NAME: RAKESH MEHTA
REG NO: 20BCI7051

NEURAL NETWROKS AND FUZZY NETWORKS
ASSIGNMENT-1

Submitted To:Dr .Sucharita Jackson

IMAGE PROCESSING USING NEURAL NETWORKS

Abstract:

The main aim of this paper is to give an clear and comprehensive idea about which algorithm fits best to solve the computer vision problem like image classification,image segmentation and object detection.In this paper we would be Mainly focusing on comparing the Artificial Neural Networks(ANN) and Convulational Neural Network.

Note : We assume that the reader is having a sound knowledge of ANNs I.e different types of Activation functions,Forward propagation and Backward Propagation Algorithms.

Image representation in Computer memory:

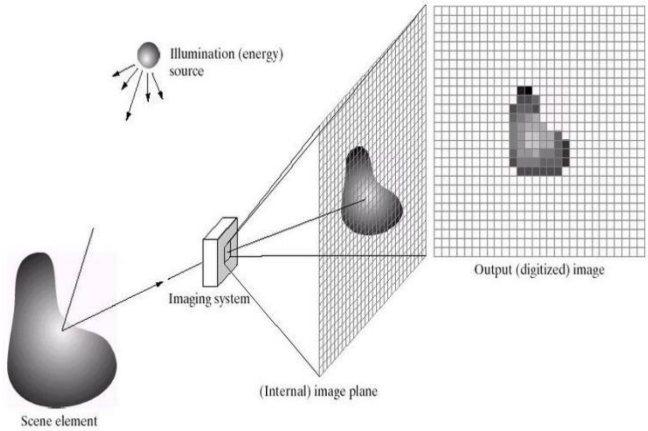
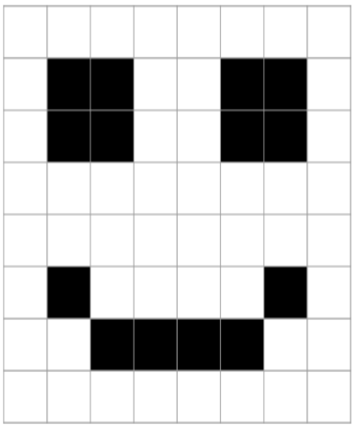


Image capturing device takes continuous light signals and converts them into digital.In computer memory it gets stored as array of pixel values i.e. digital image.

The image can be either

1. Binary - pixel can take value either 0 or 1
2. Grayscale - pixel can take value between 0 to 255
3. Color - image has 3 channels Red Blue and Green and each pixel from each channel can take value between 0 to 255

- Binary Image

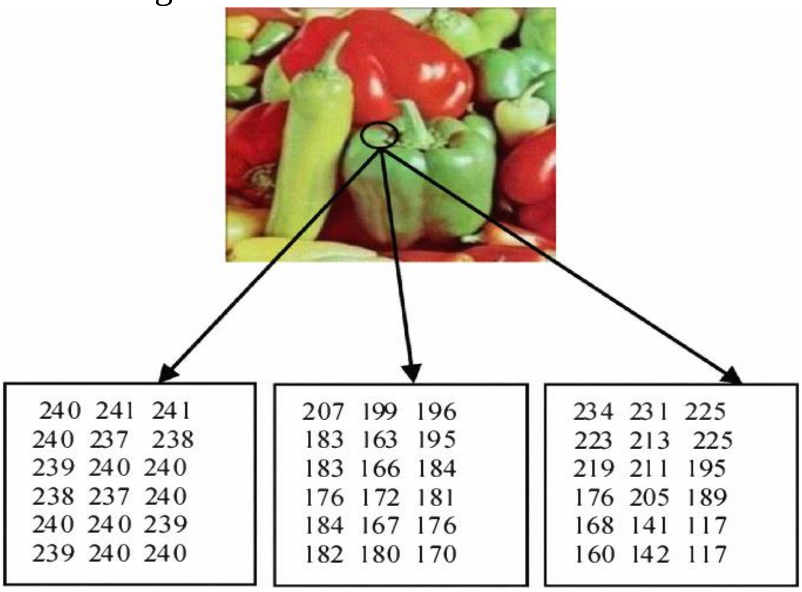


0	0	0	0	0	0	0	0
0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	1	0	0	0	0	1	0
0	0	1	1	1	1	0	0
0	0	0	0	0	0	0	0

In case of binary image pixel can take value either 0 (White) or 1 (Black).Each pixel can bi represented using only 1 bit.Range of values a pixel can take is 0 to 1.

Size of image is M * N * 1 = M * N bits

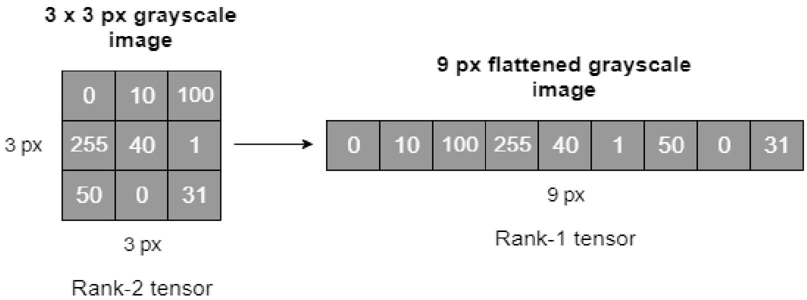
Color Image



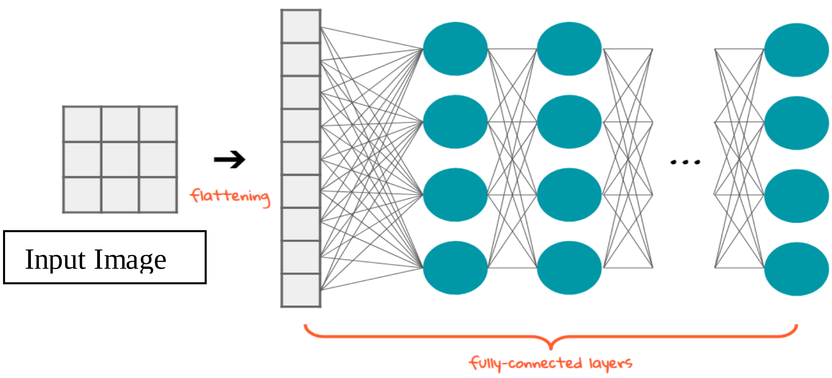
In case of color image there are 3 channels, Reb, Blue and Green.Each channel contributes to the final color .Each channel is represented by a matrix i.e. there are 3 matrices for Red, Blue and Green.
Every pixel from any channel takes value

How to pass image to ANN?

- **Image Flattening**



A 2D image is converted into 1 D vector this operation is called is Image Falttening. The flattened image is considered as one data point (image) and each pixel value represents a feature.M x N image gets converted into 1D vector of size [(M xN) x 1].
These feature values can be passed to neural network as input



Training The model:
We Train the model using forward and Backward propagation respectively.

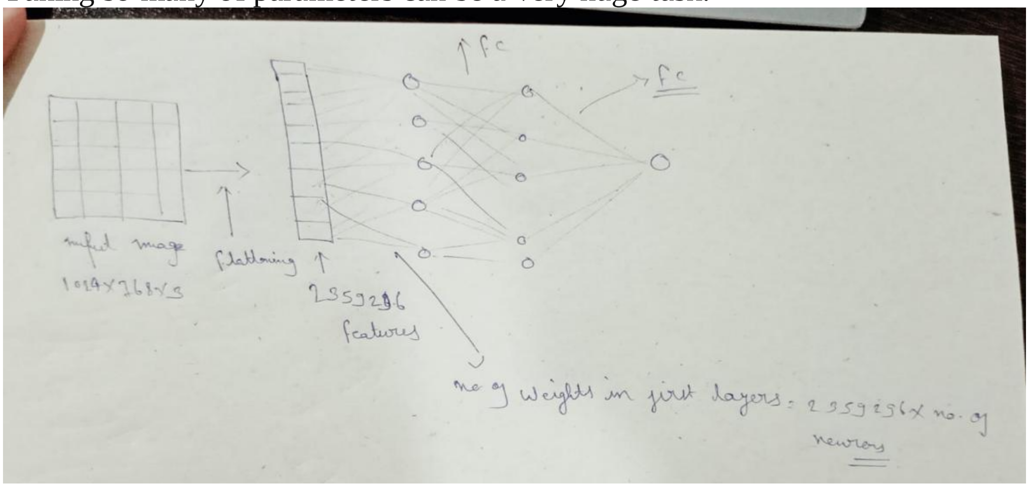
Forward Propagation -
Weights are multiplied to the pixel values from input layer.Sum of all multiplications calculated and activation function is applied ,Hidden layers performs multiplication of weights and output from previous layer, followed by application of activation function
Output layer gets predicted label.

Backward Propagation -

First we calculate the loss using the required loss functions.Then using the Gradients descent algorithms we updates the weights.

Limitation of ANN for image dataset.
1.
Feedforward neural networks can learn a **single feature representation** of the image.
In case of complex images, ANN will fail to give better predictions, this is because it cannot learn pixel dependencies present in the images.

2.
Number of parameters to learn are more and grows rapidly with the increase in the number of layers.
Eg. for 1024 x 1024 image there are approx 1 million features in the input layer and 10 million weights in first layer with 10 neurons in next layer.
This can make training for a model computationally heavy (and sometimes not feasible).
Tuning so many of parameters can be a very huge task.



3.Also ANN do not take care of local information in the image, it considers each pixel as an independent feature ,these drawbacks can be overcome by Convolutional Neural Network

What is Convolutional Neural Network CNN?

Convolutional Neural Network is a type of deep learning neural network that is artificial. It is employed in computer vision and image recognition. It’s works on the principle of **feature Extraction.** Here mainly we focus on Edge detection and we do consider the a bunch of features instead of single one which overcomes the one of the most significant problem faced by the the ANN.

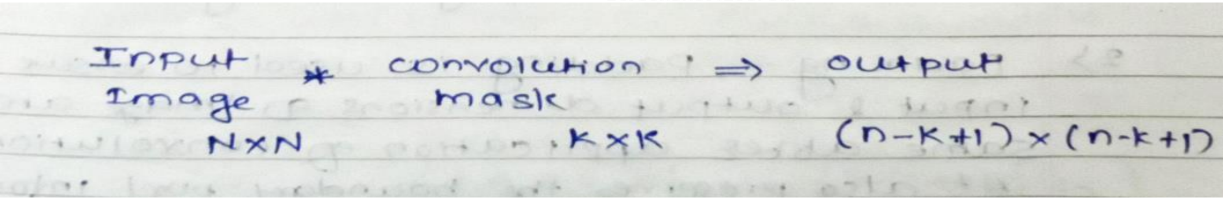
Convolutional Neural Network structure consists of four layers:

Convolutional layer

It considers the locality information from the image neighboring pixels contribute to some meaning . example some group of neighboring pixels forms ear eyes etc. ANN Considers every pixel as independent pixels.
Using convolutional operation we can Perform different operations on Image Such as edge detection, smoothing and sharpening.

Convolutional Formula:

$$S_{ij} = (I * K)_{ij} = \sum_{a=\lfloor -\frac{m}{2} \rfloor}^{\lfloor \frac{m}{2} \rfloor} \sum_{b=\lfloor -\frac{n}{2} \rfloor}^{\lfloor \frac{n}{2} \rfloor} I_{i-a,j-b} K_{\frac{m}{2}+a,\frac{n}{2}+b}$$

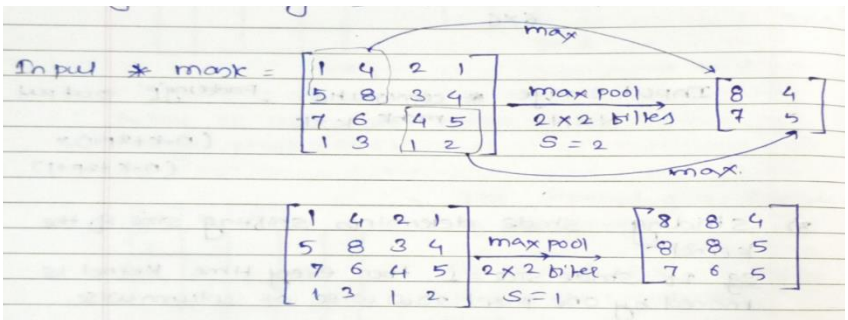


Rectified Linear Unit layer (aka ReLu)

This layer is considered as an extension of a convolutional layer. The goal of ReLu is to increase the image’s non-linearity. It is the technique of removing excess fat from a picture in order to improve feature extraction

Pooling layer:

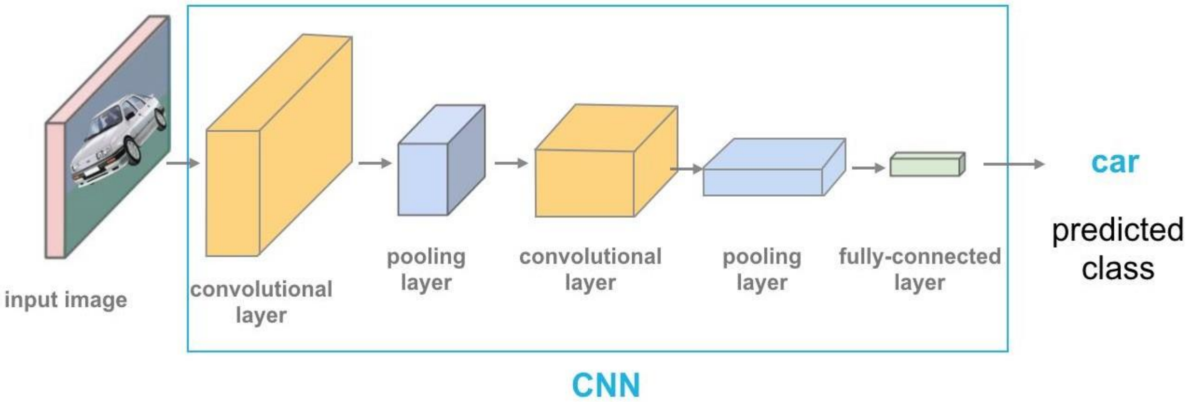
Poolng can be applied at any hidden layers once the convolutional operations is performed.
We get 2D feature map followed by that we apply pooling operations. Let’s say after performing convolutional we get the following output.



Pooling reduces the size of input.The main purpose of pooling layers is to progressively reduce the spatial size of the input,so that numbers of computation may be less.

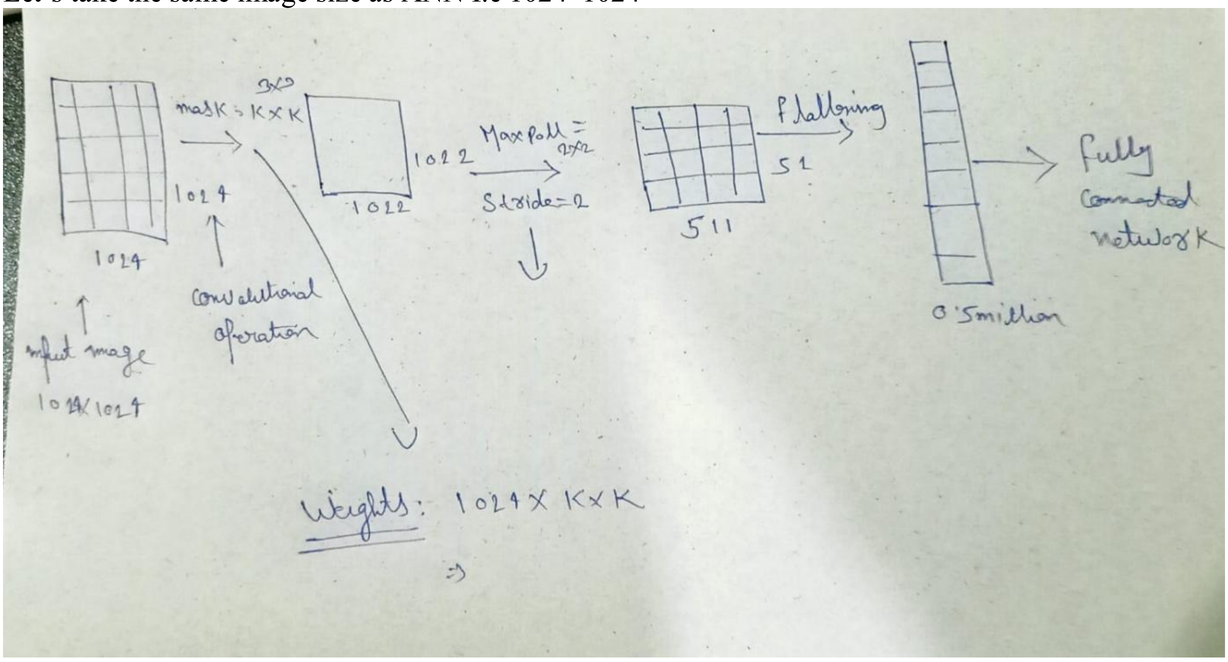
Connected layer

It is a standard feed-forward neural network. It’s the last straight line before the finish line, where everything is already visible. It’s only a matter of time until the results are confirmed.



Proof how CNN is computationaly efficient:

Let’s take the same image size as ANN I.e 1024*1024



So we can clearly see that we have reduced the features to nearly half we can reduce more if we keep applying the convolutinal and pooling layers.

Summary:

We shown Feedforward neural networks can learn a single feature representation of the image and CNN can learn multiple layers of feature representations of an image by applying filters, or transformations.In CNN, the number of parameters for the network to learn is significantly lower than the multilayer neural networks since the number of units in the network decreases, therefore reducing the chance of overfitting. Also, CNN considers the context information in the small neighborhood(Convolutional operation) and due to this feature, these are very important to achieve a better prediction in data like images. Since digital images are a bunch of pixels with high values, it makes sense to use CNN to analyze them. CNN decreases their values, which is better for the training phase with less computational power and less information loss.

Conclusion:

In our project we will be using CNN for prediction of Tb (Tuberculosis).The dataset on which we are going to use can be found using the https://www.kaggle.com/datasets/tawsifurrahman/tuberculosis-tb-chest-xray-dataset link.

REFERENCES:

https://viso.ai/deep-learning/ann-and-cnn-analyzing-differences-and-similarities/#:~:text=They%20are%20both%20unique%20in,image%20inputs%20are%20not%20necessary.

https://www.analyticsvidhya.com/blog/2021/10/applications-of-convolutional-neural-networkscnn/

https://discuss.boardinfinity.com/t/why-do-we-prefer-convolutional-neural-networks-cnn-over-artificial-neural-networks-ann-for-image-data-as-input/8534

https://www.ijser.org/researchpaper/Applications-of-Artificial-Neural-Network-in-Image-Processing-A-Survey.pdf