Deep Learning for Multi Crop Classification using Hyperspectral Data

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Abstract

To perform Multi Crop Classification using CNN

Hyperspectral data has both spatial and spectral components making a datacube which is very large to process. We have to adopt dimensionality reduction techniques and feature mapping techniques in order to train a model that can get accurate crop classification. A Hyperspectral sensor collects information which is a set of narrow wavelength range of the electromagnetic spectrum called as a spectral band. Since it is in the hyperspectral range, there will be many bands collected by the sensors . Some bands can be eliminated and reduced without affecting the classification result. These images are combined to form a three-dimensional (x, y, λ) hyperspectral data cube for processing and analysis.

Problem Definition

To classify crops of more than 5-6 kinds in a 2-D scene using Deep Learning technique of Convolutional Neural Networks.
To predict the crop acreage of an agricultural patch in Anand District.

Classical methods used for classification

- Support Vector Machines
- Random Forest Classifier

Autoencoders

Autoencoders can be used different depth to classify hyperspectral image. The ideal framework generally is to combine PCA on spectral dimension and autoencoder on the other two spatial dimensions to extract spectral-spatial information for classification.

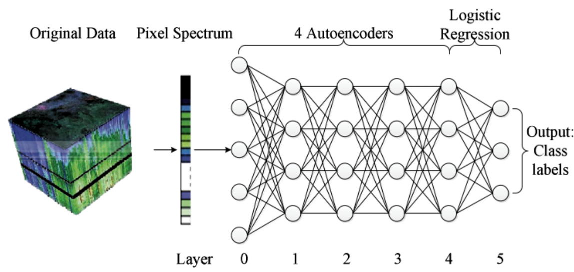

Figure 1: Source : ”Spectral-Spatial Classification of Hyperspectral Image Using Autoencoders” - Zhouhan Lin, Yushi Chen

Convolutional Neural Networks

Convolutional neural network (CNN), is the frontier of the deep learning.
It is capable of automatically discovering relevant contextual 2-D spatial features in image categorization tasks.
CNN makes use of local connections to deal with spatial dependencies by sharing weights.
The advantage of using CNN is that it significantly reduce the number of parameters of the network in comparison with the conventional 1-D fully connected neural networks.

1D CNN

This model takes only one component as input to the neural network, mostly the spectral band

2D CNN

This model can takes two component as input to the neural network, becoming more accurate.
An example is 2D CNN used for spatial feature learning of the 2-D scene's patch.

3D CNN

This is best way of training a hyperspectral cube since it takes into account more parameters, resulting in better accuracy after training.

Datasets being used

Open Datasets:

- Indian Pines Dataset.
  The following are the particulars of the dataset:

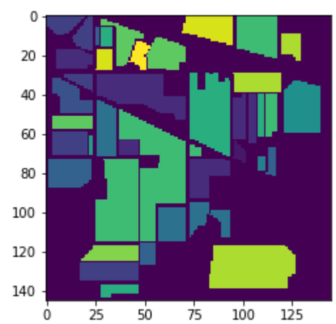

Figure 2: Indian Pines Ground Truth

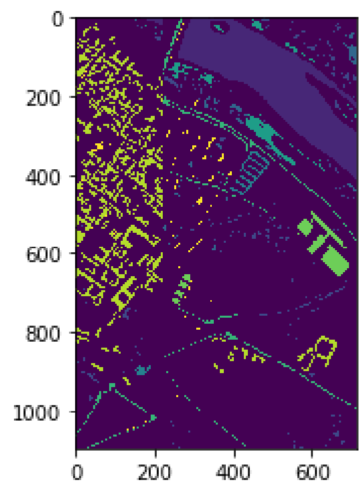

Figure 3: University of Pavia Ground Truth

  - Source: AVIRIS sensor
  - Region: Indian Pines test site over north-western Indiana
  - Time of the year: June
  - Wavelength range: 0.4 2.5 micron
  - Number of spectral bands: 220
  - Size of image: 145x145 pixel
  - Number of land-cover classes: 16

- University of Pavia Dataset

  The following are the particulars of the dataset:

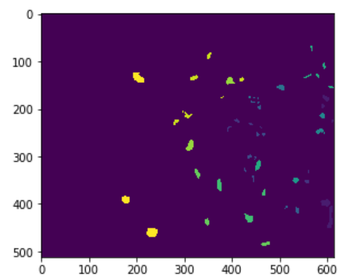

Figure 4: Kennedy Space Center Ground Truth

- Source: ROSIS sensor during a flight campaign over Pavia, nothern Italy.
- Geometric Resolution: 1.3 meters
- Number of spectral bands : 103
- Size of Image 610x610 pixel
- Number of land-cover classes: 9

- Kennedy Space Center (KSC)

  The following are the particulars of the dataset:

  - Source: NASA AVIRIS instrument
  - Number of spectral bands: 176
  - Wavelength range: 400 - 2500 nm
  - Spatial resolution : 18 m
  - Number of land-cover classes: 13

ISRO Dataset:
Complete AVIRIS and Hyperion Data over the Anand District

Monthly Schedule

The following tasks are decided to be done by each month in year 2018-19:

- August : Comparison of various classical models of classification on the Open Datasets
- September : Implementing Random Forest classifier on all datasets and reach the benchmark accuracy
- October : Develop Auto-encoder
- November : Develop 1D CNN for spectral feature learning
- December : Develop 2D CNN for spatial feature learning

- January : Develop 3D CNN and compare its accuracy with other Neural Network models.
- February : To compare CNN with other deep learning frameworks like RNN and LSTM.
- March : Refine the architecture model so that labelling accuracy increases
- April : Deriving conclusions and results from model and making a report and thesis.

Expected Results

To develop an accurate classification model for multiple crops using fully developed 3D CNN model.

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