

N23 Dinh, L., Rezapour, R. & Diesner, J. (2019). Considering transitivity and leveraging text content to assess balance in directed networks.

A wide range of networks research has incorporated structural balance as both a theoretical and an empirical foundation to explain various social processes, including attitudes, beliefs, sentiment, and trust. Structural balance originates from Heider's cognitive consistency theory (1946), which postulates the drive for any social relationship to lessen tension and maintain a balanced state. The theory has been expanded in various ways, including Cartwright and Harary (1956)'s introduction of signs for undirected networks, in which (+) sign denotes positive links and (-) denotes negative links. Since then, structural balance has often been empirically tested for undirected networks. However, many real-world networks are directed. To address this missing piece, we aim to incorporate directionality into the testing of structural balance by establishing transitivity as an additional condition for balance. Using the triad census, we develop eight triad types, of which four are balanced and transitive conditions, and four are unbalanced and intransitive conditions. We report on our findings from labeling edges in three empirical networks based on sentiment, morality, and perceived trust to uncover the balance and transitive dynamics of these real-world, directed networks. For our experiments, we use two email datasets and one social network dataset constructed from surveys of 31 decision-making teams.

To label edges in email networks with a sign that represents sentiment (+ or -), we domain-adjusted and applied the MPQA subjectivity lexicon developed by Wilson and colleagues (2005) to syntactically disambiguated email content. We labeled each email with the dominant sentiment class. Similarly, to label edges in email networks with a sign that represents morality (virtue or vice), we leveraged the Morality Foundations Dictionary created by Graham and colleagues (2009). This dictionary consists of words that represent five basic moral principles and one miscellaneous category that characterize opposing values (virtues and vices) based on the Moral Foundations Theory. Since the original lexicon is limited in size (N= 324 entries) and not syntactically disambiguated, we expanded and syntactically disambiguated the entries. We labeled each email with the dominant tendency. For email data, analysis is under way. We hypothesize to see a diverse profile of triad types with higher instances of transitive and balanced triads, given the professional nature of corporate-level email communication.

To compute balance for the trust networks, we identified all triads associated with each team. We use a positive edge sign to denote directed trust, and a negative sign to represent distrust. There are eighteen four-person groups, with eight triads contained in each group. For the 13 eight-person groups, there are 112 triads in each group. Balance analysis revealed that most triads fall under two main types of balanced and transitive states: (A2) A friend of an enemy is an enemy, and (A3), an enemy of a friend is an enemy.

We will compare results across the three empirical networks and examine how networks differ with respect to balance when also considering directionality. This work also expands and tests the theoretical foundations of balance theory.