Benet2019 Abstract:
Spectral Anomaly Detection on Attributed Networks

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Anomaly detection is an important problem in data mining with multiple applications in diverse domains. Anomalous data can be understood as the noteworthy objects with patterns or behaviors that deviate significantly from any background property. When the data is represented as a network, traditional methods consider anomalous nodes as nodes which connectivity patterns differing significantly with respect to the underlying structure. However, many real life problems have attributes associated with the nodes in addition with their connectivity information. For instance, social networks contains social ties and demographic information on the nodes, co-purchase networks contain information of articles on the nodes, etc. Therefore, outlier detection on networks requires to consider the heterogeneity of multidimensional nodal information and the scale of the underlying network.

Motivated for the previous observations, in this work we introduce some preliminary research in anomaly detection on attributes networks. We propose to effectively localize outlier nodes in different scales, e.g nodes which are anomalous with respect to its attributes in a local, intermediate or global context.

In order to do so, we address this problem under the lens of the graph signal processing framework [1]. Indeed, considering signals in the vertex domain allow us to relates nodal information with graph structure in coupled manner. By looking at the spectral properties of the graph, the harmonic behavior of the graph signal can be manipulated. For instance, when a filtering operator is applied on signals defined on attributed graphs, the smoothed signal allow us to recover suspicious outlier nodes. In particular, when a heat kernel operator is used as low-pass filter on the signal, its diffusion dynamics across the network [2] allow us to recover not only outlier candidates, but also the context for which the node is anomalous.

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[2] R Lambiotte, JC Delvenne, M Barahona. Random walks, Markov processes and the multiscale modular organization of complex networks. *IEEE Trans. Network Science and Engineering* 1 (2), 76-90, 2014