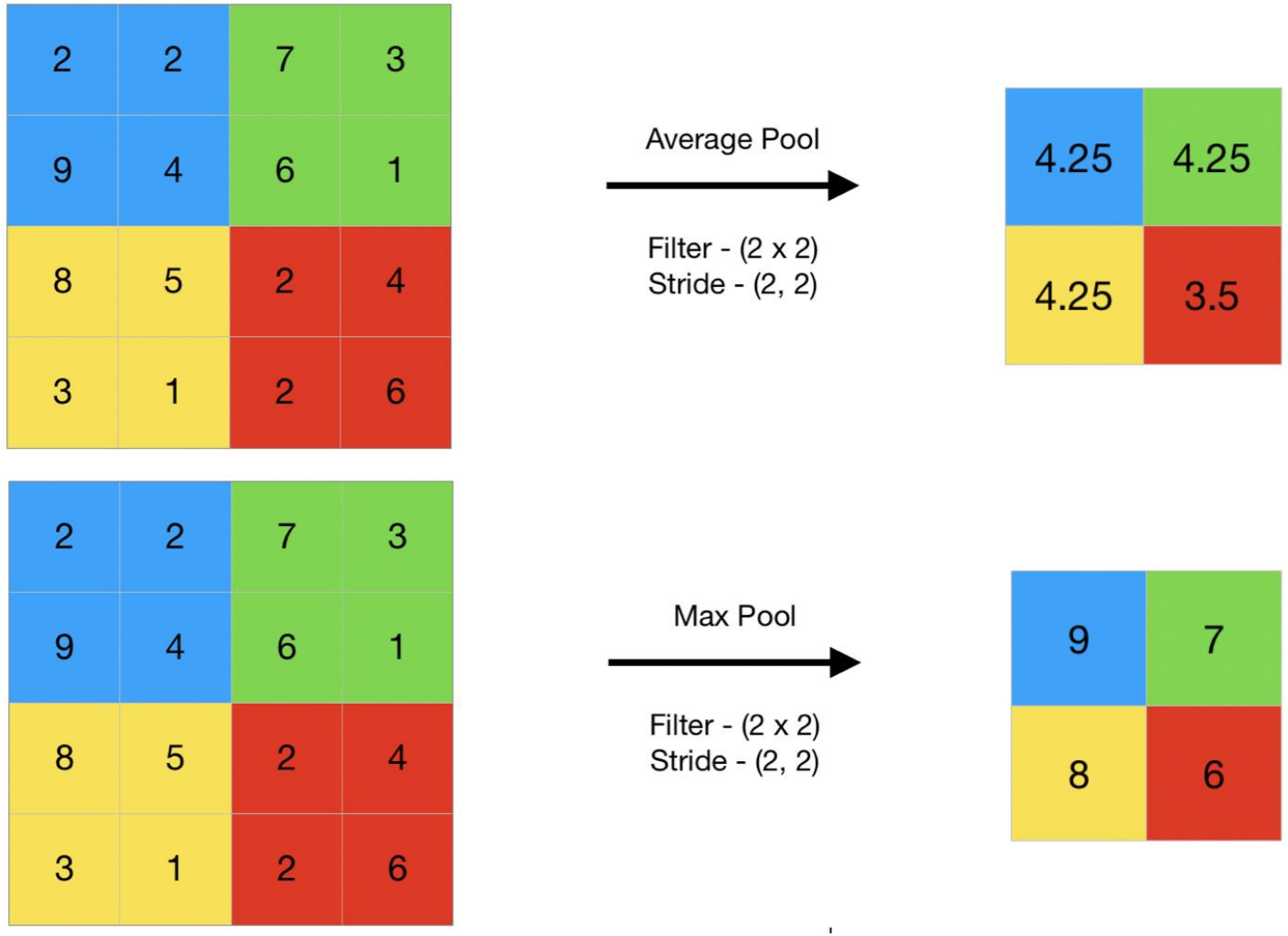
- Activation function
- Add non-linearity to the network
- Common - ReLU: max(0,x)
  Tanh
  Leaky ReLU

- Allow network to learn complex representations
- Volume remains unchanged

Pooling Layer

- Periodically inserted in the covnets
- Main function : Reduce volume size
- Make computation fast, prevent overfitting
- Common types
  - Max Pooling
  - Average Pooling

- Let max pool with 2x2 filters and stride 2,
  Resultant volume dimension: 16x16x2


2 2 7 3
9 4 6 1
8 5 2 4
3 1 2 6
Average Pool
Filter - (2 x 2)
Stride - (2, 2)
4.25 4.25
4.25 3.5
2 2 7 3
9 4 6 1
8 5 2 4
3 1 2 6
Max Pool
Filter - (2 x 2)
Stride - (2, 2)
9 7
8 6

Flattening

- Resulting feature maps are flattened
- One-dimensional vector after convolution and pooling
- As it can be passed to completely linked layer
- For categorization or regression

Fully Connected Layer

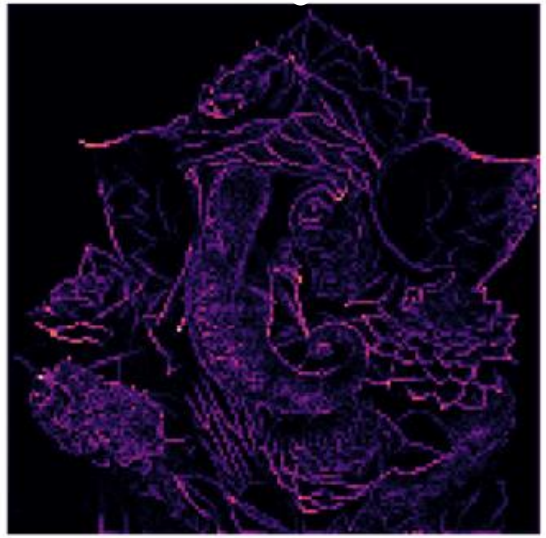
- Connect every neuron of one layer to Every neuron in the next layer
- Used for classification and regression tasks
- Providing high-level reasoning, Based on the extracted features

Input

Convolution

Activation

Pooling



Backpropagation

- Used for training CNN
- Adjusting weights of network, based on the computed error or loss
- Gradient of loss function is calculated, w.r.t. network parameters
- Weight updated using optimization algorithm like SGD or its variants

Pretrained Models

- Widely available and trained on large scale datasets, such as ImageNet
- Learned rich feature representations
- Used as starting point for various computer tasks
- Common technique – Transfer Learning where pretrained model are fine-turned on specific tasks with smaller labeled dataset

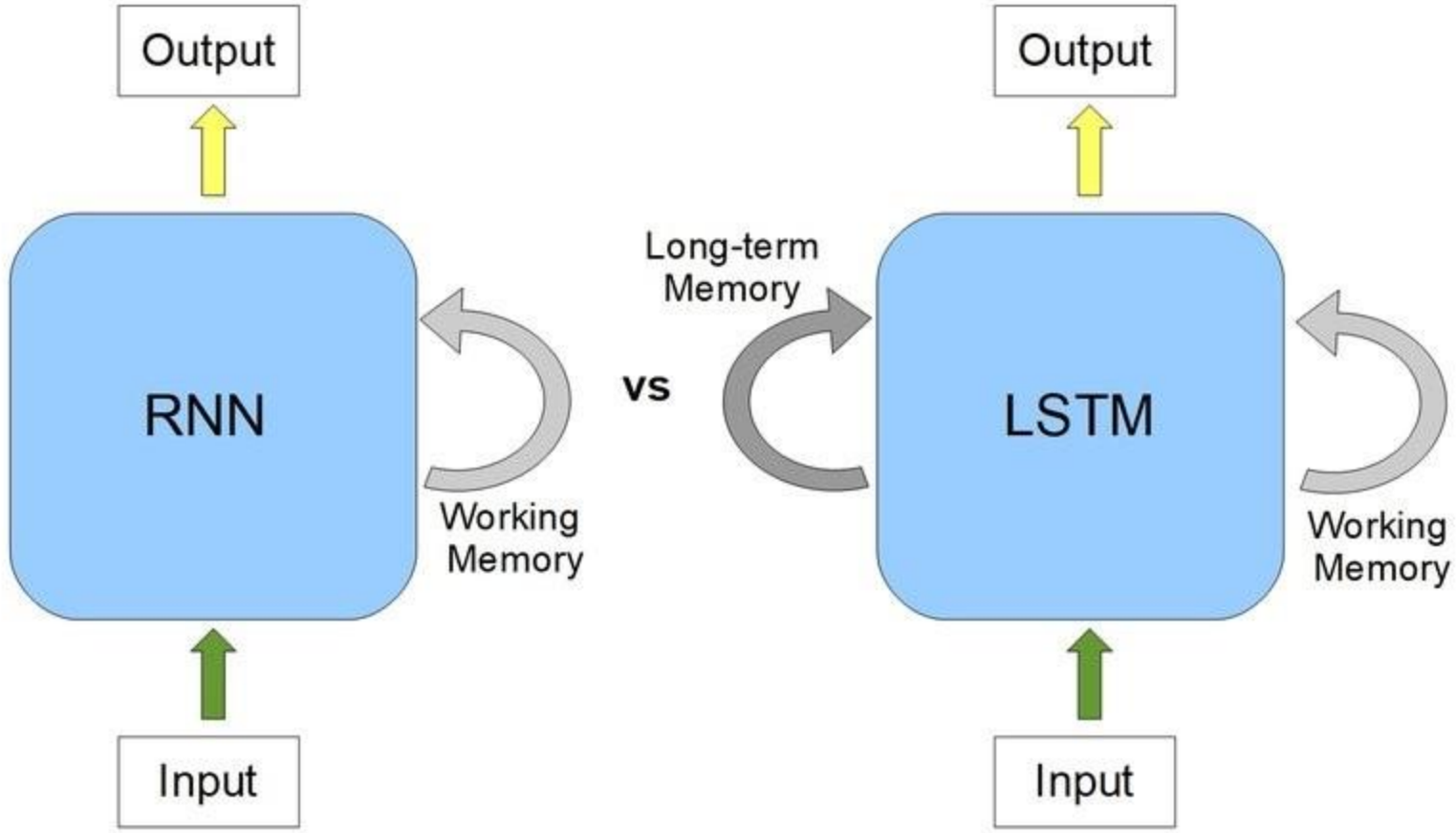
CNN Models

- VGG
- Xception
- ResNet
- DenseNet
- InceptionV3
- InceptionResnet
- MobileNet
- NasNet
- EfficientNet
- ConvNeXt

Applications

- Image Classification
- Object Detection
- Sematic Segmentation
- Image Generation
- Video Analysis

RNN vs LSTM


Output
RNN
Working Memory
Input
vs
Long-term Memory
Output
LSTM
Working Memory
Input

RNN vs LSTM

Recurrent Neural Network	Long Short-Term Memory
Basic RNN consists of single recurrent layer.	Recurrent layer with additional memory cells and gates.
Difficult to capture long term dependencies.	Memory cell allow the network to capture dependencies over longer time horizons.
Effective in processing short-term or immediate dependencies in linear data.	Effective for modeling and predicting sequences with long-range dependencies.
Training RNNs is relatively simpler than training LSTMs.	LSTMs are more complex than basic RNNs due to their additional components.
Suffer from vanishing gradient problem.	Overcome the vanishing gradient problem.

References

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THANK YOU