1) Introduction:

Earth Observation (EO) image collections are increasing immensely with a rate of several Terabytes of data a day. With the current EO technologies these figures will be soon amplified, the horizons are beyond Zettabytes of data. The challenge is the exploitation of these data and the timely delivery of focused information and knowledge in a simple and understandable format.

2) High-level feature representation:

Latent Dirichlet Allocation (LDA):

LDA is a probabilistic topic model. This model assumes the images are distribution over set of visual words drawn from a certain vocabulary. Then it discovers the latent structure behind the green collection of images. The discovered latency is called topic which suppose to represent different concepts of the images. The generative property of the LDA allows to estimate the image collection using the discovered topics.

Representing images by Bag-of-Topics:

In order to discover the high-level features, first, LDA model is applied to the Bag-of-Word (BoW) model of images. BoW represents an image based on the occurrence of the primitive feature descriptors in the image. The discovered high-level features, the so-called topics, are then used to describe images, we call it Bag-of-Topics (BoT) model. BoT represents each image as a vector, so-called topic vector, where each dimension of this vector shows the frequency of a particular topic in the image. These topic vectors are then used in learning tasks.

3) Experiments and results:

The collected EO data volumes are increasing immensely with a rate of several Terabytes of data a day. With the current EO technologies these figures will be soon amplified, the horizons are beyond Zettabytes of data. The challenge is the exploitation of these data and the timely delivery of focused information and knowledge in a simple and understandable format.

4) Visualization:

Although the main intention of content-based image retrieval and classification systems is to provide results that satisfy user’s semantic queries, the provided results are still not user satisfactory. The fundamental reason is that users understand images based on their high-level contents (e.g., tree, water, building); however, most of the current CBIR systems perform on the primitive features of the images (e.g., shape, texture, color).

In this work, the high-level features of the EO images are discovered using a statistical topic model, so-called Latent Dirichlet Allocation (LDA). Then learning algorithms are applied to the high-level representation of the images. Experimental results demonstrate that high-level features can provide comparable results to BoW model; while the dimensionality of data is much lower in BoT model. Consequently, high-level features increase the scalability of learning systems as well as providing results relevant to the users’ queries.

5) Future works:

The EO Library of Payload Data Ground Segment

Main Process module

- Multi-descriptor content indexing of Synthetic Aperture Radar images
- Statistical methods for Descriptor Selection and Fusion
- Active Learning

Content latency analysis

Pattern Recognition and Dimensionality Reduction

Immersive Visualization and Retrieval

Immersive visual information mining:

SAR data from the DLR EO Digital Library will be processed for descriptor extraction. Then descriptor space will be analyzed and projected adaptively in 3D space, visualized in the CAVE, jointly with multi-modal rendering of the images and their content. The analysis, immersed in the CAVE, will be enabled to interact with the data content using learning algorithms and navigate, explore and analyze the information in the archive. The CAVE is located in Institute for Human-Machine Communication in Technical University of Munich, Germany.