Astro 3310 Fall 2023

LAB #1

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Please copy this document to the REPORT sub-directory from the expanded [LAB1\_Data\_Package\_FA23.tar.gz](http://hosting.astro.cornell.edu/academics/courses/astro3310/LAB1_Data_Package_FA23.tar.gz). Then, edit it to write your answers in all the "\_\_\_\_\_\_" areas. When finished, be sure to upload ALL of the files within the REPORT directory to CANVAS.

Remember that you will only get credit for the files that you upload to CANVAS. Please make sure that you keep a Matlab workbook with all of the commands you used to answer the questions in the lab. Feel free to comment and organize your workbook so that it will be easy for us to follow your algorithms when we review your work. If you generate any functions for the lab, ensure that they are also in the REPORT sub-directory and properly called from the workbook file. For your convenience, there is a template for the workbook file already in the REPORT sub-directory.

YOUR NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Your NetID: \_\_\_\_\_\_\_\_\_\_

**Problem 1:Playing with the MPF Mosaic from the** [**MATLAB Image Tutorial**](http://hosting.astro.cornell.edu/academics/courses/astro3310/Matlab_images.html)

1. How many pixels are in the valid image portion the *img* array from the [**MATLAB Image Tutorial**](http://hosting.astro.cornell.edu/academics/courses/astro3310/Matlab_images.html)? That is, not counting the black background.

Hint: Make use of the **find** function

Answer: Number of pixels = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. In the *img* array, what is the range of values in the sky?

Hint: To select the pixels in the sky, you might make use of a mask array generated from an ROI created with **imfreehand** or **imrect** and **createMask**, as well as plots of column pixel values to look for discontinuities when you transition from land to sky coupled to the **find** command.

Answer: Range is from \_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

1. How many pixels represent the sky in *img*? What percentage of the image is the sky (i.e., (number of sky pixels) / (number of valid image pixels = answer to the first question) \* 100)?

Hint: See hint for question 2.

Answers: Number of sky pixels = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

The sky is \_\_\_\_\_\_\_\_\_\_% of the image.

1. Extract a square area from the *img* array, approximately centered at Barnacle Bill that is rougly 200 x 200 pixels in size. Call this variable "bbimage" and save it to a file named BBimage.mat in the appropriate format for the "mat" suffix.

Hint: Make use of **imcrop**.

Answer: Put your BBimage.mat in the REPORT sub-directory

1. Display your bbimage with the appropriate stretch to show what's hiding in Barnacle Bill's shadow. Generate a Matlab figure that you can paste below and save in Matlab’s .fig format in the REPORT sub-directory in a file name BBimage.fig. Also save the resulting stretched array (not the figure file, but the array itself) to an 8-bit TIFF file named BBimage.tiff.

Hint: Use the examples from the [**MATLAB Image Tutorial**](http://hosting.astro.cornell.edu/academics/courses/astro3310/Matlab_images.html)

Answer: Put your BBimage.fig and BBimage.tiff files in the REPORT subdirectory and insert a copy of your Matlab figure file here.

**Problem 2: Playing with a Cassini RADAR Image of Titan’s Lakes**

1. Using the **read\_isis.m** and **pds\_label\_parse\_v3.m** functions stored in the SUBROUTINES sub-directory, load the ISIS cube of the T28 Cassini Synthetic Aperture Radar (SAR) image stored in the DATA sub-directory (t28\_reproc2\_corramb\_bidr.s0nsqt\_corr.128) into Matlab. Both **read\_isis** and **pds\_label\_parse\_v3** include headers that explain their operation. Use **pds\_label\_parse\_v3** to generate a Matlab structure filled with header information and determine the calendar date that the SAR image was acquired and how long the spacecraft took to acquire it.

Hint: **info=pds\_label\_parse\_v3(‘t28\_reproc2\_corramb\_bidr.s0nsqt\_corr.128’);**

Answer: Date of SAR image acquisition = \_XX/XX/20XX\_\_

Duration of SAR image acquisition = \_\_\_\_\_\_\_\_ minutes

1. One of Titan’s largest lakes, Jingpo Lacus, is centered near LINE 13402, SAMPLE 992. When you display the image as loaded using **read\_isis,** the line dimension is along the x-axis of a display figure generated using **imagesc.** This is the along-track direction of the swath. We commonly display the transpose of the array when making figures so that the along-track direction is vertical in the figure. If you do this, then the LINE direction is parallel to the y-axis instead. Regardless of how you display the image, extract a square area from the SAR image array, approximately centered on Jingpo Lacus that is roughly 500 x 500 pixels in size. Call this variable “jingpo” and save it to a file named Jingpo.mat in the appropriate format for the “mat” suffix. After you have extracted the sub-array, type “**clear sar\_img”** (where **sar\_img** is the variable name you read the data into with **read\_isis**) to free up the computer memory being taken up by the large array that you just cropped.

Hint: When displaying the SAR swath in order to find Jingpo, a decent linear stretch is 0 to 1. If you use a logarithmic stretch in dB (sar\_dB = 10\*log10(sar\_img)), a decent starting point is -20 to 0.

Answer: Put your Jingpo.mat in the REPORT sub-directory

1. SAR images are subject to a multiplicative, exponentially distributed, noise known as speckle. While there are several techniques, including multiple looks and spatial averaging, that are used to reduce speckle it is still prevalent in the T28 image of Jingpo. While the dataset you are working with has already been down-sampled by a factor of two, use the **fspecial** and **imfilter** commands to further smooth your Jingpo array using a 2x2 box car. Create a Matlab figure that shows a side-by-side comparison of the original and smoothed arrays. Save the figure as Jingpo\_Smoothed.fig and insert a copy of the figure file here.

Hint: Use the examples from the [**MATLAB Image Tutorial**](http://hosting.astro.cornell.edu/academics/courses/astro3310/Matlab_images.html)

Answer: Put your Jingpo\_Smoothed.fig file in the REPORT subdirectory and insert a copy of your Matlab figure here.

1. Display your smoothed Jingpo image with the appropriate stretch to show the structure in the lake (i.e., try to maximize contrast amongst the dark pixels). Generate a Matlab figure that you can paste below and save in Matlab’s “.fig” format in the REPORT sub-directory in a file name Jingpo.fig. Also save the resulting stretched array (not the figure file, but the array itself) to an 8-bit TIFF file named Jingpo.tiff. What do you think you are seeing in the lakebed?

Hint: Use the examples from the [**MATLAB Image Tutorial**](http://hosting.astro.cornell.edu/academics/courses/astro3310/Matlab_images.html)

Answer: Put your Jingpo.fig and Jingpo.tiff files in the REPORT subdirectory and insert a copy of your Matlab figure here.