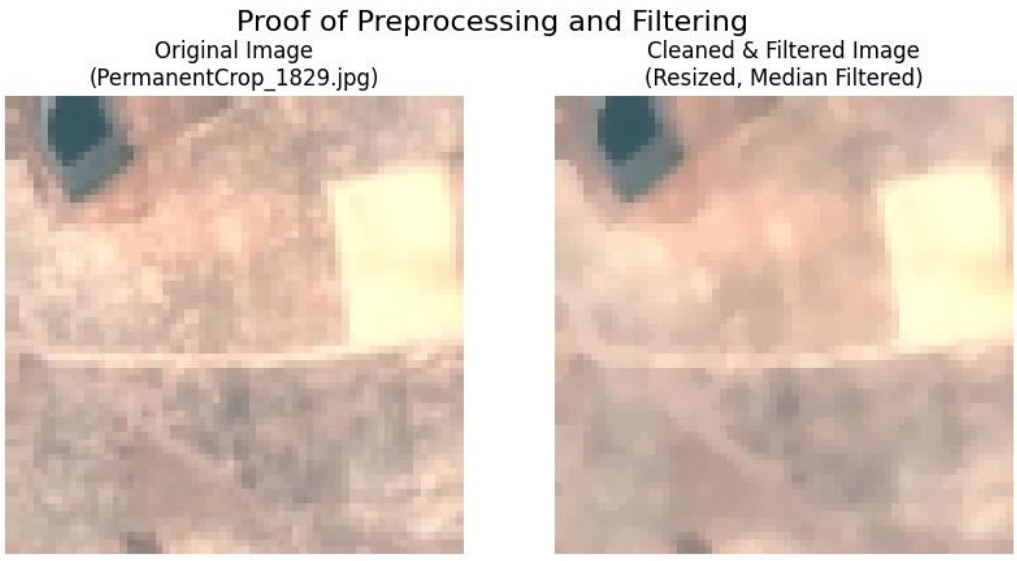
LoopVerse 2025 – EuroSAT Land Cover Classification Report

Dataset & Environment

Dataset: EuroSAT (combined RGB and multispectral)
Environment: Google Colab (CPU/GPU as available)
Packages used: tensorflow, keras, opencv (cv2), tifffile, numpy, matplotlib, sklearn (TSNE, metrics), pandas.

Data Cleaning and Preprocessing

- Handled .tif, .png, .jpg.
- Removed corrupted images
- Normalize image dimensions and channels. Converted gray scale and 4-channel images into bgr
- Applied median filter to remove noise.
- Resizes images to target_size (64×64)



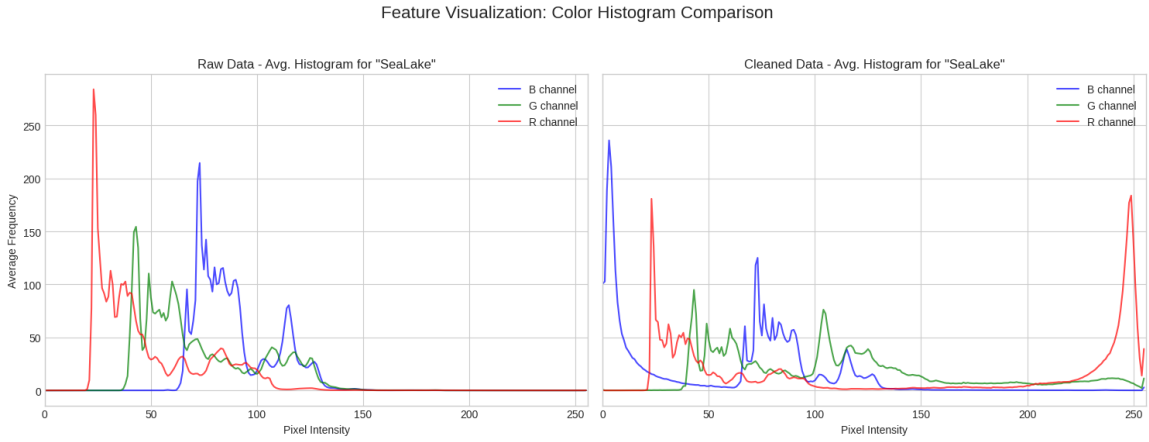
Data augmentation

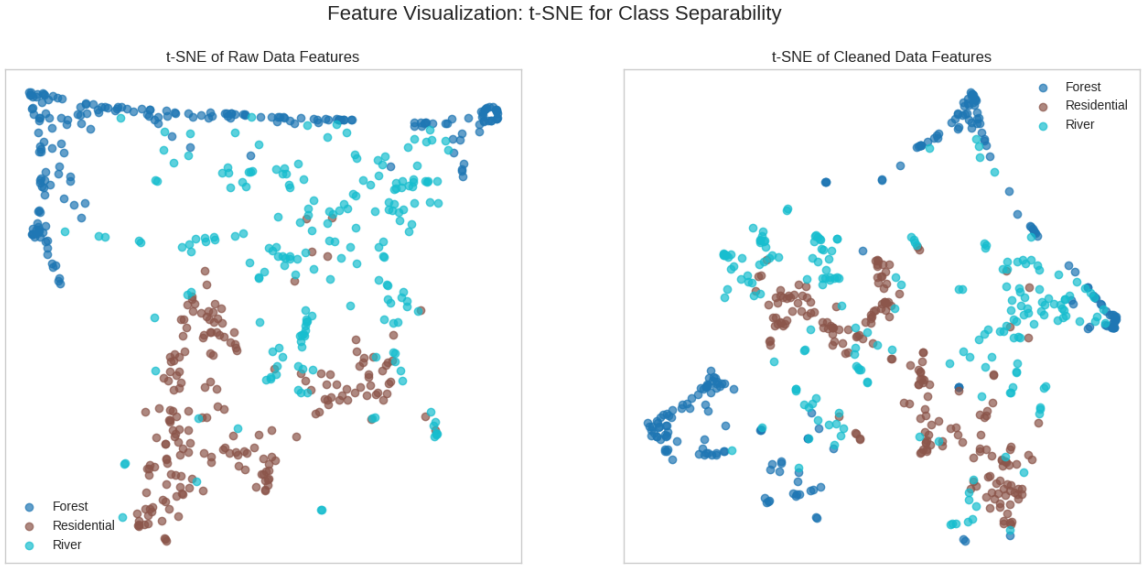
- Random flips (horizontal & vertical)
- Random rotation (0.2 radians ≈ 11.5°)
- Random zoom (0.2)

2. Feature Extraction

- **Color histograms** (per channel) were computed and averaged per class. The notebook compares average histograms for raw vs cleaned datasets to show whether cleaning improves separability.

- **t-SNE on low-level features**: the notebook extracts low-level descriptors (color histograms and/or flattened intensity features) for a sampled subset of images and runs sklearn.manifold.TSNE to obtain 2D embeddings for visualization of class separability (raw vs cleaned).





3. CNN Model Architecture

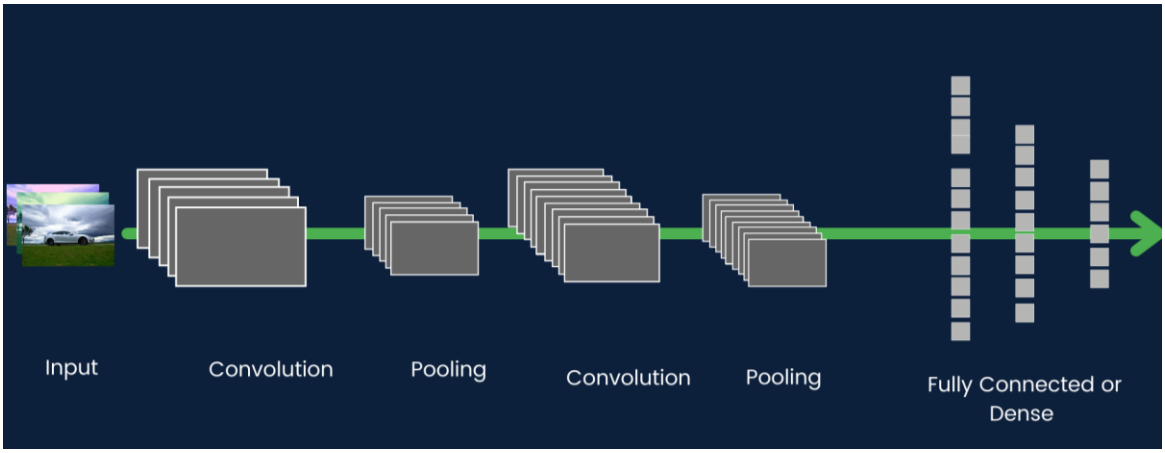
Provide a diagram of the CNN architecture with details on each layer (filters, kernel sizes, activation functions).

Baseline model (summary):

- Input & rescaling layer (1/255).
- Conv Block 1: Conv2D(32, 3x3), BatchNorm, MaxPool
- Conv Block 2: Conv2D(64, 3x3), BatchNorm, MaxPool
- Conv Block 3: Conv2D(128, 3x3), BatchNorm, MaxPool
- Dense head: Flatten → Dense(256, ReLU) → Dropout(0.5) → Dense(num_classes, softmax)
- Compiled with optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'].

Improved model (summary):

- Adds a data_augmentation Sequential block using RandomFlip, RandomRotation, RandomZoom before rescaling.
- Uses optimizer = Adam(learning_rate=1e-4) for a lower LR.
- Uses callbacks: EarlyStopping(monitor='val_loss', patience=5, restore_best_weights=True), ReduceLROnPlateau(factor=0.2, patience=2)



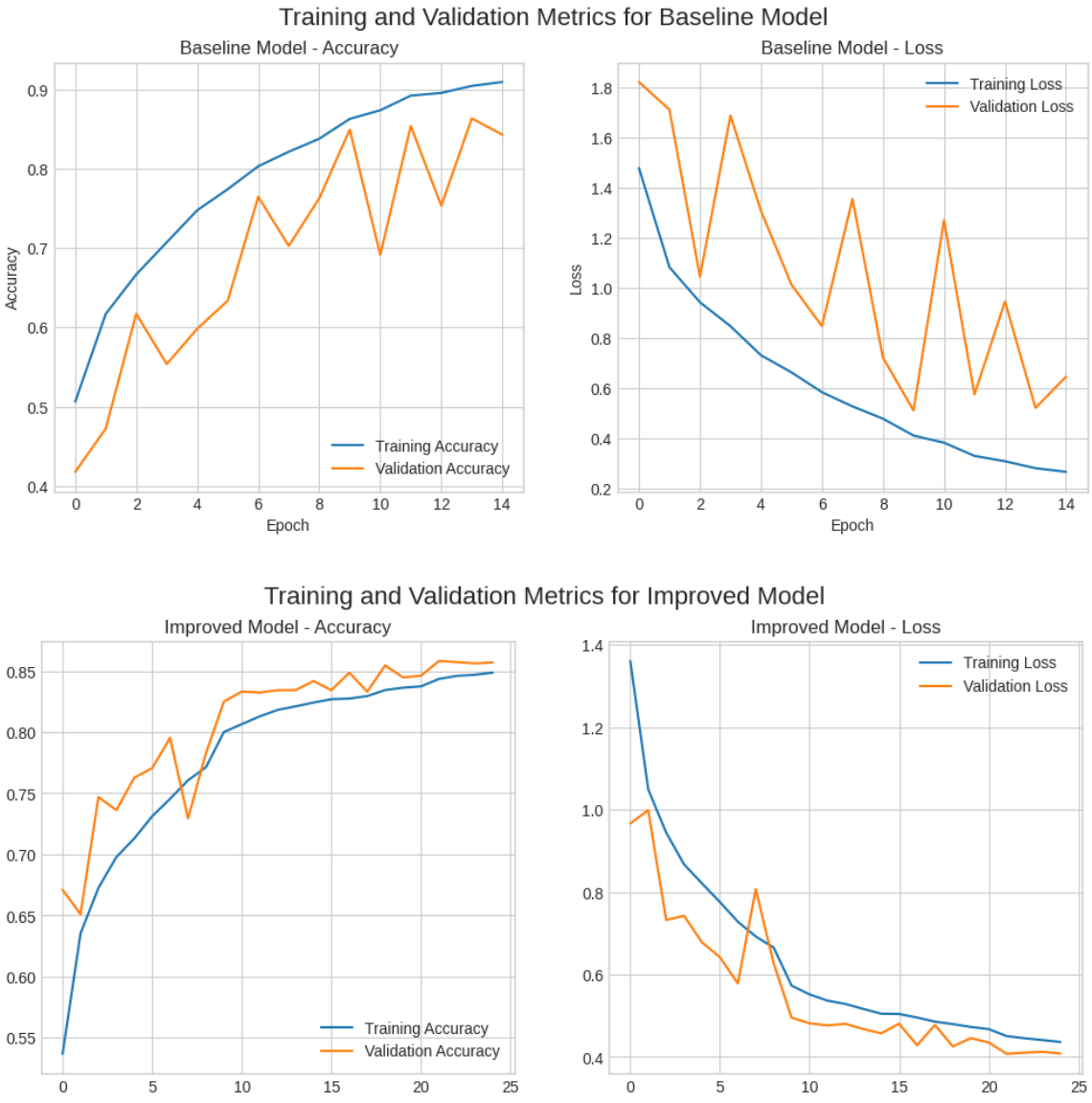
4. Training and Performance Improvement

Common settings used

- Image size: 64×64
- Batch size: 32
- Train/Validation split: 80/20 (validation_split=0.2)
- Epochs: baseline used ~15; improved uses up to 25 with EarlyStopping

5. Results and Evaluation

Include training and validation accuracy/loss curves.



Provide the confusion matrix showing per-class performance.

For Improved Model

Include a table with accuracy, precision, recall, and F1-score.

--- Classification Report ---

	precision	recall	f1-score	support
AnnualCrop	0.91	0.83	0.87	552
Forest	0.95	0.97	0.96	617
HerbaceousVegetation	0.87	0.78	0.82	529
Highway	0.74	0.71	0.72	491
Industrial	0.91	0.96	0.94	486
Pasture	0.83	0.90	0.86	395
PermanentCrop	0.80	0.76	0.78	533
Residential	0.82	0.99	0.90	627
River	0.87	0.83	0.85	508
SeaLake	0.99	0.94	0.97	565
accuracy			0.87	5303
macro avg	0.87	0.87	0.87	5303
weighted avg	0.87	0.87	0.87	5303

Attach CSV output with image_id and predicted_label.

EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop
EuroSAT_MS_AnnualCrop	AnnualCrop

6. Analysis and Comparison of Models

Compare baseline CNN with improved CNN.

For Baseline Model

```
--- Classification Report ---
                     precision    recall  f1-score   support

          AnnualCrop       0.95      0.84      0.89       552
              Forest       0.93      0.98      0.95       617
HerbaceousVegetation       0.46      0.98      0.63       529
             Highway       0.96      0.83      0.89       491
          Industrial       0.99      0.97      0.98       486
             Pasture       0.99      0.66      0.79       395
       PermanentCrop       0.94      0.63      0.76       533
         Residential       1.00      0.66      0.79       627
               River       0.87      0.93      0.90       508
             SeaLake       0.97      0.97      0.97       565

            accuracy                           0.85      5303
           macro avg       0.91      0.85      0.86      5303
        weighted avg       0.91      0.85      0.86      5303
```

EuroSAT_MS_River_1801.png	River
EuroSAT_MS_River_1802.png	River
EuroSAT_MS_River_1803.png	AnnualCrop
EuroSAT_MS_River_1804.png	River
EuroSAT_MS_River_1805.png	River
EuroSAT_MS_River_1806.png	River
EuroSAT_MS_River_1807.png	River
EuroSAT_MS_River_1808.png	River
EuroSAT_MS_River_1809.png	HerbaceousVegetation
EuroSAT_MS_River_181.png	River
EuroSAT_MS_River_1810.png	AnnualCrop
EuroSAT_MS_River_1811.png	River
EuroSAT_MS_River_1812.png	River
EuroSAT_MS_River_1813.png	River
EuroSAT_MS_River_1814.png	River

7. Conclusion

Summarize the overall findings and the effectiveness of your approach.

- Model Collapse is Fixed: The model is no longer predicting a single class. It is successfully identifying and predicting all 10 land-use types.
- Balanced Distribution: Each class has been predicted hundreds of times, which is what we would expect from a model that has learned to distinguish between the different features.