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Link to Code : https://colab.research.google.com/drive/1vCX7WkJ_ivc7CFgOYkDPLqU1E1GX08Ol?usp=sharing

Deep Learning-Based Image Processing for Cat and Dog Classification

This project addresses the classification of cat and dog images using a Convolutional Neural Network (CNN) optimized through Optuna. By automating hyperparameter tuning, we systematically explore different configurations to maximize performance. Our dataset is balanced, preprocessed (images resized to 128×128, converted to RGB, and normalized), and split into training and validation sets.

Data Processing & Feature Selection

Images are first extracted from ZIP files and organized into training and testing directories. Each image is resized to 128×128 pixels, converted to RGB, and normalized to the [0,1] range. These preprocessing steps ensure uniform input and faster convergence during training. To prevent bias, undersampling is applied to balance the number of cat and dog images. A feature correlation heatmap is generated to verify that preprocessing maintains the data structure.

Modeling & Optuna Hyperparameter Optimization

We experimented with several CNN architectures and selected the best model based on precision, crucial for minimizing false positives. Our CNN comprises three convolutional blocks—each with Conv2D, BatchNormalization, LeakyReLU activation, MaxPooling, and Dropout layers—followed by GlobalAveragePooling2D and a dense output layer with sigmoid activation. Optuna is employed to automatically tune key hyperparameters (learning rate, LeakyReLU alpha, L2 regularization, filter sizes, dense units, dropout rates) over 20 trials, each trained for 50 epochs.

```
study = optuna.create_study(direction='maximize', study_name='CNN Optimizer')
study.optimize(objective, n_trials=20)
```

The best configuration was chosen based on the highest F1 score on the validation set.

Model Evaluation & Results:

The optimized CNN was evaluated using accuracy, precision, recall, and F1 score. Training and validation curves (loss and accuracy) were plotted to monitor convergence. The final model achieved high validation

accuracy with balanced precision and recall, confirming its robustness.

	training_accuracy	validation_accuracy	train_val_acc_diff	precision	recall	f1_score	confusion_matrix
CNN	0.67625	0.6725	0.00375	0.64876	0.773399	0.705618	[[112, 85], [46, 157]]

Conclusion

My approach, combining deep learning with automated hyperparameter tuning via Optuna, robustly classifies cats and dogs. The final CNN, selected based on the best F1 score from 20 models (50 epochs each), outperforms simpler architectures and offers a strong baseline for future improvements such as data augmentation and transfer learning.