

1 Instructions

This lab is about image classification. This is a complicated lab, so all steps of the lab have been demonstrated in `lab6demo.m` on a simple 3-band RGB image, `demo.jpg` (These two files are in the following directory: <http://topex.ucsd.edu/rs/lab6/demo/>). You should start by downloading these files and running this script to help you understand the steps of the lab. Please save your code for the following exercises to an m-file and send it to me via email (suadusum@ucsd.edu).

1.1 Background Information

Image classification generally has 3 steps:

- 1) Create a *training set* of pixels you identify as belonging to a certain group.
- 2) Classify all the pixels of an image into groups based on your training set.
- 3) Assess how well each pixel fits into a group, and identify pixels that do not fit well into any group.

For an overview of classification, read pages 296–300 in the textbook *Physical Principles of Remote Sensing* by Rees.

2 Exercises: MODIS

This section uses a composite image of Wilkins Sound in the Antarctic Peninsula made from the first seven spectral bands of data collected by MODIS (which stands for Moderate Resolution Imaging Spectroradiometer). The data for these bands are available at <http://topex.ucsd.edu/rs/lab6/modis/>, with the n -th MODIS band having the file name `modisn.dat` (e.g., calibrated radiances from MODIS band 1 are stored in `modis1.dat`). The files in this folder have been saved in ASCII format, and are a subset of a MODIS swath acquired on March 6, 2008 from the Terra satellite at 14:05 UTC. The nominal resolution is 500 m per image pixel. For further information about MODIS satellite data, you may read more at: https://lpdaac.usgs.gov/products/modis_overview

The seven MODIS bands that have been provided correspond to the following spectral ranges and applications:

band #	min (μm)	center (μm)	color	applications
1	0.620	0.670	Red	Absolute Land Cover Transformation, Vegetation
2	0.841	0.876	Near-IR	Cloud Amount, Vegetation Land Cover Transformation
3	0.459	0.479	Blue	Soil/Vegetation Differences
4	0.545	0.565	Green	Green Vegetation
5	1.230	1.250	Mid-IR	Leaf/Canopy Differences
6	1.628	1.652	Mid-IR	Snow/Cloud Differences
7	2.105	2.155	Mid-IR	Cloud Properties, Land Properties

Table 2.1: MODIS Spectral Bands

Download all the files for the individual bands and save them in the same directory as your m-file. There is also a file there called `lab6start_modis.m` which provides some skeleton code that will help with accomplishing the exercises.

This particular image was chosen because it depicts an episode of the disintegration of the Wilkins Ice Shelf in March 2008. A team led by researchers at the National Snow and Ice Data Center and the Scripps Institution of Oceanography wrote a journal article [1] detailing how this event was observed through remote sensing, which may be accessed at <http://dx.doi.org/10.1016/j.epsl.2008.12.027>.

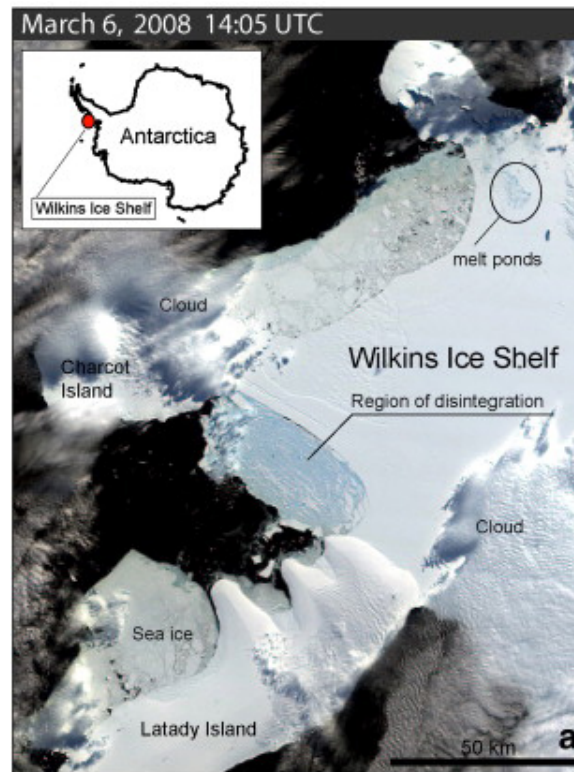


Figure 2.1: Descriptions of areas seen in the Wilkins Sound MODIS image (*Scambos et al, 2009*)

2.1 Exercise 1

Start by reading in all 7 bands of the Wilkins Sound MODIS image. Display all 7 bands individually, and also display an RGB image. You will use this RGB image to identify pixels for your training set.

2.2 Exercise 2

Decide how many groups or classes you'd like to sort your image into: e.g., sea ice, open ocean, clouds, etc. Create a 3-column matrix, called `tpix`, containing the row, column, and group number of each training pixel. To do this, use the Data Cursor feature in your RGB image window. Click on a pixel in the image and a box opens telling you the x-value (column), y-value(row), and R-, G-, and B-values of that pixel.

You will need to identify at least 2 training pixels per group. When you have identified the location of each training pixel, create a 7-column matrix, called `train`, that contains each of the 7 band-values for every pixel identified in `tpix`.

1) Before we can use MATLAB's `classify` function, the image data need to be reshaped into a vector with 7 columns (the 7 band values) and $nx*ny$ rows. For this MODIS image, $nx = ny = 400$, so the matrix of all pixels, `AllPix`, will have 7 columns and 160,000 rows. Also, in order to use `classify`, `AllPix`, `train`, and `group` must be data-type `double`, not `uint8`, so you will need to convert them.

2) Classify the image using MATLAB's `classify` function. This step may take the computer a minute. The syntax for this command is:

```
[class, err, misfit] = classify(AllPix, train, group);
```

`AllPix` is the matrix of 7 band-values for each pixel across the image, `train` is your training set, and `group` is which group each training pixel belongs to. `class` is a vector telling you which group each pixel belongs

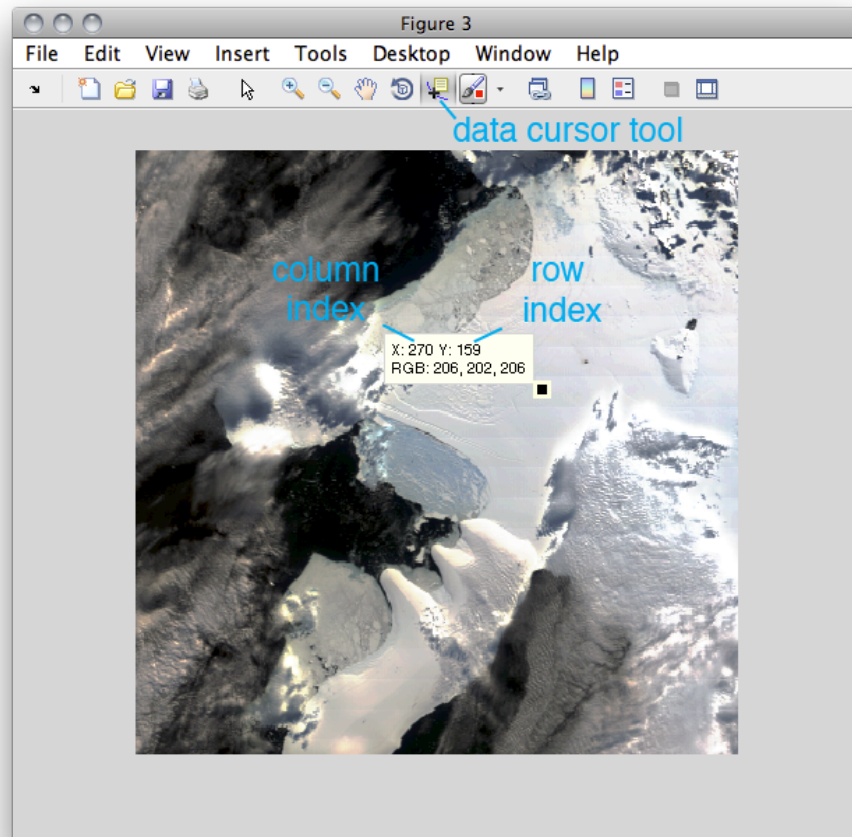


Figure 2.2: An example of using the Data Cursor tool to select a training pixel, in this case, possibly for an "ice shelf" classification group.

to, `err` is a dummy variable you can ignore, and `misfit` is a matrix telling you how well each pixel fits into each group (0=doesn't fit, 1= perfect fit).

3) To look at the classification and the misfit, we'll need to reshape `class` and `misfit` back into matrices $n \times ny$. Then we can look at the classification with `image` or `imagesc`. (You can use any colormap for this, or if you like you can create a colormap with a color for each group number that makes sense to you, e.g., white for clouds, blue for ocean. See `lab6demomodis.m` for how to do this.) Does the classification make sense? Is all the ocean in one group? All the clouds in another?

2.3 Exercise 3: OPTIONAL

BONUS: Look at the misfit matrix for each group/class. Find the maximum group-misfit value for each pixel: this tells you which pixels fit well into one of the defined groups. Find the pixels with maximum group-misfit value less than 0.9 (pixels that don't fit into any of the groups), and change their class value to a new group number. Now look at the class matrix again with `image` or `imagesc`. Where are the pixels that weren't well fit by any of your training set pixels?

2.4 Exercise 4: OPTIONAL

BONUS: Redo your classification with a different set of training pixels.

References

- [1] Ted Scambos, Helen Amanda Fricker, Cheng-Chien Liu, Jennifer Bohlander, James Fastook, Aitbala Sargent, Robert Massom, An-Ming Wu, Ice shelf disintegration by plate bending and hydro-fracture: Satellite observations and model results of the 2008 Wilkins ice shelf break-ups, *Earth and Planetary Science Letters*, Volume 280, Issues 14, 15 April 2009, Pages 51-60, ISSN 0012-821X, <http://dx.doi.org/10.1016/j.epsl.2008.12.027>