Linearizing Belief Propagation for Efficient Label Propagation

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Abstract. How can we tell when accounts are fake or real in a social network? And how can we tell which accounts belong to liberal, conservative or centrist users? Often, we can answer such questions and label nodes in a network based on the labels of their neighbors and appropriate assumptions of homophily ("birds of a feather flock together") or heterophily ("opposites attract"). One of the most widely used methods for this kind of inference is Belief Propagation (BP), which can effectively been used as a principle for label propagation in partially labeled networks. One main problem with BP, however, is that the convergence in graphs with loops is not guaranteed.
In this talk, I will present two principles for efficient label propagation that are based on the idea of linearizing Belief Propagation [1]. First, I will introduce 'Linearized Belief Propagation' (LinBP), a linearization of BP that allows a closed-form solution via intuitive matrix equations and, thus, comes with convergence guarantees. It handles homophily, heterophily, and more general cases that arise in multi-class settings. In the second part, I will present 'Single-pass Belief Propagation' (SBP), a "localized" version of LinBP that propagates information across every edge at most once and for which the final class assignments depend only on the nearest labeled neighbors. In addition, SBP allows fast incremental updates in dynamic networks. Runtime experiments show that LinBP and SBP are orders of magnitude faster than standard BP, while leading to almost identical node labels.

References

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 In: R. Bergmann, S. Görg, G. Müller (Eds.): Proceedings of the LWA 2015 Workshops: KDML, FGWM, IR, and FGDB. Trier, Germany, 7.-9. October 2015, published at http://ceur-ws.org