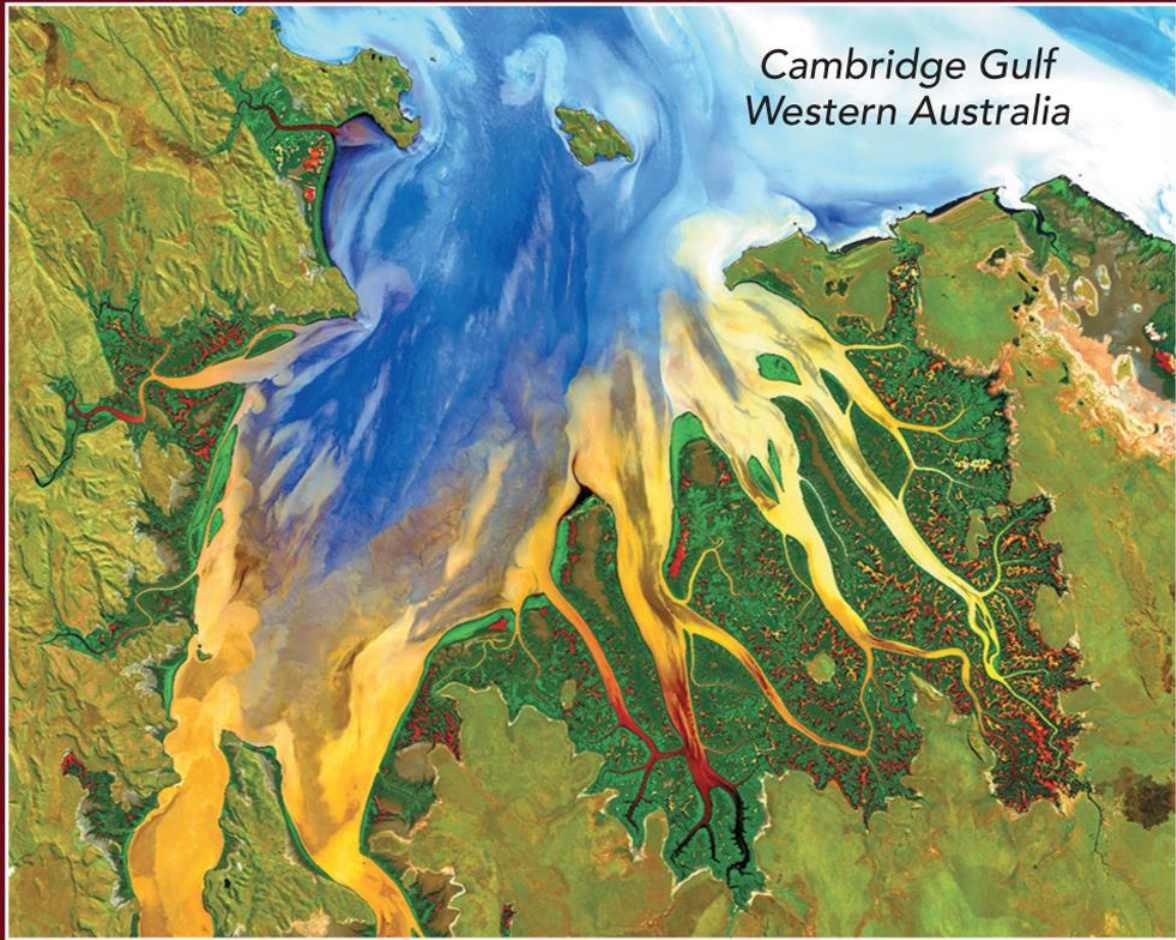


COURSE: SATELLITE IMAGE PROCESSING

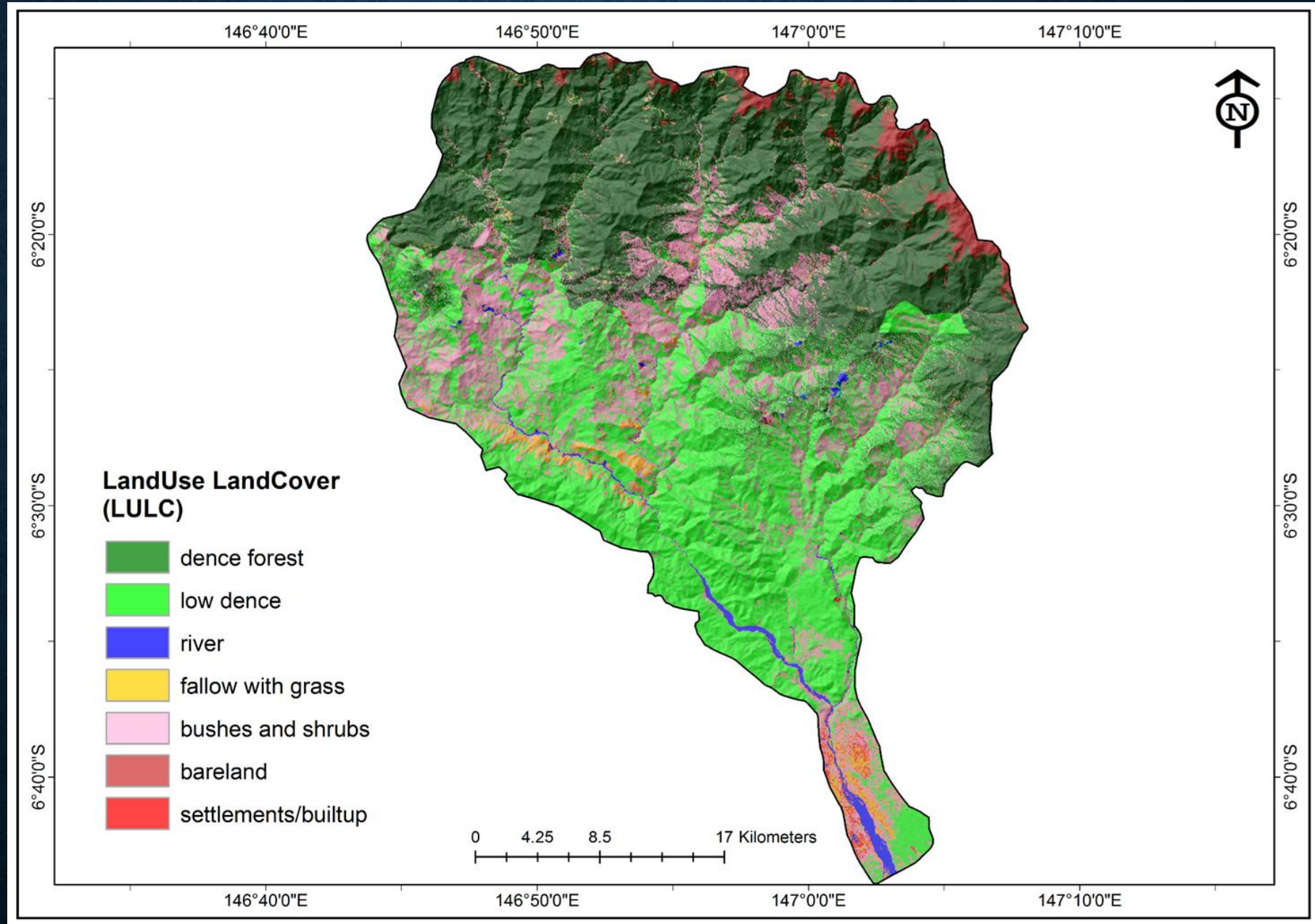
LECTURE 9 – Satellite Remote Sensing Image Classification

Lecturer: Dr. Tingneyuc Sekac, Ph.D. PNG University of Technology

Remote Sensing Digital Imagery Pattern Recognition



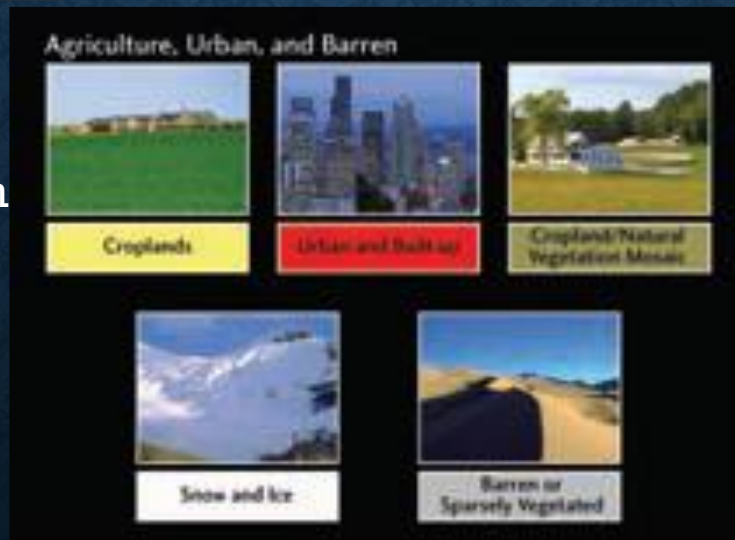
Feature Classification and Extraction



Feature Classification and Extraction



Land-cover map of North America produced from Terra MOD IS 1×1 km data collected between November 2000 and October 2001.



Object Base Image Classification



a. Color-infrared aerial photography (1 × 1 ft. resolution).



b. Segmentation scale 20.



c. Classification of individual objects.

Legend	Class
	Buildings
	Dock
	Exposed Mudflat
	Grass
	<i>Juncus</i>
	<i>Salicornia</i> /Harbottom
	Shadow
	Shrub-Scrub/Forest
	Tall Creekside <i>Spartina alterniflora</i>
	Intermediate <i>Spartina alterniflora</i>
	Water

Satellite Image Classification techniques

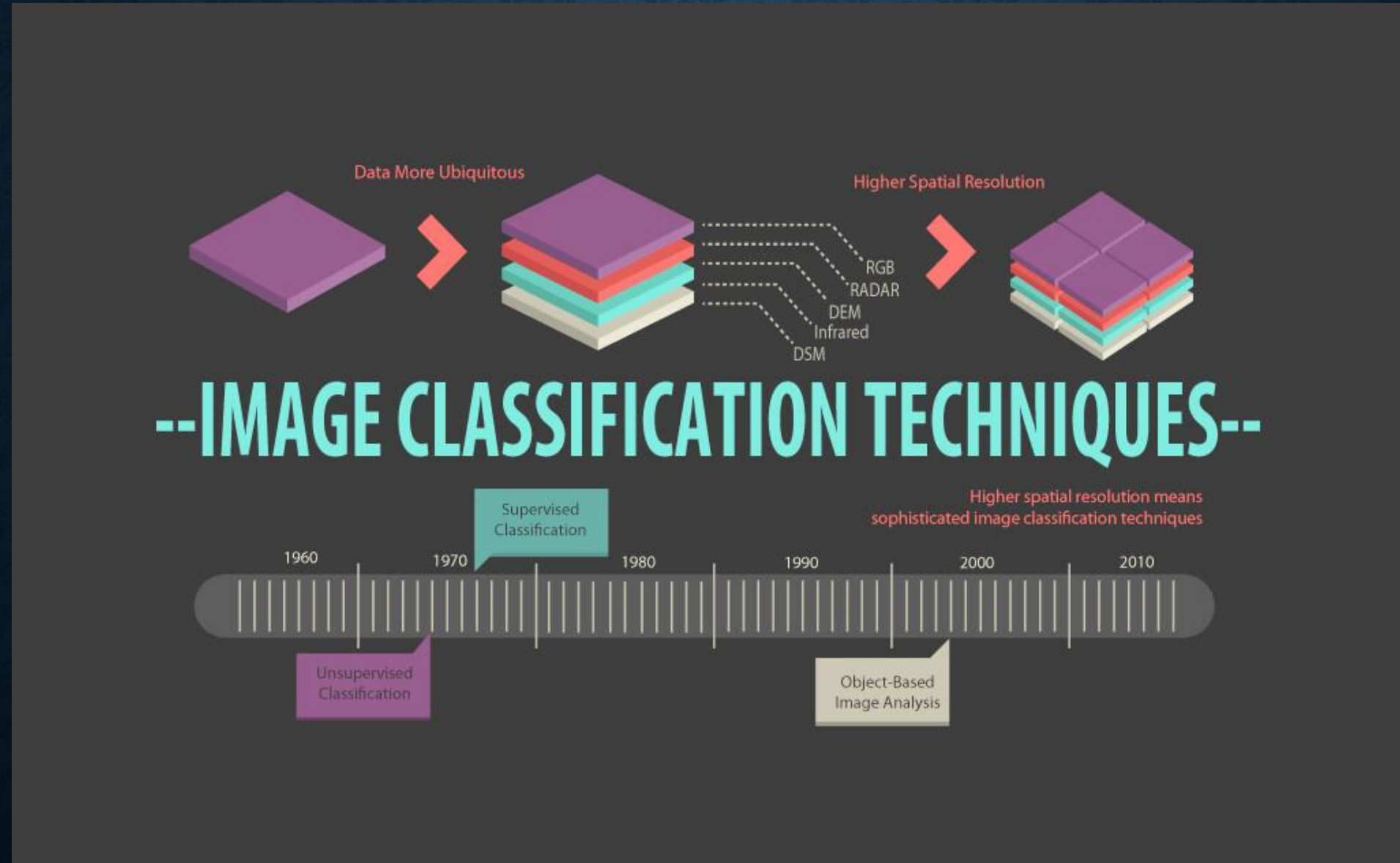
Commonly Used image classification techniques in Remote Sensing are:

1. Unsupervised image classification
2. Supervised image classification
3. Object-based image analysis

Unsupervised and supervised image classification are Pixel-based.

Object-based is about object segmentation using shapes, textures/patterns.
Utilize high spatial resolution imagery.

Satellite Image Classification Techniques



Unsupervised Image Classification Techniques

- ❑ Unsupervised classification (also commonly referred to as clustering) is an effective method of partitioning remote sensor image data in multispectral feature space and extracting land-cover information
- ❑ Unsupervised classification normally requires only a minimal amount of initial input from the analyst.
- ❑ This is because clustering does not normally require training data.

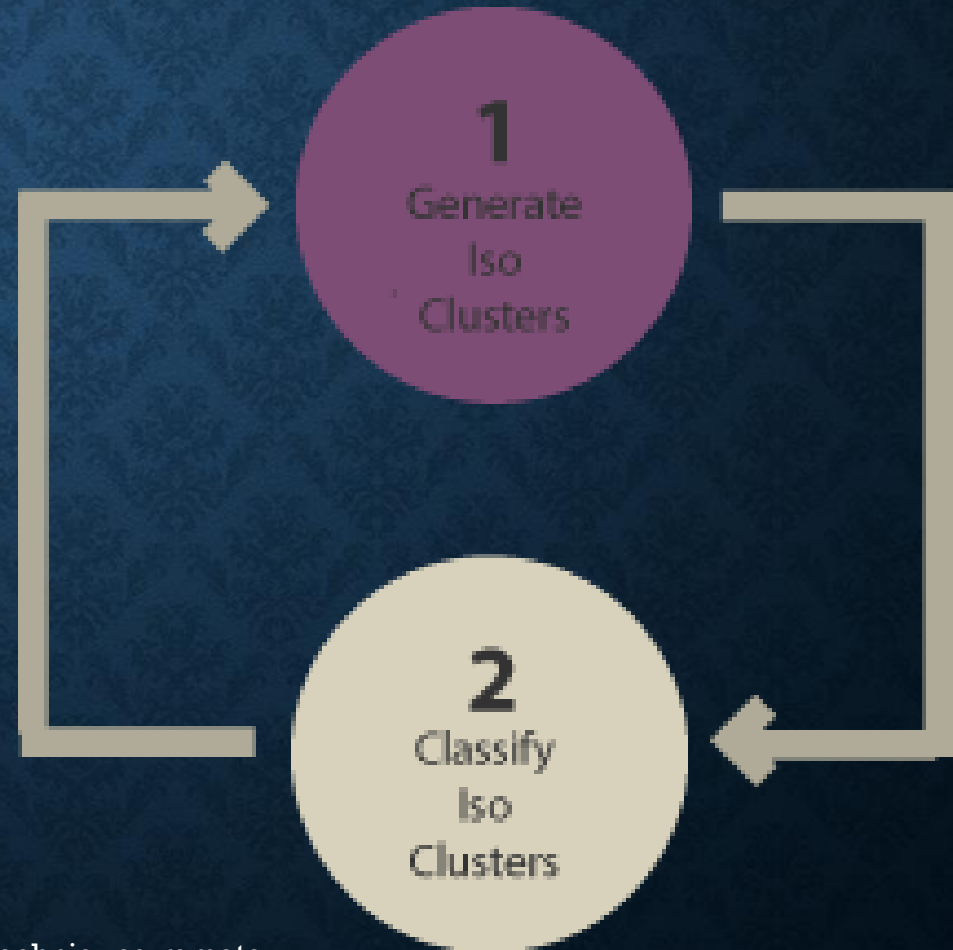
Unsupervised Classification

- ❑ Unsupervised classification is the process whereby numerical operations are performed that search for natural groupings of the spectral properties of pixels, as examined in multispectral feature space.
- ❑ The clustering process results in a classification map consisting of m spectral classes.
- ❑ The analyst then attempts to assign or transform the spectral classes into thematic information classes of interest (e.g., forest, agriculture, urban, etc...).

Steps of Unsupervised Classification

The two basic steps for unsupervised classification are:

1. Generate clusters
2. Assign classes



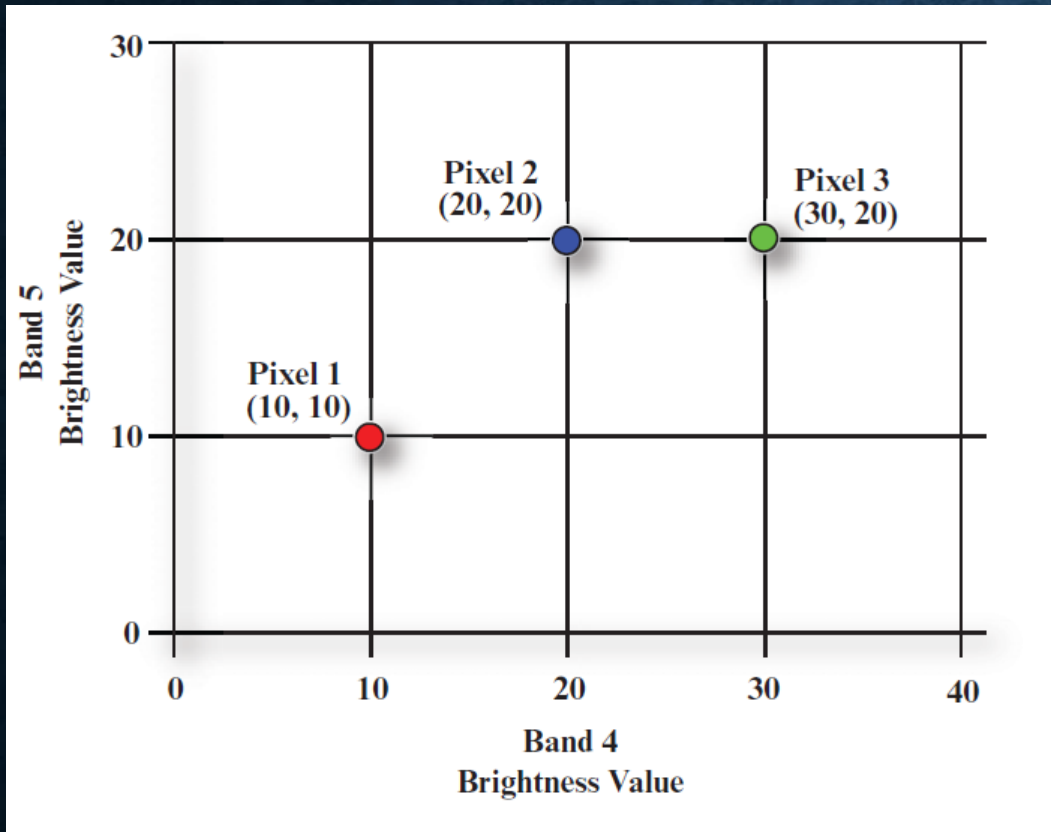
Commonly Used Unsupervised Classification Algorithm

1. K-means (clusterization)

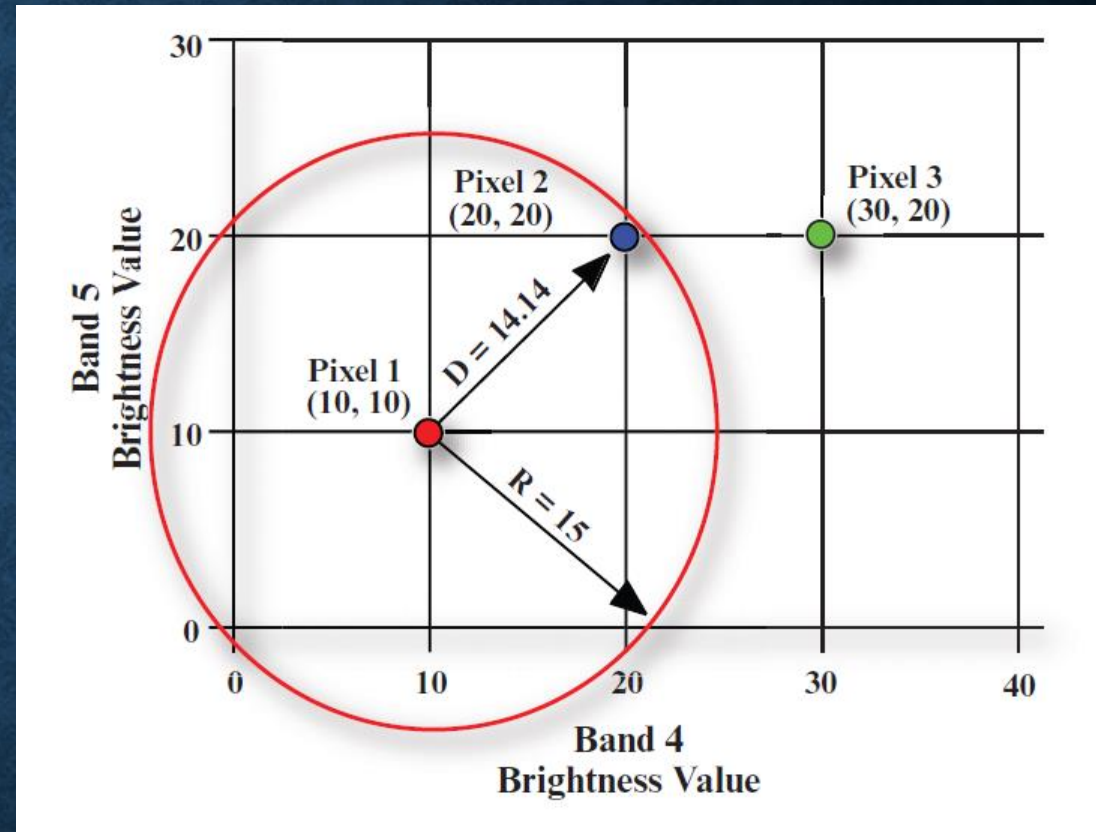
2. ISODATA

- ✓ After picking a clustering algorithm, you identify the number of groups you want to generate.
- ✓ Create 8, 20, or 42 clusters.
- ✓ These are unclassified clusters.
- ✓ The next step is to manually assign land cover classes to each cluster.

Steps of Unsupervised Classification

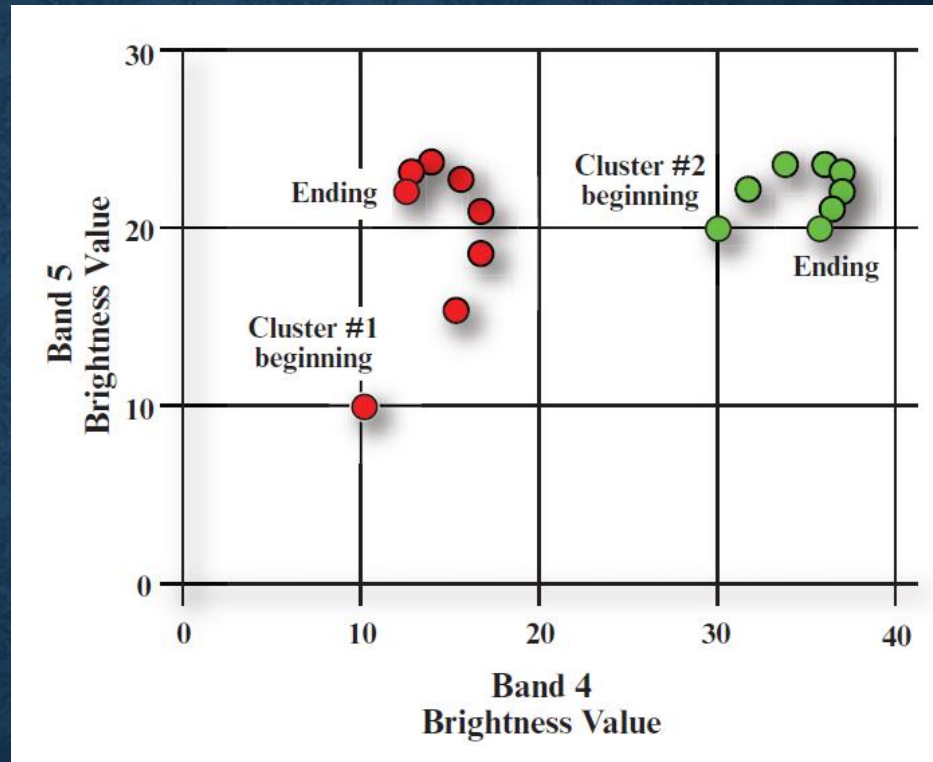
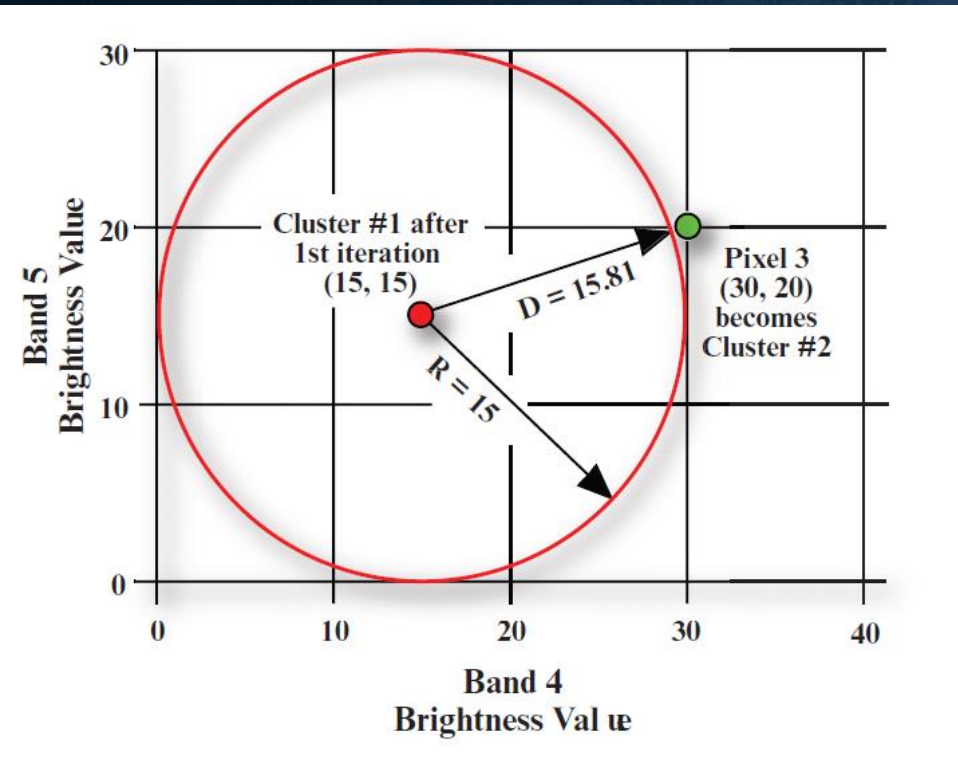


Original values of pixels 1, 2, and 3 as measured in bands 4 and 5 of the hypothetical remotely sensed data.



The distance (D) in two-dimensional spectral space between pixel 1 (cluster 1) and pixel 2 (cluster 2) in the first iteration is computed and tested against the value of R, the minimum acceptable radius. In this case, D does not exceed R; therefore, we merge clusters 1 and 2,

Steps of Unsupervised Classification



How clusters migrate during the several iterations of a clustering algorithm .

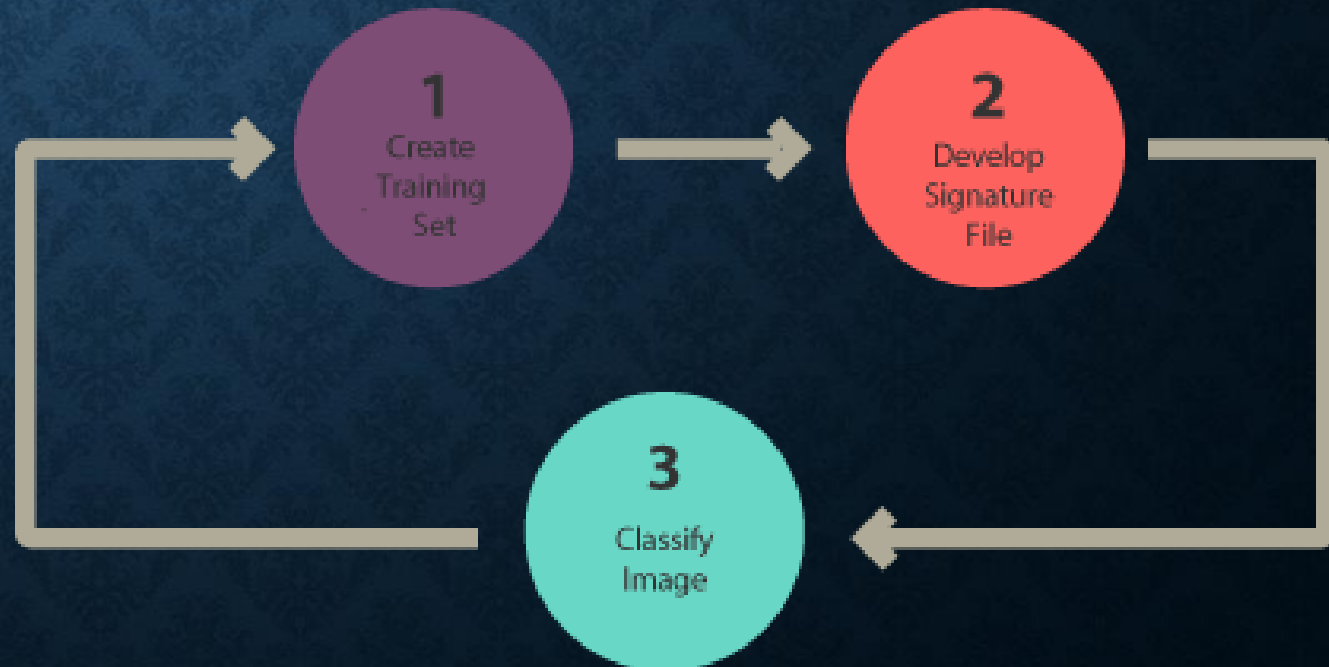
The final ending point represents the mean vector

Pixels 1 and 2 now represent cluster 1. Note that the location of cluster 1 has migrated from (10, 10) to (15, 15), after the first iteration. Now, pixel 3 distance (D) is computed to see if it is greater than the minimum threshold, R. It is, so pixel location 3 becomes cluster 2. This process continues until all 20 clusters are identified. Then the 20 clusters are evaluated using a distance measure, to merge the clusters that are closest to one another.

Supervise Image Classification

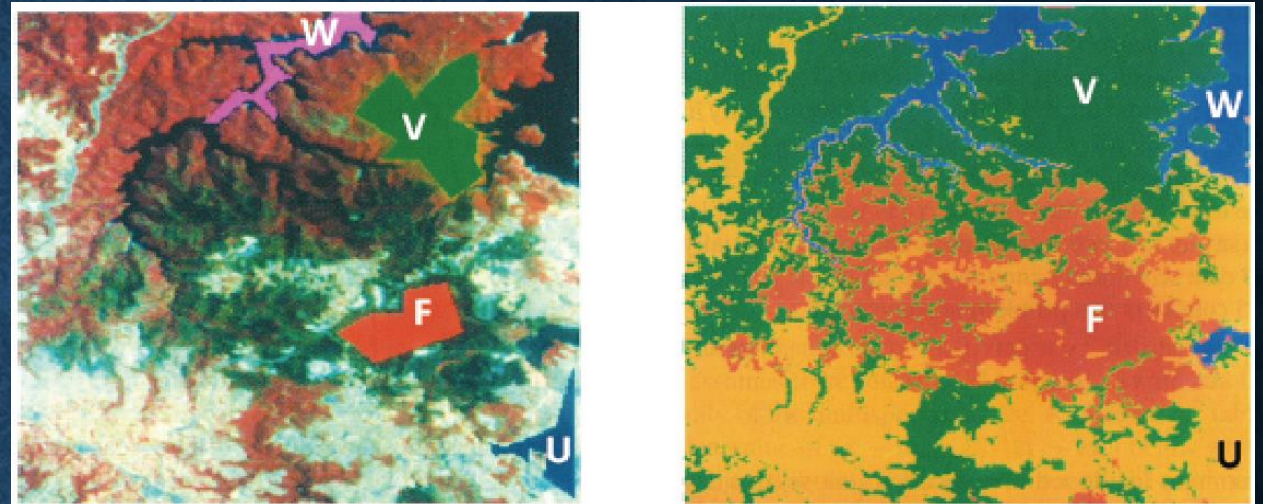
- ❑ In supervised classification, you **select representative samples** for each land cover class.
- ❑ The software then uses these “**training sites**” and applies them to the entire image.
- ❑ The three basic steps for supervised classification are:

1. Select training areas
2. Generate signature file
3. Classify



Supervise Classification – Training Sites

- ❑ Create training samples.
- ❑ For example, mark urban areas by marking them in the image.
- ❑ For each land cover class, training samples are created and hence this generates a signature file
- ❑ Signature file, stores all training samples' spectral information.



Class	No. of Pixels	Area (ha)
Water	4830	2137
Fire Burn	14182	6274
Vegetation	28853	12765
Urban	22791	10083

Source: Richard and Jia, 2006

Assigning of Training Classes in Supervised Classification

- ❑ Major step of supervised classification is the selection of the training pixels.
- ❑ It is important that the data used to select the training pixels be collected at the same time of the data to be classified.
- ❑ It is important to at least identify training classes for all classes of interest, preferably all classes in the image.

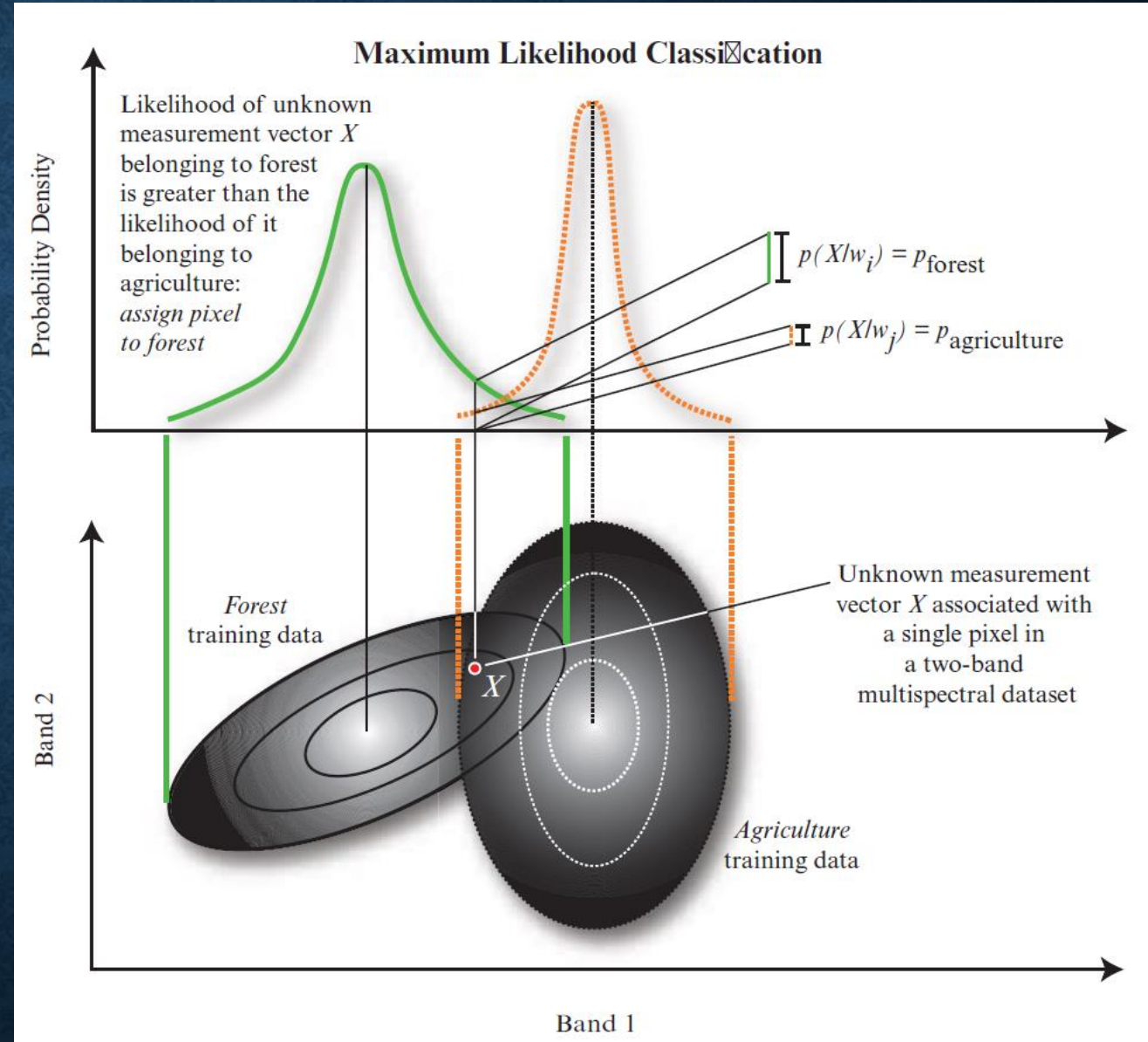
Supervised Image Classification Algorithm

- ❑ Maximum Likelihood Classification Algorithm
- ❑ Minimum Distance to Means Classification Algorithm
- ❑ Parallelepiped Classification Algorithm
- ❑ Nearest-Neighbor Classifiers

Maximum likelihood Classification

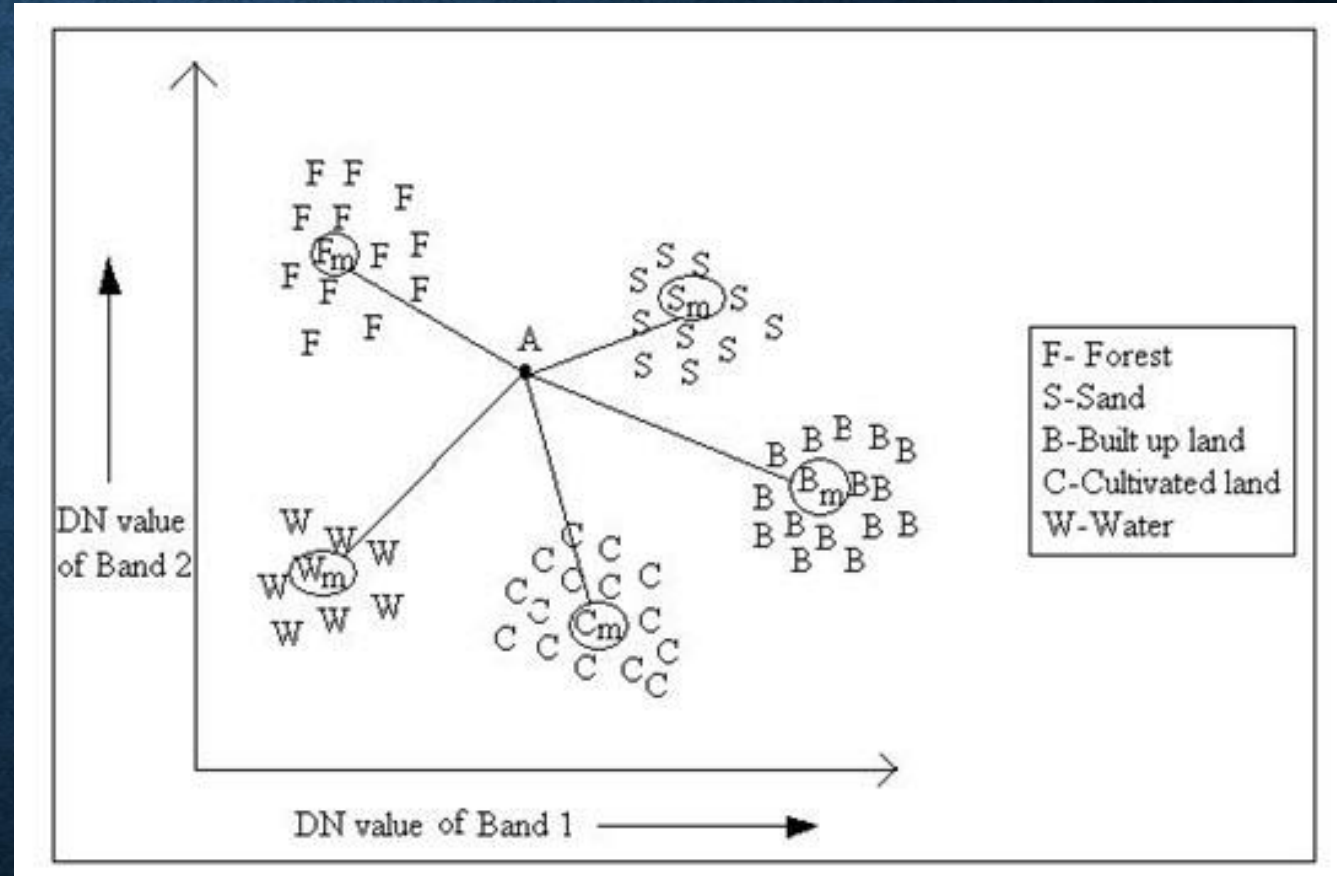
□ Hypothetical example of how the maximum likelihood decision rule functions when two training class probability density functions (forest and agriculture) measured in two bands overlap.

□ The unknown measurement vector X associated with a single pixel in a two-band dataset would be assigned to forest because the probability density of its measurement vector X is greater for forest than for agriculture.



Minimum Distance to Mean Classification

- DN values of five training sets are plotted and their means are computed.
- Unknown pixel 'A' will be classified or be assigned to a class by a distance calculation from the mean of each class to the pixel A



Supervised and Unsupervised Classification

Minimum Distance to Means
Supervised Classification of Charleston, SC,
Using Landsat Thematic Mapper Data



a.

Class	Legend
1. Residential	
2. Commercial	
3. Wetland	
4. Forest	
5. Water	

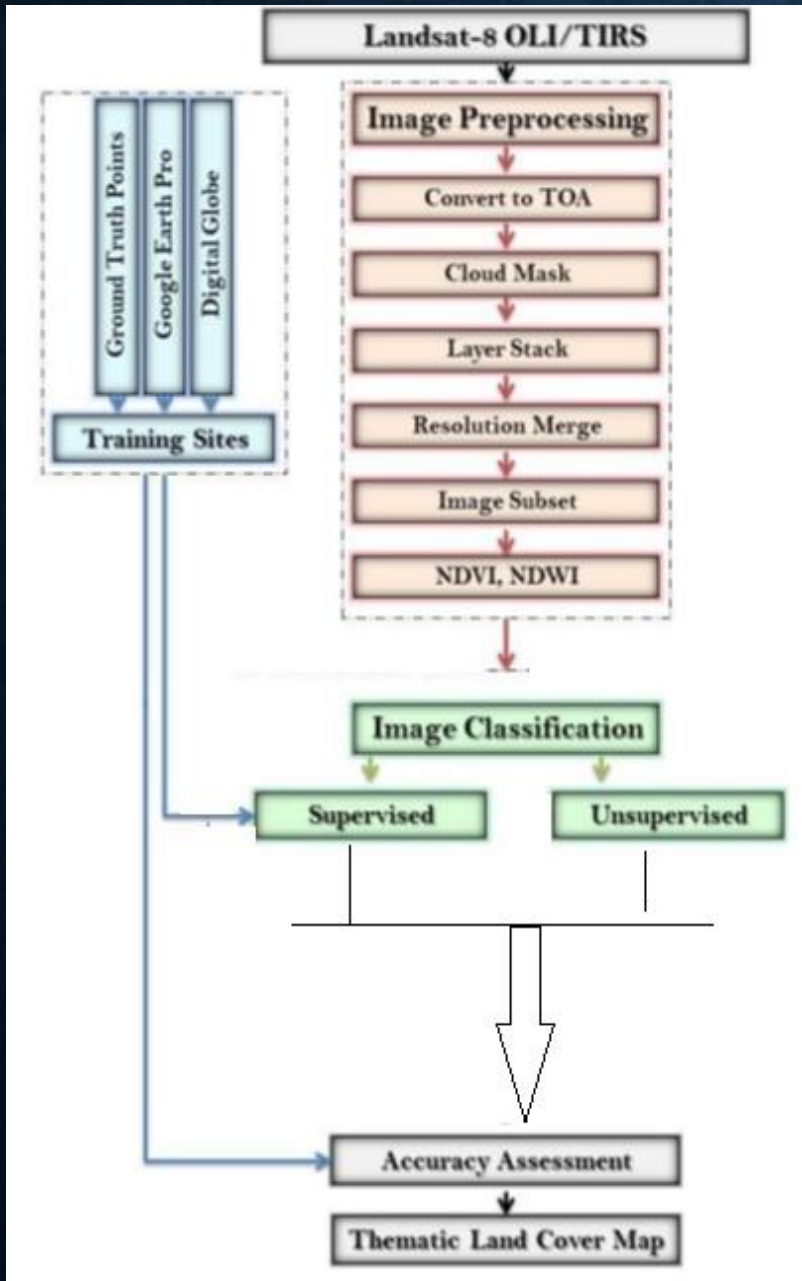
Unsupervised Classification



b.

Class	Legend	Class	Legend
1. Water		11. Commercial 2	
2. Forest		12. Commercial 2	
3. Forest		13. Commercial 2	
4. Wetland		14. Residential	
5. Wetland		15. Commercial 2	
6. Residential		16. Commercial 2	
7. Residential		17. Residential	
8. Park/golf		18. Residential	
9. Residential		19. Commercial 1	
10. Commercial 1		20. Commercial 2	

Satellite Image Processing and Classification Summary



Possible Landsat Bands to do layerstack and Run classification

Bands	Wavelength (micrometers)	Resolution (meters)
Band 1 - Coastal aerosol	0.43-0.45	30
Band 2 - Blue	0.45-0.51	30
Band 3 - Green	0.53-0.59	30
Band 4 - Red	0.64-0.67	30
Band 5 - Near Infrared (NIR)	0.85-0.88	30
Band 6 - SWIR 1	1.57-1.65	30
Band 7 - SWIR 2	2.11-2.29	30
Band 8 - Panchromatic	0.50-0.68	15
Band 9 - Cirrus	1.36-1.38	30
Band 10 - Thermal Infrared (TIRS) 1	10.6-11.19	100
Band 11 - Thermal Infrared (TIRS) 2	11.50-12.51	100

Object-Based Image Analysis (OBIA) Classification

- ❑ The development of remote sensing systems such as IKONOS, QuickBird, GeoEye-1, WorldView-2, and others that produce data with high spatial resolutions.
- ❑ Unfortunately, classification algorithms based on single pixel analysis often are not capable of extracting the information desired from high spatial resolution image data.
- ❑ For example, the spectral complexity of urban land-cover materials can result in limitations when using per-pixel analysis

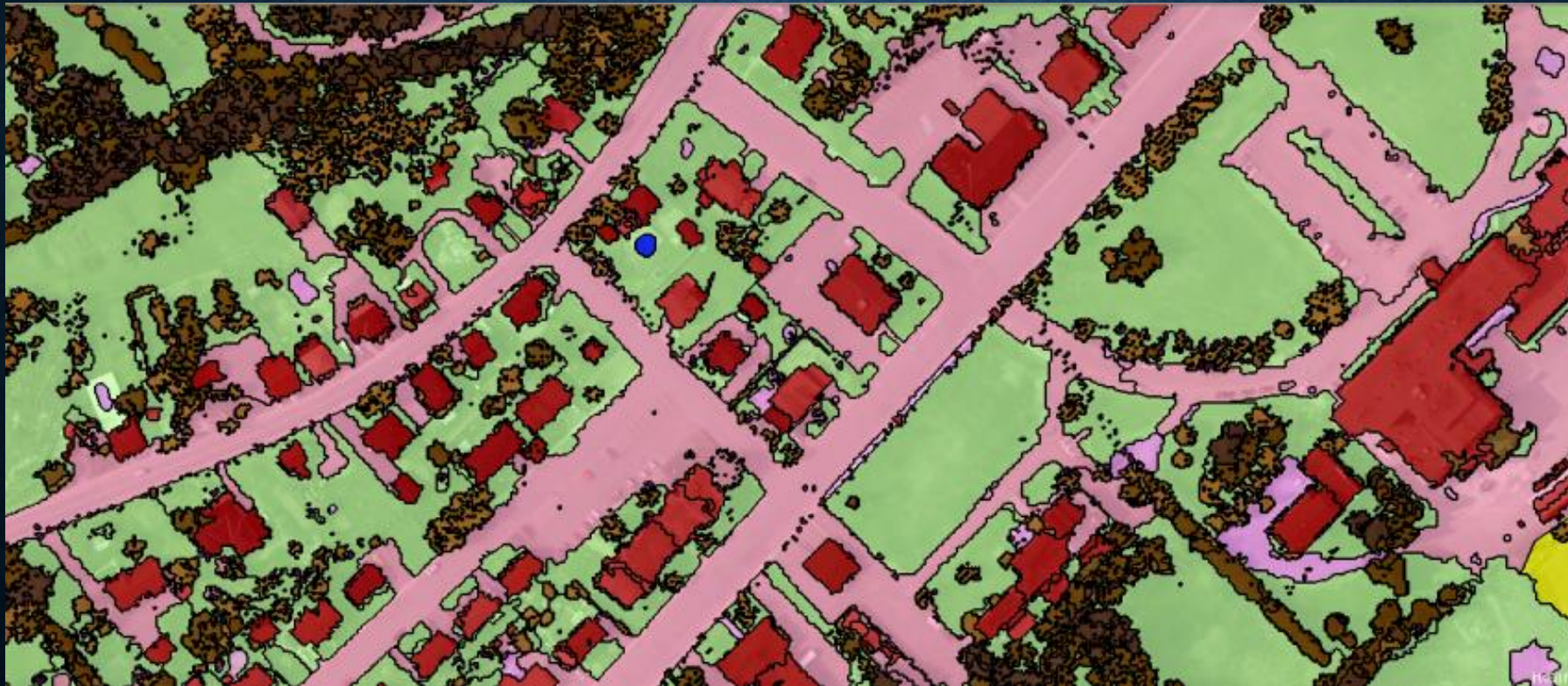
Object-Based Image Analysis (OBIA) Classification

- ❑ The need for high-resolution imagery classification has given rise to the creation of object-based image analysis (OBIA).
- ❑ The algorithms typically incorporate both spectral and spatial information in the image segmentation phase.
- ❑ The result is the creation of *image objects* defined as individual areas with shape and spectral homogeneity.

Object-Based Image Analysis (OBIA)

The 2 most common segmentation algorithms are:

1. Multi-resolution segmentation in eCognition
2. The segment mean shift tool in ArcGIS



Object-Based Image Analysis (OBIA)

In OBIA/classification, you can use different methods to classify objects. For example, you can use:

- Shape
- Texture
- Spectral
- Geographic Context
- Nearest Neighbor (NN) Classification

Object-Based Image Analysis (OBIA)

SHAPE: If you want to classify buildings, you can use a shape statistic such as “rectangular fit”. This tests an object’s geometry to the shape of a rectangle.

TEXTURE: Texture is the homogeneity of an object. For example, water is mostly homogeneous because it’s mostly dark blue. But forests have shadows and are a mix of green and black.

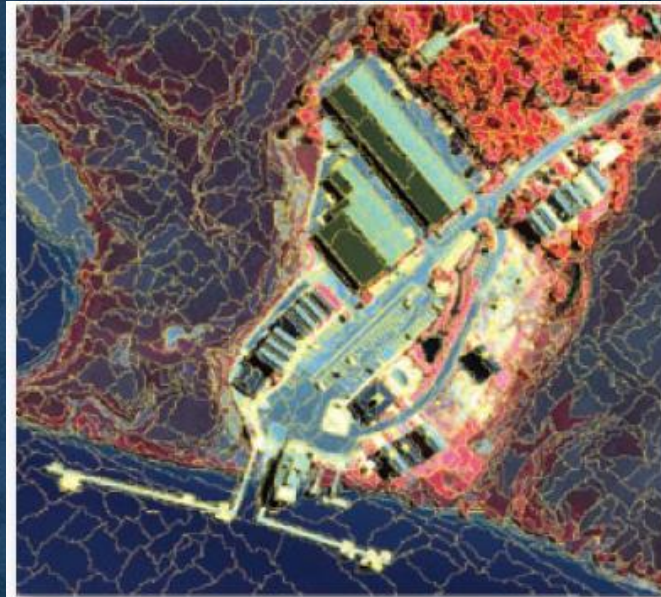
SPECTRAL: You can use the mean value of spectral properties such as near-infrared, short-wave infrared, red, green, or blue.

GEOGRAPHIC CONTEXT: Objects have proximity and distance relationships between neighbors.

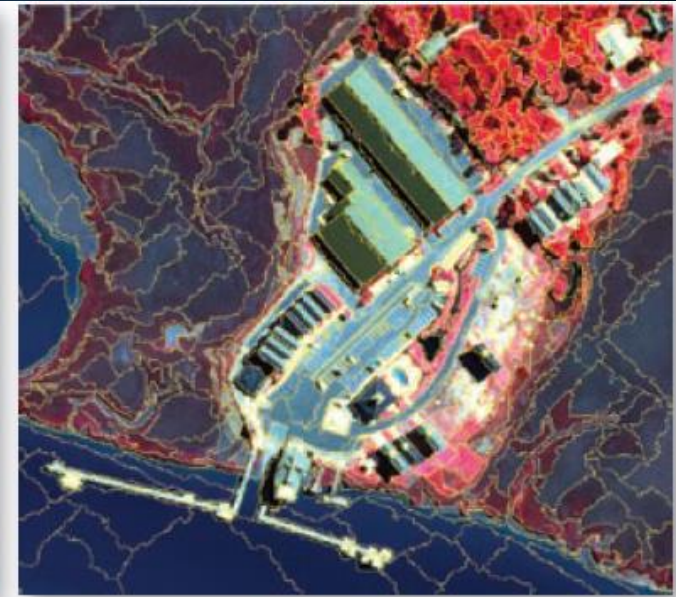
NEAREST NEIGHBOR CLASSIFICATION: Nearest neighbor (NN) classification is similar to supervised classification. After multi-resolution segmentation, the user identifies sample sites for each land cover class. Next, they define statistics to classify image objects. Finally, the nearest neighbor classifies objects based on their resemblance to the training sites and the statistics defined.

Object-Based Image Analysis (OBIA) Classification

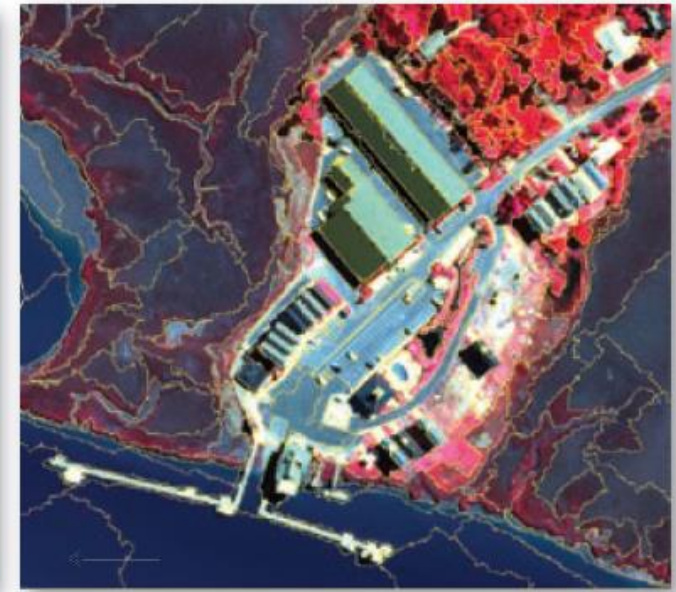
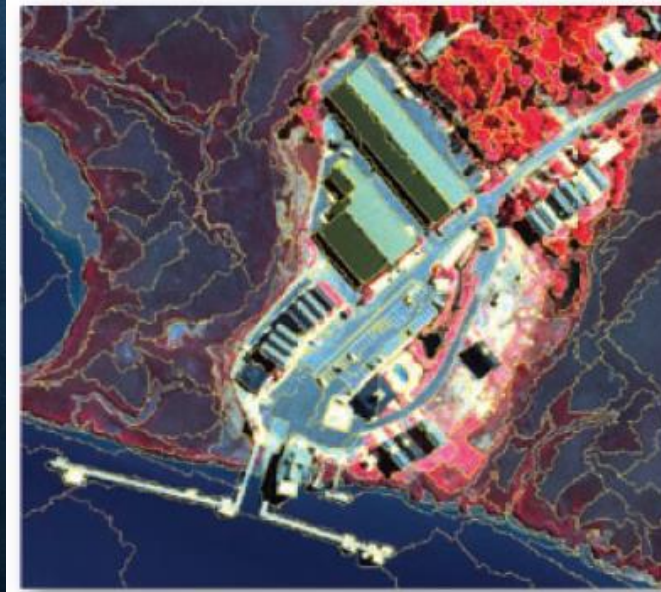
- Image Segmentation Based on Spectral (Green, Red, Near-infrared) and Spatial (smoothness and Compactness) criteria



a. Segmentation scale 10.



b. Segmentation scale 20.



Object-Based Image Analysis (OBIA) Classification

- ❑ One of the most important aspects of performing this type of image segmentation using remote sensor data is that each image object in the dataset (i.e., each polygon) contains not only the mean spectral values of all pixels found within each band but also various spatial measurements that characterize the shape of the polygon.

Object-Based Image Analysis (OBIA) Classification

Four OBIA classification maps derived from four different sets of image segmentation scale data.



a. Segmentation scale 10.



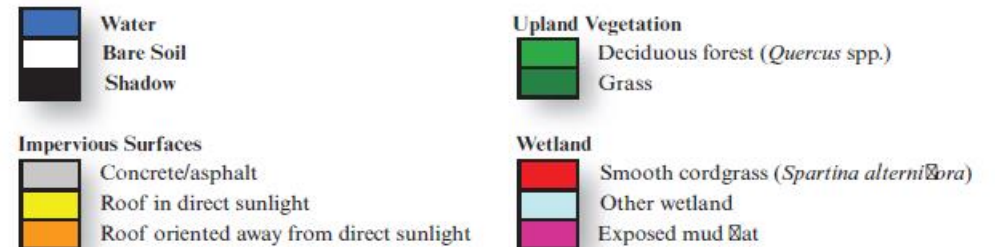
b. Segmentation scale 20.



c. Segmentation scale 30.



d. Segmentation scale 40.



References:

Jensen, John R., 2015- Introductory digital image processing : a remote sensing perspective / John R. Jensen, University of South Carolina.
pages cm. -- (Pearson series in geographic information science) 4th ed.