Ph.D. Thesis proposal

Learning Spatio-temporal data by graph representations

Keywords
Time-varying graphs; Graph Neural Networks; Recurrent Neural Network; Attention mechanism

Supervisors and contact

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Hosting Institution

Computer science laboratory of Tours / Laboratoire d'Informatique Fondamentale et Appliquées de Tours (LIFAT, lifat.univ-tours.fr), Tours, France

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PhD Subject

In many application domains like action recognition or prediction, video segmentation, traffic forecasting or anomaly detection in brain activity signals, time-varying data are frequently represented by graphs. Two main representations are commonly considered: a temporal sequence of graphs or a spatio-temporal graph connecting graph nodes through time. While there is a solid literature on data analysis based on such representations, the domain has strongly evolved over the last 5 years with the advances in deep learning on Graph Neural Networks.

Such methods have been less investigated for time-varying graphs, particularly when both the graph structure and the data attached to this structure are varying.

We can distinguish two main models: Recurrent Neural Networks (RNN) combined with spatial convolutions rely on the sequential representation [1, 2, 3]; or Graph Convolutional Networks alternating temporal and spatial convolutions [4, 5, 6].

The aim of this thesis is to:

1. Study new representations for spatio-temporal graphs: we want to investigate some new representations in two main directions: representing temporal data as attributes of nodes and edges, and representing temporal data as edge connections between spatial positions represented by nodes at different times.
2. Propose new Neural Network architectures for data represented by this kind of graphs: we want to propose adapted convolutions, decimation and pooling, and study the

definition of a recurrent neural network that operates directly in the space of the graphs (for example generating new graphs). One direction of study will also be the Spatial-Temporal Graph Attention Networks (STGAT [7]) and Graph Transformer Networks (GTN [8]).

3. Program these models (in Python), and compare them to the state-of-the-art on standard datasets for different applications, in particular, skeleton-based gesture recognition.

How to candidate

The candidate must send by email a CV, motivation letter and marks of Bachelor, Master of Science to the supervisors before the 8 of April 2022. A first selection will occur and then interviews will be proposed between April and the end of June.
The candidate profile is:

- Master degree in Computer Science, Applied Mathematics, Data Science, or similar.
- Skills:
    - strong background in computer science and maths
    - experiences in neural networks, deep learning, Python programming, numerical analysis will be privileged
    - knowledge in video and image analysis would be appreciated
    - good communication skills and reporting, autonomy and curiosity

The PhD could start around October 2022

References

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