**RECENT ADVANCES IN CONVOLUTIONAL NEURAL NETWORKS**

INTRODUCTION

Deep learning has proved its usefulness in many areas like Object recognition, Speech recognition, Natural language processing etc. Among the different types of neural networks, Convolution Neural Networks (CNN) is used much extensively. In early days, due to the lack of training data and computing power, it is very difficult to train CNN. But now a day’s many researchers achieved state of art as large training data is available for training and computing power has increased manifold.

CNN is first introduced by Yann LeCun el. al. in 1998 and improved by B.B LeCun in 1990. They developed a multilayer neural network, LeNet-5 which can classify handwritten digits. But it has problems in handling complex datasets. Since 2006, many developments has been made in this field. Krizhevsky et. al developed AlexNet which has deeper architecture than LeNet. Several other developments has been made since then such as ZFNet, VGGNet, GoogleNet etc. They made improvements in reducing filter size and making the network deeper and so on.

BASIC CNN COMPONENTS

In general, CNN consists of 3 different types of layers:

* Convolution layer.
* Pooling layer.
* Fully connected layer.

The convolution layer learns feature representation of inputs, pooling layer is responsible to achieve spatial invariance by decreasing resolutions while the fully connected layers are used to perform high level reasoning.

IMPROVEMENTS IN CNN

* **Convolution layer**: To improve the convolution layer, Network In Network (NIN) technique and Inception module is used. In these improvements, the linear filter is replaced by a micro network which enhances the power to extract more intricate information. Inception module is a logical culmination of NIN which uses variable filter size to capture different visual patterns of different sizes and approximates the optical structure.
* **Pooling layer**: Many recent developments in pooling operations has been done which lead to different techniques like Lp pooling, Mixed pooling, Spectral pooling etc. The aim of these recent developments is to lower the computational burden by reducing the number of connections between convolution layers.
* **Activation functions**: A proper activation function is required which in turn improves the performance of a CNN. Instead of using a simple sigmoid function, recent developments have led to the usage of Rectified Linear Unit (ReLU), Leaky ReLU, Parametric ReLU, Randomized ReLU, Exponential linear unit (ELU) and so on. In ReLu, the negative part of the function is set to 0, while developments in ReLU has led to modification in handling the negative part in a more scientific manner rather than simply setting it to 0.
* **Loss functions**: Although mean squared loss (L2 loss), cross entropy loss etc is being used extensively in the minimization process of a loss function in a neural network, recently a number of sophisticated loss functions has been developed which can further improve the efficiency of a neural network. Softmax loss, Hinge loss, Contrastive loss etc are the recent advances in the loss function.
* **Regularization**: It is aimed to reduce the overfitting of the data. Two recent developments have been made in this field viz. Dropout and Dropconnect. These methods prevent the network from becoming too dependent on any one neuron and force the network to be accurate even in the absence of certain information.
* **Optimization**: Recent improvements on optimization of data have been done in the field of weights initialization, stochastic gradient descent and batch normalization. These techniques are aimed to accelerate the entire training process.

FAST PROCESSING OF CNN’s

Various improvements have been done in order to achieve the fast processing of CNN’s. Fast Fourier Transform (FFT), Matrix factorization (in which a data matrix is broken into two sub matrices of the same rank for fast handling of the data) and Vector quantization (which compresses the dense layers to make CNN models smaller) are the recent improvements in this area.

APPLICATIONS OF CNN’s

CNN has been used extensively in different areas of digital processing. These applications include Image classification, Object tracking, Pose estimation, Text detection and recognition, Visual saliency discretion, Action recognition and Scene labeling.