Detecting weak, hierarchically-structured sparse network activations

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Abstract

The ability to detect weak and sparse activation patterns in networks is critical to several applications, such as identifying the onset of anomalous activity and incipient congestion in the Internet, or faint traces of a biochemical spread by a sensor network. This is a challenging problem since weak and sparse patterns can be invisible in per node statistics as well as a global network-wide aggregate. Most prior work considers situations in which the activation/non-activation of each node is statistically independent, but this is unrealistic in many problems. In this talk, I will describe a method that can exploit the (possibly non-local) statistical dependencies in the activation process to enable detection of much weaker patterns than could be detected with current techniques.

The proposed method constructs a sparsifying wavelet transform that succinctly represents structured activation patterns that conform to a hierarchical dependency graph. Transforming the network data effectively achieves adaptive fusion of the network measurements. Thus, weak network activity gets amplified and can be detected in the transform domain. I will present theoretical guarantees of the method as well as some practical results for detecting incipient congestion in Internet-like topologies.