**Report: Analysis of Training Sample Size and Network Choice in Image Classification**

# Introduction

This report presents a comparative analysis of two image classification models—Scratch Model and Pretrained Model—utilized in a cats vs. dogs classification task. The primary objective is to understand the relationship between training sample size and the performance of the models based on various metrics including training accuracy, training loss, validation accuracy, and validation loss.

# Dataset and Methodology

The analysis was conducted using a dataset of images categorized into two classes: cats and dogs. The dataset was divided into four sample sizes: 1000, 1500, 2000, and 2500 images. Each model was trained on these sample sizes, and their performances were evaluated using metrics such as accuracy and loss for both training and validation datasets.

# Model Descriptions

1. Scratch Model: A custom Convolutional Neural Network (CNN) built from scratch with multiple convolutional layers, pooling layers, and regularization techniques to mitigate overfitting.

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| --- | --- | --- | --- | --- |
| **Dataset Size** | **Train**  **Accuracy** | **Train Loss** | **Val**  **Accuracy** | **Val Loss** |
| 1000 | 0.6031 | 0.6989 | 0.6125 | 0.6855 |
| 1500 | 0.5944 | 0.6719 | 0.6 | 0.6697 |
| 2000 | 0.61 | 0.659 | 0.6204 | 0.6581 |
| 2500 | 0.6222 | 0.6415 | 0.632 | 0.6419 |

1. Pretrained Model: A transfer learning approach using the ResNet50 architecture, pretrained on the ImageNet dataset, which allows for leveraging learned features from a large dataset.

# Performance Metrics

The performance of both models across different sample sizes is summarized in the tables below:

# Scratch Model Performance

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| --- | --- | --- | --- | --- |
| **Dataset Size** | **Train**  **Accuracy** | **Train Loss** | **Val**  **Accuracy** | **Val Loss** |
| 1000 | 0.6432 | 5.0321 | 0.4921 | 5.8759 |
| 1500 | 0.6559 | 4.882 | 0.5033 | 5.7566 |
| 2000 | 0.6702 | 4.721 | 0.5102 | 5.6421 |
| 2500 | 0.6825 | 4.5698 | 0.519 | 5.5263 |

# Pretrained Model Performance

**Analysis of Findings** 1. Scratch Model:

* The training accuracy improved steadily with increasing dataset sizes, indicating that the model benefits from more training data.
* Validation accuracy also showed a gradual increase, albeit at a slower rate than training accuracy, which suggests some overfitting as the model becomes more complex with larger datasets.

2. Pretrained Model:

* The pretrained model exhibited lower training accuracy compared to the scratch model across all sample sizes. However, it achieved consistently higher validation accuracy.
* The validation loss was significantly lower than that of the scratch model, suggesting better generalization to unseen data, which is a crucial factor in model evaluation.

# Relationship Between Training Sample Size and Choice of Network

* Training Sample Size: As the training sample size increased, both models demonstrated improved training accuracy and reduced loss. However, the improvement was more pronounced in the Scratch Model, which suggests that it is more sensitive to the amount of training data available.
* Choice of Network: The choice of network greatly influenced performance metrics. The Scratch Model showed a tendency to overfit with larger datasets, while the Pretrained Model managed to generalize better despite its lower training accuracy. This indicates that for image classification tasks, especially with limited data, pretrained models often provide a significant advantage in terms of validation performance.

# Conclusion

The findings highlight the importance of both training sample size and network choice in achieving optimal model performance. While increasing the sample size generally enhances training outcomes, the choice of a pretrained model can significantly improve generalization capabilities, as observed in the validation metrics. Future work should explore deeper architectural modifications and different regularization techniques to further enhance the performance of the Scratch Model while leveraging the benefits of transfer learning in the Pretrained Model.