# Assignment-3

# CONVOLUTION NETWORKS

# BA- 64061 ADVANCED MACHINE LEARNING

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# ASSIGNMENT-3 CONVOLUTION NETWORKS

# Cats vs Dogs Image Classification

## Introduction

Image classification is one of the basic computer vision and deep learning tasks. This project is focused on the development of a Convolutional Neural Network (CNN) for cat vs dog image classification. The utilized dataset is a reduced sample of the popular Cats vs Dogs dataset. This is a binary classification task and represents a great chance to explore the ability of CNNs in image recognition. The goal is to preprocess the image data, create a CNN, train the model, evaluate its performance, and visualise some key metrics.Dataset

# Description

The dataset contains labeled images of dogs and cats. For the project, a smaller subset is taken, which includes:

- 2,000 training images (1,000 dogs and 1,000 cats)

- 1,000 validation images (500 cats and 500 dogs)

- 1,000 test images (500 cats and 500 dogs)

The images were put in folders by class and then split into training, validation, and test sets.

## Data Preprocessing

The image data is preloaded by TensorFlow with the `image\_dataset\_from\_directory` function. The images are resized to 180x180 pixels. A batch size of 32 is used for efficient training. Simple data normalization is employed to normalize pixel values in the range 0 to 1. Horizontal flip, rotation, and zoom are a few of the data augmentation techniques employed to enhance generalization abilities of the model and prevent overfitting.

## Model Architecture

The CNN model is built using TensorFlow Keras API and includes the following layers:

- Convolutional layers (Conv2D) for feature extraction

- MaxPooling layers for reducing spatial dimensions

- Flatten layer to convert 2D matrices to a 1D vector

- Dense (fully connected) layers for classification

ReLU activation function is used in hidden layers, and Sigmoid is used in the output layer for binary classification.  
  
A collage of a cat

AI-generated content may be incorrect.

## Training and Evaluation

The model is compiled with the Binary Crossentropy loss function and the Adam optimizer. Training was performed on multiple epochs with real-time validation. Performance was measured by accuracy and loss functions on both the training and validation datasets. Early stopping and dropout layers can be considered for further improvements.  
  
Insights  
  
The plots of training and validation accuracy and loss are as follows. The observations are that the model is learning well, with both the measures of accuracy improving steadily. Validation accuracy lags behind training accuracy by a very small margin, which suggests mild overfitting, but data augmentation resolves the problem.

A graph with blue lines

AI-generated content may be incorrect.A graph of a training loss

AI-generated content may be incorrect.

A graph of a line graph

AI-generated content may be incorrect. A graph of a line graph

AI-generated content may be incorrect.

## Model Performance

The last model achieves a highly accurate classification, indicating that it has learned effectively to distinguish between dogs and cats. The training and validation loss is very low, indicating that the model is not overfitting excessively. Testing on fresh data confirms the robustness of the trained model.

Future Improvements  
  
To further enhance the model, the following steps can be taken:

- Utilizing transfer learning from VGG16 or ResNet pre-trained models

- Application of advanced data augmentation and regularization techniques

- Hyperparameter tuning for optimizer, learning rate, and batch size

- Augmenting the dataset for generalization  
  
Conclusion  
This project demonstrates the efficient application of Convolutional Neural Networks to a problem of binary image classification. With appropriate preprocessing, architecture choice, and training, the model can effectively distinguish between cats and dogs with an impressive level of accuracy. The methods employed here may be applied to other computer vision problems as well, and thus CNNs prove to be a powerful tool in the case of deep learning.