Digital Image Classification: Exploring Supervised and Unsupervised Techniques

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Introduction

Visual image interpretation offers an explanation of the process of interpreting visual images. In this process, the ability to see well is essential for extracting meaning from visuals. While computers can be utilized for digitization and visualization, human operators are still required for interpretation.

Digital picture categorization is introduced in this section. In this method, the operator defines the criteria under which the computer is to conduct an interpretation. The operator is a person. One method used in the field of digital picture interpretation is image categorization. Other methods include scene reconstruction (making 3D object models, for example) and automated object identification (detecting roads, for example). In the areas of interest of ITC, image categorization is the approach that is most frequently used.

Multispectral classification

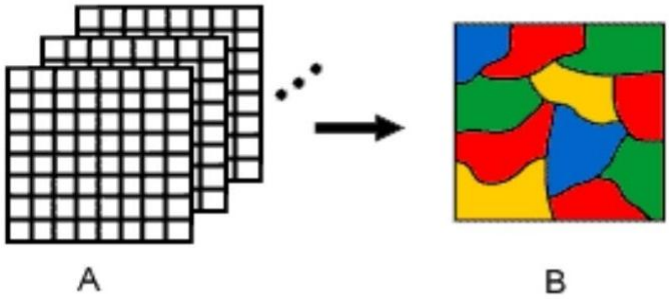
- Multispectral classification is the process of assigning pixels to classes. Typically, each pixel is treated as an individual unit composed of values in several spectral bands.
- If a pixel satisfies a set of criteria, the pixel is assigned to the class that corresponds to that criteria.
- Multispectral classification can be performed using a variety of algorithms, including fuzzy logic, hybrid approaches that frequently involve the use of ancillary information, and hard classification using supervised or unsupervised approaches.

Image classification

The classification procedure is used to identify different feature types on the surface of the earth based on the theory that they have distinct spectral reflectance and remittance qualities. The act of classifying every pixel in a picture or in raw remotely sensed satellite data in order to produce a certain set of labels or land cover themes is known as image classification. (Lillesand, Keifer 1994).

Digital image classification

- Grouping of similar pixels
- Separation of dissimilar ones
- Assigning class label to pixels
- Resulting in manageable size of classes



Reason for digital image classification

- To convert the constant variability of picture data into meaningful map patterns for the viewer.
- To gain understanding from the data on surface properties and ground cover
- Understand the terrain and group items into distinct groups
- Determine the area.
- Economical when it comes to analyzing big datasets. The outcomes are replicable.
- Greater objectivity compared to visual interpretation.
- Effective examination of intricate multi-band (spectral) interactions.

Image classification process

The process of image classification typically involves five steps:

1. Selection and preparation of the RS images

Depending on the land cover types or whatever needs to be classified, the most appropriate sensor, the most appropriate dates of acquisition and

the most appropriate wavelength bands should be selected.

2. **Definition of the clusters in the feature space**

Here two approaches are possible: supervised classification and unsupervised classification. In a supervised classification, the operator defines the clusters during the training process; in an unsupervised classification, a clustering algorithm automatically finds and defines the number of clusters in the feature space.

3. **Selection of the classification algorithm**

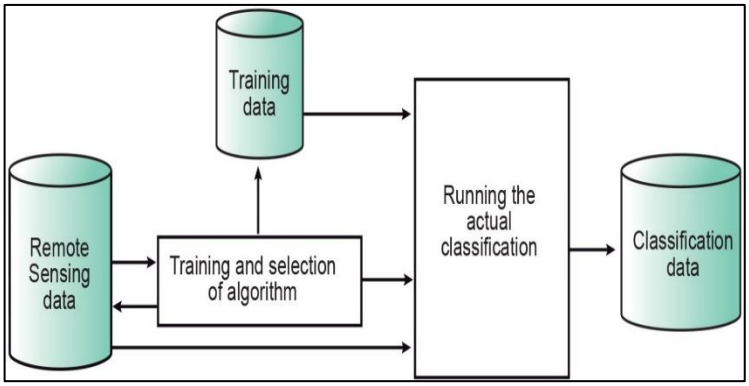
Once the spectral classes have been defined in the feature space, the operator needs to decide on how the pixels (based on their feature vectors) are to be assigned to the classes. The assignment can be based on different criteria.

4. **Running the actual classification**

Once the training data have been established and the classifier algorithm selected, the actual classification can be carried out. This means that, based on its DNs, each "multi-band pixel" (cell) in the image is assigned to one of the predefined classes.

5. **Validation of the result**

Once the classified image has been produced its quality is assessed by comparing it to reference data (ground truth). This requires selection of a sampling technique, generation of an error matrix, and the calculation of error parameters.



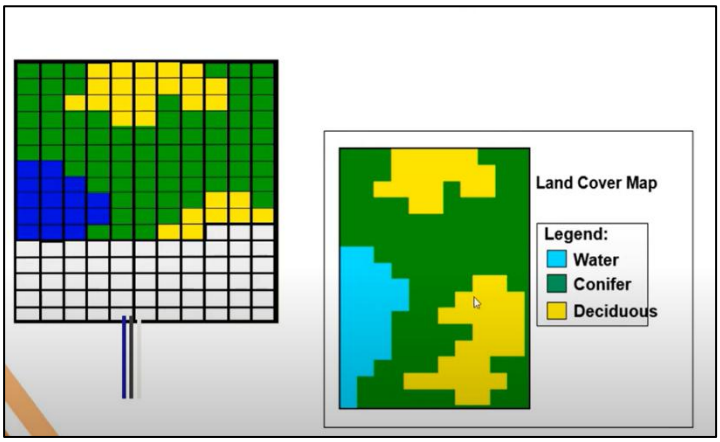
Basis for image classification

- Different objects have different radiometric properties
- Thus, different objects have different spectral signatures
- But however, a given class will be represented by different DN values and hence different signatures.

Types of classification

Supervised classification

- It is a classifier which requires a training sample for each class. Then based on how "close" each pixel to be classified is to each training sample.
- It can be defined as the process of using samples (training data) of known identity to classify pixels of unknown identity.
- The identity and location of some of the land cover types such as urban, agriculture, wetland are known as priori through a combination of field work and experience.
- The analyst attempts to locate specific sites in the remotely sensed data that represent homogenous examples of these land cover types known as training sites.
- Multivariate statistical parameters are calculated for these training sites.
- Every pixel both inside and outside the training sites is evaluated and assigned to the class of which it has the highest likelihood of being a member.

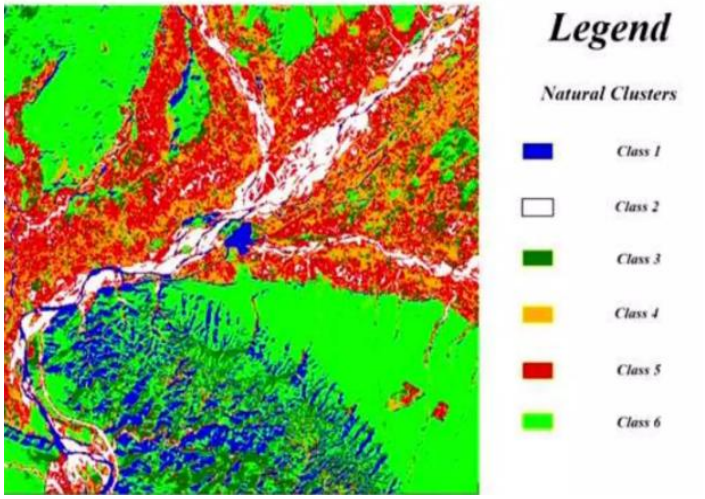


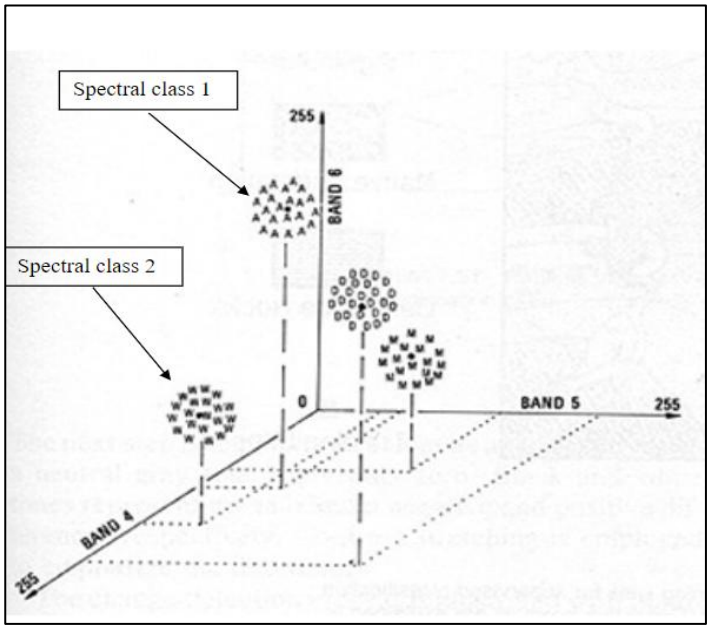
Unsupervised classification

- It is an ex-post approach. It is a classifier which does not compare pixels to be classified with training data. Rather, examine a large number of unknown data vectors and divided them into classes based on properties inherent to the data themselves.
- The identities of land cover types to be specified as classes within a scene are generally not known as priori because ground reference information is lacking or

surface features within the scene are not well defined. Assumes no prior knowledge.

- The computer is required to group pixels with similar spectral characteristics into unique clusters according to some statistically determined criteria.
- Analyst then combine and re-labels the spectral clusters into information classes.





Supervised vs unsupervised classification

Supervised training

- It is important to have a set of desired classes in mind, and then create the appropriate signatures from the data.
- Supervised classification is usually appropriate when you want to identify relatively few classes, when you have selected training sites that can be verified with ground truth data, or when you can identify distinct, homogenous regions that represent each class.
- On the other hand, if you want the classes to be determined by spectral distinctions that are inherent in the data so that you can define the classes later, the unsupervised training. application is better suited to
- Unsupervised training enables you to define many classes easily, and identify classes that are not in contiguous, easily recognized regions.
- In supervised training, you rely on your own pattern recognition skills and priori knowledge of the data to help the system determine the statistical criteria (signatures) for data classification.
- To select reliable samples, you should know some information- either spatial or spectral- about the pixels that you want to classify.

Unsupervised Classification

- It requires only a minimum amount of initial input from the analyst.
- Numerical operations are performed that search for natural groupings of the spectral properties of pixels.
- User allows computer to select the class means and covariance matrices to be used in the classification.
- Once the data are classified, the analyst attempts a posteriori to assign these natural or spectral classes to the information classes of interest.
- Some clusters may be meaningless because they represent mixed classes.
- Clustering algorithm used for the unsupervised classification generally very according to the efficiency with which the clustering takes place.
- Two commonly used methods are- • 1. Chain method • 2. Iso data clustering

Advantage of supervised classsification

- The analyst has control of a selected menu of informational categories tailored to a specific purpose and geographic region.

- It is tied to specific areas of known identity, called training areas. - It is not necessary to match the spectral categories with the informational categories of interest.
- The operator may be able to detect serious errors in classification by examining how training data have been classified.

Advantage and disadvantage of unsupervised classification

Advantages

- No prior knowledge is required
- Human error is minimized
- Unique classes are recognized

Disadvantages

- Spectral classes information classed
- Additional labeling is required
- Spectral properties vary over time, across images

Conclusion

One of the most important uses of remote sensing is the production of Land Use / Land Cover maps and thus can be done through a process called "Image Classification". Image Classification had made great progress over the past decades in the following four areas: (1) producing land cover map at regional and global scale; (2) development and use of advanced classification algorithms, such as subpixel, pre-field, and knowledge-based classification algorithms; (3) use of multiple remote-sensing features, including spectral, spatial, multitemporal, and Multisensor information; and (4) incorporation of ancillary data into classification procedures, including such data as topography, soil, road, and census data. Accuracy assessment is an integral part in an image classification procedure.The success of an image classification in remote sensing depends on many factors, the availability of high-quality remotely sensed imagery and ancillary data, the design of a proper classification procedure, and the analyst's skills and experiences.

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