

Comparative Analysis of CNN Architectures: FungiCLEF, AnimalCLEF, and PlantCLEF (CLEF 2025)

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Introduction to the Project



Objective

Compare DenseNet121, Inception v3, and a Custom CNN on FGVC tasks.



Datasets

FungiCLEF, AnimalCLEF, and PlantCLEF, covering diverse species and image types.



Goal

Evaluate trade-offs in accuracy, generalization, and efficiency among the models.

Datasets Overview

- **FungiCLEF:** 7,819 training images and 2,427 classes; includes metadata such as habitat, GPS, and toxicity.
- **AnimalCLEF:** Wildlife re-ID for 3 species, emphasizing identification of individual animals.
- **PlantCLEF:** 1.4M images across 7.8k species; large-scale and multi-label classification with metadata.



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Related Work



Wei et al. (CVPR 2021)
Introduced Progressive Transfer Learning to enhance FGVC by leveraging hierarchical category information.



Zhao et al. (ECCV 2020)
Developed MetaFGNet, a method designed to handle noisy labels in fine-grained classification tasks.



Horn et al. (BMVC 2018)
Established iNaturalist baselines, highlighting challenges of large-scale fine-grained classification.

Model Architectures



DenseNet121

Pretrained with dense connections that improve gradient flow and feature reuse.



Inception v3

Employs auxiliary classifiers and multi-scale feature extraction for enhanced performance.



Custom CNN

Constructed with 3 convolutional layers, dropout regularization, and 2 fully connected layers.

Preprocessing & Training Setup



Input Sizes

224 for DenseNet121, 299 for Inception v3, and 150 for Custom CNN.



Normalization

Applied using ImageNet mean and standard deviation to standardize inputs.



Optimizer & Loss

Adam optimizer with lr=0.001, using CrossEntropy Loss function.



Evaluation Metrics

Models assessed based on Accuracy and Validation Loss for performance comparison.

Results Summary: Accuracy & Validation Loss

Dataset	Model	Accuracy (%)	Validation Loss
FungiCLEF	DenseNet121	82.2	0.14
	Inception v3	80.5	4.78
	Custom CNN	73.8	0.95
AnimalCLEF	DenseNet121	98.9	0.73
	Inception v3	99.1	1.50
	Custom CNN	92.0	4.57
PlantCLEF	DenseNet121	82.0	0.45
	Inception v3	82.0	0.47
	Custom CNN	86.5	0.36

Results Summary: Accuracy & Validation Loss



FungiCLEF

DenseNet121 leads with 82.2% accuracy and 0.14 validation loss, outperforming others.



AnimalCLEF

Inception v3 slightly outperforms DenseNet121 with 99.1% accuracy; Custom CNN shows reduced loss.



PlantCLEF

Custom CNN surprisingly achieves top accuracy at 86.5%, despite lower validation loss than Inception.

Challenges in FGVC for Biodiversity



Label Noise

Crowdsourced datasets often contain mislabeled images, impacting training effectiveness.



Class Imbalance

Significant variation in class representation skews model learning.



High Inter-class Similarity

Species often appear visually similar, complicating fine-grained classification.



Incomplete Labels

Missing or partial test labels reduce the validity of evaluation metrics.

Future Work

- **Vision Transformers:** Explore the use of ViTs for improved attention mechanisms in fine-grained tasks.
- **Metadata Fusion:** Combine image features with metadata (e.g., GPS, taxonomy) to enhance prediction.
- **Self-supervised Learning:** Leverage unlabeled quadrat data for pretraining models more robustly.
- **Real-time Systems:** Develop models optimized for real-time deployment in ecological monitoring.



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THANK YOU