**PhD Dissertation**

**Adaptive Graph-Based Algorithms for Conditional Anomaly Detection**

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**Abstract**

We develop a set of graph-based methods for conditional anomaly detection and semi-supervised learning based on label propagation on a data similarity graph. When data is abundant or arrive in a stream, the problems of computation and data storage arise for any graph-based method. We propose a fast approximate online algorithm that solves for the harmonic solution on an approximate graph. We show, both empirically and theoretically, that good behavior can be achieved by collapsing nearby points into a set of local representative points that minimize distortion. Moreover, we regularize the harmonic solution to achieve better stability properties.   
  
We also present graph-based methods for detecting conditional anomalies and apply it to the identification of unusual clinical actions in hospitals. Our hypothesis is that patient-management actions that are unusual with respect to the past patients may be due to errors and that it is worthwhile to raise an alert if such a condition is encountered. Conditional anomaly detection extends standard unconditional anomaly framework but also faces new problems known as fringe and isolated points. We devise novel nonparametric graph-based methods to tackle these problems. Our methods rely on graph connectivity analysis and soft harmonic solution. Finally, we conduct an extensive human evaluation study of our conditional anomaly methods by 15 experts in critical care.

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