Machine learning has become a standard paradigm for the analysis of remote sensing and geoscience data at both local and global scales. In the upcoming years, with the advent of new satellite constellations, machine learning will have a fundamental role in processing large and heterogeneous data sources. Machine learning will move from mere statistical data processing to actual learning, understanding, and knowledge extraction. The ambitious goal is to provide responses to the challenging scientific questions about the Earth system.

In this tutorial, we will present the remote sensing image processing chain, and take the attendants on a tour of different strategies for feature extraction, classification, unmixing, retrieval, and pattern analysis for remote sensing data analysis. We will present powerful methodologies for remote sensing supervised remote sensing data classification: extracting knowledge from data, including interactive approaches via active learning, classifiers that encode prior knowledge and invariances, semisupervised learning that exploit the information of unlabeled data, and domain adaptation to compensate for shifts in the ever-changing data distributions. Latest advances in the field of unmixing will be reviewed, covering sparse approaches, spatial-spectral methods, and methods constrained by physical models. Finally, we will pay attention to recent advances in bio-geophysical parameter estimation that care about remote sensing data characteristics, such as spatial and temporal structures or the presence of heteroscedastic noise. Beyond theory, we will also present results of recent studies illustrating all the covered issues. Finally, we will provide MATLAB code and demos to the attendees to try the different methodologies, and provide a solid ground for their future experimentations.

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