

## Remote Sensing for Earth Observation: Practical 4- Unsupervised classification

### Aims and objectives for practical 4 and 5

The purpose of this and the following practical is to classify the land cover types of Hong Kong harbour using two different classification approaches. In this exercise we will look at how to produce a thematic map using unsupervised classification.

### Core tasks for this session

1. Exploring the Landsat image and viewing the data in feature space
2. Undertake an unsupervised classification using IsoData
3. Interpret the results of unsupervised classification
4. Create a suitably labelled thematic map


After completing practicals 4 and 5 you should be able to

- Use ENVI to perform simple classification of remotely sensed imagery
- Critically discuss the advantages and disadvantages of supervised and unsupervised classification
- Create an output map using ENVI

## Locating the Data for this Practical

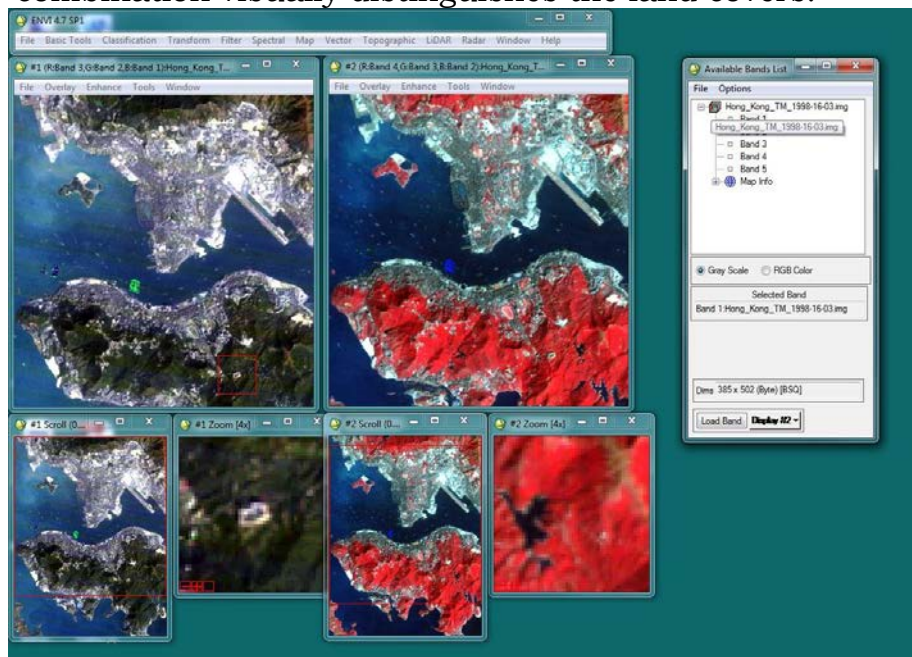
Data for this practical should be downloaded in the usual manner.

### Images Used in this Practical

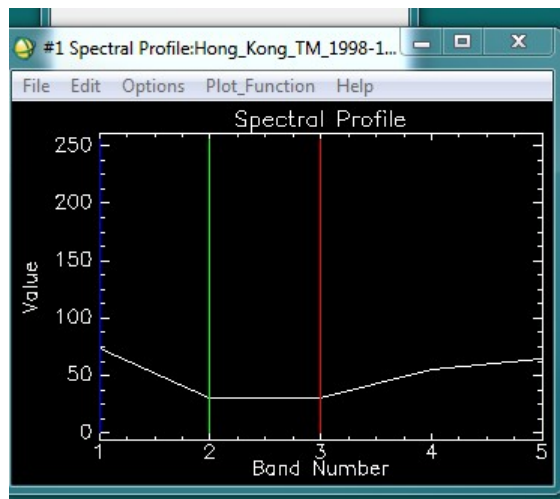
File name	Hong_Kong_TM_1998-03-16	Quick look (RGB, 3,2,1)
Location	Hong Kong	
Sensor	Landsat Enhanced Thematic Mapper (ETM)	
Spatial	30 x 30 m	
Temporal	March 1998	
Spectral	Band 1 = Blue (0.45 - 0.52 $\mu\text{m}$ ) Band 2 = Green (0.52 - 0.60 $\mu\text{m}$ ) Band 3 = Red (0.63 - 0.69 $\mu\text{m}$ ) Band 4 = NIR (0.76 - 0.90 $\mu\text{m}$ ) Band 5 = SWIR (1.55 - 1.75 $\mu\text{m}$ )	

## Exploring the Landsat Image

1. Open **ENVI Classic** : ENVI 5.x >Tools> ENVI Classic (64bit)
2. Load **Hong\_kong\_TM\_1998-16-03** into a new display as a true colour composite. **File/ Open Image File**. Then select RGB bands 3, 2, 1 **Load RGB**.
3. Explore the image to get an understanding of the different spectral properties of the different types of land cover and how best to view them.
  - a. **Review Image colours**. Using the available bands list menu, display the image in new windows using different band combinations (false colour composites) to see which combination visually distinguishes the land covers.



- b. **Cursor Location/Value**. Use the Cursor location/value function to preview image values in all 5 bands. **Right click in the image display to open the dialog**. Move the cursor around the image and examine the data values for specific land covers. Note the relation image colour and data value.
- c. **Examine Spectral plots**. Use ENVI's spectral profiling to examine the spectral characteristics of the data. **Right click in the image display/ Z profile (spectrum)**.



Get a feel for the spectral shape of the different areas in the image. Pay attention to the location of the image bands in the spectral profile, marked by the red, green and blue lines in the plot.

**Question: Do you think this image has undergone radiometric calibration and atmospherically correction?**

## Viewing the data in feature space

By now you should be familiar with spectral signatures and what they represent. They allow us to determine regions of the electromagnetic spectrum which are suitable for discriminating between cover types. It is sometimes useful to be able to compare two (or more) spectral regions (bands) to aid image interpretation. Indeed, most classification procedures utilise many image bands.

Scatter plots can be used to display two image bands in a plot window. From this plot, and some knowledge of spectral signatures, we can determine the general cover types as well as their location within the image.

We will now produce a series of scatter plots using the Hong Kong image

1. Open **ENVI Classic** : ENVI 5.x >Tools> ENVI Classic
2. Load the image into a new display
3. Select **Tools / 2D Scatter Plots** from the menu in the main image window
4. Chose band 3 from the Hong Kong image as the 'X' axis and band 4 as the 'Y' axis
5. Click **OK**. A scatter plot (or a plot of the *feature space*) of the brightness values of band 3 plotted against the brightness values in band 4 should appear. Note that, points in the scatter plot represent pixels from the *Main* image window only.
6. Now position the mouse cursor anywhere in the main window and drag it around with the left button depressed. Pixel values contained in a ten square pixel region surrounding the crosshair will be highlighted in red on the scatterplot. Moving the cursor about in this way gives a "dancing pixels" effect.

7. We can also do the opposite, that is, select pixels within the scatter plot and highlight them in the image. To draw a polygon on the scatter plot, place the mouse cursor in the scatter plot window and click the **left mouse** button, then move to another location and click the **left mouse** button again. A red line should appear linking the two points. Note that each time you click the left button you create a new point which is linked to the previous point by a line. To close the region i.e. draw a line from the last created point to the initial point, click the **right** button. To draw additional polygons of different colours, right click on the scatter plot and select **new class**
8. Use the 2D Scatter Plot function to compare all combinations of the ETM bands e.g. 1 & 2, 2 & 3, 1 & 3, 3 & 4, 3 & 5 and 4 & 5 and answer the following question

- **Formative question 1:**

- ❖ ***Which bands do you think would be most useful for the classification of the Hong Kong harbour and why. Hint use scatter plots between different bands to determine the differentiation between the bands***

## **Unsupervised Classification**

*Unsupervised Classification* is a technique for classifying land cover features in a digital image. In the unsupervised approach, the dominant spectral response patterns that occur within an image are extracted and the desired information classes are identified through collection of ground data – by visits to the site in the image.

In ENVI *Unsupervised Classification* is provided by way of two modules named IsoData and k-means. In this practical we will use IsoData.

## **TASK 1: Unsupervised Classification Using IsoData**

1. Open **ENVI Classic** : ENVI 5.x >Tools> ENVI Classic
2. Load **Hong\_kong\_TM\_1998-16-03** into a new display as a true colour composite
3. On the main ENVI toolbar select **Classification/ Unsupervised/ IsoData**
4. Specify **Hong\_Kong\_TM\_1998-16-03** as the input file click **OK**.

5. Fill in the input and output information in the Unsupervised Classification dialog box. Set the **Number of Classes** from minimum of 5 to maximum 10 and the **Maximum Iterations** to 1.

Maximum Iterations is the number of times that the IsoData utility will re-cluster the data. It prevents the utility from running too long, or from getting stuck in a cycle without reaching the convergence threshold. The convergence threshold is the maximum percentage of pixels whose cluster assignments can go unchanged between iterations. This prevents the IsoData utility from running indefinitely.

6. Select Choose and navigate to your home directory, name the file **class\_isodata\_1** and click **OK and OK** to begin the process and save the output.
7. After you have run the unsupervised classification with the above parameters, re run the classification but change the Maximum Iterations to **10**. Save this file as **class\_isodata\_10**
8. Load each classification image into a new display (make sure you know which is which!). Now we will derive the statistics for each “class” in each of the two classified images. On the main ENVI toolbar select **Classification/Post Classification/Class Statistics Overlay/Classification/** select your file named **class\_isodata\_1** as your input file. Click **OK**
9. Select the **original Landsat TM** file as your “**Input file associated with classification image**” and click **OK**. You want to see the statistics for all classes so **Select all classes** and click OK. A statistics file combining information from the original and classified images will appear. To add a key to the plot right click on the plot and select “**plot key**”. Click the drop down box labeled **stats for** to look at the stats for each individual class. You will need to scroll down in the text box below the graphs to see the stats.
10. Repeat the above steps to generate a statistics file for the file **class\_isodata\_10**. Compare the outputs from the two classifications visually and statistically.

### ❖ ***Formative question- 2***

***What differences do you notice between the unsupervised classification with a single iteration and the unsupervised classification with ten iterations? Explain why this is the case***

## **TASK 2: Post classification combination of classes**

For the rest of this practical we will only use the classified image created with 10 iterations i.e. **class\_isodata\_10**.

We want the final output map to contain just the following 5 classes:

1. Thick vegetation
2. Sparse vegetation (grass)
3. Urban
4. Bare soil/concrete
5. Water

To do this we need to decide which classes to merge in order to produce these five classes

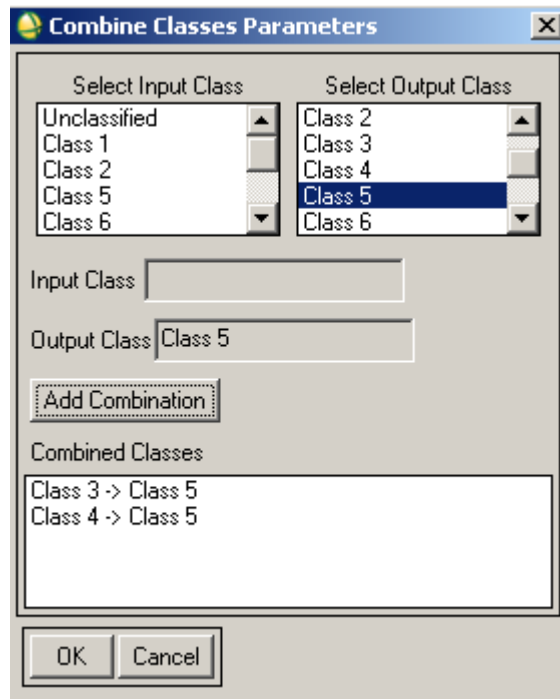
1. Generate class statistics to help identify which classes relate to what land cover types (using the procedure outlined in task 1)
2. On a sheet of paper mark down the classes which you wish to merge. For example classes 1 and 2 are both water and therefore can be merged into a single water class. In some cases merging may not be necessary as the existing class may relate well to what you want to map.
3. Once you have determined the classes to be merged select **Classification/Post classification/combine classes** from the ENVI main menu. Select your classified image i.e. **class\_isodata\_10** as the input file and click **OK**.
4. The **Combine Classes Parameters** dialogue window appears, this is where you combine your classes for merging.

For example if you would like to combine three classes i.e. classes 3, 4, 5

- Select/ highlight the **input class**, in this example class 3, and the **output class** (i.e. what class do you want it to be combined with and appear as in the final image) in this example class 5
- Add this combination to the combined class list by clicking the **Add Combination** button, your class combination appears in the Combined Classes text box.
- Then combine class 4 with class 5 (as above) and again select Add combination. Classes 3, 4 and 5 are now combined and will appear in the final output with the label Class 5.

You should continue in this way until all classes which need to be combined are added to the combined classes window. Then click **OK**.

5. Click the double arrow in the window that opens and **select YES as the Answer to Remove Empty Classes?** Navigate to your home directory and save the image file as **class\_isodata\_combined**



6. Now we will change the class colours and names to make the classification easier to visually interpret. If not already loaded load `class_isodata_combined` into a new display. **Select Tools/Color mapping/Class color mapping** and edit the information to produce 6 classes with the following names:
  1. Unclassified with colour Black (to change colour click on colors 1-20 and select the relevant colour)
  2. Water with colour Blue
  3. Urban with colour Yellow
  4. Thick Vegetation with colour Green
  5. Sparse Vegetation (grass) with colour Sienna
  6. Bare soil/concrete with colour Cyan

*(NB if you can't remember, look back at your notes to determine what land cover your merged classes represent).*

7. When completed select **options** from the toolbar and "Save changes". This will save your label and colour changes.
8. To overlay the classified image onto your reflectance image, open the reflectance image in a new display (if not already open), select **Overlay/Classification** and select your classified image. Clicking the tick boxes will toggle the various layers on/off. The options menu will allow you to see the statistics of each class and to change the transparency.

### TASK 3: Map composition

Map composition is a process of creating an image-based map from remote sensing image and interactively adding key map components. In ENVI, the map composition process usually consists of basic template generation followed by interactive customisation using the ENVI QuickMap utility.

QuickMap allows you to set the map scale and the output page size and orientation to select the image spatial subset to use for the map; and to add basic map components such as map grids, scale bars, map titles, logos, projection information, and other basic map annotation.

You are referred to the ENVI tutorial “Map composition” for guidance on how to create an effective map in ENVI. This document can be found in the folder where the practical data is stored.