Temporally Evolving Hierarchies in Networks

Tue Herlau Morten Mørup Mikkel N. Schmidt
DTU Compute
Technical University of Denmark
Lyngby, 2800
{tuhe,mm,mns}@imm.dtu.dk

Real-world networks often exhibit the following two key features, temporal evolution and hierarchical organization. Consider for instance a social network. The network is temporally organized both by people entering or becoming inactive in the social network, and also at a shorter timing by people changing workplaces, schools or interests [3].

Structurally, networks are often organized at multiple scales, where the coarse to the fine scales may correspond to countries, districts, schools, classes or cliques, and an organization of all vertices in a hierarchy provide a natural representation of such structure, as well as naturally giving rise to small-world properties often found in real networks [1].

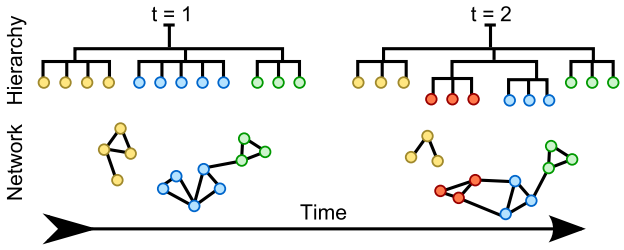

Figure 1: A network of 12 vertices observed at two time instances. Between time $t = 1$ to $t = 2$, three vertices from the yellow and blue community change hierarchical organization forming the red community.

While both temporal evolution and hierarchical organization have been independently motivated and studied multiple times [3, 1], to our knowledge no-one has proposed a statistical generative model to capture both effects.
Drawing on ideas from probability theory and new developments in hierarchical network modelling [2, 4], the proposed model infers a distribution over temporal hierarchies from network data using Markov-chain Monte Carlo sampling. We demonstrate the feasibility of the model on three different social networks and discuss some of the challenges in modelling temporal hierarchies.

References

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