Non-Linear Optimization Project Proposal

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Motivation

In areas like the Caribbean that face considerable risk from natural hazards like earthquakes, hurricanes, and floods, these forces of nature can have a devastating effect. This is especially true where houses and buildings are not up to modern construction standards, often in poor and informal settlements. Such buildings are often not fit for facing these natural disasters and cause severe damages in life and money (change this). Traditional method for identifying high-risk buildings involves manual inspection by going door to door by foot, which is extremely time consuming and expensive. Aerial imagery provides an inexpensive method of capturing the characteristics of the roof construction material, which is one of the major risk factors for the natural calamities. This project would explore a data driven method for characterizing the roof construction material from satellite imagery, which would help in faster, cheaper prioritization of building inspections and target resources for disaster preparation where they will have the most impact. This project is a part of an open challenge by Driven Data[1]

Problem Formulation and Scope

Since this problem itself is very vast, I have decided to break it down into two parts. For the purpose of this class project, I will focus on the problem as a roof detection task. I am treating this as a per-pixel segmentation task where each pixel is classified as a roof or non-roof. The most popular architectures for segmentation tasks are FCN[2] and UNet[3], which will be explored during the course of this project.

Dataset

This project is part of an Open Challenge of Driven Data, and they have provided high-resolution drone images of identified buildings in St. Lucia, Guatemala, and Colombia. Specifically, the data consists of a set of overhead imagery of seven locations across three countries with labeled building footprints, two from Colombia, two from Guatemala and three from St. Lucia. Two of the locations have labels from automated processes, which might have noisy data. The images are of GEOTIFF format, and the information about the roof can be extracted from the corresponding GEOJSON files. For the purpose of the segmentation task, the GEOTIFF file should be furthur processed into 512x512 non-overlapping tile sizes and the labels should be rasterized from the GEOJSON file.

The size of the dataset is small (around 22k instances of roof), hence I might augment other datasets like AIRS dataset [4] along with the existing one.

Technical Details

Potential frameworks for this task are Tensorflow and Pytorch, and the choice of coding language is Python. Aerial imagery are very high resolution images as well as very large in size. I will be using a software called QGIS[5] for visualizing the ground truth and results.

References

[1] Open AI Caribbean Challenge: Mapping Disaster Risk from Aerial Imagery *https://www.drivendata.org/competitions/58/disaster-response-roof-type/page/142/.*

[2] J. Long et al, *Fully convolutional networks for semantic segmentation* Proc. IEEE Int. Conf. Computer Vision and Pattern Recognition (CVPR), pp. 3431-3440, 2015.

[3] Olaf Ronneberger et al. *U-Net: Convolutional Networks for Biomedical Image Segmentation.* Medical Image Computing and Computer-Assisted Intervention (MICCAI), Springer, LNCS, Vol.9351: 234–241, 2015.

[4] Qi Chen et al. *Aerial Imagery for Roof Segmentation: A Large-Scale Dataset towards Automatic Mapping of Buildings.* Article in ISPRS Journal of Photogrammetry and Remote Sensing, 147:42-55, January 2019

[5] QGIS: A Free and Open Source Geographic Information System *https://www.qgis.org/en/site/*