Part 4: Contextual Classification in Remote Sensing

* There are different ways to incorporate contextual information in the classification process. All experiments show performance improvement of about 1% to 3% with the use of contexts.
* Markov Random Field is the most popular contextual image model (Chapter 14) The power points presented for this chapter are based on the IGARSS2005 paper, “MRF model parameter estimation for contextual supervised classification of remote sensing images”, by G. Moser, S.B Serpico, and F. Causa.
* Time series model of the remote sensing data is another way to use the contextual information. The autoregressive (AR) model is most popular. To include the multiple images in the problem formulation the vector or multivariate AR time series can be used. (next two slides)

2-D Multivariate Time Series Image Model

- To simplify the computation, AutoRegressive Vector (ARV) is reduced to:

$$\boldsymbol{X}_i = \boldsymbol{W} + \boldsymbol{\phi}_1 \boldsymbol{X}_{i-1} + \boldsymbol{\phi}_2 \boldsymbol{X}_{i-2} + \ldots\ldots + \boldsymbol{\phi}_p \boldsymbol{X}_{i-p} + \boldsymbol{\varepsilon}_i$$

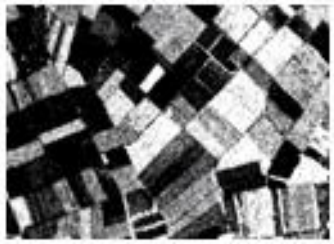
- Example: m=2, p=2 , W=0 of ARV model

$$\begin{bmatrix} x_i \\ y_i \end{bmatrix} = \begin{bmatrix} \phi_{1,11} \phi_{1,12} \\ \phi_{1,21} \phi_{1,22} \end{bmatrix} \begin{bmatrix} x_{i-1} \\ y_{i-1} \end{bmatrix} + \begin{bmatrix} \phi_{2,11} \phi_{2,12} \\ \phi_{2,21} \phi_{2,22} \end{bmatrix} \begin{bmatrix} x_{i-2} \\ y_{i-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \end{bmatrix}$$

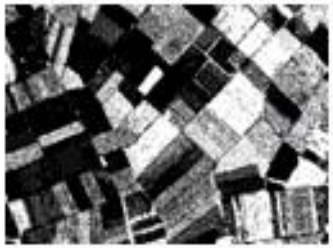
The ARV-SVM Composite Image

Class 1: Sugar Beets
Class 2: Stubble
Class 3: Bare Soil
Class 4: Potatoes
Class 5: Carrots

Original th-c-hh (one example of 15 remote sensing input data)



Multivariate AR – SVM without smooth post-processing result



Multivariate AR – SVM with post-processing but without tone rescaling result

Multivariate AR – SVM with post-processing and tone re-scaling result

Part 5: Other Topics

1. Normalized Hilbert Transform (Chapter 1)

   To deal with both nonstationary and nonliear processes typically experienced in remote sensing data such as ocean waves, Long and Huang proposed normalization procedure for empirical mode decomposition (NEMD) and Hilbert transform (NHT), which provides the best overall approach to determine the instantaneous frequency (IF) for the nonlinear and nonstationary data.

Other Topics continued-1

2. Performance Assessment (Chapter 26)

a) After a classification is being carried out, its accuracy can be determined if ground truth is available. Classification accuracy refers to the extent to which the classified image or map corresponds with the description of a class at the earth surface. This is commonly described by an error matrix, in which the overall accuracy and the accuracy of the individual classes is calculated.

b) The κ-statistic derived from the error matrix is based on the difference between the actual agreement in the error matrix, and the chance agreement. The sample outcome is the statistic, an estimate of κ is defined by:

$$\hat{\kappa} = \frac{p_0 - p_c}{1 - p_c}$$

where p_0 and p_c are the actual agreement and the chance agreement Let n_{ij} equal the number of samples classified into

Other Topics continued-2

category *i*, as belonging to category *j* in the reference data. The value can be calculated using the following formula,

$$\hat{\kappa} = \frac{n\sum_{i=1}^{k} n_{ii} - \sum_{i=1}^{k} n_{i+} n_{+i}}{n^2 - \sum_{i=1}^{k} n_{i+} n_{+i}}$$

where *k* is the number of classes, n_{ii} is the number of correctly classified pixels of category *i*, n_{i+} is the total number of pixels classified as category *i*, n_{+i} is the total number of actual pixels in category *i* and *n* is the total number of pixels.

Inspite of its shortcomings, the κ-statistic is more suitable for performance assessment. The authors proposed the use of Bradley-Terry model to assess the uncertainly in an error matrix, which takes into account of the preference of one category over another category.

Thank You !!!

Q & A