Signal Coverage Mapping using Measurements and Machine Learning

# 1. Introduction

This project implements a signal coverage mapping workflow using real-world or simulated measurements of signal strength, along with machine learning and geospatial interpolation techniques. The workflow allows comparison between interpolation, machine learning ensemble models, and theoretical propagation models.

# 2. Data Requirements

The following input data files are required in the 'data/' folder:

|  |  |  |
| --- | --- | --- |
| File Name | Required Columns | Description |
| measurements.csv | latitude, longitude, signal, altitude (optional) | Drive-test or simulated measurements of received signal strength (dBm). |
| opencellid\_towers.csv | latitude, longitude | Cell tower reference positions (from OpenCellID or similar sources). |
| dem.tif | Raster GeoTIFF | Digital Elevation Model covering the region of interest (from SRTM, USGS, etc.). |

# 3. Folder Structure

The project directory should be organized as follows:  
  
project/  
│  
├── code/  
│ ├── signal\_mapping.m  
│ ├── utils\_geo.m  
│ ├── utils\_eval.m  
│ ├── utils\_viz.m  
│  
├── data/  
│ ├── measurements.csv  
│ ├── opencellid\_towers.csv  
│ ├── dem.tif  
│ └── webmap/

# 4. Methodology

The workflow consists of the following main steps:  
1. Load and clean measurement data.  
2. Engineer features using tower data and DEM elevation.  
3. Perform baseline spatial interpolation.  
4. Train an ensemble machine learning model.  
5. Perform spatial cross-validation to evaluate models.  
6. Generate and compare coverage maps.  
7. Export results as GeoTIFF and interactive web maps.

# 5. How to Run

1. Place all required files into the folder structure described above.  
2. Open MATLAB and navigate to the 'code/' folder.  
3. Run the main script:  
  
 signal\_mapping  
  
4. After successful execution, the following outputs are generated:  
- data/coverage\_interpolated.tif  
- data/coverage\_ensemble.tif  
- data/webmap/coverage\_interpolated\_map.html  
- data/webmap/coverage\_ensemble\_map.html  
  
5. Open the HTML files in any browser to view interactive coverage maps.

# 6. Conclusion

This project provides a reproducible workflow for radio signal coverage prediction. It demonstrates the use of data-driven models alongside traditional interpolation and theoretical propagation models, allowing evaluation of accuracy and visualization of results in both raster and web map formats.