# CoCo Seminar Series
# Spring 2015

## Graph Theoretic Approaches for Analysis of Dynamical Systems: Application to Manufacturing and Neurophysiology

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**Wednesday March 18th, 2015**
**8:30-9:30am**
**Engineering Building R-3**
**(SSIE Conference Room)**

The central theme of this talk is to demonstrate the potential of graph theoretic signal processing approaches for monitoring the dynamics of complex bio-physical systems in a data rich environment. Specifically, we address the following key research question: how to fuse information from multidimensional signals for monitoring of complex systems and process. This so-called *curse of dimensionality* permeates diverse domains, for instance, quantifying the surface finish of finely polished surfaces from micrograph images; classifying geometric integrity of 3D printed parts from laser scans; detection of drifts from vibration and force sensor data in manufacturing processes; and identification of epileptic seizures from EEG signals, among others. We propose an approach that maps a multidimensional signal as an un-weighted undirected network graph. In other words, given a continuous $\mathcal{X}^{N\times d}$ data stream (visualize $N$ as time and $d$ as the number of sensors), we define a graph transform $\mathcal{G}(\cdot)$, such that $\mathcal{G}(\mathcal{X}^{N\times d}) \longrightarrow G(V,E)$, where $G$ is an un-weighted and undirected graph indexed by its vertices $V$ and edges $E$. The algebraic connectivity of the graph $G(V,E)$ as manifest in the Eigen spectra of the graph Laplacian $\mathcal{L}$ will be used as system discriminants. We present experimental case studies from both the manufacturing (semiconductor polishing and additive manufacturing), and neurophysiological domains where the Eigen spectra of the graph Laplacian $\mathcal{L}$ is invoked to capture system change points and deleterious process drifts within a few seconds of their onset.

Dr. Prahalad Rao is an Assistant Professor of Systems Science and Industrial Engineering at Binghamton University. His main research thrust is sensor-based modeling and monitoring of advanced manufacturing processes, such as diamond turning, planarization, and 3D printing. His research interests include sensing, signal processing, and dynamical systems.
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