Assignment 3

Convolution Neural Networks

A Convolutional Neural Network (CNN) is an advanced type of artificial neural network that is specifically designed for tasks related to computer vision and image recognition. It utilizes a convolution layer that applies various filters to the input image, allowing it to extract meaningful features from the image data. This process of sliding the filters over the image is known as convolution, and it generates a series of feature maps that highlight different characteristics of the image. Overall, CNNs are powerful tools for processing image data and extracting meaningful insights from it.

Analysis:

The Cats and Dogs dataset consists of 25,000 images of cats and dogs. Images are trained using the convolution network to predict the test images.

Model	Training from scratch			Pretrained Model		
Performance Metric	Accuracy	Validation Loss	No. of epochs	Accuracy	Validation Loss	No. of epochs
Initial Model (Training=1000, Validation=500, Test=1000)	72.3%	1.80	30	96.5%	4.92	30
Data Augmentation (Training=2000, Validation=500, Test=1000)	83.9%	2.19	60	48.3%	0.69	20
Increased Training Data (Training=2500, Validation=500, Test=500)	91.7%	2.34	30	-	-	-
Optimal Training Data (Training=2500, Validation=500, Test=500)	96.9%	4.92	30	96.5%	0.69	5

When training a neural network from scratch, the model's weights are initially assigned randomly and are gradually updated during the training process. However, to achieve good performance, a large and high-quality labeled dataset is required. For example, an initial model built from scratch on a dataset resulted in an accuracy of 72.3% and a validation loss of 1.80.

Alternatively, a pre-trained neural network model can be used for similar but smaller datasets. In this approach, the weights of a model trained on a large dataset are downloaded and used as a starting point for training on the smaller dataset. This approach improves the performance of the model and reduces overfitting because the model has already learned useful features from the larger dataset that can be leveraged for the smaller dataset. This approach also saves time and computational resources since the model does not need to be trained from scratch. For instance, an initial model built using a pre-trained neural network on a smaller dataset resulted in an accuracy of 96.5% and a validation loss of 4.92, which is a significant improvement over the model trained from scratch.

Data Augmentation

After further training, the test accuracy for the network trained from scratch increased to 83.9%, and the validation loss decreased to 2.19. On the other hand, for the pre-trained network, the test accuracy improved to 48.3%, but the validation loss increased to 0.69. This could be due to the fact that during the training process, various transformations such as rotating, flipping, and zooming are performed on each image, creating new forms of the original data. This helps the model learn more robust features and improve its overall performance while reducing overfitting.

However, in the case of the pre-trained network, the increase in validation loss could be attributed to the introduction of noise during the data augmentation process, leading to the overfitting of the model. Despite this, the overall improvement in test accuracy suggests that the model has learned useful features that are transferable to the new dataset, which is a significant advantage of using pre-trained networks over building a model from scratch.

Training sample Increment

A CNN performs better when the training sample size is increased because it learns more data and can identify more underlying patterns in it. Therefore, it is evident that Test accuracy has grown to 91.7% in the network. In this instance, the validation loss increased to 2.34 in the network that was trained from scratch and to 0.04 in the pre-trained network.

Optimal training Sample

Increasing the size of the training dataset tends to improve the performance of the model. However, after a certain point, the performance of the model tends to become stable even with additional samples. This occurs because the model has already learned all the robust features it needs, and the addition of new samples does not provide much new information that can improve its performance.

After testing the model with various training sample sizes, it was found that the best sample size for both networks is 4000. For the network trained from scratch, this resulted in an accuracy of 96.9% and a validation loss of 4.92. On the other hand, the pre-trained network achieved a test accuracy of 96.5% and a validation loss of 0.69, indicating that the transfer learning approach resulted in a much more accurate and efficient model.

Conclusion

After comparing the performance of the network trained from scratch and the pre-trained network, it is evident that the pre-trained network is the better model. Although increasing the size of the training dataset may improve the accuracy of the model, it can also lead to an increase in validation loss.

Data augmentation works well for the training from the scratch network, but it does not necessarily improve the performance of the pre-trained network. Therefore, the best approach would be to use the pre-trained network with an increased training dataset. This approach requires a smaller number of epochs, making it a more efficient and accurate model.