# Convolution Neural Networks

## Summary:

The Cats and Dogs dataset comprises 25,000 images featuring both cats and dogs. These images are being utilized to train a convolutional neural network for the purpose of predicting test images. This report includes an analysis of the performance of different Convolutional Neural Networks (CNNs) models built from scratch with different training sample sizes. Followed by the analysis of the performance of different CNN models built using pre-trained models with different training sample sizes. In addition to the different sample sizes, CNN models built from scratch and built using pre-trained models are built using the augmented data.

## Introduction:

Convolutional Neural Networks (CNNs) are a class of deep-learning neural networks used for image classification and recognition i. They take in an input image, assign importance to various objects in the image, and differentiate one from the other. CNNs are feedforward neural network that learns feature engineering through filters or kernel optimization. Using regularised weights over fewer connections prevents vanishing and exploding gradients during backpropagation in neural networks. Convolutional Neural Networks (CNNs) require less pre-processing than other image classification algorithms. It implies that the network can learn how to optimize the filters or kernels through automated learning. The ability of CNNs to independently extract features without prior knowledge or human intervention is a significant advantage.

Convolutional networks were inspired by the organization of the animal visual cortex, as the connectivity pattern between neurons resembles biological processes.

## Observations and Analysis

This analysis includes an overview of the Convolutional Neural Network (CNN) models that have been developed and evaluated. The primary focus of the analysis is on the performance metrics, and the impact of training sample size.

Initially trained a set of models from scratch using a sample size ranging from 1000 to 4000 and the results of the models on the test datasets are displayed in Table 1. The first model, trained with 1000 samples, achieved an accuracy of 69.3% with a validation loss of 0.59 after 30 epochs. The model with an increased sample size of 2000 and data augmentation showed a significant accuracy improvement to 80.9% with a validation loss of 0.44. In the third model, the training sample size is increased to 2000 but without data augmentation, exhibiting an accuracy of 69.5% and a validation loss of 0.59. Two models were trained with sample sizes of 3000 and 4000 respectively, resulting in accuracies of 69.9% and 73.4%, and validation losses of 0.57 and 0.56.

By leveraging the pre-trained models and variations in training sample size, multiple CNNs are built, and Table 2 has all the results of the models on the test dataset. The initial pre-trained model, with 1000 samples, achieved 97% test accuracy but had a high validation loss of 5.26. The subsequent model, incorporating data augmentation with 2000 samples, boosted the test accuracy to 97.6% while significantly reducing the validation loss to 2.13. A model with 2,500 training samples showed a test accuracy of 97.4% but a higher validation loss of 5.75. With 3000 samples, the model achieved a test accuracy of 97.5% and a validation loss of 5.9. The model, with 4000 training samples, maintained a high-test accuracy of 97.1% and achieved a lower validation loss of 4.8.

**Table 1: CNNs built using Training from scratch.**

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| --- | --- | --- | --- | --- |
| **Models /**  **Performance Metrics** | **Training Model from Scratch** | | | |
| **Training sample size** | **Accuracy (%)** | **Validation loss** | **epochs** |
| Initial Model | 1000 | 69.3 | 0.59 | 30 |
| Model Adding  Data Augmentation | 2000 | 80.9 | 0.44 | 100 |
| Model with Increased Training sample size | 2000 | 69.5 | 0.59 | 30 |
| Model with Increased Training sample size | 3000 | 69.9 | 0.57 | 30 |
| Model with Increased Training sample size | 4000 | 73.4 | 0.56 | 30 |

**Table 2: CNNs Built using the pretrained Model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Models /**  **Performance Metrics** | **Pretrained Model** | | | |
| **Training sample size** | **Test Accuracy (%)** | **Validation loss** | **epochs** |
| Initial Model | 1000 | 97.0 | 5.26 | 20 |
| Model Adding  Data Augmentation | 2000 | 97.6 | 2.13 | 50 |
| Model with Increased Training sample size | 2500 | 97.4 | 5.75 | 20 |
| Model with Increased Training sample size | 3000 | 97.5 | 5.9 | 20 |
| Model with Increased Training Sample Size | 4000 | 97.1 | 4.8 | 20 |

## Conclusion

These results provide valuable insights into the impact of training sample size and data augmentation on model performance. For the models trained from scratch, it was observed that the model trained with 2000 samples, combined with data augmentation, exhibited the highest accuracy at 80.9%. This emphasizes the importance of a sufficiently large and diverse training dataset in enhancing model performance.

The pre-trained models, on the other hand, showcased an even more impressive performance. Even with a base sample size of 1000, the test accuracy was as high as 97%, demonstrating the advantage of leveraging pre-trained models. Furthermore, data augmentation further enhanced accuracy, with a test accuracy of 97.6% and significantly reduced validation loss of 2.13 for the 2000-sample model.

Overall based on the results obtained in the analysis the pre-trained models coupled with data augmentation offer the best performance compared to the models built from scratch. They offer a best balance between accuracy and generalization.

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