IMAGE PROCESSING USING CNN(CONVOLUTIONAL NEURAL NETWORKS)

Mirzayeva Nargiza Muslim qizi
The Tashkent University of Information Technologies named after Muhammad ibn Musa al-Khwarizmi

Annoation: *This article will explain convolutional neural networks, how deep their algorithm is, how they are created, where they are used, and why they are used and this article will explain to you how to construct, train and evaluate convolutional neural networks.*

Keywords: *Neural Networks, cross-fertilization, color images, the International Neural Network Society (INNS), the European Neural Network Society (ENNS), and the Japanese Neural Network Society (JNNS), CNN(Convolutional neural networks), MNIST Dataset, Multi-Layer Perceptrons.*

Аннотация: *В этой статье будут объясняться сверточные нейронные сети, насколько глубок их алгоритм, как они создаются, где они используются и почему они используются, и эта статья объяснит вам, как создавать, обучать и оценивать сверточные нейронные сети*.

Ключевые слова: *Нейронные сети, перекрестное опыление, цветные изображения, Международное общество нейронных сетей (INNS), Европейское общество нейронных сетей (ENNS) и Японское общество нейронных сетей (JNNS), CNN (сверточные нейронные сети), набор данных MNIST, Multi- слой персептронов*

INTRODUCE

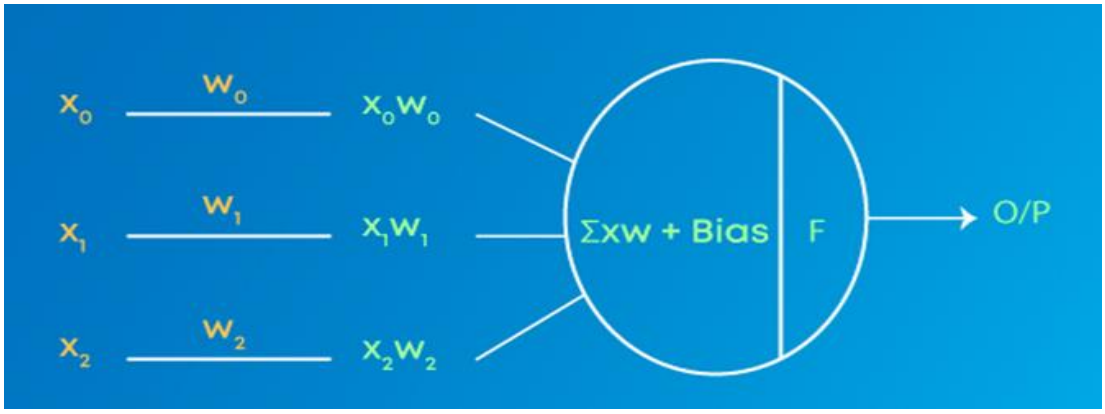
Neural Networks provides a forum for developing and nurturing an international community of scholars and practitioners who are interested in all aspects of neural networks, including deep learning and related approaches to artificial intelligence and machine learning. Neural Networks welcomes submissions that contribute to the full range of neural networks research, from cognitive modeling and computational neuroscience, through deep neural networks and mathematical analyses, to engineering and technological applications of systems that significantly use neural network concepts and learning techniques. This uniquely broad range facilitates the cross-fertilization of ideas between biological and technological studies and helps to foster the development of the interdisciplinary community that is interested in biologically-inspired artificial intelligence. Accordingly, the Neural Networks editorial board represents experts in fields including psychology, neurobiology, computer science, engineering, mathematics, and physics.

Neural networks represent deep learning using artificial intelligence. Certain application scenarios are too heavy or out of scope for traditional machine learning algorithms to handle. As they are commonly known, Neural Network pitches in such

scenarios and fills the gap. Also, enrol in the neural networks and deep learning course and enhance your skills today.

Artificial neural networks are inspired by the biological neurons within the human body which activate under certain circumstances resulting in a related action performed by the body in response. Artificial neural nets consist of various layers of interconnected artificial neurons powered by activation functions that help in switching them ON/OFF. Like traditional machine algorithms, here too, there are certain values that neural nets learn in the training phase.

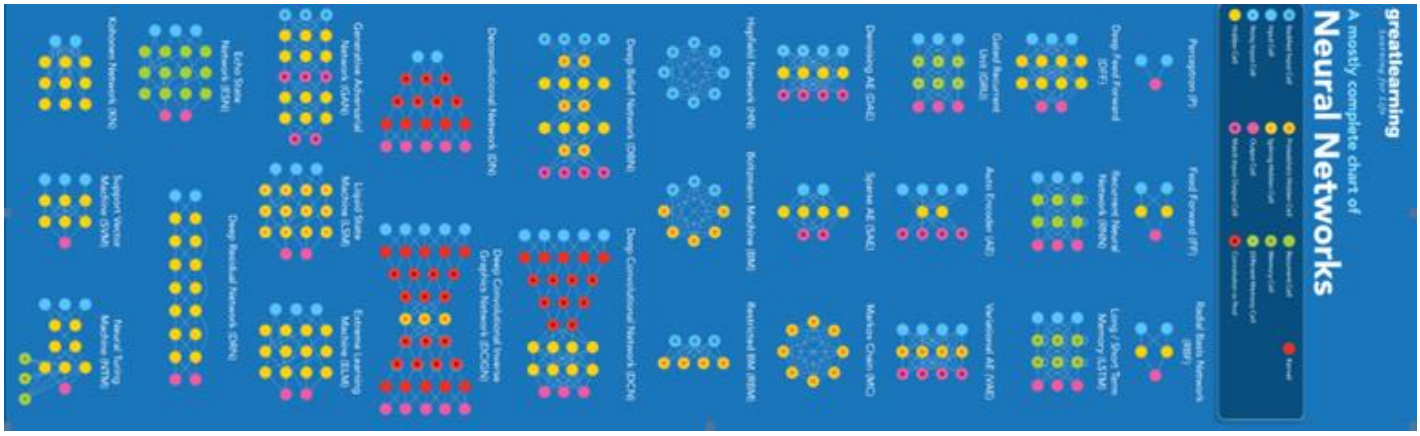
Briefly, each neuron receives a multiplied version of inputs and random weights, which is then added with a static bias value (unique to each neuron layer); this is then passed to an appropriate activation function which decides the final value to be given out of the neuron. There are (1st pic.) various activation functions available as per the nature of input values. Once the output is generated from the final neural net layer, loss function (input vs output)is calculated, and backpropagation is performed where the weights are adjusted to make the loss minimum. Finding optimal values of weights is what the overall operation focuses around. Please refer to the following for better understanding.



1st pic.

Neural Networks is the archival journal of the world's three oldest neural modeling societies: the International Neural Network Society (INNS), the European Neural Network Society (ENNS), and the Japanese Neural Network Society (JNNS). A subscription to the journal is included with membership in each of these societies.

Types of Neural Networks

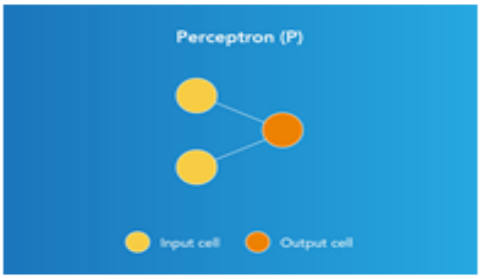


There are many types of neural networks available or that might be in the development stage. They can be classified depending on their: Structure, Data flow, Neurons used and their density, Layers and their depth activation filters etc. Also, learn about the Neural network in R to further your learning(**2nd pic.)**.

2nd pic. Types of Neural network

We are going to discuss the following neural networks:

A. Perceptron



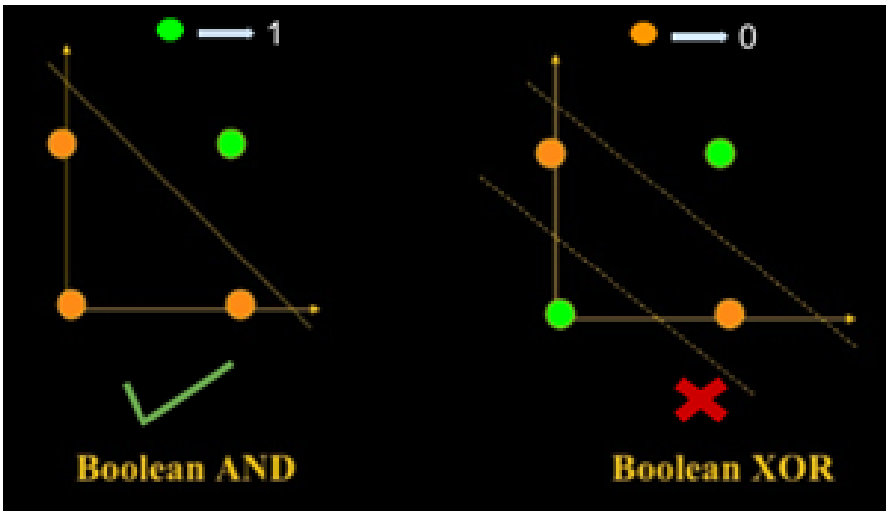
3rd pic. Perceptron

Perceptron model, proposed by(**3rd pic.**) Minsky-Papert is one of the simplest and oldest models of Neuron. It is the smallest unit of neural network that does certain computations to detect features or business intelligence in the input data. It accepts weighted inputs, and apply the activation function to obtain the output as the final result. Perceptron is also known as TLU(threshold logic unit) Perceptron is a supervised learning algorithm that classifies the data into two categories, thus it is a binary classifier. A perceptron separates the input space into two categories by a hyperplane represented by the following equation:

Check out this free neural networks course to understand the basics of Neural Networks

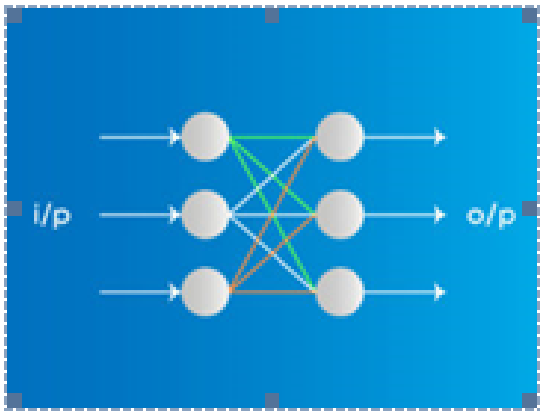
Advantages of Perceptron Perceptrons can implement Logic Gates like AND, OR, or NAND.

Disadvantages of Perceptron Perceptrons can only learn linearly separable problems such as boolean AND problem(**4th pic.**). For non-linear problems such as the boolean XOR problem, it does not work.



4th pic.

B. Feed Forward Neural Networks(5th pic.)



5th pic.

Applications on Feed Forward Neural Networks:

- Simple classification (where traditional Machine-learning based classification algorithms have limitations)
- Face recognition [Simple straight forward image processing]
- Computer vision [Where target classes are difficult to classify]
- Speech Recognition

The simplest form of neural networks where input data travels in one direction only, passing through artificial neural nodes and exiting through output nodes. Where hidden layers may or may not be present, input and output layers are

present there. Based on this, they can be further classified as a single-layered or multi-layered feed-forward neural network.

Number of layers depends on the complexity of the function. It has uni-directional forward propagation but no backward propagation. Weights are static here. An activation function is fed by inputs which are multiplied by weights. To do so, classifying activation function or step activation function is used. For example: The neuron is activated if it is above threshold (usually 0) and the neuron produces 1 as an output. The neuron is not activated if it is below threshold (usually 0) which is considered as -1. They are fairly simple to maintain and are equipped with to deal with data which contains a lot of noise.

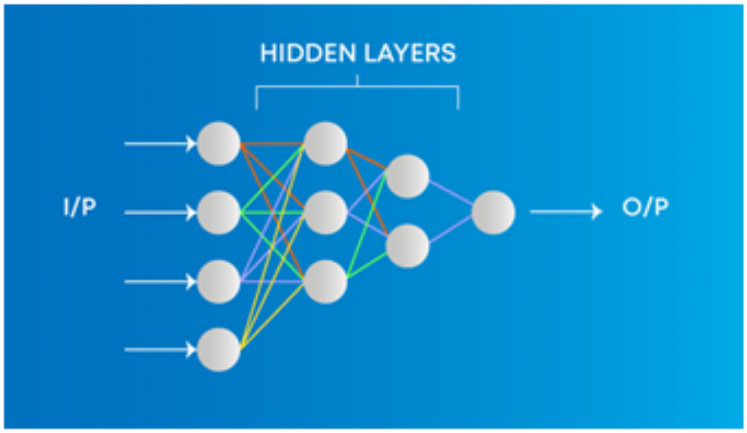
Advantages of Feed Forward Neural Networks

- Less complex, easy to design & maintain
- Fast and speedy [One-way propagation]
- Highly responsive to noisy data

Disadvantages of Feed Forward Neural Networks:

1. Cannot be used for deep learning [due to absence of dense layers and back propagation]

C. Multilayer Perceptron(6th pic)



6th pic.

Applications on Multi-Layer Perceptron

- **Speech Recognition**

- **Machine Translation**
- **Complex Classification**

An entry point towards complex neural nets where input data travels through various layers of artificial neurons. Every single node is connected to all neurons in the next layer which makes it a fully connected neural network. Input and output layers are present having multiple hidden Layers i.e. at least three or more layers in total. It has a bi-directional propagation i.e. forward propagation and backward propagation.

Inputs are multiplied with weights and fed to the activation function and in backpropagation, they are modified to reduce the loss. In simple words, weights are machine learnt values from Neural Networks. They self-adjust depending on the difference between predicted outputs vs training inputs. Nonlinear activation functions are used followed by softmax as an output layer activation function.

Advantages on Multi-Layer Perceptron

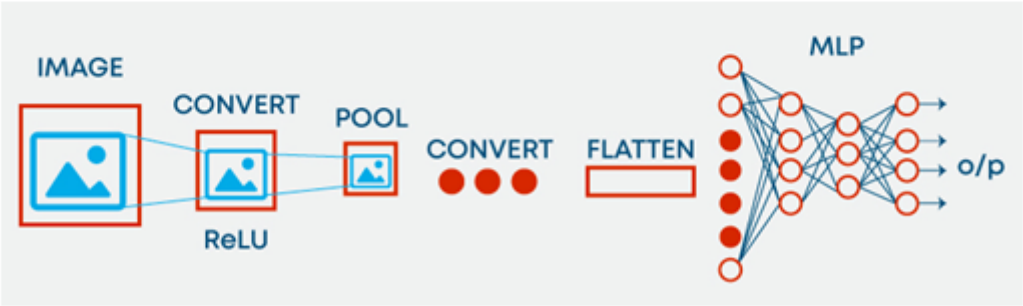
1. Used for deep learning [due to the presence of dense fully connected layers and back propagation]

Disadvantages on Multi-Layer Perceptron:

1. Comparatively complex to design and maintain

Comparatively slow (depends on number of hidden layers)

D. Convolutional Neural Network(7th pic.)



7th pic.

Applications on Convolution Neural Network

- **Image processing**
- **Computer Vision**

- Speech Recognition
- Machine translation

Convolution neural network contains a three-dimensional arrangement of neurons instead of the standard two-dimensional array. The first layer is called a convolutional layer. Each neuron in the convolutional layer only processes the information from a small part of the visual field. Input features are taken in batch-wise like a filter. The network understands the images in parts and can compute these operations multiple times to complete the full image processing. Processing involves conversion of the image from RGB or HSI scale to grey-scale. Furthering the changes in the pixel value will help to detect the edges and images can be classified into different categories.

Propagation is uni-directional where CNN contains one or more convolutional layers followed by pooling and bidirectional where the output of convolution layer goes to a fully connected neural network for classifying the images as shown in the above diagram. Filters are used to extract certain parts of the image. In MLP the inputs are multiplied with weights and fed to the activation function. Convolution uses RELU and MLP uses nonlinear activation function followed by softmax. Convolution neural networks show very effective results in image and video recognition, semantic parsing and paraphrase detection.

Quick check – Deep Learning Course

Advantages of Convolution Neural Network:

1. Used for deep learning with few parameters
2. Less parameters to learn as compared to fully connected layer

Disadvantages of Convolution Neural Network:

- Comparatively complex to design and maintain
- Comparatively slow [depends on the number of hidden layers]

The various deep learning methods use data to train neural network algorithms to do a variety of machine learning tasks, such as the classification of different classes of objects.

Convolutional neural networks are deep learning algorithms that are very powerful for the analysis of images.

Three Layers of CNN. Convolutional Neural Networks specialized for applications in image & video recognition. CNN is mainly used in image analysis tasks like Image recognition, Object detection & Segmentation.

There are three types of layers in Convolutional Neural Networks:

1) Convolutional Layer: In a typical neural network each input neuron is connected to the next hidden layer. In CNN, only a small region of the input layer neurons connect to the neuron hidden layer.

2) Pooling Layer: The pooling layer is used to reduce the dimensionality of the feature map. There will be multiple activation & pooling layers inside the hidden layer of the CNN.

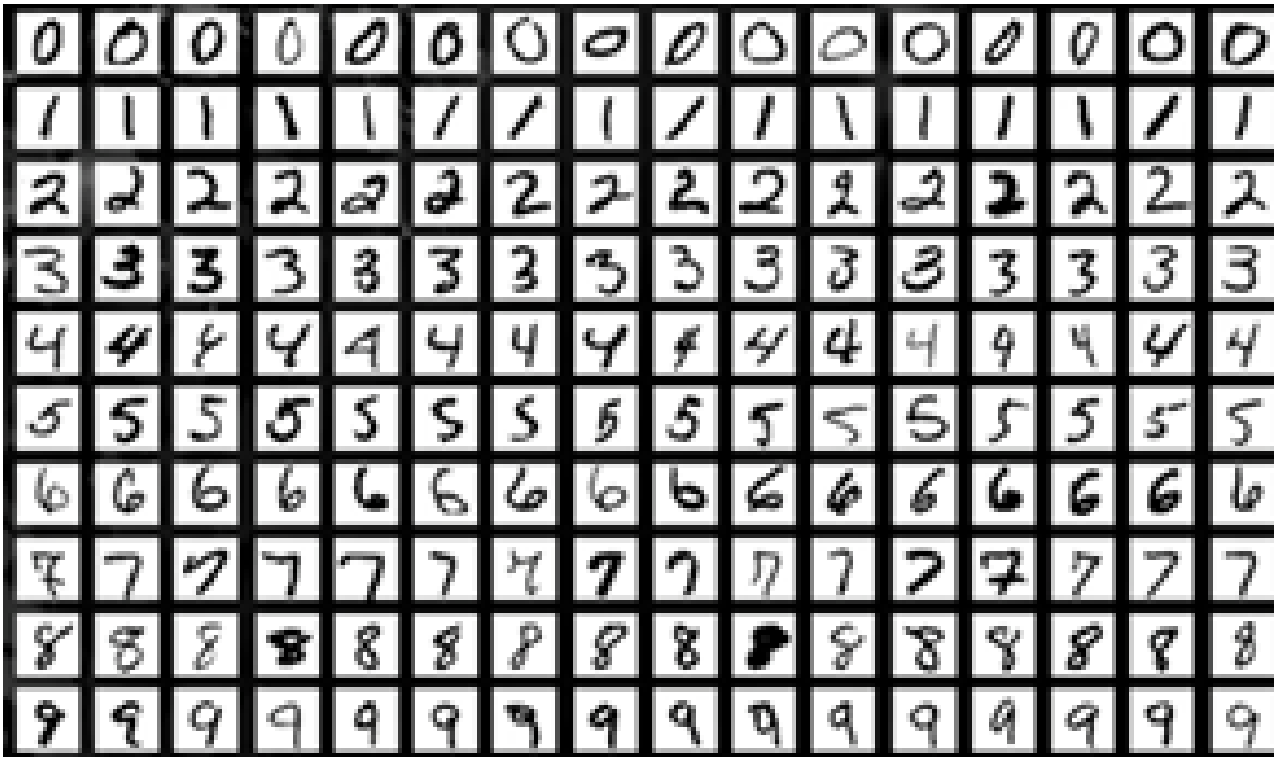
3) Fully-Connected layer: Fully Connected Layers form the last few layers in the network. The input to the fully connected layer is the output from the final Pooling or Convolutional Layer, which is flattened and then fed into the fully connected layer.

We will be working on object recognition in image data using the MNIST dataset for handwritten digit recognition.

MNIST Dataset. In this article, we will be working on object recognition in image data using the MNIST dataset for handwritten digit recognition.

The MNIST dataset consists of images of digits from a variety of scanned documents. Each image is a 28X28 pixel square. In this dataset 60,000 images are used to train the model and 10,000 images are used to test the model.

There are 10 digits (0 to 9) or 10 classes to predict(8th pic).



8TH PIC.

Deep Learning Model with Multi-Layer Perceptrons using MNIST. In this model, we will build a simple neural network model with a single hidden layer for the MNIST dataset for handwritten digit recognition. A perceptron is a single neuron model that is the basic building block to larger neural networks. The multi-layer perceptron consists of three layers i.e. input layer, hidden layer and output layer. The hidden layer is not visible to the outside world. Only the input layer and output layer is visible. For all DL models data must be numeric in nature.

A classical CNN architecture looks like as shown below 9th pic:

Output Layer (10 outputs)
Hidden Layer (128 neurons)
Flatten Layer

Dropout Layer 20%
Max Pooling Layer 2×2

Convolutional Layer 32 maps, 5×5
Visible Layer 1x28x28

The first hidden layer is a Convolutional layer call Convolution2D. It has 32 feature maps with size 5×5 and with a rectifier function. This is the input layer. Next is the pooling layer that takes the maximum value called MaxPooling2D. In this model, it is configured as a 2×2 pool size.

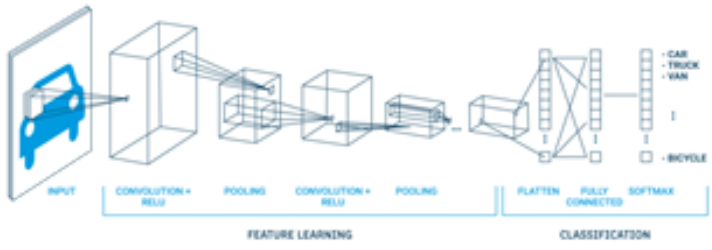
Conclusion.

We know that, there are 10% neurons in our brain, so our brain works only 10%. Neurons transport information in brain. Neurons in our brain are very necessary cells. In this way of life, in modern technologies, neurons perform their functions, just like in our brain(10th pic).

10th pic.

A neuron, neurone, or nerve cell is an electrically excitable cell that communicates with other cells via specialized connections called synapses. The neuron is the main component of nervous tissue in all animals except sponges and placozoa. Non-animals like plants and fungi do not have nerve cells.

Neurons are typically classified into three types based on their function. Sensory neurons respond to stimuli such as touch, sound, or light that affect the cells of the sensory organs, and they send signals to the spinal cord or brain. Motor neurons receive signals from the brain and spinal cord to control everything from muscle contractions to glandular output. Interneurons connect neurons to other neurons within the same region



9th pic.

of the brain or spinal cord. When multiple neurons are connected together, they form what is called a neural circuit.

So, A deep neural network (DNN) is an artificial neural network (ANN) with multiple layers between the input and output layers. They can model complex non-linear relationships. Convolutional Neural Networks (CNN) are an alternative type of DNN that allow modelling both time and space correlations in multivariate signals.

The neural networks presented in the article provide important insights into the neurons created for working with pictures or videos, how they are created, and their practical application.

In conclusion, we can say that the future of neurons with this complex system created by human hands is great.

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