Ph.D. in Information Technology
Thesis Defense

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Ava VALI – XXXIII Cycle

HYPERSPECTRAL IMAGE ANALYSIS AND ADVANCED FEATURE ENGINEERING FOR OPTIMIZED CLASSIFICATION AND DATA ACQUISITION

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Abstract:

Hyperspectral imaging (HSI) is a technology that combines spectroscopy with imaging capacities to capture valuable diagnostic information for detecting objects and precisely distinguishing their constituent materials in a non-invasive manner. Although the technology has been known for almost five decades, it recently gained the popularity it deserves among the research community due to new computational and technological advances. Besides the field of remote sensing- in which HSI initially emerged- such advances have introduced this technology to several new domains for a wide range of applications. Recent studies determine the great potential of Machine Learning in realizing these applications, yet passing them to real use cases is complicated by some open critical challenges that require further studies and adaptations. Despite some similarities that an HSI product shares with classic RGB images, its distinct characteristics make it a whole new story that requires dedicated research. Specifically, despite the promising potentials of Deep Learning end-to-end approaches that recently have stolen the spotlight in processing RGB images, this study discusses how impractical they are in HIS-related cases and discusses their shortcomings and limitations.

After a precise investigation of the causes and open challenges, this study highlights the impact of feature engineering within the Machine Learning pipeline on dealing with these challenges in supervised hyperspectral-based classification tasks, proposes a baseline for its configuration, and empowers the idea with advanced strategies for automatic optimization. Then, it develops this framework idea into a prototype AutoML to not only automate the process of model configuration and selection but also to provide a considerable amount of statistical information for additional analysis and comparative discussions. It also empirically investigates the possibility of automating feature engineering as a stand-alone step within the framework and discusses its benefits to different aspects of the process, from data acquisition to data analysis. At last, it performs two different experiments to evaluate the implemented framework.

PhD Committee

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