

Remote Sensing Class Activities

10 Points Each

Introduction

The goal of these short activities is to reinforce specific topics covered in the lecture and/or lab. They are meant to be completed during class time and to facility discussion and engagement.

Activity 1: Remote Sensing Article Search

Since the field of remote sensing changes rapidly, it is important to understand where to look to obtain up-to-date information relating to data and techniques. This information is commonly found in peer reviewed academic journal articles. In this exercise you will search for academic journal articles using Google Scholar (<https://scholar.google.com/>). Fill out the information associated with the articles you find in the tables below. Make sure the articles are (1) published in a peer reviewed academic journal and (2) relate to the topic of interest.

Find three example articles relating to the use Sentinel-2 Multispectral Instrument (MSI) imagery for mapping or differentiating forest community types. Only include articles published between 2018 and 2022. Fill out the information about the articles in the table below. (1 Point Each)

Article Name	Journal Name	Publication year	Number and/or volume	Number of citations

Find three example articles relating to the use light detection and ranging (LiDAR) data for mapping or detecting archeological features. Only include articles published between 2018 and 2022. Fill out the information about the articles in the table below. (1 Point Each)

Article Name	Journal Name	Publication year	Number and/or volume	Number of citations

Find four example articles relating to the use of synthetic aperture radar (SAR) data for mapping or monitoring flooding. Only include articles published between 2018 and 2022. Fill out the information about the articles in the table below. (1 Point Each)

Article Name	Journal Name	Publication year	Number and/or volume	Number of citations

Activity 2: Photogrammetry Problems

Answer the following questions using the provided information and photogrammetric equations.

Assume that two road intersections shown on a photograph can be located on a 1:24,000 scale topographic map. The measured distance between the intersections is 50.8 mm on the map and 80.6 mm on the photograph.

Question 1: What is the scale of the photograph? (1 Points)

Question 2: At that scale, what is the length of a fence line that measures 100.2 mm on the photograph? (2 Points)

A camera equipped with a 180 mm focal length lens is used to take a vertical photograph from a flying height of 3,000 m above ground level. The terrain is flat and located at an elevation of 700 m.

Question 3: What is the scale of the photograph? (1 Points)

Assume that a vertical photograph was taken at a flying height of 4,500 m above sea level using a camera with a 180 mm focal length lens.

Question 4: Determine the photo scale at point A, which lies at an elevation of 1,200 meters. (1 Points)

Question 5: Determine the photo scale at point B, which lies at an elevation of 1,960 meters. (1 Points)

Question 6: What ground distance corresponds to a 13.2 mm photo distance measured at each of these elevations? (1 Points)

A camera equipped with a 160 mm focal length lens is used to take a vertical photograph from a flying height of 3,000 m above ground level. The average elevation of the terrain is 400 meters.

Question 7: What is the average scale of the photograph? (1 Points)

Assume the relief displacement for a water tower is 1.78 mm, and the radial distance from the center of the photo to the top of the tower is 51.22 mm. The flying height is 2,000 m above the base of the tower.

Question 8: Find the height of the tower. (2 Points)

Activity 3: Sensor Characteristics

Use this website to answer the following questions about the MODIS sensor:

<https://modis.gsfc.nasa.gov/about/specifications.php>

1. How many bands does the MODIS sensor have in the SWIR range? (1 Point)
2. How many bands does the MODIS sensor have in the NIR range? (1 Point)
3. What is the range of spatial resolutions (i.e., cell sizes) of the MODIS bands? (1 Point)

Use this website to answer the following questions about the proposed Landsat Next sensor:

<https://www.usgs.gov/landsat-missions/landsat-next>

4. How many thermal bands will the proposed mission provide? (1 Point)
5. What is the range of spatial resolutions (i.e., cell sizes) of the proposed bands? (1 Point)
6. What are the primary uses of the red edge bands? (1 Point)
7. What are some of the proposed uses of the thermal bands? (1 Point)
8. What is the proposed revisit time for the mission and how does this compare to Landsat 8 and 9? (1 Point)

Use this website to answer the following questions about the PlanetScope constellation: <https://docs.sentinel-hub.com/api/latest/data/planet/planet-scope/>

9. What bands do these sensors provide and what is the range of spatial resolutions (i.e., cell sizes) of the provided bands? (1 Point)
10. What is the return interval? (1 Point)

Activity 4: Contrast Enhancement

You have been provide with an Excel Spreadsheet (**contrastStretch.xlsx**) that contains the following sheets: original, toLinear, to1SD, and to2PClip. In the original sheet, each pixel holds a digital number (DN) value corresponding to a 10 m spatial resolution near infrared channel from the Sentinel-2 Multispectral Instrument (MSI). A color ramp has been applied to the cells to generate a grayscale image.

The cells values have been copied into the other three sheets. Your tasks is to modify these cell values using different contrast stretch methods. This will require calculating statistics from the cells in the original sheet and using these values, the copied cell values, and contrast enhancement equations to modify the DN values in the other sheets.

Task 1: Convert the DN values represented in the toLinear sheet using a linear transformation. The largest value should be scaled to 255 and the lowest value should be scaled to 0. (2 Points)

Task 2: Convert the DN values represented in the to1SD sheet using a 1 standard deviation stretch. Small values that are less more than 1 standard deviation from the mean should be scaled to 0. Large values that are more than 1 standard deviation from the mean should be scaled to 255. All other values should be scaled linearly from 0 to 255. (4 Points)

Task 3: Convert the DN values represented in the to2PClip using a 2% clip stretch. The highest 2% of values should be scaled to 255 while the lowest 2% should be scaled to 0. All other values should be linearly scaled from 0 to 255. (4 Points)

Deliver the edited Excel file with the DN values in the sheets modified as specified above.

Activity 5: RMSE Activity

You have been provided with an Excel spreadsheet called **rmseData.xlsx**. It contains four columns and a total of five measurements. The Correct X and Correct Y columns represent the correct coordinates for point locations while the Predicted X and Predicted Y columns represent the predicted coordinates generated using a georeferencing process. Use these values and cell math within the spreadsheet to calculate the RMSE_x, RMSE_y, and total RMSE associated with the georeferencing result. Provide your edited sheet with the calculations performed and the answers included. (10 Points)

Activity 6: Band Ratios

You have been provided with an Excel spreadsheet (**ls8SpectralData.xlsx**) that includes spectral values from the Landsat 8 OLI sensor at 8 locations of varying land cover: barren, water, grass, impervious surface, forest, snow, and burned (pixel that experienced a forest fire). These data were extracted from an image collected in April and near Los Angeles in southern California. They represent leaf-on conditions. The digital number (DN) values have not been converted to surface reflectance, as is generally preferred when calculating band ratios. However, the DN values will be sufficient for this simple exercise.

The class column provides the land cover class of the sample while the Blue Edge, Blue, Green, Red, NIR, SWIR1, and SWIR2 columns provide the DN values.

Task: Use the provided DN values and cell math to calculate the following band ratios: simple ratio, normalized difference vegetation index (NDVI), normalized difference water index (NDWI) after Gao, NDWI after McFeeters, normalized difference snow index (NDSI), normalized burn ratio (NBR), visible atmospherically resistant index (VARI), and normalized difference built-up index (NDBI). (4 Points)

Question 1: Based on your NBR calculations, what other land cover types might be confused with burned areas when using this index? Explain your reasoning based on the spectral reflectance properties of the different cover types. (1 Point)

Question 2: Based on your NDBI calculations, what other land cover types might be confused with built-up areas (i.e., impervious surfaces) using this ratio? Explain your reasoning based on the spectral reflectance properties of the different cover types. (1 Point)

Question 3: Based on your NDSI calculations, what other land cover types might be confused with snow? Explain your reasoning based on the spectral reflectance properties of the different cover types. (1 Point)

Question 4: Based on your NDWI calculations, what land cover types might be confused with water? Explain your reasoning based on the spectral reflectance properties of the different cover types. (1 Point)

Question 5: Of the two NDWI methods, which was best at differentiating water from the other land cover types represented in the spreadsheet? Explain your reasoning. (1 Point)

Question 6: Of the NDVI and VARI methods, which did the best job at differentiating vegetation (the forest and grass samples) from the other land cover types represented in the sheet? Explain your reasoning. (1 Point)

Activity 7: Convolution Operations

The following 6×6 grid represents an array of DN values making up a small proportion of an image. Apply the three 3×3 kernels beneath it to the array and populate the 4×4 arrays with the results. Note that the outer most rows and columns are not included in the output arrays since they do not have a full set of neighboring cells. In other words, none of the outer cells are included in the output. (10 Points)

101	96	103	106	107	111
98	89	93	113	108	112
95	87	10	15	101	103
94	91	13	11	100	104
103	89	94	106	105	110
100	97	97	104	101	113

1	2	1
2	4	2
1	2	1

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	-0	2
-1	0	1

Activity 8: Accuracy Assessment Problems

You have been provided with an Excel file (**accuracyAssessment.xlsx**) that includes two sheets. The first sheet (Multiclass) provides a confusion matrix for a multiclass classification with 10 classes (annual crop, sea/lake, forest, herbaceous vegetation, highway, industrial, pasture, permanent crop, residential, and river). The second sheet (Binary) provides a confusion matrix for a binary classification with a positive and negative class. Blank cells have been provided to calculate summary metrics from the tables.

Task 1: Calculate overall accuracy, the Kappa statistic, and all class user's and producer's accuracies for the multiclass classification using the provided confusion matrix and cell math. (6 Points)

Task 2: Calculate recall, precision, specificity, negative predictive value (NPV), and F1-score using the binary confusion matrix and cell math. (4 Points)

Provide the edited Excel file that includes all of your calculations and results.