EPFL

Consistent time series forecasting of future deforestation in the Amazon rainforest

Context

The deforestation of the Amazon, the world's largest rainforest, is a major environmental issue. The Amazon plays an important role in both regional and global climate, has an extremely rich biodiversity, and provides crucial carbon storage capabilities.

The development of remote sensing technologies has enabled the monitoring of the Amazon from space at an unprecedented level of detail. As a result, high-resolution maps of deforestation are produced every year, providing detailed data of where and when deforestation has taken place.

In this project, the archive of deforestation maps in the Brazilian Amazon is used for training a deep learning model to forecast future deforestation. The model predicts which pixels of a given location will be deforested in the upcoming year based on deforestation maps from the past, as well as other auxiliary data.

Since the model uses small, local patches independently of one another, additional steps are required to ensure its predictions are consistent when put together. For example, the total predicted deforestation for each municipality and state should agree with the known observed values. This is crucial to obtain realistic, spatially coherent predictions that can be trusted by decision-makers for enforcement and policy.

Figure: The typical « fishbone pattern » common in the Amazon – forest is cleared along newly established roads [image source: Mongabay].

Project

The aim of this project is to identify, implement, and evaluate one or several methods of forecast reconciliation. You will be provided an existing, trained model to forecast deforestation. Your implemented solution should ensure the model's predictions are consistent with the ground truth when aggregated at different spatial levels, such as administrative boundaries.

Specifically, you may take the following steps:
- Conduct literature review to understand the common methods of forecast reconciliation / hierarchical time series forecasting
- Forecast deforestation across the Brazilian Amazon.
- Aggregate the predictions spatially and compare against observed ground truth
- Implement selected methods to enforce the predictions to match ground truth at different spatial levels
- Evaluate the methods with respect to
    - the coherence of the predictions
    - the overall model's accuracy
    - computational complexity

Requirements

- Very good knowledge of machine learning; experience with time series forecasting is an advantage
- Experience or strong interest in remote sensing and geospatial data analysis.
- Proficiency in Python and relevant libraries (e.g., rasterio, geopandas, numpy, matplotlib).
- Strong willingness to learn and ability to work independently

Literature
- Primer on consistent time series forecasting https://otexts.com/fpp3/hierarchical.html
- TBD

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