DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 36TH CYCLE

Title of the research activity:	**Remote Sensing for Earth Observation with Machine Learning techniques**
State of the Art:	Remote sensing, the technique of observing and analyzing targets without being in direct contact with them, allows to gather information about Earth atmosphere and surface. Earth Observation (EO) data are used to map and model the spatial and temporal pattern of Earth surface/atmosphere parameters (e.g. land cover types, surface temperature, albedo, water vapor, precipitation events, pollutants, etc.). Advances in space-based remote sensing and data availability have contributed to the growing number of EO studies, exploiting the global spatial coverage and the revisit time of satellite missions. Satellite sensor measurements are extensively used to retrieve geophysical parameters: for instance, suitable image processing and statistical analysis allow to detect land changes and thermal involvements. Machine Learning (ML), i.e. the automated approach to infer empirical models from the data alone, is a successful technique to process remote sensing data and images, currently revolutionizing many areas of research, science, and technology. Also, ML is routinely used to work with large volumes of data (big data) in different formats. For a successful application of ML, two aspects are essential: a machine learning algorithm, and a comprehensive training data set. Then, once the training phase has been performed, an independent validation test is necessary to assess the ML technique accuracy. If the ML algorithm provides poor performance, a ML modification is necessary as well as the availability of a more complete training data set. Now, several open source tools and common programming environments are available to facilitate the use of ML.
Short description and objectives of the research activity:	The research activity will be based on the following tasks: - Definition of the area of interest (urban and/or rural) - Choice of the geophysical parameters to monitor. For instance, in an urban area, useful parameters are: surface and air temperature, albedo, land cover types, pollutants. - Choice of the satellite platforms and sensors (e.g. multispectral radiometers): data download, calibration and atmospheric correction. - Retrieval and modeling of the selected parameters using ML techniques. Regressions and neural networks will be the typical (but not the only) ML techniques to be implemented for parameter estimations and image classifications. - Assessment of the ML algorithm performance: modification/optimization of the algorithms. - Application of ML techniques to image downscaling: from existing downscaling models to new performing models. Novel and original results are expected: the starting point is the study of the broad existing literature.

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