Signed Nonlinear Networks: A Passivity and Electrical Circuit Theory Approach

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Date: Wednesday, April 10, 2019  
Time: 12:30 pm  
Location: ECAD 109  
There will be Pizza, Drinks, and Coffee

Abstract: Signed networks provide a powerful modeling framework for multi-agent systems that capture both cooperative and antagonistic interactions. The use of positive and negative edge weights in linear network protocols may appear by design to achieve certain objectives (such as optimizing some performance criteria or achieving some desired steady-state), or as the result of infiltration from malicious actors. The study of signed networks has focused primarily on graphs with scalar edge weights. However, in many systems, the interaction protocols between neighboring agents may be described by more complicated non-linear functions. In this direction, we first study how to extend the notion of signed graphs to graphs with nonlinear edge weight functions. Inspired by notions from passivity theory, we classify edge functions as either passive or active, which leads to a generalization of signed scalar networks. We then provide some basic convergence results for signed nonlinear networks comprised of agents with passive dynamics. For the case of single integrator agents, we show a connection to notions from electrical circuit theory and the equivalent circuit model to derive convergence results for networks with active edges. This leads to a generalization of existing results on linear signed networks. Our results are demonstrated with some illustrate numerical examples, we and discuss future research opportunities using this framework.

Bio: Daniel Zelazo is an Associate Professor of Aerospace Engineering at the Technion - Israel Institute of Technology. He received his BSc. (’99) and M.Eng (’01) degrees in Electrical Engineering & Computer Science from the Massachusetts Institute of Technology. Before beginning his doctoral studies, he worked for two years on audio compression algorithms as a research engineer at Texas Instruments, Japan. In 2009, he completed his Ph.D. from the University of Washington in Aeronautics and Astronautics. From 2010-2012 he served as a post-doctoral research associate and lecturer at the Institute for Systems Theory & Automatic Control in the University of Stuttgart. His research interests include topics related to multi-agent systems, optimization, and graph theory.