MAPPER REGULARIZED SEMI-SUPERVISED MANIFOLD ALIGNMENT FOR THE FUSION OF SIMULATED ENMAP IMAGE AND SENTINEL-1 DUAL-POL DATA

Jingliang Hu, Danfeng Hong, Xiao Xiang Zhu

Remote Sensing Technology Institute (IMF), Germany Aerospace Center (DLR)
Signal Processing in Earth Observation (SiPEO), Technical University of Munich (TUM)

ABSTRACT

The German EnMAP mission, scheduled launch in 2020, will provide high spectral resolution of 244 bands ranges from 420 to 2450 nm with ground sampling distance of 30 meters. Sentinel-1, the SAR component of the European Copernicus Program, provides dual-Pol SAR data of the global coverage. Hyperspectral image and PolSAR data are the ideal data sources for classification task in optical and SAR remote sensing, respectively. The fusion of them is promising for applications of classification, since spectral information of hyperspectral image is complementary to the geometric and dialectic information of PolSAR data. As a preparation of EnMAP application, this work investigates the fusion of simulated EnMAP data and Sentinel-1 dual-Pol data for land cover land use classification.

Semi-supervised manifold alignment, an advanced manifold method of data fusion, is studied in this work for fusing EnMAP and Sentinel-1 data sets. The approach projects data sources of multi-modality into a latent space, such that, 1) data of the same class locate near each other, 2) data of different classes locate far away from each other, and 3) topological structure of individual data source is preserved. The first two objectives are achieved by using labeled data, which are natural criterion benefiting classification. The third objective derives topological structures of original data sources, including labeled and unlabeled data, which implicitly attaches unlabeled data to label information. Conventional semi-supervised manifold alignment approaches implements the straightforward K-nearest neighbor (KNN) method to derives topological structure of data. However, recently, topological data analysis (TDA) emerges as a new mathematical sub-field of big data analysis, which studies geometric and topological properties in the data. One of the successful TDA tools, MAPPER, has been proven to be able to reveal unknown knowledge in genetic studies. In this work, we proposes a novel semi-supervised manifold alignment method topologically regularized by MAPPER. Compared to the conventional way of KNN, MAPPER is able to describe the structure of data set more precise and more comprehensive. In our application of fusing hyperspectral and PolSAR data, the proposed method demonstrates superiorities in comparison to conventional manifold alignment methods.

Index Terms— Topological Data Analysis (TDA), MAPPER, Manifold Alignment, Data Fusion, PolSAR, Hyperspectral Image, Classification