

## Séminaire conjoint CIRRELT / Département OSD

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### USING INTEGER PROGRAMMING MODELS FOR THE STRUCTURAL ANALYSIS OF SIGNED NETWORKS BASED ON BALANCE THEORY



**Abstract:** A signed network is one with positive and negative edges. We analyze signed networks from the perspective of balance theory. A signed network is strongly balanced (weakly balanced) if its nodes can be partitioned into  $k \leq 2$  clusters ( $k$  clusters) such that positive edges are within the clusters and negative edges are between the clusters. We use mathematical programming models to optimally cluster the nodes of a network by minimizing the total number of intra-cluster negative and inter-cluster positive edges. These optimization models cluster a network into clusters of nodes that are internally cohesive and mutually divisive. The optimal partitions of a network allow us to quantify the extent to which it is weakly or strongly balanced. In other words, we measure the distance of a network to weak and strong balance in terms of the minimum number of edges whose sign change leads to weak and strong balance respectively. The concepts of strong and weak balance in signed networks can be extended to applications beyond the classic friend-enemy interpretation of balance theory in the social context. Through extensive computational analysis, we explore common structural patterns across a range of networks representing philosophers and Wikipedia editors to Bitcoin traders and US Congress legislators. This talk provides an overview of using integer programming to develop exact graph optimization models and algorithms for signed networks. A wide range of use cases will be discussed for signed networks from sociology, biology, chemistry and physics to finance, international relations, and political science.

**Biography:** Samin Aref is an assistant professor, teaching stream in data science at the Department of Mechanical and Industrial Engineering, University of Toronto (Canada, 2021-present). He holds a PhD in Computer Science from the University of Auckland (New Zealand, 2019) and an MSc in Industrial Engineering from Sharif University (Iran, 2014). He has worked as a visiting assistant professor at the University of British Columbia (Canada, 2022) and a research scientist at the Max Planck Institute for Demographic Research (Germany, 2018-2021). Samin's research is at the intersections of network science, machine learning, operations research and optimization, data science, and social computing for which he has secured funding from several organizations in Germany, New Zealand, and Canada. Samin has contributed to the fundamental mathematics of analyzing groups and systems and has developed new methods for studying the migration and mobility of researchers in Russia, Mexico, Germany and the UK

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Responsable :  
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