Suzanna's presentation - a review

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This is a report on the presentation made by Suzanna Pozzoli on the 26th November 2020 for the course *Advanced Course in Data Mining and Analytics*. Overall, I found it to be a good presentation, and below follows my opinion on the matters in question.

1 Content

The content of the papers were interesting, as it concerned questions on how to extract higher-order structures on graphs; both on a large and a small scale.

Starting with the first paper, *Higher-order organization of complex networks* [1] it presented a highly scalable algorithm that can, given a motif (see 5) or a range of them, derive insights into which nodes play particular roles and are important when partitioning the network and by identifying different motif structures. I am a bit concerned that the method is a bit too dependent on which motif one chooses, and the way to find a suitable motif is very computationally intensive. However, I still find the paper very interesting with possibilities to extend.

Regarding the second paper, *Annotated hypergraphs: models and applications* [2], I am slightly more concerned about the content. It presents new methods and frameworks that treats the question on how to extract information from graphs that have polyadic interactions; in other words, where more than 2 nodes can be involved in a single edge, and a node can have different roles in different edges. While the theory is soundly elaborated and the techniques are well presented, I was not extremely impressed by the use cases shown. It has, in my opinion, more potential than what was shown. As in the first paper, I am a bit concerned regarding some choices that the common practitioner has to make him- or herself. An example is the role-interaction kernel $\mathbf{R}$ that is far from clear how to construct, and which values that should be imposed between different roles in this matrix is not straightforward. Here, more work is needed to motivate this, and possibly even a learning framework that can automatically learn and optimize the construction of this matrix, rather than leaving it as a hyper parameter.

Finally, coming to the last paper, *A structural graph representational learning framework* [3], this might be the most interesting one. It presents a technique

on how to derive rich node embeddings that contains and represents information related to the higher-order structure of the nodes. It also presents two use cases; link prediction and visitor stitching, and shows how it outperforms state-of-the-art such as `node2vec` and other techniques. It also presents and proposes many different extensions and shows how the framework is highly modifiable, which is also a strength.

2   Suitability of the chosen papers

In terms of suitability and whether it fits into the course, I have no doubt it does fit into the scope of the course. They all touch upon questions on graph analytics and deriving insights or useful embeddings by extracting some type of information from different graphs.

3   Links between the papers

The presentation were connected in the sense that they all touched upon the theme of higher-order organization of networks. The first [1] touched upon analyzing and deriving insights based on motif structures, the second [2] concerned deriving metrics and analysis from networks where nodes can have different roles in different edges and the third [3] created a high-quality embedding based on motif structures found in a network. In that sense, they all leverage different ways of extracting higher-order organizations and "meta-information" about graphs for different application purposes, so they had a clear link. However, the use-cases were a bit different, but I do not think that it is necessarily a bad thing; it rather shows the usefulness of the perspective in question.

4   Quality of presenting

The presentation was clear and well-articulated. It was easy to follow, and I think she highlighted most of the important points.

If there was anything I missed in the presentation, it would have been some more figures and graphs to both show examples (such as the last figure in [3]) and more visual examples of how some of the things worked, instead of mathematical formulations. One example of what I would have liked to see more is examples like her demonstration of the null model from [2]. That was a really good presentation of how the sampling worked, and more examples like that would have helped improve the quality of the presentation.

5   Explanations

- Motif - Network motifs - building blocks for complex networks, basically smaller network subgraphs. See [1] for a more thorough explanation.

References

[1] Austin R Benson, David F Gleich, and Jure Leskovec. Higher-order organization of complex networks. *Science*, 353(6295):163–166, 2016.

[2] Philip Chodrow and Andrew Mellor. Annotated hypergraphs: Models and applications. *Applied Network Science*, 5(1):9, 2020.

[3] Ryan A Rossi, Nesreen K Ahmed, Eunyee Koh, Sungchul Kim, Anup Rao, and Yasin Abbasi-Yadkori. A structural graph representation learning framework. In *Proceedings of the 13th International Conference on Web Search and Data Mining*, pages 483–491, 2020.