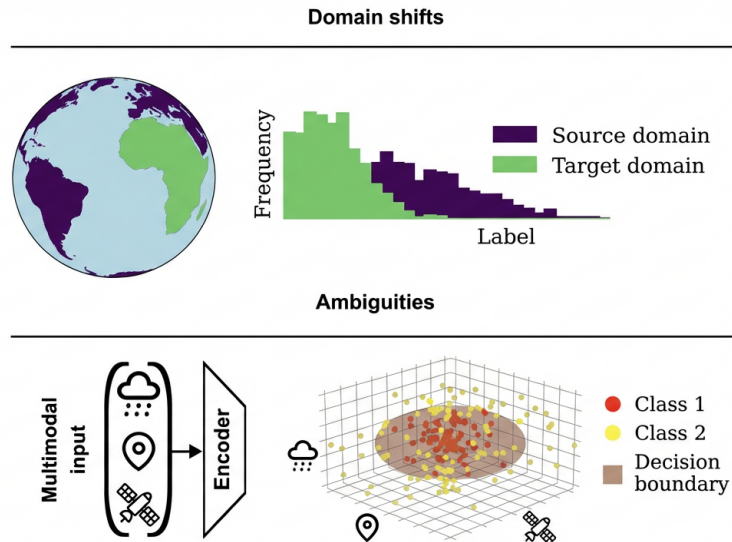


MASTER'S PROJECT AVAILABLE

Parameter-Efficient Test-Time Adaptation for Earth Observation



Motivation

Geospatial foundation models show massive potential for global climate monitoring, biomass estimation, and ecological tracking. However, when these models are evaluated on out-of-distribution geographic domains (e.g., trained in the US/Europe but tested in Africa), their performance drops drastically. A recent breakthrough based on Test-Time Training (TTT) [1] mitigates this by adapting the model at test time using unlabeled sensor data. However, standard TTT updates the *entire* massive encoder via backpropagation, making it highly memory-intensive and computationally impractical for deployment on edge devices or standard GPUs.

Objective & Methodology

This thesis aims to develop a Parameter-Efficient Test-Time Training (PE-TTT) framework. By integrating lightweight adaptation techniques, the goal is to achieve state-of-the-art geographic generalization while reducing GPU memory requirements during the test-time update phase.

Key Tasks:

- **Baseline Implementation:** Utilize the MMEarth-Bench dataset to establish standard baselines using modern pre-trained vision models.
- **Efficient Adaptation:** Implement and evaluate parameter-efficient fine-tuning techniques specifically for the test-time phase. This includes exploring Low-Rank Adaptation (LoRA) [2], visual adapters, or updating only affine LayerNorm statistics.
- **Benchmarking:** Rigorously evaluate the trade-off between geographic generalization accuracy and computational efficiency (VRAM usage and inference speed).

Requirements

- Strong programming skills in Python and PyTorch.
- Solid understanding of Deep Learning, particularly Vision Transformers (ViTs) or CNNs.
- Familiarity with domain adaptation or parameter-efficient fine-tuning (LoRA) is a strong plus.

References

- [1] Gordon, L. *et al.*, "MMEarth-Bench: Global Model Adaptation via Multimodal Test-Time Training," *arXiv*, 2025.
- [2] Hu, E. J. *et al.*, "LoRA: Low-Rank Adaptation of Large Language Models," *ICLR*, 2022.

Application

If you are interested in this project, please email your CV and a brief transcript to:
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