Earth Observation

Land Cover Classification over Delhi-NCR using Remote Sensing and Deep Learning

Project Summary

This project applies Earth Observation and Deep Learning techniques to classify land cover types over the Delhi-NCR region using high-resolution RGB satellite images. The pipeline involves spatial filtering using vector data, patch extraction from ESA WorldCover 2021 raster data, and classification using a ResNet18-based Convolutional Neural Network.

Data Sources

- **ESA WorldCover 2021**: 10m resolution land cover raster
- **GeoJSON Boundaries**: delhi_ncr_region.geojson and delhi_airshed.geojson
- **RGB Image Patches**: 128×128 pixel PNGs named using lat/lon center coordinates

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Workflow

1. Spatial Preprocessing

- Loaded the Delhi-NCR region boundary and created a uniform 60x60 km grid over the region.
- Overlayed the grid on the boundary to filter out satellite patches based on whether their centers fall inside a grid cell.

2. Label Generation

- For each image, a 128x128 pixel patch was extracted from the ESA WorldCover raster centered on the image's location.
- The most frequent land cover class (mode) within the patch was assigned as the image label.
- Mapped ESA class codes to human-readable names (e.g., Built-up, Cropland, Tree Cover).

3. Dataset Preparation

- Stratified 60/40 train-test split was applied.
- Class imbalance was observed with Cropland and Built-up dominating.

4. Model Training

- A ResNet18 model was fine-tuned using PyTorch.
- Achieved ~93% training accuracy over 5 epochs.

5. Evaluation

- Test accuracy: ~64%
- Macro F1 Score: ~0.22
- Performance was skewed toward dominant classes (Cropland, Built-up).
- Confusion matrix and class-wise F1 scores were plotted.
- Correct and incorrect predictions were visualized.

Key Results

- **Train Accuracy**: 92.9%
- **Test Accuracy**: 64.0%
- **Macro F1 Score**: 0.22

Future Improvements

- Incorporate NDVI or multispectral data for better land cover discrimination.
- Address class imbalance via data augmentation or synthetic oversampling.
- Explore temporal changes with multi-year imagery.

Repository Structure

```
EarthObs/
├── delhi_ncr_region.geojson
├── delhi_airshed.geojson
├── worldcover_bbox_delhi_ncr_2021.tif
├── rgb/            # RGB image tiles (128x128 PNGs)
├── train_eval.ipynb  # Full notebook pipeline
```
