EuroSAT Land Cover Classification
LoopVerse 2025

Group Member:

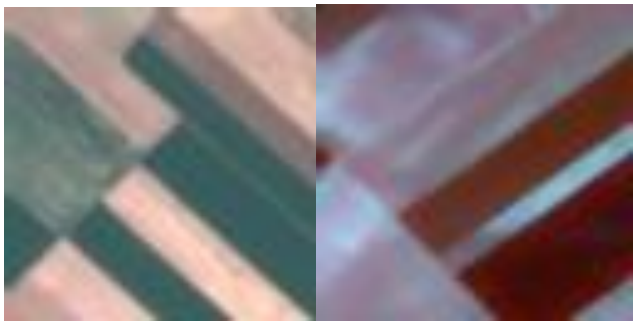
Fatima Khalid

Farheen Shaukat

1. Data Cleaning & Preprocessing

We handled mixed formats (.tif, .png, .jpg), removed corrupted images with black patches/unreadable files, normalized all images to **64×64×3**, and applied **Median filtering** to reduce noise while preserving edges.

Original **Filtered**



AnnualCrop_1096 1

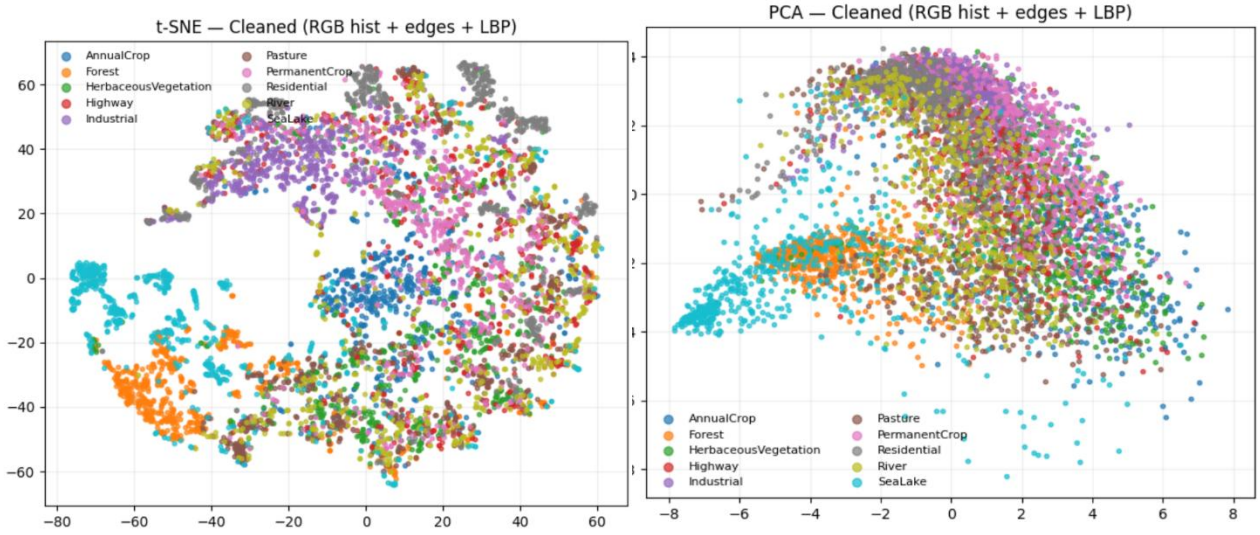
AnnualCrop_1 1

2. Low-level Feature Visualization

Extracted **color histograms** and **Canny edge maps** to confirm improved separability between classes after cleaning.

- Smoother histograms and clearer edges were observed, indicating reduced noise.

Visual Proof:



3. CNN Architecture

Baseline CNN:

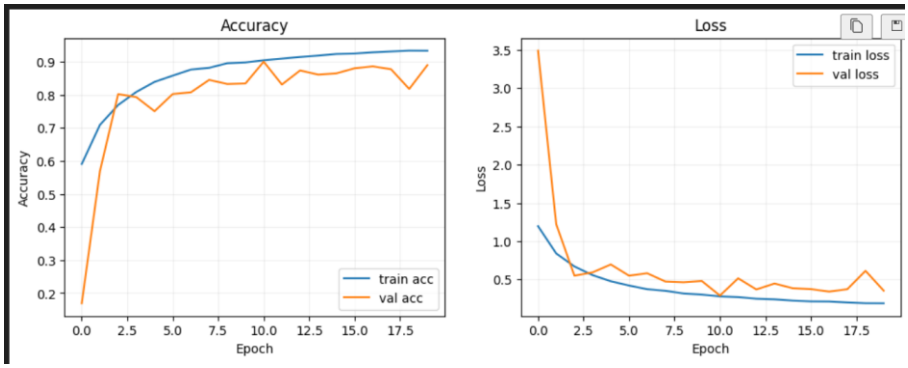
- Input: (64, 64, 3)
- Conv2D(32, 3×3) + BatchNorm + ReLU → MaxPooling
- Conv2D(64, 3×3) + BatchNorm + ReLU → MaxPooling
- Conv2D(128, 3×3) + BatchNorm + ReLU → GlobalAvgPool
- Dropout(0.3) → Dense(128) + ReLU → Dense(softmax)

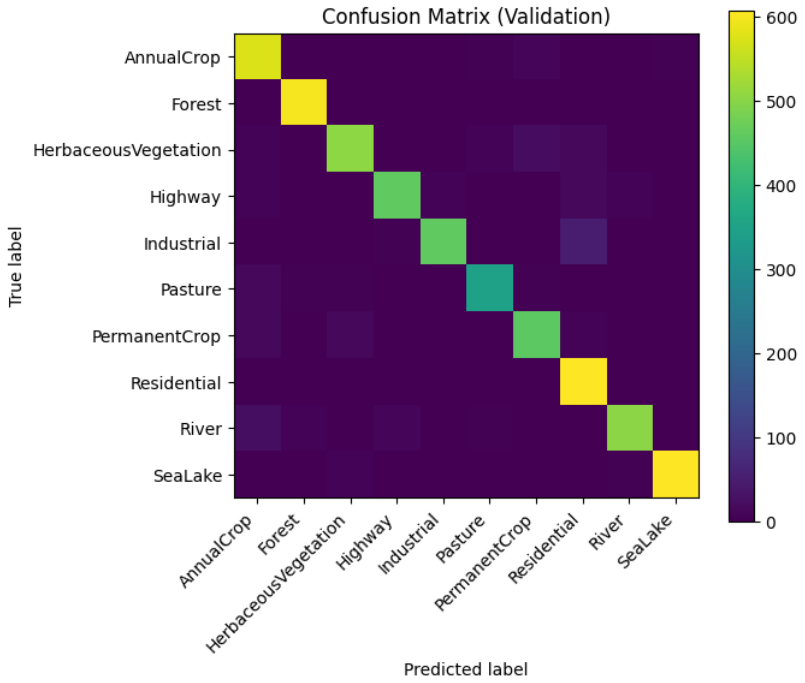
Improved CNN:

- Deeper stacks (64/128/256) with L2 regularization
- Extra Conv+BN blocks before pooling
- Higher dropout (0.25–0.4)
- Adam optimizer + LR scheduler

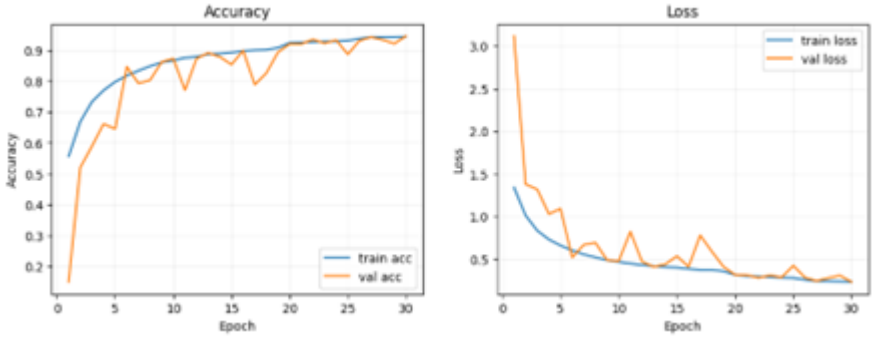
5. Confusion Matrices

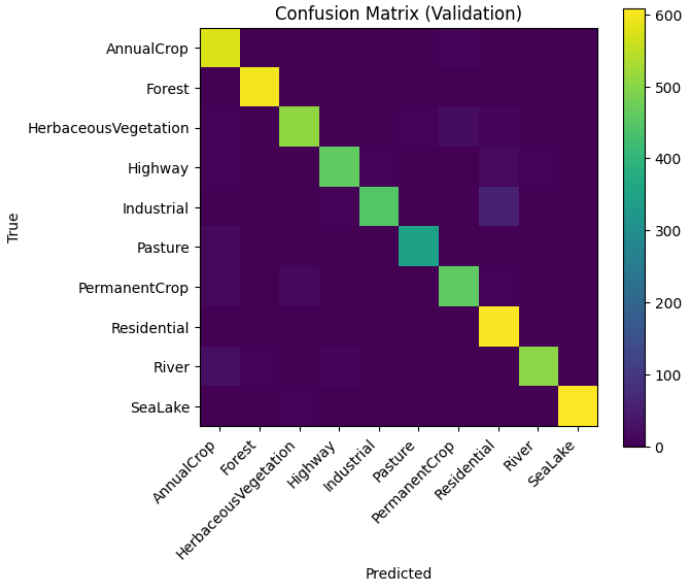
Classification report (**validation**):





Classification report (**Improved**):





6. Metrics Summary

Class	Precision	Recall	F1-Score	Support
AnnualCrop	0.904	0.966	0.934	597
Forest	0.974	1.000	0.987	600
HerbaceousVegetation	0.955	0.907	0.930	557
Highway	0.964	0.933	0.948	493
Industrial	0.981	0.896	0.937	512
Pasture	0.961	0.933	0.947	374
PermanentCrop	0.928	0.925	0.927	491
Residential	0.880	0.998	0.935	607
River	0.973	0.918	0.944	547
SeaLake	0.989	0.977	0.983	622
Accuracy			**0.948**	5400
Macro Avg	0.951	0.945	0.947	5400
Weighted Avg	0.950	0.948	0.948	5400

Improved:

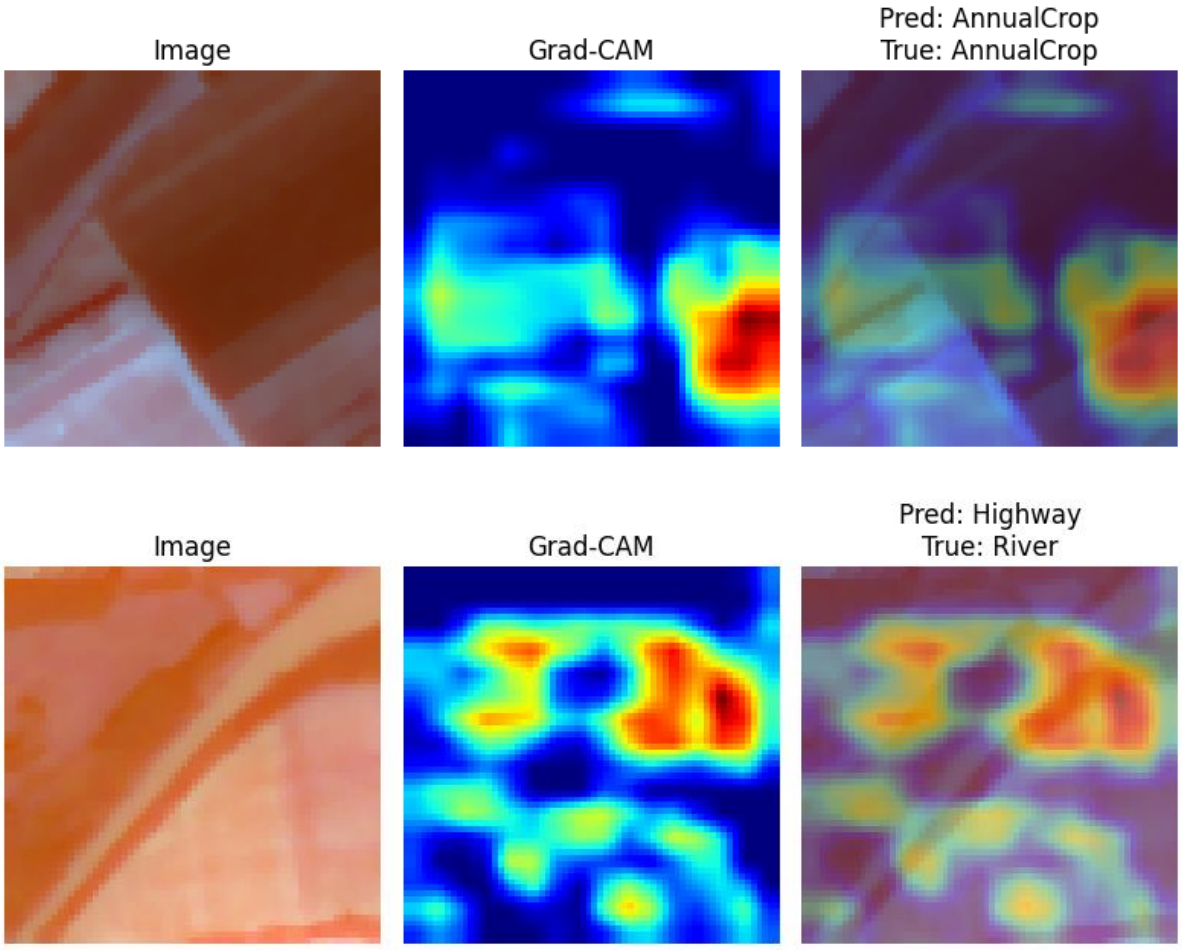
CLASS	PRECISION	RECALL	F1-SCORE	SUPPORT
ANNUAL CROP	0.903	0.968	0.935	597
FOREST	0.974	0.998	0.986	600
HERBACEOUSVEGETATION	0.955	0.912	0.933	557
HIGHWAY	0.962	0.933	0.947	493
INDUSTRIAL	0.985	0.869	0.923	512
PASTURE	0.961	0.933	0.947	374
PERMANENTCROP	0.927	0.931	0.929	491
RESIDENTIAL	0.871	0.998	0.930	607
RIVER	0.977	0.918	0.946	547
SEALAKE	0.987	0.979	0.983	622
ACCURACY			**0.947**	5400
MACRO AVG	0.950	0.944	0.946	5400
WEIGHTED AVG	0.949	0.947	0.947	5400

7. Performance Improvements

We applied:

- Data augmentation (horizontal flip, rotation, brightness, contrast)
- Batch normalization after every convolution
- L2 regularization
- Adam optimizer with ReduceLROnPlateau scheduler
- Early stopping

8. Final Predictions



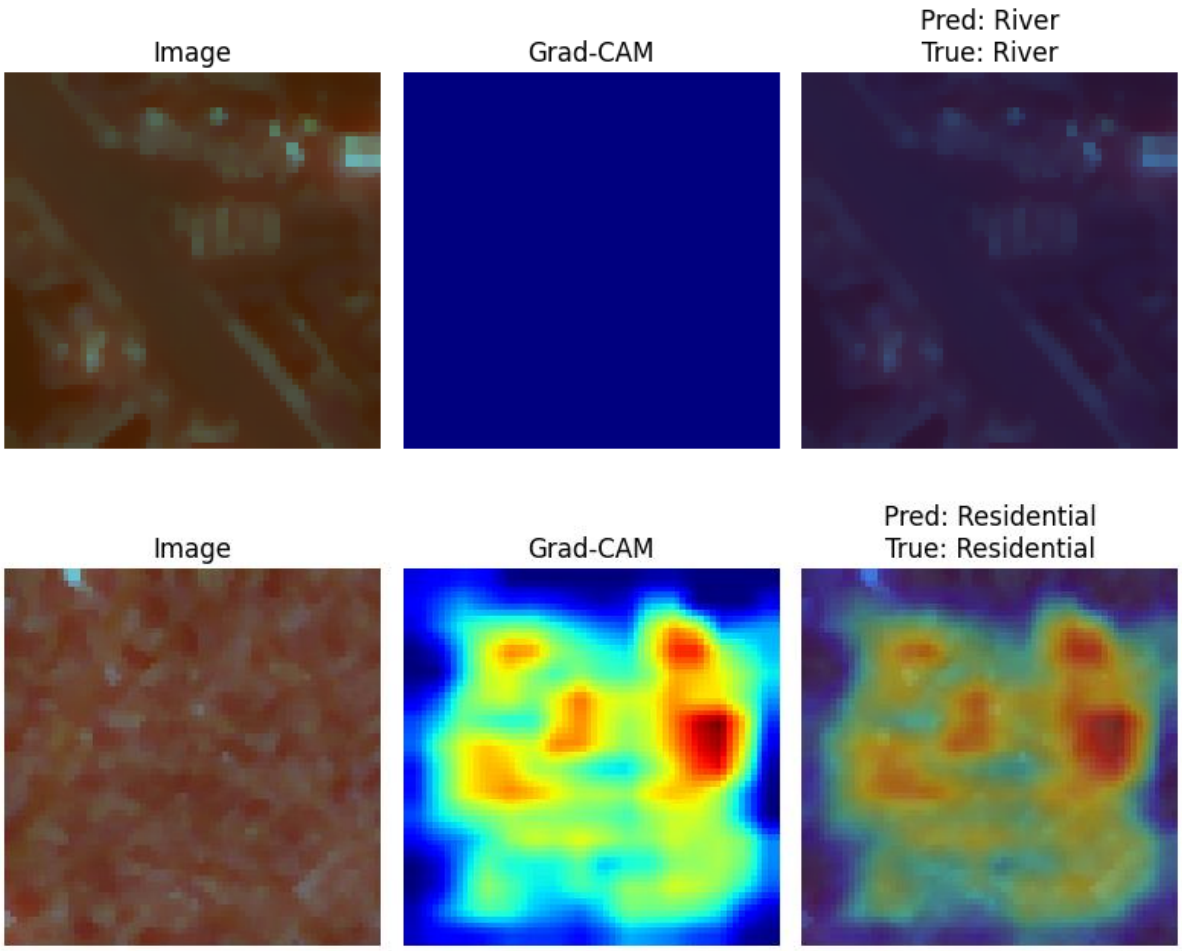
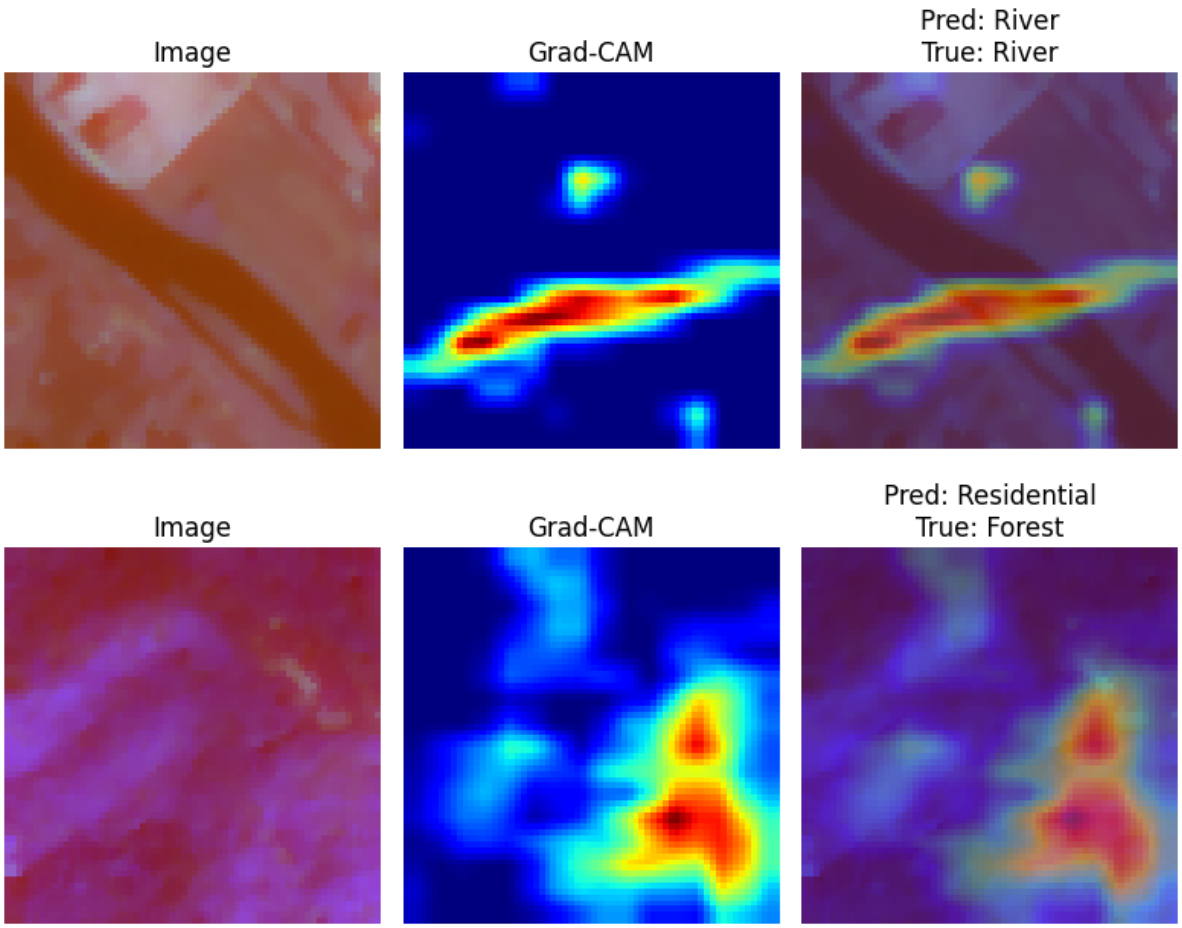


Image
Grad-CAM
Pred: River
True: River
Image
Grad-CAM
Pred: Residential
True: Residential



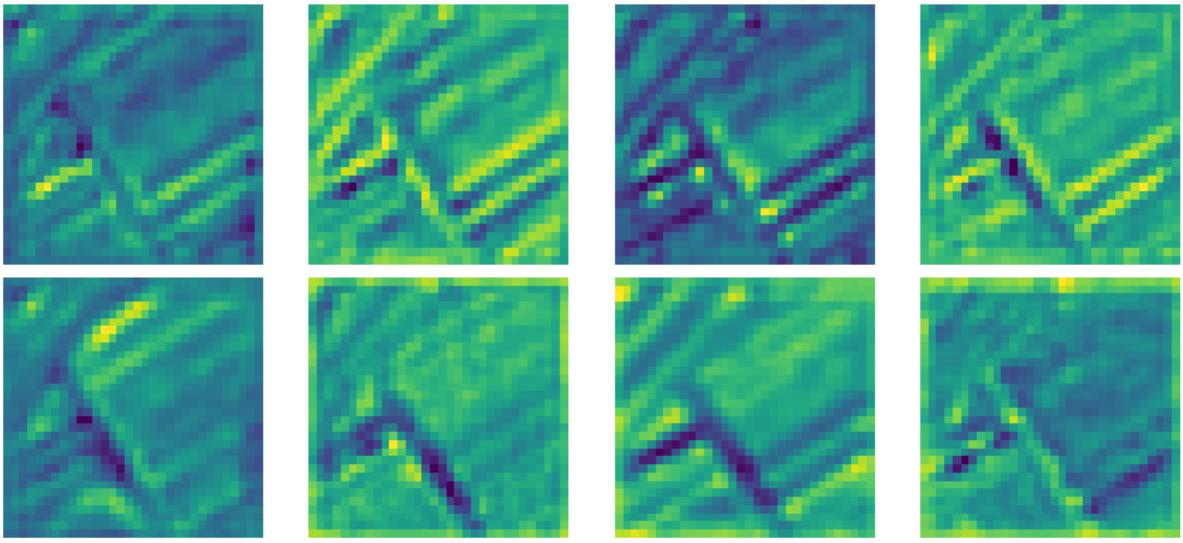
9. Visualization of Learned Feature Maps

We visualized feature maps from the **conv2d_23** layer of the improved CNN model. Each map represents the activations for a different convolutional filter when applied to a sample image from the dataset.

Interpretation:

- **Bright regions** indicate areas where the filter strongly activates, meaning it detects patterns relevant to that filter.
- **Dark regions** indicate low or no activation.
- In deeper layers like conv2d_23, filters respond to more abstract features — combinations of textures, shapes, or terrain patterns in satellite images.

Feature maps — layer conv2d_23 (8 channels)



Feature maps — layer conv2d_20 (8 channels)