COMP/ELEC576 Final Project Proposal

Understanding Clouds from Satellite Images

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Background and Motivation

Climate change has been at the top of our minds and at the forefront of important political decision-making for many years. Scientists are continuing to do research on the world's ever-changing atmosphere.

Shallow clouds play a huge role in determining the Earth's climate. They're also difficult to understand and to represent in climate models. By classifying different types of cloud organization, researchers at the maximum Planck hope to improve our physical understanding of these clouds, which in turn will help us build better climate models.

There are many ways in which clouds can organize, but the boundaries between different forms of organization are murky. This makes it challenging to build traditional rule-based algorithms to separate cloud features. The human eye, however, is really good at detecting features—such as clouds that resemble flowers.

We hope to build a model to classify cloud organization patterns from satellite images, which can help scientists to better understand how clouds will shape our future climate, and reduce uncertainties in climate projections.

Dataset

The dataset and labels are images taken by two polar satellites, TERRA and AQUA, while each of them passes through a certain region and records the image from its own perspective. Due to the inconsistency of the coverage region, some images are stitched together and the black region indicates the inconsistency.

- train.csv - the run-length encoded segmentations for each image-label pair in the train_images
- train_images.zip - folder of training images
- test_images.zip - folder of test images; used to predict the segmentation masks of each of the 4 cloud types (labels) for each image.

Goals and Method

Our goal for this project is to build a model to classify cloud organization patterns from satellite images into four different categories. The challenge of segmentation lies in the fact that the boundary between different forms of the cloud is murky, and it's even harder to distinguish the boundary of two clouds with similar forms.

For each image in the dataset, we must segment the regions with four label names: *Fish, Flower, Gravel, Sugar*. And each segmentation, most likely, only contains a partition of the complete form of each label.

By visualizing the masks based on the run-length encoded segmentations for each image-label pair in the training dataset, we can get the intuition about how clouds segmented. Then it's necessary to augment the training data. After having the segmentation, we can classify the pattern of it with our four labels.

There are many potential models we can adopt to build the segmentation model. For example, we can use ResUNet to train our dataset, since ResUNet can demonstrate state of the art performance for pixel-level classification of objects which has an overwhelmingly good performance versus the models that emphasis feature level.

Expected Result

	Image_Label	EncodedPixels
	14792 unique values	
1	002f507.jpg_Fish	1 1
2	002f507.jpg_Flower	1 1
3	002f507.jpg_Gravel	1 1
4	002f507.jpg_Sugar	1 1
5	0035ae9.jpg_Fish	1 1
6	0035ae9.jpg_Flower	1 1
7	0035ae9.jpg_Gravel	1 1
8	0035ae9.jpg_Sugar	1 1
9	0038327.jpg_Fish	1 1
10	0038327.jpg_Flower	1 1

Fig 1.1 Sample submission format

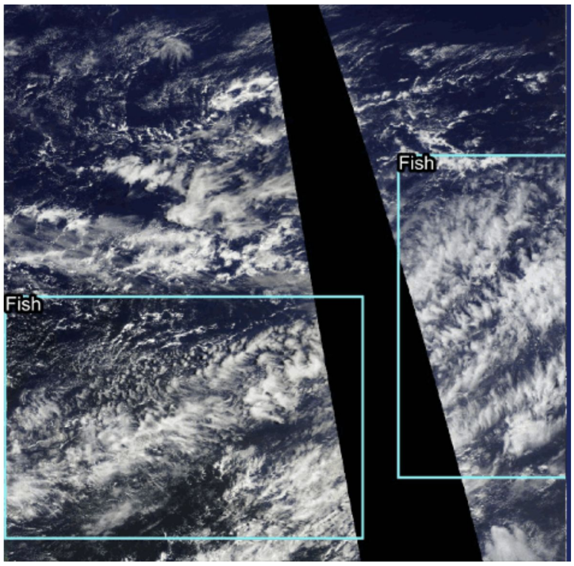

Fig 1.2 Sample segmentation output

Note: Each prediction masks is restricted down to 350 x 525 px

Feasibility and Limitations

Some related research as listed in the references has been done for this topic and achieved some positive results. Given the time frame for this class project, this should be a feasible project for us. However, due to the small footprint of the imager (MODIS) onboard these satellites, an image might be stitched together from two orbits. The remaining area, which has not been covered by two succeeding orbits, is marked black, which may potentially limit our ability to correctly segment and predict the pattern in the image.

References

Kaggle Competition: Understanding Clouds from Satellite Images
NASA Worldview
Sugar, Flower, Fish or Gravel: Crowd-sourcing Page for Labeling Cloud Patterns
ResUNet-a: a deep learning framework for semantic segmentation of remotely sensed data