Image-Based Deep Learning for Crop Type Discrimination

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AAGI Analytics for the Australian Grains Industry

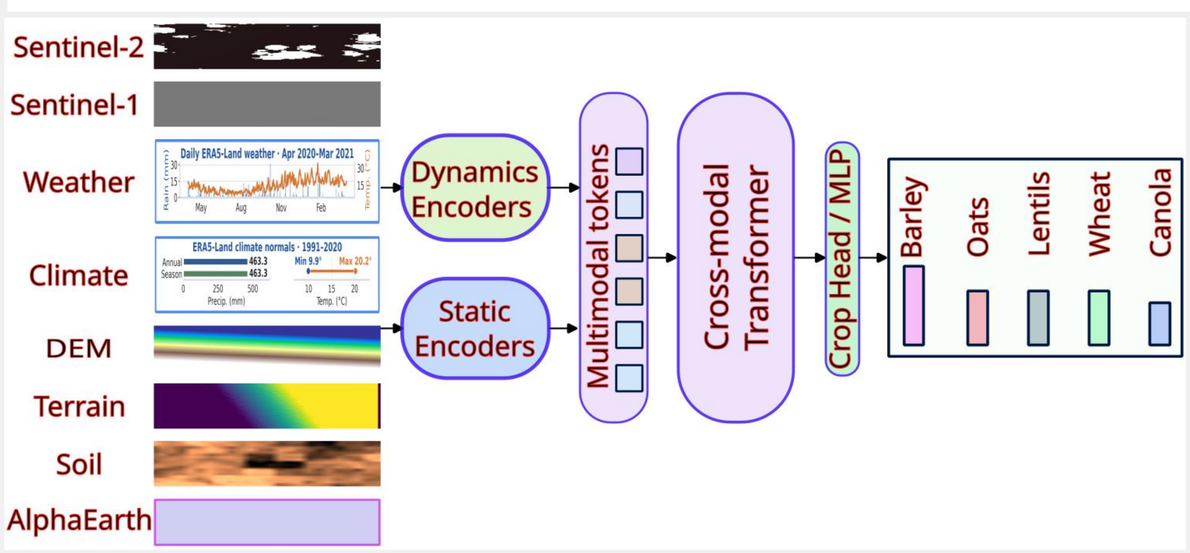
ABSTRACT

This research develops a multimodal deep learning framework to accurately identify crop types for agricultural monitoring and sustainable land management. It integrates Sentinel-1 radar, Sentinel-2 multispectral imagery, AlphaEarth embeddings, DEMs, soil properties, and weather data. By fusing these data sources, the framework improves crop classification accuracy, robustness, and scalability across diverse Australian agricultural landscapes. It supports growers, researchers, and policymakers through improved crop mapping and data-driven decision-making. Data assets initiated under CropPhen (UOQ2002-010RTX) and the ARC Linkage CropVision project (LP190100240).

1. Introduction

Crop type prediction across Australian agricultural regions, seasons, and years faces two key challenges: spatial and temporal generalisation. A multimodal geospatial AI framework will fuse Sentinel-1/2 imagery, AlphaEarth embeddings, DEM, soil, and weather/climate data through a cross-modal transformer with reliability-gated fusion, keeping predictions robust when observations are missing. Deliverables include an automated data ingestion platform, an integrated multimodal dataset, an AI foundation model, and decision-support tools, with uncertainty estimation supporting scalable, reliable predictions.

2. Proposed Achitecture



3. GeoFusion Data Downloader



4. Dataset – Wimmera Central Vic



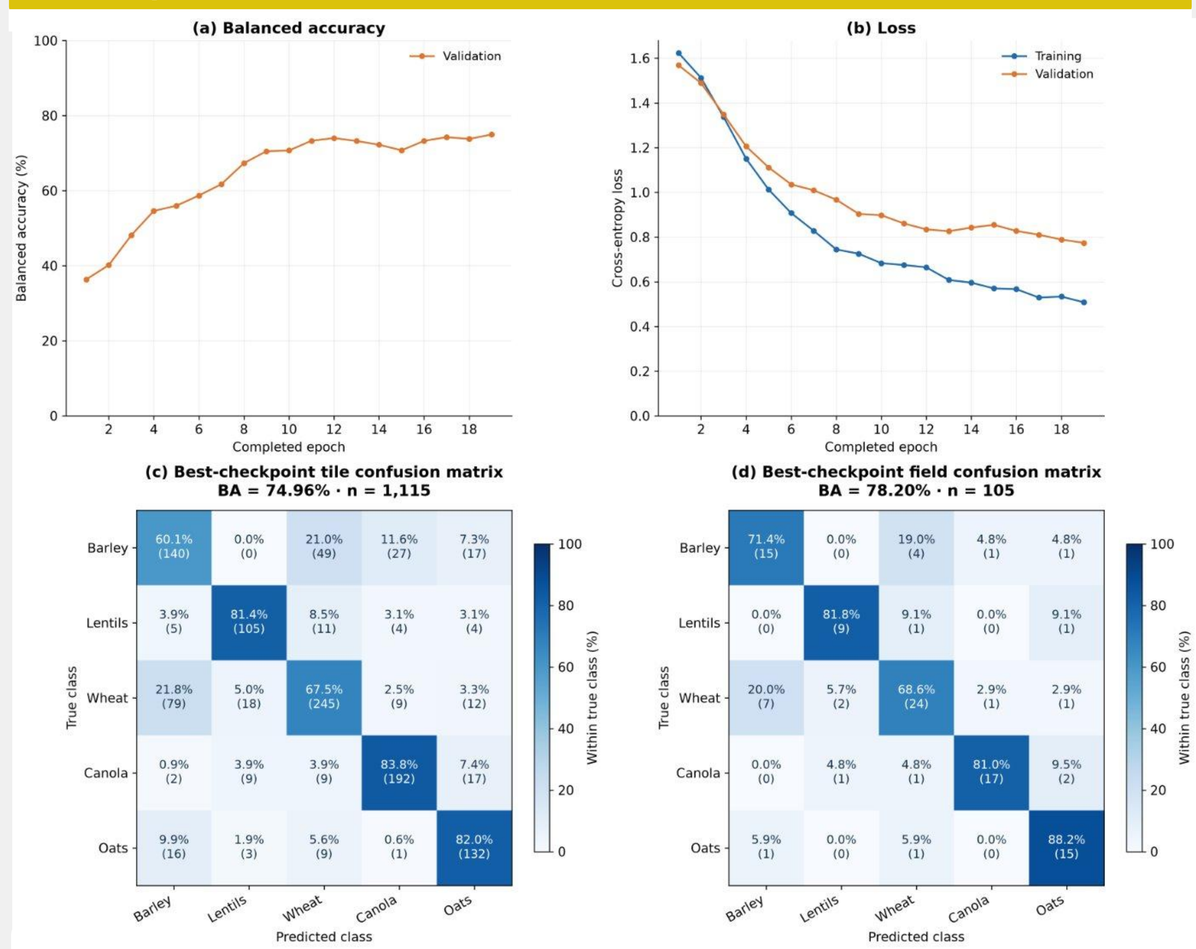
Crop composition (fields) and evaluation area

Crop	Training	Validation	Total	Composition
Barley	121	21	142	20.4%
Lentils	60	11	71	10.2%
Wheat	198	35	233	33.5%
Canola	115	21	136	19.5%
Oats	97	17	114	16.4%
All crops	**591**	**105**	**696**	**100.0%**

Training: 591 fields (84.91%) · 59,003.2 ha | Validation: 105 fields (15.09%) · 9,388.9 ha

Total: 68,392.2 ha · Five retained crops · Seed 42 · Field/site-disjoint split · No test split

5. Experimental Results



(a) Validation balanced accuracy increased over 19 epochs, approaching 75%. (b) Training and validation cross-entropy losses decreased, with a widening gap between the curves. Row=normalised confusion matrices at the best checkpoint show balanced accuracies of (c) 74.96% at the tile level (n = 1,115) and (d) 78.20% at the field level (n = 105). Misclassification occurred primarily between barley and wheat. Cell annotations indicate within-class percentages and sample counts.

6. References

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2. Astruc, G., Gonthier, N., Mallet, C., & Landrieu, L. (2025). AnySat: One Earth observation model for many resolutions, scales, and modalities. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 19530–19540). https://doi.org/10.1109/CVPR52734.2025.01835

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The support of the Grains Research and Development Corporation (GRDC) provided through the Analytics for the Australian Grains Industry (AAGI) project is acknowledged.