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Proposal 1

Object

Use neural networks to identify roads from remote sensing images.

Motivation

I want to learn deep learning techniques and apply them on data related urban issues. In this project, I would like to build a neural network to identify roads from remote sensing images. The outcome of this project can contribute to open-source dataset of urban roads through automation rather than manual mapping. I had experiences of classifying different land uses using other machine learning techniques in R, so I want to learn about deep learning using Python.

Datasets Identified

SpaceNet, an open-source project for building machine learning algorithms on remote sensing imageries, provided several challenges with labeled training and testing dataset. Specifically, their third challenge features road network detection.

Dataset Summary

The dataset mentioned above contains satellite images from four cities: Las Vegas, Paris, Shanghai, and Khartoum. This project will focus on the Shanghai dataset first, but if there is extra time, other cities would also be considered. The Shanghai dataset contains WorldView-3 images that cover 1000 square kilometers of the city with 3537 km road center lines labeled (SpaceNet and Van Etten et al., 2018). Road label are provided in .geojson format. Types of roads are also differentiated in the labels. The dataset provides four types of images: multi-spectral images, panchromatic images, pan-sharpened multi-spectral images, and pan-sharpened RGB imagery. This project will focus on using pan-sharpened RGB images because those are the most intuitive ones for humans. The training set has 1198 images, and the test set has 399 images. However, the labels of the test set are not provided since the dataset was used for a challenge. Thus, for training the neural network in the next step, I will split the original training set into a new training set and a new testing set. The dimension of each image is 1300 x 1300 pixels, and each pixel has a 0.31m x 0.31m spatial resolution. In other words, each image covers a 400m x 400m area in Shanghai. The color depth is 48-bit, so each band (red, blue, and green) has a 16-bit color depth. That means a pixel value in each band ranges from 0 to 65535. Not all images come with perfect condition because some of the images were damaged as they were, so no labels were provided for those images.

Summary of Methods

My first step is convert the .geojson files in to binary masks – road pixels will be buffered from the vector strings and labeled with 1 while non-road pixels will be labeled with 0. The challenge organizer has provided some Python scripts for generating the masks, and they can be found in this GitHub repo. However, since the scripts were written four years ago and not never updated, some of the old version packages are broken. I tried to fix the codes and I am currently partially successful – I am

able to generate mask rasters on a ten-image sample set, while the codes themselves still ran into errors. Another thing that I noticed is the roads are buffer regardless of their types. So, a narrow street has the same width as a freeway does.

The second step will be to download some existing U-Net CNN algorithms and feed the model with sample data to understand the input, output, and their architectures. I will also try to replicate the architecture used by the winners of the challenge to see what works well for the road detection task.

The last step will be to build on the existing methods and incorporating other geographic features for training the model. One possible direction is to modify the mask generating process and mandate different buffer distances for different types of roads. Another potential method is to integrate features from OSM into the images, so the neural net will not only process the color bands information but also geographic information in pixels.

Deliverables

The final deliverable will be a report documenting the methods and result analysis. A GitHub repo containing all the data and codes will be created and maintained.

(One more thing…Totally random and perhaps out of the scope of this class)

I want to make my project more usable for real life data generation but probably not have enough time this semester to complete. The training images provided by SpaceNet have really fine spatial resolution, which means this kind of imagery products can be very expensive to get. I am thinking tailoring free images taken at roughly the same time and using the road labels provided by SpaceNet to train a new neural network model. The only thing is that free images have coarser spatial resolution, for example, one source I can think of now is the Sentinel imagery which has about 5m or 10m resolutions. By doing so, people can download free images of places of their own interest (from the same source though) and input it to my model to generate road data.

References

SpaceNet 3: Road Network Detection. https://spacenet.ai/spacenetroads dataset/
Van Etten, A., Lindenbaum , D., & Bacastow , T.M. (2018). SpaceNet : A Remote Sensing Dataset and Challenge ArXiv , abs/1807.01232