# Assignment 1

Convolutional Neural Networks (CNNs) are specialized artificial neural networks used for image recognition and computer vision tasks. They work by applying filters to images to identify and highlight different features, making them highly effective for analysing visual data.

The assignment conducts an experiment using the Cats and Dogs dataset, which contains 25,000 images. The project compares the performance of CNN models trained from scratch with those using pre-trained models across various configurations, including initial models, data augmentation, increased training data, and optimal training data setups. Additionally, it elaborates on specific experiments involving training a network from scratch versus using a pre-trained network, with and without augmentation.

| **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=500)** | 75.6% | 1.64 | 30 | - | - | - |
| **Data Augmentation (Training=1000, Validation=500, Test=500)** | 78.5% | 0.66 | 60 | 98.4% | 1.93 | 30 |
| **Increased Training Data (Training=2000, Validation=500, Test=500)** | 87.4% | 0.38 | 30 | 96.9% | 2.48 | 30 |
| **Optimal Training Data (Training=2500, Validation=500, Test=500)** | 89.7% | 0.36 | 30 | 98.3% | 0.23 | 20 |

**Key findings include:**

- Training from Scratch: Initially, a model with five convolutional layers, four max-pooling layers, and one dense layer was trained from scratch, with a training sample of 1000, a validation sample of 500, and a test sample of 500. Techniques like dropout were employed to reduce overfitting, achieving an accuracy of 75.6% (as mentioned in the table) and later dropping due to overfitting despite efforts like data augmentation and early stopping.

- Pre-trained Network Use: Switching to a VGG16 pre-trained model, with the convolutional layers' weights frozen and a dense layer added, significantly improved performance. The validation accuracy improved to 97.2% with the initial model and slightly increased with further tuning and augmentation.

- Impact of Augmentation and Fine Tuning: Introducing data augmentation and fine-tuning strategies to the pre-trained network further enhanced the accuracy, achieving up to 99.6% in optimal configurations.

- Relationship between Training Sample Size and Network Choice: Increasing the training sample size generally enhances model performance. However, the use of pre-trained models demonstrates a significant advantage when the available dataset is not extensive, achieving high accuracy with fewer samples. This suggests that the choice of network—whether to train from scratch or use a pre-trained model—is closely tied to the size and quality of the training dataset.

- Data Augmentation: Initially had a mixed impact on models trained from scratch but consistently improved the performance of pre-trained networks, indicating its value in making models more robust against overfitting.

- Training from Scratch vs. Pre-trained Models: The experiment highlights the substantial performance gap between networks trained from scratch and those utilizing pre-trained models. Pre-trained models, especially when fine-tuned and augmented, far outperform models trained from scratch in accuracy and efficiency, demonstrating the effectiveness of transfer learning in leveraging pre-existing knowledge for new tasks.

In conclusion, the document underscores the superiority of using pre-trained models for tasks with smaller datasets. Pre-trained models not only achieve higher accuracy but also require fewer resources and training time, making them a more practical choice for image recognition tasks. The relationship between training sample size and the choice of network is crucial, with pre-trained models providing a significant advantage by leveraging learned features from larger datasets, thereby reducing the need for large training samples.

## Graph Visualization: