PhD Thesis proposal (2021-2024)

Deep Multimodal Learning and Analysis of Spatio-Temporal Dynamics by using Remote Sensing Imagery

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Thesis abstract:

The research work associated with this thesis will be funded by the Auvergne Rhône Alpes region, through the IATOAURA project (Artificial Intelligence in Territorial Observation for AURA). More specifically, this thesis aims to propose multimodal and multi-resolution learning frameworks for the analysis of natural hazards from essential and latent variables, deduced from observations of the Earth's surface by remotely sensed imagery. The main motivation is the contibution of satellite vision and artificial intelligence in automatically capturing the spatio-temporal dynamics associated with sensitive surfaces of territories. The thesis will focus on areas that are likely to present risks for human activities (landslides and surface deformation, displacement of glaciers, avalanches, volcanic activities).

The characteristics of these surfaces having stochastic spatio-temporal dynamics constrained by local geometry and seasonal external disruptive effects, the thesis will consider the development of deep learning frameworks that will operate on the dynamic information jointly carried by the spatial and temporal dimensions, in addition to jointly integrating multimodality and multiresolution constraints.

The thesis will propose new paradigms of weakly supervised learning as well as integrating constraints such as invariance to cyclostationary disturbances in spatiotemporal multimodal data. In this data, information can:

- be observable only on a scale or a channel of a specific acquisition mode (backscattered intensity, interferometric phase/coherence, polarimetric features or optical spectral bands);
- be visible only at certain resolutions;
- move in several spatio-temporal directions;

The retrieval of information then raises difficult issues in terms of large dimensionalities of the space to be explored. The thesis will build deep learning systems integrating intrinsic constraints such as temporal closure of displacement combinations and extrinsic constraints such as seasonality and multimodality to solve such issues. The so-called weak supervision strategy is motivated by the observation that an expert annotation is unthinkable due to the high number of continuous variables to predict.

Bibliography:

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