



UNDERGRADUATE THESIS

COMPARATIVE ANALYSIS OF CROSS-ENTROPY LOSS AND FOCAL LOSS FUNCTIONS IN HANDLING DATA IMBALANCE FOR CORN LEAF DISEASE CLASSIFICATION USING DENSENET121

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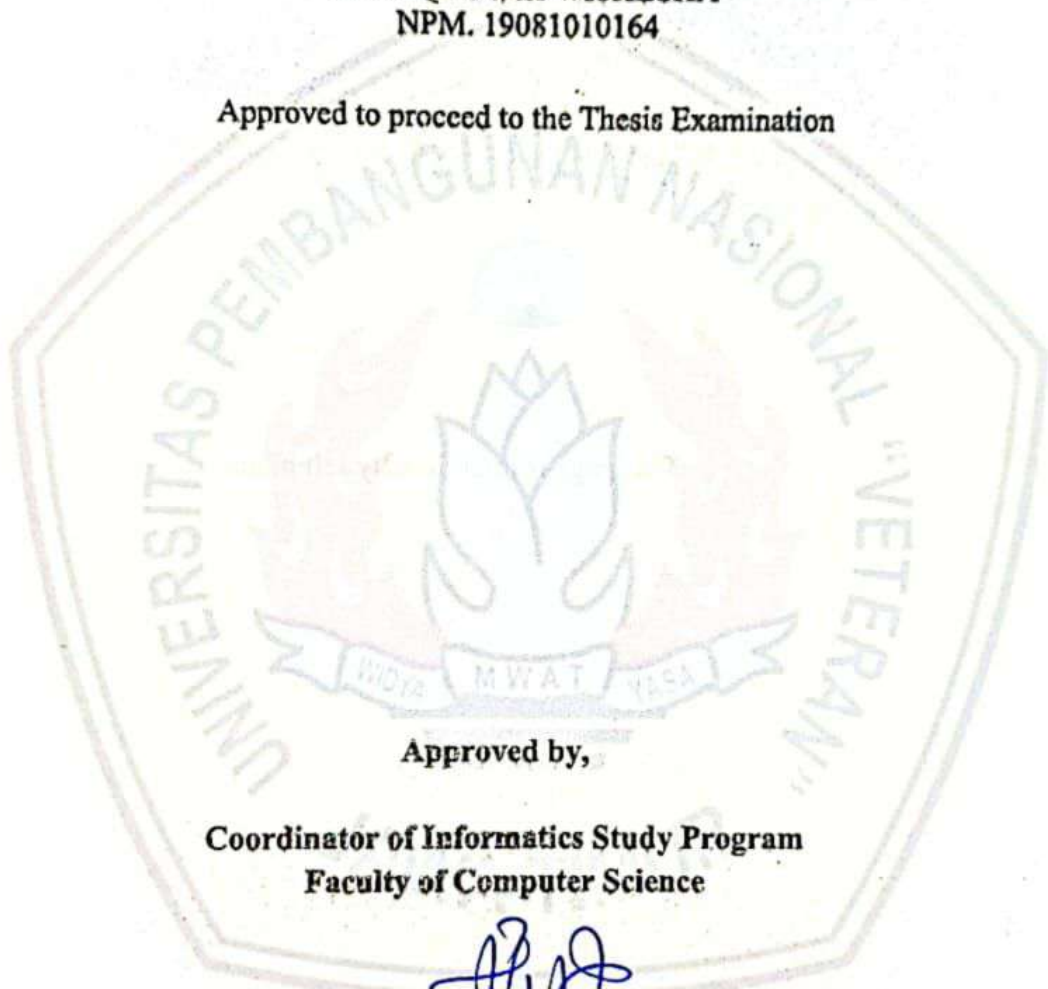

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ABSTRACT

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Class distribution imbalance is a structural challenge commonly encountered in agricultural image datasets, including the PlantVillage corn leaf disease dataset. This study compares the effectiveness of two loss functions standard Cross-Entropy Loss and adaptive Focal Loss in addressing this imbalance within the DenseNet121 architecture. The dataset comprises 4,188 images across four classes, with the minority class Gray Leaf Spot containing only 574 images compared to 1,306 images of the majority class Common Rust. Experiments were conducted in two scenarios: Scenario S-1 using Cross-Entropy Loss as the baseline, and Scenario S-2 using Focal Loss with $\gamma=2.0$ and dynamically computed per-class α values. Evaluation results show that the Cross-Entropy Loss model achieved an overall accuracy of 95.81% with a Gray Leaf Spot Recall of 0.8421. The Focal Loss model successfully improved the minority class Recall to 0.8684 an absolute reduction of 3 False Negative cases but at the cost of a Precision drop from 0.8889 to 0.7674 and an overall accuracy of 93.78%. These findings confirm that Focal Loss effectively enhances model sensitivity toward the minority class as hypothesized, yet introduces a precision-recall trade-off that must be considered in practical deployment contexts. This research provides an empirical contribution to the discourse on loss function selection in agricultural image classification under moderate data imbalance conditions.

Keywords : Focal Loss, Cross-Entropy Loss, DenseNet121, Corn Leaf Disease Classification, Imbalanced Dataset, Gray Leaf Spot, Deep Learning

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