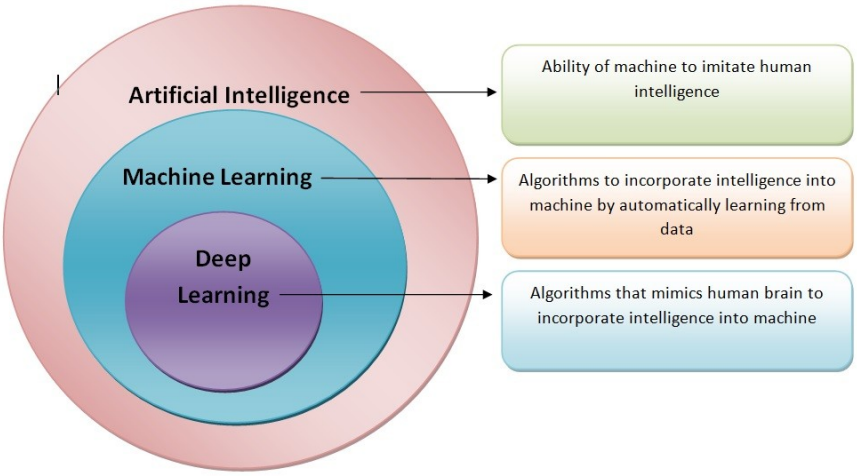
CNN & DEEP LEARNING

DL is a method in ai that teaches /trains the computer to process data in a way that is inspired by the human brain , these models can recognize complex patterns in pictures, text,sound and other data to produce accurate insights and predictions . Dl can be used to automate tasks that require human inteligence , such as describing images, recognizing faces , nlp tasks ,fraud detectipn , digital assistants etc.Due to this reason the importance and the scope of dl is immense.



The componentes of a dl network are

1.input layer – has several nodes which input the system these nodes form input.
2.hidden layer -layers process information at different levels, adapting their behavior as they receive new information. Deep learning networks have hundreds of hidden layers that they can use to analyze a problem from several different angles.
3.output layer .

Benifits -
1.Efficient processning of unstructured data
2.Hidden relationships and pattern discoveries
3.Unsupervised Training
4.Volatile Data processing-volatile datasets have large variations

Key Elements in deep learning

1.Supervised Learning

- Supervised learning is the most common approach, where the model is trained on labeled data to learn a mapping from inputs to outputs. Examples include image classification, object detection, and speech recognition.

- The model is trained to minimize a loss function that measures the difference between the model's predictions and the ground truth labels. Popular loss functions include cross-entropy loss for classification and mean squared error for regression.

2.Unsupervised Learning

- Unsupervised learning aims to discover patterns and structure in data without labels. Examples include clustering, dimensionality reduction, and generative modeling.

- Techniques like autoencoders and generative adversarial networks (GANs) can learn useful representations of data in an unsupervised way.

3.Transfer Learning

- Transfer learning involves using knowledge gained from solving one problem and applying it to a different but related problem.

- A model trained on a large dataset like ImageNet can be fine-tuned on a smaller dataset for a specific task, leveraging the learned features.

4.Regularization

- Regularization techniques prevent overfitting by adding a penalty for model complexity to the loss function. Examples include L1/L2 regularization, dropout, and data augmentation.

- Dropout randomly sets activations to zero during training to force the model to learn more robust features.

5.Optimization

- Optimization algorithms like stochastic gradient descent (SGD) and its variants (e.g. Adam, RMSProp) are used to update model parameters to minimize the loss function.

- Techniques like learning rate scheduling and gradient clipping can stabilize training.

6.Architecture Design

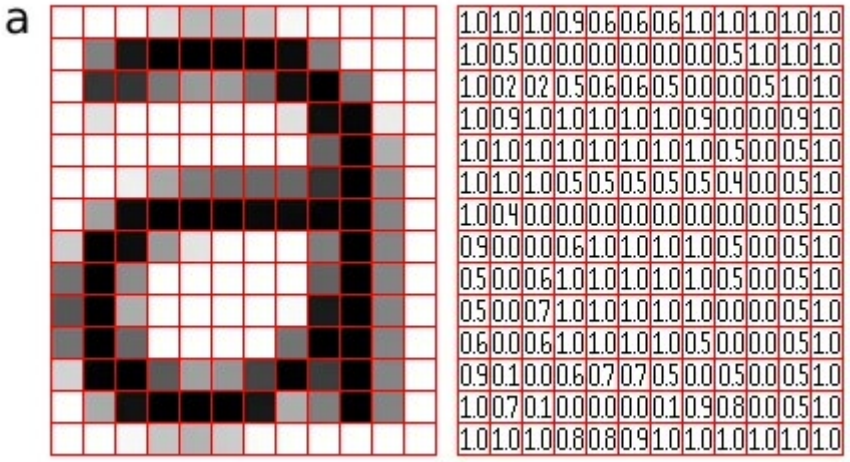
- The architecture of the neural network, including the types of layers, their connectivity, and hyperparameters, is crucial for performance.

- Popular architectures include convolutional neural networks (CNNs) for images, recurrent neural networks (RNNs) for sequences, and transformers for long-range dependencies.

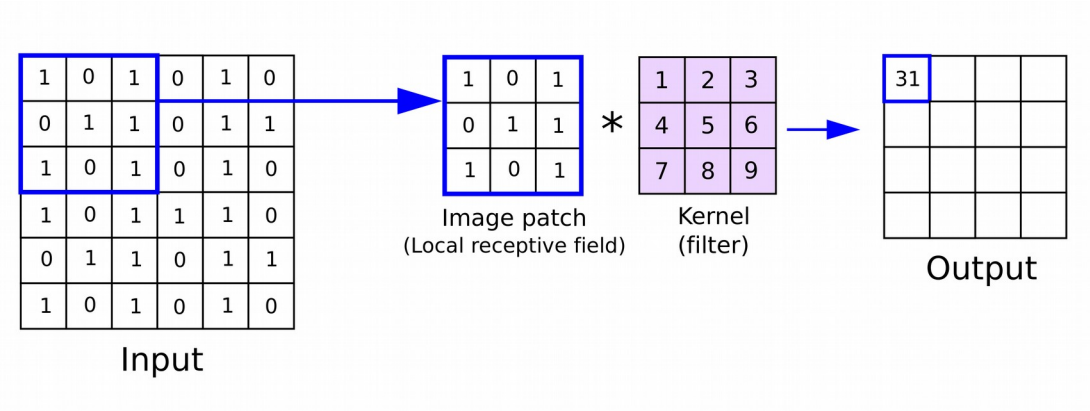
- Neural architecture search algorithms can automatically design optimal architectures for a given task and dataset.

CNN-convolutional neural networks

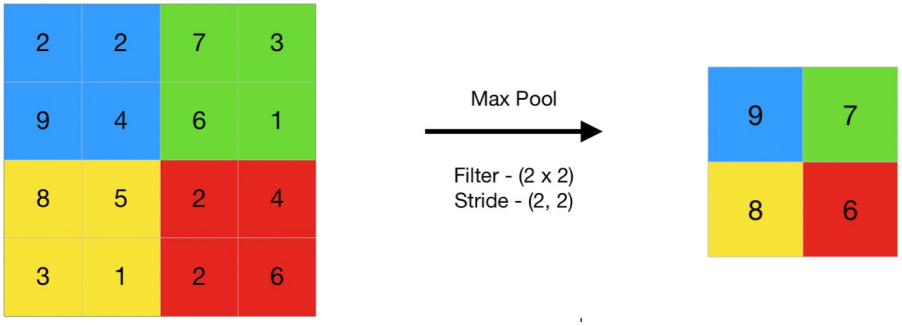
A Convolutional Neural Network, also known as CNN or ConvNet, is a class of nn that specializes in processing data that has a grid-like topology, such as an image,a digital image is a binary representation of visual data. It contains a series of pixels arranged in a grid-like fashion that contains pixel values to denote how bright and what color each pixel should be.

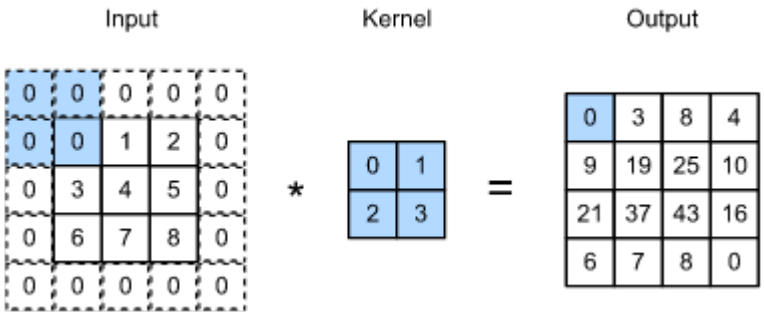


A CNN typically has three layers: a convolutional layer, a pooling layer, and a fully connected layer.
1.Convolutional layer
-Uses a filter-kernel-a small matrix with weights initailized. The kernel slides over the images height and wdith and performs multipication also known as a dot product



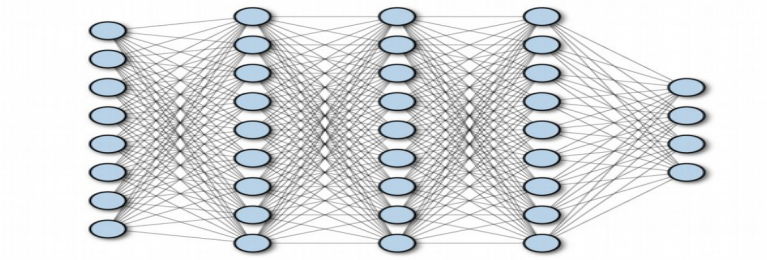
2.Pooling Layer
-Aims to reduce the dimensionlity of input data [down sampling].less complex mdodels with higher level features are typically less prone to over fitting , but it can lead to a loss of data. Padding is also added to get the desired dimension .
Eg – max pooling , min pooling , mean pooling etc .





Formula for adding padding- $W_{out} = \frac{W - F}{S} + 1$

3.Fully Connect Layer
-serves as the final stage of the network, transforming the spatially-organized features into class predictions, enabling the CNN to perform accurate image classification tasks.



Non-linearity layers are often placed directly after the convolutional layer to introduce non-linearity to the activation map.Some of theses operations are

1.Sigmoid
2.Tanh
3.Relu

Examples of cnn

1. LeNet-5: The Pioneer

2. AlexNet: Igniting Deep Learning Resurgence

3. VGGNet: The Pursuit of Simplicity

4. GoogLeNet (Inception): Embracing Parallelism

5. ResNet: Tackling Vanishing Gradients

6. MobileNet: Lightweight Efficiency

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