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Projects / Local Chapter Project

Standardized Comparison of Urban Green Space Mapping Through Remote Sensing for Frankfurt, Germany

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Challenge Background

Monitoring urban vegetation is a costly and time-consuming task — hence there is an increased interest in automated mapping techniques. The use of remote sensing imagery to distinguish different land cover and land use types in an urban environment is a mature sub-discipline of remote sensing research.

However, the amount of literature dedicated to green space segmentation and classification remains notably smaller. Still, standardized comparisons of different mapping techniques are rare. For example, for green spaces that lie below the resolution limit of the concerned sensor - which is for example 10m x 10m for freely accessible sentinel-2 imagery - need to be detected on sub-pixel-level.

Here, it can be aimed to calculate the percentage of pixel to which green spaces contribute, based on either single bands or indices. So called “unmixing” of pixels can then be performed through, e.g. with multiple endmember spectra mixture analysis, based on, e. g., linear or Gaussian models.

For these techniques open questions remain regarding the ultimate resolution limit. Likewise, it has to be investigated whether alternative techniques, such as e.g. input amplification, can push resolution limits further.

Also, a plethora of further information exists in remote sensing such as e. g. seasonal change analysis, or temperature mapping that provide further information about the presence/absence of urban greenery. Albeit computationally more costly, deep learning strategies such as U-nets or the recently proposed selective state space models (SSM) can enhance predictive power.

The Problem

Albeit different methods exist for satellite-based urban green space mapping - many of which were introduced within the last 3-4 years - systematic comparisons of resolution limits between different methods (especially different categories of methods) are rare.

This project aims to compare different unmixing techniques to deep learning architectures (in particular a U-net and SSM) in combination with or without change detection as well as potentially input amplification in their ability to detect and map small patches of urban greenery.

The project is focused on the geographical area of Frankfurt am Main, Germany. For this city, high-resolution, summer air photographs in the RGB-spectra as well as near infrared spectra are available.

Goal of the Project

1. Train project members in python-based geospatial methodology and basic knowledge in remote sensing
2. Use publicly available air photographs and maps of Frankfurt/ Main, Germany, to create fine-grained ground truth data segmented for urban green space mapping
3. Compare methodologically highly distinct algorithmic methods for ability to segment even small urban green spaces
4. Evaluate whether two deep learning techniques, U-net and mamba, can enhance detection of small urban green spaces further and publish results

Project Timeline

1 Practicing geospatial libraries in jupyter notebooks. Also, teams should get a feel how to self-organize. As an initial goal, all groups are supposed to segment a given urban geographic area based on satellite channel signals and indices.

2 Literature research of the algorithmic methodology of each group. The goal of the second week is to present in depth the given algorithmic method (e.g. what is known about its detection limit in urban spaces, when it was introduced etc.) including an action plan how the group will use the gained insights to map urban green spaces (and which error they expect).

3 The ground truth data from the air photos and potentially open-source maps.

4 Writing code to analyze one single urban location with the algorithmic so

5 Scaling up the code to the entire urban area and comparing outcomes to ground truth data (i. e. calculating error margins).

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6 Desk research about U-net and Mamba architectures along with according inputs and parameters used to segment urban green spaces.

7 Writing first deep learning codes for advanced urban green space segmenting.

8 Choosing a final deep learning model and testing it on the entire data set as well as blog post writing.

What you'll learn

1. Geospatial data handling in Python
2. Image segmentation
3. Image scaling and georeferencing
4. Building Machine Learning Models
5. Spatial error analysis
6. Building deep learning models
7. Scientific communication

First Omdena Local Chapter Project?

- **Beginner-friendly, but also welcomes experts**
- **Education-focused**
- **Duration: 4 to 8 weeks**
- **Open-source**

Your Benefits

- **Address a significant real-world problem with your skills**
- **Build your project portfolio**
- **Access paid projects (as an Omdena Top Talent)**
- **Get hired at top organizations**

Requirements

- Good English
- Suitable for AI/ Data Science beginners but also more senior collaborators
- Learning mindset

Application Form

Application Closed.

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Frankfurt, Germany Chapter

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