PhD position at University of Rennes 1, France - IRISA/LS2N Laboratories

Starting date: January 1st, 2022, or as soon as possible in 2022
Title: Combining educational resources through graph representation learning
Supervisors: Zoltan Miklos (IRISA, Université de Rennes 1), Hoël Le Capitaine (LS2N, Université de Nantes), Mickaël Foursov (IRISA, Université de Rennes 1)
Work site: Rennes, France
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Keywords: educational resources, knowledge graphs, graph representation learning, higher-order networks
Candidate profile: Master in computer science or equivalent; good programming skills (in Python); very good command of English (knowledge of French is not required, but it is a plus).
3-years funding (Labex Cominlabs): Net salary ~1,500€ (including national health insurance, employment insurance) before income taxes.
To apply: send your application to zoltan.miklos@irisa.fr with a detailed curriculum vitae, grade transcripts (with your class ranking if possible), two references, and your MSc theses in PDF format. Applications will be received until the position is filled.

Context and motivation

There is a large number of publicly available learning resources. To combine these resources and create potential coherent sequences to achieve a specific learning goal is a challenging task for educators. Identifying resources to complete or complement an existing course also requires a considerable effort. At the same time, teachers and professors are confronted with the task of creating online courses within a very short time, in particular during the Covid sanitary crisis. Making sense of large collections and especially identifying connections between learning resources is challenging and time-consuming.

Objectives and scientific challenges

The objective of the CLARA project, financed by Cominlabs, is to support and assist educators in associating learning resources to learning paths, in particular relative to the designed curricula. We would like to design such methods with the help of various methods from artificial intelligence. Specifically, we will associate various pieces of information to the resources, such

as metadata and knowledge graphs. Then we would like to exploit graph matching and graph representation learning [Ham2020] techniques that relate these individual graphs and identify more specific connections between the ressources.
However, the graph representation learning methods are not directly adapted to address the specific problem of linking open educational resources, for the following reasons :

- There could be several knowledge graphs that are associated with a specific resource. We could also have different versions of the same knowledge graph.
- Besides the knowledge graphs, we can have other metadata that could be exploited.
- Most importantly, if we would like to complete an existing path of resources with an additional one, the choice might depend on the entire path and not only one single resource of this path. In other words, in order to predict which resources are related and could be used in a curriculum, we should exploit higher-order features [Bick2021] of the networks and tensors that we will construct. The learned graph representation should also represent the paths of resources.

We propose to work on this specific problem in the thesis. We plan to develop representation learning techniques for higher-order networks that can support path finding methods. There are some recent works in this direction, including [Rossi18], [Saebi21] and [Benson2018]. However, these works do not focus on knowledge graphs. Moreover, prerequisite relations between concepts, if they are known, should also be given special attention.

References

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[Bick2021] Christian Bick and Elizabeth Gross and Heather A. Harrington and Michael T. Schaub. What are Higher-Order Networks? https://arxiv.org/abs/2104.11329
[Rossi18] Ryan A. Rossi, Nesreen K. Ahmed, and Eunyee Koh. 2018. Higher-order Network Representation Learning. In *WWW '18 Companion: The 2018 Web Conference Companion, April 23–27, 2018, Lyon, France.*
[Saebi21] Mandana Saebi , Giovanni Luca Ciampaglia , Lance M. Kaplan , Nitesh V. Chawla. HONEM: Network Embedding Using Higher-Order Patterns in Sequential Data
[Benson2018] Benson, Austin R. and Abebe, Rediet and Schaub, Michael T. and Jadbabaie, Ali and Kleinberg, Jon. Simplicial Closure and Higher-Order Link Prediction. Proceedings of the National Academy of Sciences. 115(48), 2018. 10.1073/pnas.1800683115