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Short Report on Image Classification Using Deep Learning

1. Introduction

This project focuses on classifying natural scene images into six categories using a deep learning model. The dataset, originally published by Intel, consists of 25,000 images labeled into the following classes:

- Buildings
- Forest
- Glacier
- Mountain
- Sea
- Street

The objective is to develop a model that can accurately classify images into these categories using Convolutional Neural Networks (CNNs).

2. Process and Methodology

Data Acquisition and Preprocessing

- The dataset is downloaded from Kaggle and stored in a local directory.
- Images are resized to 150x150 pixels for uniform processing.
- Data is split into training (14k images), testing (3k images), and prediction (7k images) sets.
- Image normalization is performed to scale pixel values between 0 and 1.
- Data augmentation techniques like rotation, flipping, and zooming are applied to improve model generalization.

Model Implementation

- A Convolutional Neural Network (CNN) is used for classification.
- The architecture consists of:
    - Convolutional layers with ReLU activation to extract image features.
    - MaxPooling layers to reduce dimensionality and prevent overfitting.
    - Fully connected (Dense) layers for final classification.

    - Softmax activation in the output layer to predict class probabilities.
- The model is trained using the Adam optimizer and categorical cross-entropy loss function.

3. Results and Findings

- **Accuracy**: 84.9% – This indicates that 84.9% of the model's predictions are correct. While this is a strong result, there's room for improvement, especially if the goal is to achieve near-perfect performance or to handle more complex data.
- **Precision**: 85.2% – This shows that when the model predicts a positive class, it is correct 85.2% of the time. A higher precision value is generally better but balancing it with recall is important.
- **Recall**: 84.9% – This indicates that 84.9% of the actual positives were correctly identified by the model. Recall focuses on how well the model detects all relevant instances of a class, so this value is strong, but it can be improved in cases where false negatives are critical.
- **F1-Score**: 84.9% – The F1-Score is a harmonic mean of precision and recall, showing a balance between both. A score of 0.849 suggests the model is relatively well-balanced, but improvement is still possible.

4. Conclusion and Future Improvements

- The CNN-based model effectively classifies natural scene images with good accuracy.
- Future improvements could include:
    - Using a deeper architecture like ResNet or VGG for better feature extraction.
    - Fine-tuning a pre-trained model to leverage existing knowledge.
    - Incorporating more advanced augmentation techniques to improve generalization.