Multi-scale graph representation learning for remote sensing image analysis

Master/Ecole d'Ingenieur internship

Expected starting: February/March 2021 (6 months)

Keywords

Deep learning on graphs, Structured data, Graph embedding, Remote Sensing

Context and objectives

In the past few years, the amount of earth observation missions using remote sensing technologies has increased dramatically, providing a huge number of multimodal data coming from different sensors: optical, radar, lidar, etc. The need of efficient and reliable methods for multimodal remote sensing data analysis becomes crucial to exploit their complementary information for tackling various applications such as land-cover mapping and updating, scene understanding, urbanization trend detection and prediction, etc. Among modern techniques, object-based approach using graph model appears to be a promising solution.

This internship proposal aims at studying the ability of graph structures to model and characterize the spatial relationships of objects and regions from an image at different scales. That means we are interested to work on object/region levels, not the pixel level from the image. From the achieved graph structures, recent frameworks based on graph representation learning (e.g. graph convolutional neural networks, graph autoencoder) and graph distance metric learning could be investigated to perform structured graph embedding into robust feature spaces. For remote sensing applications, we are interested in various tasks including image retrieval, classification and scene matching, with applications to ecological or humanitarian challenges.

More specifically, this work will concentrate on extracting meaningful spatial graphs that can be used for reasoning (akin to [5]). The work will leverage on theoretical works developed in the team [6] to design sensible loss between graphs objects to learn efficiently neural networks that will predict the graph structure.

Potential outcomes of the internship will lead to publications in remote sensing, computer vision or machine learning fields, depending on the nature of the contributions. Let us finally note that this internship will be part of the AI chair OTTOPIA funded by ANR (starting beginning of 2021), for which potential fundings are available for the candidate to enter a PhD track after the internship.

Work program

In order to address the aforementioned objectives, a tentative work program is given below.

- Bibliographical study of graph representation learning and graph distance metrics as well as their adaptation to image data
- Evaluation of existing frameworks related to graph-based deep learning for image analysis and processing
- Development of frameworks for multi-scale image analysis using graph-based deep networks
- Evaluation and benchmarking on remote sensing image scene matching and retrieval

Required background and skills

- Student Master 2, Ecole d'Ingénieur or equivalent with excellent academic track;
- Background in computer science and/or machine/statistical learning and/or applied mathematics for signal and image processing;
- Excellent programming in Python (familiar with one of deep learning packages, such as PyTorch or Tensorflow, is a must.)

Supervision

The expected intern will join the OBELIX research group (`www.irisa.fr/obelix`) from IRISA (UMR 6074) is located in the UBS (Université Bretagne Sud) campus in Vannes 56000, France.

The internship will be jointly supervised by **Dr. Minh-Tan Pham**[1] (Maître de Conférences at UBS) and **Prof. Nicolas Courty**[2] (Professor at UBS).

Application

Send your CV + Motivation letter + Master transcripts to `minh-tan.pham@irisa.fr` and `nicolas.courty@irisa.fr` **(before 15 November 2020)**. Potential candidates will be contacted for interview.

References

[1] Bronstein, M.M., Bruna, J., LeCun, Y., Szlam, A. and Vandergheynst, P., Geometric deep learning: going beyond euclidean data IEEE Signal Proc. Magazine, 34(4), pp.18-42, 2017.

[2] Park, Jiwoong, et al. Symmetric graph convolutional autoencoder for unsupervised graph representation learning. Proceedings of the IEEE International Conference on Computer Vision. 2019.

[3] Khan, Nagma, et al. Graph convolutional network for multi-label VHR remote sensing scene recognition. Neurocomputing 357 (2019): 36-46.

[4] Chaudhuri, Ushasi, Biplab Banerjee, and Avik Bhattacharya. Siamese graph convolutional network for content based remote sensing image retrieval. Computer Vision and Image Understanding 184 (2019): 22-30.

[5] Xu, H., Jiang, C., Liang, X., and Li, Z. Spatial-aware graph relation network for large-scale object detection IEEE CVPR, 2019.

[6] Vayer, T., Chapel, L., Flamary, R., Tavenard, R., Courty, N. Fused Gromov-Wasserstein Distance for Structured Objects. Algorithms, 13(9), 212, 2020.

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[2] `http://people.irisa.fr/Nicolas.Courty/`