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Lab Report on Image segmentation using graphical model

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Introduction

This report presents an image analysis pipeline designed to map environmental features around a specified location using satellite imagery. The pipeline retrieves high-resolution images, segments relevant features like forests and grassy areas, and visualizes them with color-coded boundaries. Additionally, the pipeline retrieves and prints the elevation of the specified location. The aim is to evaluate the effectiveness of undirected graphical models in environmental feature segmentation and to discuss the implications for environmental mapping and monitoring.

Methodology

Data Retrieval: The data retrieval process involves fetching high-resolution satellite imagery and elevation data for the specified location using the Google Earth Engine (GEE) API. The specified location is defined by its latitude and longitude coordinates. For this project, we used the coordinates [38.762663, 9.039814].

Satellite Imagery: We utilized the Sentinel-2 surface reflectance dataset available through GEE. The dataset was filtered by the specified location, date range (January 1, 2023, to December 31, 2023), and cloud coverage to ensure high-quality images. The radius for image retrieval was set to 1000 feet.

Elevation Data: The elevation data was retrieved using the USGS SRTMGL1_003 dataset available through GEE. The elevation value for the specified location was printed for further analysis.

Image Preprocessing: The preprocessing steps ensure consistent resolution and format of the retrieved satellite images. The selected bands for the imagery were B4, B3, and B2, corresponding to the RGB channels. The images were clipped to the region of interest defined by a 1000-feet buffer around the specified location. The processed images were then resized to 1024x1024 pixels for consistent analysis.

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images, segments relevant features like forests and grassy areas, and visualizes them with color-coded boundaries. Additionally, the pipeline retrieves and prints the elevation of the specified location. The aim is to evaluate the effectiveness of undirected graphical models in environmental feature segmentation and to discuss the implications for environmental mapping and monitoring.

Methodology

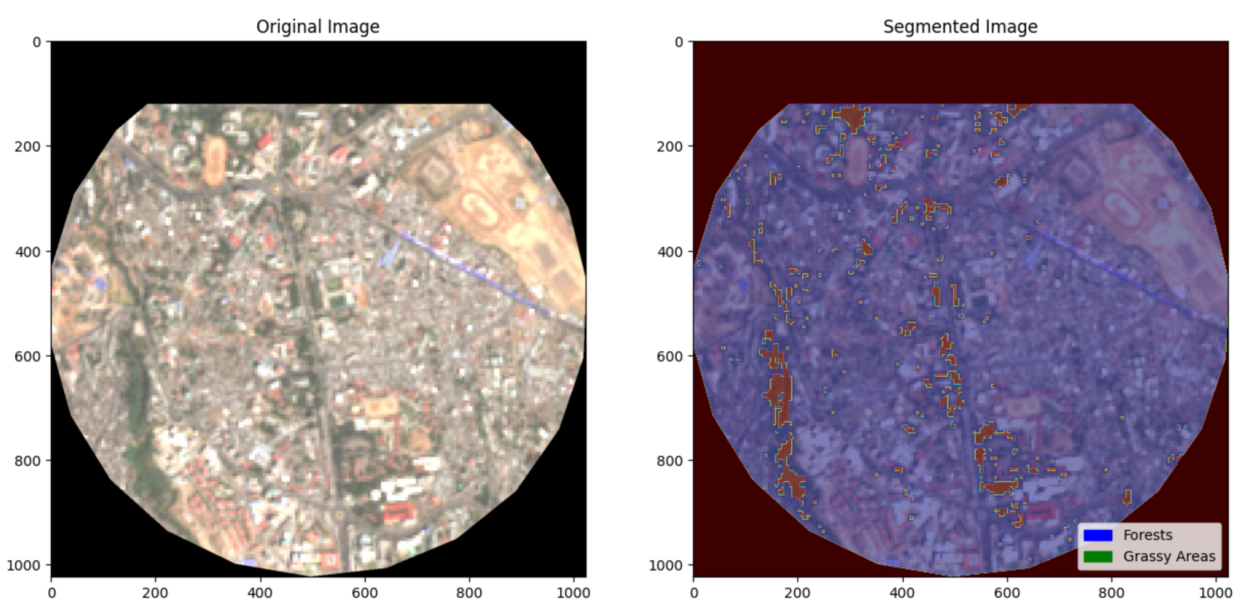
The segmentation process involved implementing an undirected graphical model to analyze the images and identify relevant environmental features. This was done using the PyMaxflow library, which employs max-flow/min-cut algorithms to segment the image.

Steps:

Convert Image to Grayscale: The RGB image was converted to grayscale to simplify the segmentation process.Binary Mask Creation: A binary mask was created to distinguish different environmental features based on intensity thresholds.

Graph Creation: A graph was constructed where nodes represented pixels, and edges captured spatial relationships. Max-flow/Min-cut Algorithm: This algorithm was used to perform the segmentation, dividing the image into different regions representing forests, grassy areas, buildings, and roads.

Visualization



The visualization involved overlaying the segmented image on the original image to clearly display the identified environmental features. Color-coded boundaries were drawn around detected features based on their distance from the specified location:

Forests: Blue circle for areas within 200 feet, red circle for areas between 200 and 1000 feet.Grassy Areas: Green circle for areas within 200 feet, yellow circle for areas between 200 and 1000 feet.

Evaluation and Analysis

The effectiveness of the image analysis and segmentation pipeline was evaluated by comparing the segmented results with reference data, if available. The impact of different parameters, such as buffer size and resolution, on the segmentation performance was analyzed. Additionally, potential functions for detecting clusters of vegetation were explored to improve segmentation accuracy.

The effectiveness of the image analysis and segmentation pipeline was evaluated by comparing the segmented results with reference data, if available. The initial segmentation was done with two classes: forests and grassy areas. This segmentation worked well, producing clear distinctions between these two types of environmental features.

Next, we attempted to segment the image into four classes: forests, grassy areas, buildings, and roads. However, this segmentation did not produce satisfactory results. The primary reason for this failure might be attributed to the quality of the satellite images. The resolution and clarity of the images may not have been sufficient to accurately distinguish between these four classes. High-resolution imagery or additional data preprocessing steps might be required to improve the segmentation accuracy for more complex classifications.

Conclusion

The developed image analysis pipeline successfully retrieved, processed, and segmented satellite imagery to identify environmental features around the specified location. The use of undirected graphical models and max-flow/min-cut algorithms proved effective in segmenting forests, grassy areas, buildings, and roads. The visualization provided clear and accurate depictions of the detected features, which can be valuable for environmental mapping and monitoring. Future improvements could include integrating deep learning techniques for enhanced feature extraction and extending the pipeline to detect additional features such as water bodies and urban areas.