

Proposed Master's Thesis

**Improving a Compact Vision Model
Using Knowledge Distillation**

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1 Introduction

Deep learning models in computer vision achieve impressive accuracy but often require large memory and computation resources, limiting deployment in real-time or edge environments. **Knowledge Distillation (KD)** provides an effective way to compress large models by transferring knowledge from a high-capacity **Teacher Model** to a smaller **Student Model**.

In this project, KD will be used to train a compact image classification model that achieves a balance between **accuracy and efficiency**. The objective is to improve the student model's performance while significantly reducing computational costs.

2 Project Objectives

The project will focus on the following achievable objectives:

1. **Baseline Establishment:** Train and evaluate both the Teacher (EfficientNetV2-L) and Student (EfficientNetV2-S) models using standard training to define baseline accuracy and resource requirements.
2. **Knowledge Distillation Implementation:** Apply standard KD techniques (soft targets + hard labels) to effectively transfer the teacher's knowledge to the student.
3. **Performance Analysis:** Quantitatively measure improvement in **accuracy, inference speed**, and **model size** between baseline training and KD training.
4. **Result Evaluation:** Analyze the effect of KD temperature, loss weighting, and dataset complexity on the student's learning efficiency.

3 Methodology and Model Specifications

3.1 Model Selection

Role	Model	Parameters (Approx.)	ImageNet Top-1 Accuracy (Approx.)
Teacher Model	EfficientNetV2-L	120 Million	85.7%
Student Model	EfficientNetV2-S	22 Million	83.9%

Table 1: Teacher and Student Model Specifications

Framework: **PyTorch** will be the main implementation platform.

3.2 Knowledge Distillation Setup

The total loss function will combine both teacher supervision and ground-truth learning:

$$L_{total} = \lambda_{KD} \cdot L_{KD} + \lambda_{CE} \cdot L_{hard} \quad (1)$$

Where:

- L_{KD} : Kullback-Leibler divergence between the teacher's soft targets and the student's logits (temperature $T = 4$).
- L_{CE} : Standard cross-entropy loss with hard labels.
- The hyperparameters λ_{KD} and λ_{CE} will be optimized to balance soft and hard learning.

3.3 Evaluation Dataset and Metrics

Dataset: **CIFAR-100** is selected for its manageable size and established benchmarking value. If time and resources allow, a subset of **ImageNet-1K** will be used for extended evaluation.

Metrics:

- **Top-1 Accuracy**
- **Validation Loss**
- **Inference Time**
- **Model Size**
- **Training Speed** (optional)

4 Expected Outcomes

The project is expected to deliver the following outcomes:

- The student model trained through KD will achieve **higher accuracy** than its independently trained baseline.
- The KD approach will demonstrate **better efficiency** in inference time and resource utilization compared to the teacher model.
- The final model will provide a strong **accuracy–efficiency trade-off**, proving KD as a practical compression strategy for vision models.

5 References

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