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**Assignment**

**Q1. What do you mean by Convolutional Neural Network?**

Ans.

Just like ANN (Artificial Neural Network), CNN (Convolutional Neural Network) works, but there are additional convolutional layers involved in this type of neural network. It is majorly used for finding patterns in image input. It resembles the structure of human nerve cell as it contains an Input Layer, Hidden Layer and Output Layer just like ANN. The images are converted into pixel-by-pixel numerical value, which is after being convolved, max-pooled and flattened is provided to the dense layer. Some of the major applications are Face Recognition, Object Detection and Classification.

**Q2. Why do we prefer Convolutional Neural networks (CNN) over Artificial Neural networks (ANN) for image data as input?**

Ans.

* ANN fails to work with complex input data, and as one can say an image is a collection of pixel-by-pixel values varying whether it is RGB (Red, Green and Blue) – (3 Channels) or Grey-scaled – (1 Channel). It becomes a 2D matrix of pixel values, which is more complex to handle with the help of ANN. By switching to CNN, we can easily handle such complex input images.
* It is not possible in ANN to learn various features present in the image, at the same time as CNN can learn. We can fetch many features with help of feature matrix provided at the time of adding convolutional layer. We can also add various filters to fetch more features.
* CNN helps to avoid Model Overfitting, as it requires a smaller number of learning parameters as compared to ANN. It also reduces the value of pixels at the time of training, so that training can be done much faster, without losing much information.

**Q3. Explain the different layers in CNN.**

Ans.

* **Convolution Layer**

The convolution layer helps to extract features from the image by multiplying each pixel with respect to the provided feature matrix. This feature matrix is sometimes selected by the programmer itself, but it can also be automatically generated by the libraries like TensorFlow or Keras at the time of adding the convolutional layer to the model network.

Here, a stride of same width and height is used to fetch a portion of image, so that it can be convolved by multiplying it to the feature matrix. After convolving the features matrix over a portion of the image, the stride is then shifted to the next portion. After, this we obtain a new matrix, with new dimensions. This matrix is then provided to the Pooling Layer.

* **Pooling Layer**

The matrix coming out of the convolutional layer is passed through pooling layer to diminish the features present in the image to that extend, that it does not affect the training of the neural network, and reduces the computational cost. This makes CNN more preferable for training over image data input. There are various ways to apply Pooling Layer, some of them are:

1. Max-Pooling Layer:

Here the highest pixel value present in the stride is taken as the output value for Pooled matrix

1. Mean-Pooled or Average-Pooled Layer:

Here the mean pixel value calculated by the pixel value present in the stride is taken as the output value for Pooled Matrix.

* **Flattening Layer**

Here the 2D matrix, which has gone through multiple layers of Convolution and Pooling Layer is provided to convert it into a flattened matrix. This is done, so that the we can feed the input value to the input layer of the neural network (Dense Layer or Fully Connected Layer), without complex 2D iteration. The single dimension array of value is provided to the network.

* **Dense Layer or Fully Connected Layer**

Here, the main neural network processing takes place, the input is provided by the flattening layer, which is then passed through the hidden layers, these hidden layers computes

**Q4. Explain the significance of the RELU Activation function in Convolution Neural Network.**

Ans.

The RELU operation is applied following each convolution operation. Furthermore, the activation function of RELU is non-linear. Every negative pixel value in the feature map is replaced with zero by this procedure, which is applied to every pixel.

Typically, the image has a wide range of pixel values since it is extremely nonlinear. An algorithm would have an extremely tough time correctly predicting this situation. In these situations, RELU activation function is used to reduce non-linearity and simplify the task.

This layer aids in the detection of features by reducing the image's nonlinearity and turning negative pixels into zero, which also enables the detection of fluctuations in features.

As a result, adopting a non-linear activation function like RELU causes convolution, a linear operation, to become non-linear.

**Q5. What are the different types of Pooling? Explain their characteristics.**

Ans.

* Max Pooling

The term "max pooling" refers to a pooling process that chooses the largest element from the feature map area that the filter covers. This means that the result following the max-pooling layer would be a feature map that included the most noticeable features from the prior feature map.

* Average Pooling

The average of the items in the feature map area that the filter is covering are calculated using average pooling. Therefore, average pooling delivers the average of the features present in a patch, whereas max-pooling gives the most prominent feature in a specific patch of the feature map.

* Global Pooling

Each channel in the feature map is reduced to a single value by global pooling. As a result, a nh x nw x nc feature map is transformed into a 1 x 1 x nc feature map. This is the same as applying a filter with the dimensions nh x nw, or the feature map's dimensions.

**Q6. Explain the role of the flattening layer in CNN.**

Ans.

The final procedure in a convolution neural network is flattening.

It entails converting the pooled feature map produced during the pooling process into a one-dimensional vector. You do this so that you can feed them into the dense layer as inputs.