M2 RESEARCH INTERNSHIP PROPOSAL IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Title : OPTIMAL TRANSPORT FOR UNSUPERVISED CHANGE DETECTION BETWEEN HETEROGENEOUS IMAGES

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Level : Master 2 / 3rd year of Eng. degree

Duration: 4 to 6 months

Allowance: ~600€/month

CONTEXT

A classical image processing task consists in detecting changes between two images sharing the same spatial and spectral resolutions. As they are acquired through the same sensors, identifying changes is somewhat straightforward. Still, one can consider change detection between two multi-band images acquired through sensors of different modalities, examples include emergency situations and punctual missions. The usual approach to tackle this matter is to independently apply a transformation to each image so they end up with common high spatial and high spectral resolutions. The resulting images can then be easily compared. However, such preprocessing steps discard the coupled information of the images. Recently, Ferraris and co-authors proposed to view change detection as a robust fusion problem by building two latent images of same resolution as degraded versions of the observed images [1]. The latent images are thus fused by enforcing spatial sparsity, highlighting the changes between the two observed images.

OBJECTIVE

The general trail of this internship is to view images as probability measures in order to leverage an optimal transport (OT) – also called earth mover's distances – framework [2] for unsupervised change detection. OT consists in transporting the mass, or energy, of a distribution onto another one, in a least costly way, which is known to conserve important features of the geometry of the distributions. In particular, the Gromov-Wasserstein (GW) metric allows to compare distributions living in different spaces, and therefore to measure the dissimilarities between two images of different modalities, without the need for prior data transformation as it has been done in [3] for image fusion. A first goal will be to design a proper model to detect changes between two images using GW, by keeping in mind that both images are correlated, and a common framework needs to be developed. A second important problem to address is the numerical computation of the model, as optimal transport is notoriously computationally expensive [4].

BIBLIOGRAPHY

[1] V. Ferraris, N. Dobigeon, M. Chabert. "Robust fusion algorithms for unsupervised change detection between multi-band optical images – A Comprehensive case study." Information Fusion, vol. 64, p. 293-317 (2020).
[2] C. Villani. "Topics in Optimal Transportation." Number 58. American Mathematical Soc., 2003.
[3] J. Mifdal, B. Coll, N. Courty, J. Froment, B.. "Hyperspectral and multispectral Wasserstein barycenter for image fusion." IEEE Int. Geosc. Remote Sens. Symp. (IGARSS), 3373-3376 (2017).
[4] G. Peyré, M. Cuturi. "Computational Optimal Transport: With Applications to Data Science." Foundations and Trends in Machine Learning, 11(5-6), 355-607 (2019).

CANDIDATE PROFILE

Prospective applicants should have a strong background in **signal/image processing**, **machine learning** or **applied mathematics** (probability & statistics, optimization, etc.), good scientific programming skills (e.g., Python or Matlab) and good communication skills in English, both written and oral. Particular interests in remote sensing and/or Earth observation will be appreciated.

PRACTICAL DETAILS

- Starting date : February – March 2021, for 4 to 6 months.
- The internship will took place at IRIT (located at INP-ENSEEIHT) in Toulouse.
- The internship gratification is about 600€ per month.
- To apply, please send a detailed CV, official transcripts from each institution you have attended (in French or English), and a motivation letter to elsa.cazelles@irit.fr

APPLICATION PROCEDURE

Formal applications should include detailed cv, a motivation letter, and transcripts of Bachelor's degree.
Applications should be sent by email to: **elsa.cazelles@irit.fr**
More information about ANITI: **https://aniti.univ-toulouse.fr/**