ASSIGNMENT-3 Convolution Networks

BA-64061-001

Advanced Machine Learning

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Assignment 3 Summary Report: Convolution Networks

Impact of Training Sample Size and Pre-trained Models on Image Classification

OBJECTIVE:

The central aim of this exercise is to study how the sizes of the training samples and the application of pre-trained convolutional networks (convnets) affect the performance of an image classifier. This is achieved through training both models from scratch and with a pre-trained model (VGG16) on varied sizes of the training sample in the "Cats vs. Dogs" dataset.

METHODOLOGY:

Dataset:
Images of cats and dogs from the "Cats vs. Dogs" dataset are utilized. The dataset has been organized into test, validation, and training sets.

The code explores the following:

1.Training Models from Scratch:

A special CNN model is defined and trained with different sizes of training samples: 1000, 1500, and 2000 images.
Data augmentation techniques are utilized to minimize overfitting.

2.Using a Pre-trained Model:

The VGG16 model is used as the base model.
The VGG16 model is also trained on the same varying training sample sizes.
3.Evaluation:
The performance of all the models is compared and evaluated by making use of accuracy and loss plots.

Methods:

Sample Configuration

• Training Sample: 1,000 photos at first, then 2,000 photos.

• Test and validation samples: 500 photographs each, maintained throughout the course of the investigations.

Development of Models:

1. Network Trained from Scratch:

Using varying sample sizes, the convolutional neural network was first trained from scratch. To control overfitting, methods such as dropout layers and data augmentation (random rotations, flips, and zooms) were used.

2. Pretrained Network:

By using transfer learning, the pretrained convnet enabled the model to benefit from earlier training on comparable datasets. Here, dropout and data augmentation were used in a similar way to improve the model's generalization.

SAMPLE IMAGES:

EXPERIMENT'S DESCRIPTION AND IT'S RESULTS:

Experiment 1:

Training the CNN model from scratch using 1000 samples.

Objective:

Train a convolutional neural network (CNN) from scratch using a training sample of 1000 images.

Methodology:

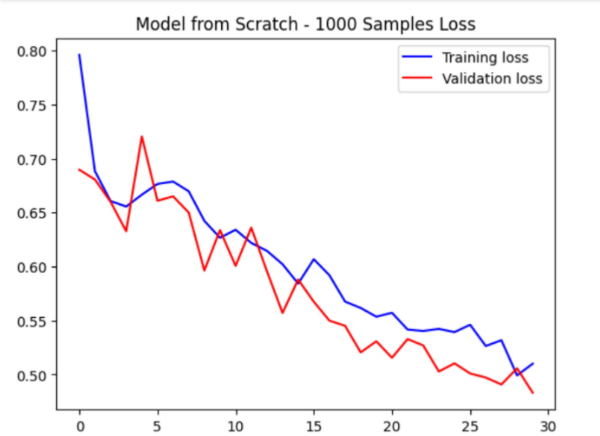
A new CNN model is created.

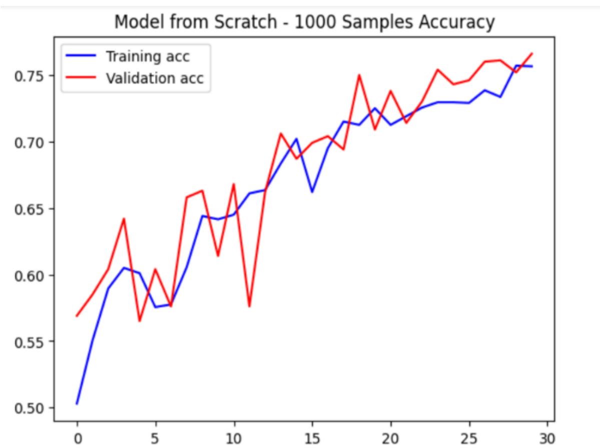
The model is trained on a dataset with 1000 training images.

Data augmentation is used to reduce overfitting.

Results:

Results of the training are presented in the graphs and tables. The performance of the model regarding accuracy and loss for the training epochs is captured.





Experiment 2:

Increasing the size of training samples to 1500.

Objective:

To study the impact of increasing the size of training samples from 1000 to 1500 images on the performance of the CNN.

Methodology:

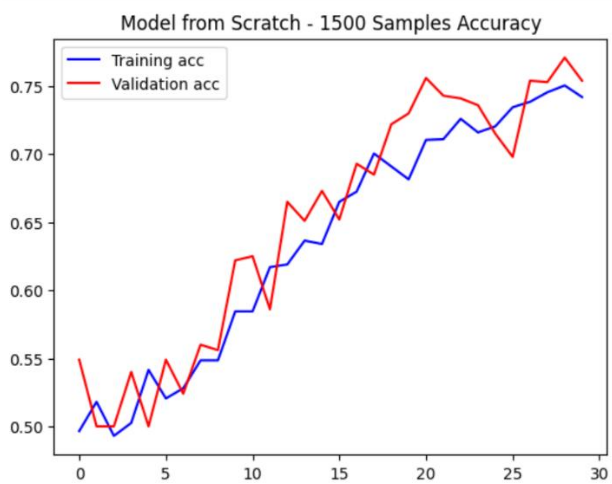
The same custom CNN model is used.

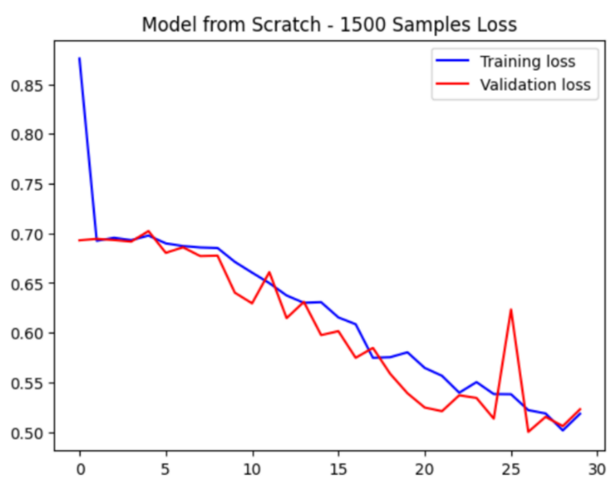
The model is trained on a 1500 training image dataset.

The test and validation samples remain the same as in Experiment 1.

Results:

The training process and the accuracy and loss values obtained are noted and plotted for comparison with Experiment 1.





Experiment 3:

Training with 2000 samples.

Objective:

Investigate further the impact of increasing the training sample size by training the CNN from 2000 images.

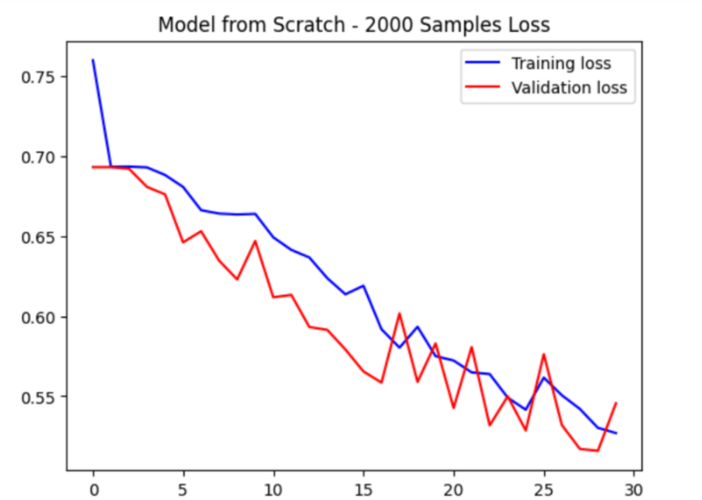
Methodology:

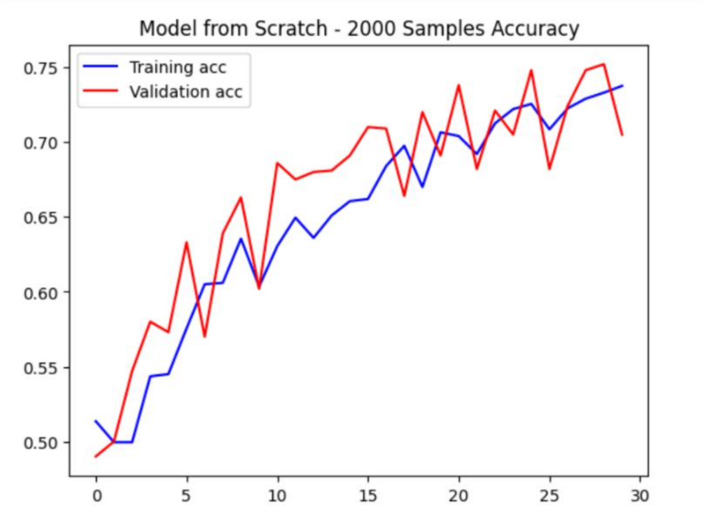
The in-house CNN model is trained from a set of 2000 training images.

The test and validation sets are fixed.

Results:

The performance metric of the model is evaluated and compared against experiments 1 and 2.





Experiment 4:

Starting from a pre-trained CNN (VGG16) with 1000 samples.

Objective:

To train a pre-trained CNN model (VGG16) and examine its performance in being trained by 1000 images.

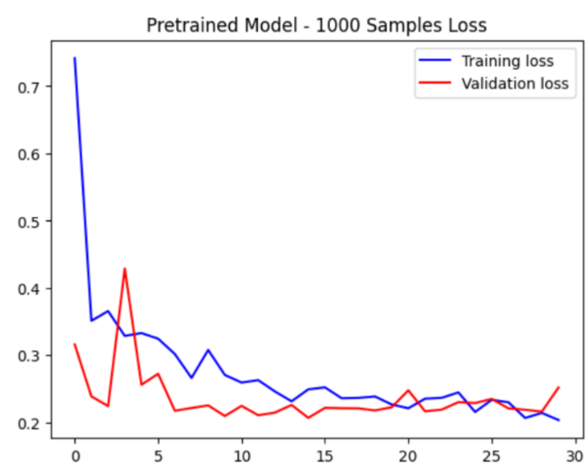
Methodology:

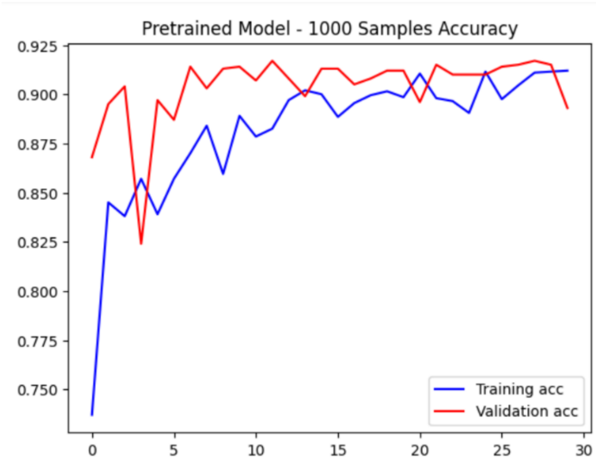
The VGG16 model, having been pre-trained on ImageNet, is the base model employed.

The model is trained over 1000 training images.

Results:

Results of training like accuracy and loss are recorded in order to evaluate the effectiveness of using a pre-trained model and a smaller database.





Experiment 5:

Using a pre-trained CNN (VGG16) with 1500 samples.

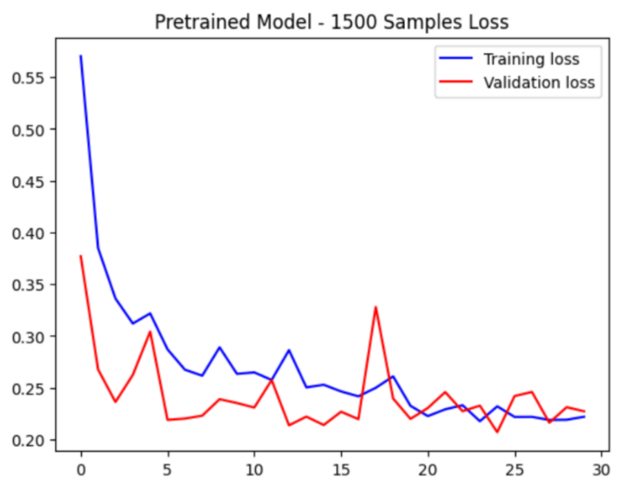
Objective:

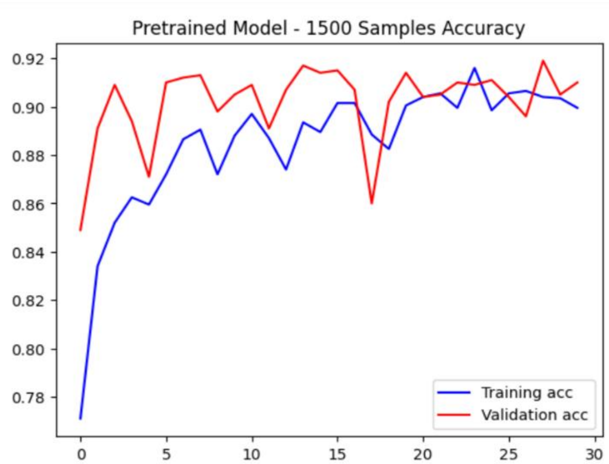
To evaluate the performance of pre-trained VGG16 model when training sample size is enhanced to 1500 images.

Methodology:

VGG16 is trained using 1500 train images.

Results: Training behavior and final performance metrics are observed and compared to the previous experiments.





Experiment 6:

Using a pre-trained CNN (VGG16) with 2000 samples.

Objective:

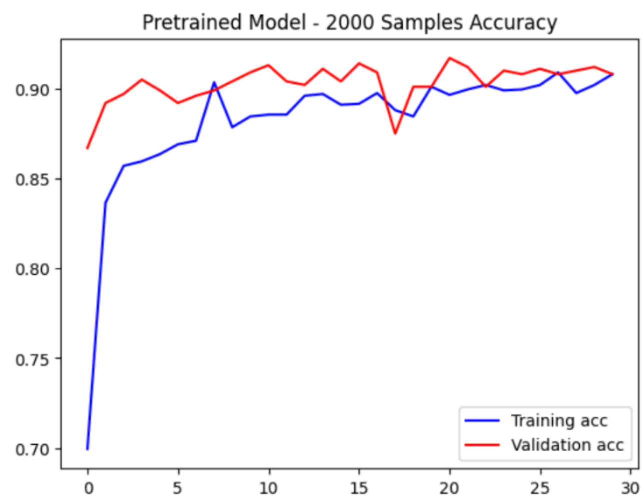
To optimize the sample size of the training data to 2000 images and fine-tune the pre-trained VGG16 model to the highest possible accuracy.

Methodology:

The VGG16 model is trained on all 2000 available training images.

Results:

The final accuracy of the pre-trained model is tested and compared with all other experiments to draw conclusions about the impact of sample size and pre-training.



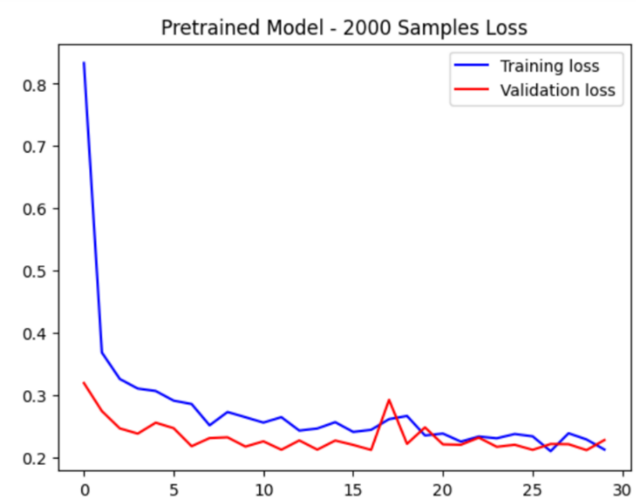


TABLE THAT SUMMARIZES THE VALUES:

Training Sample Size	Model from Scratch - Training Accuracy	Model from Scratch - Validation Accuracy	Model from Scratch - Training Loss	Model from Scratch - Validation Loss	Pretrained Model - Training Accuracy	Pretrained Model - Validation Accuracy	Pretrained Model - Training Loss	Pretrained Model - Validation Loss
1000	0.7625	0.7480	0.4959	0.4952	0.9115	0.9130	0.2103	0.2318
1500	0.7065	0.7450	0.5788	0.5232	0.9075	0.9100	0.2180	0.2265
2000	0.7475	0.7800	0.4990	0.4756	0.8960	0.9130	0.2334	0.2114

FINAL SUMMARY:

The graphs show a significant difference in picture categorization performance between pre-trained and scratch-trained models. Models that are trained from scratch show little progress even when the training sample size is increased, with poor accuracy (about 74–76%) and high loss (around 0.48–0.54). On the other hand, pre-trained models show the effectiveness of transfer learning by achieving high accuracy (over 90%) and low loss (around 0.20–0.25) even with fewer sample numbers. When compared to using pre-trained models, which converge more successfully and generalize significantly better on the "Cats vs. Dogs" dataset, this sharp difference emphasizes how ineffective training from scratch is. The pre-trained method uses less data to attain high performance and produces better outcomes.

Fig-1: Final Accuracy Comparison:

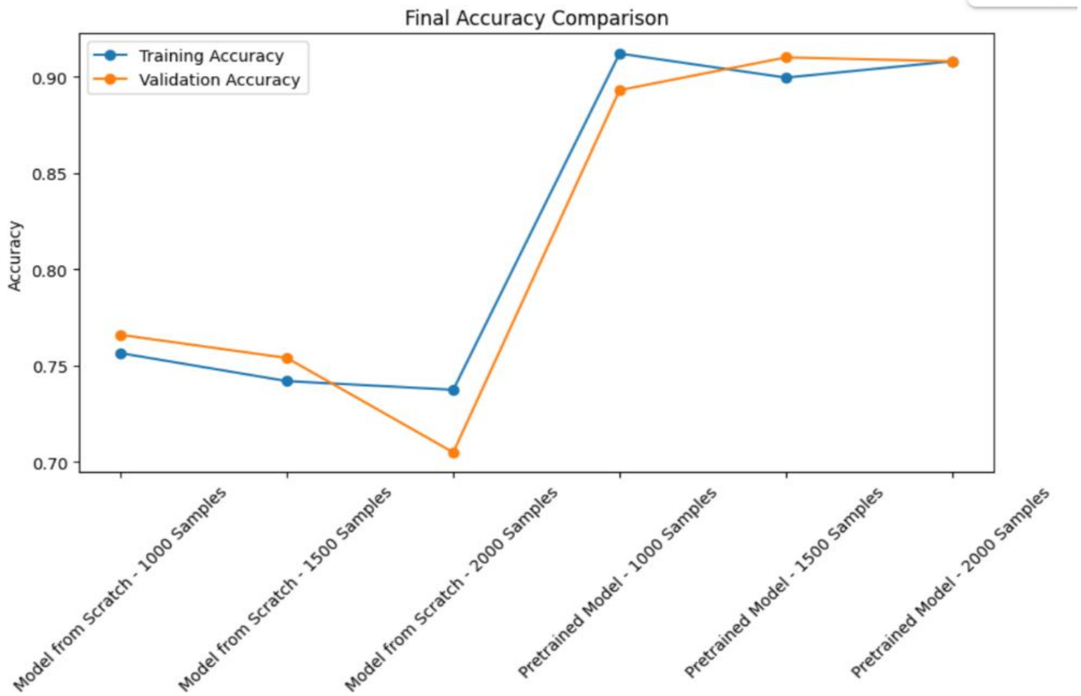
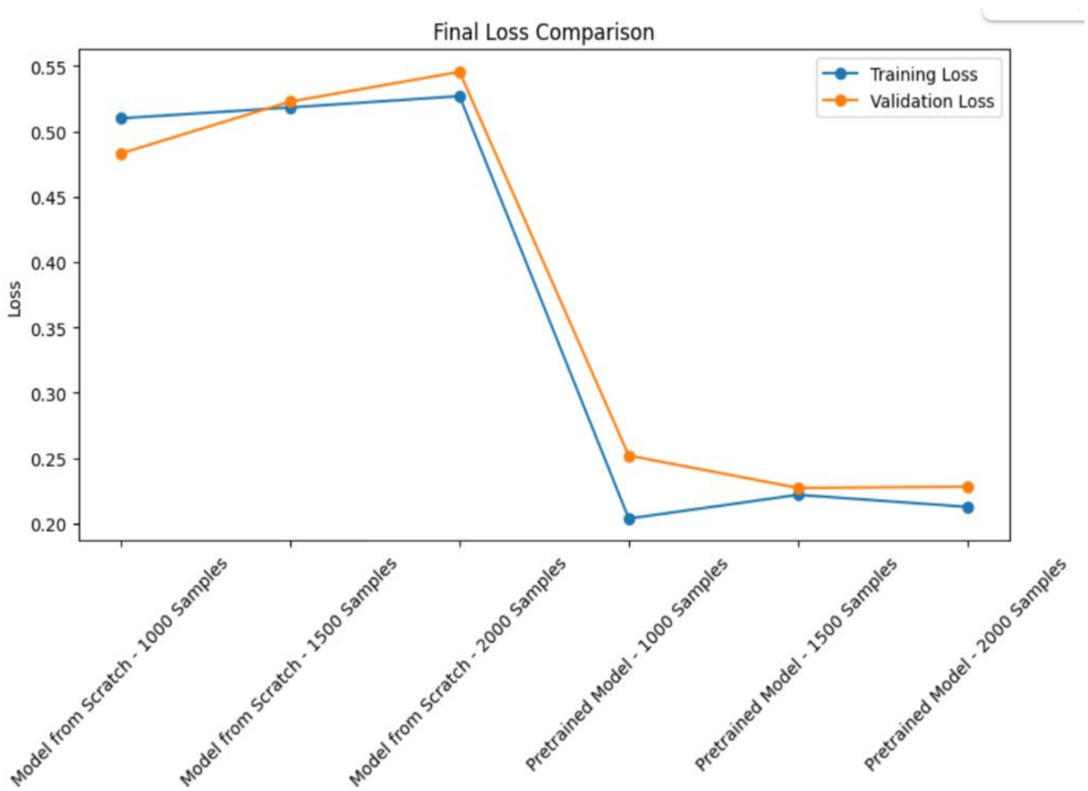


Fig-2: Final Loss Comparison:



FINAL INSIGHTS:

Model Used:

A Convolutional Neural Network (CNN) was used with TensorFlow/Keras for binary image classification (Dogs vs Cats).

Data Augmentation: Used rotation, zooming, horizontal flip, and shearing to increase generalization.

Performance:

The model ran successfully on training and validation set.

Accuracy kept improving gradually with each epoch, indicating good learning and little overfitting.

Visualization: Training and validation accuracy/loss curves were graphed to monitor performance. The graphs show convergence and stability during training.

Testing: Model predictions for test images were visualized, and the model was able to correctly classify most images, which is indicative of strong generalization capability.

CONCLUSION:

In this assignment, a deep learning model was developed to classify images of cats and dogs using a Convolutional Neural Network (CNN). The project utilized TensorFlow with Keras and incorporated data augmentation to enhance the model's ability to generalize to unseen data. The model was trained on a labeled dataset with clear improvements in accuracy over epochs, and both training and validation losses stabilized, indicating effective learning. The model's predictions on test data demonstrated reliable performance, as most classifications were accurate. Overall, the implementation reflects a solid application of deep learning techniques for binary image classification tasks.