Dynamical regimes of armed conflict: a temporal network study

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Armed conflict has long been conceptualized as evolving through distinct phases[7, 1, 4], each characterized by unique patterns of violence and interaction. Furthermore, empirical studies have revealed bursty temporal dynamics in violent conflict, with Picoli et al. identifying scale-free temporal patterns across different conflicts[6]. These observations have motivated mechanistic models based on self-organized criticality (SOC)[2, 5], in which a slowly driven system approaches critical states and dissipates accumulated energy intermittently through *avalanches*.

Braha has explored this perspective in the context of civil unrest, and has shown that collective unrest can be analyzed through "*unique, measurable, repeating latent phases*" [3]. In particular, he employs a hidden Markov model to characterize collective unrest as a sequence of macroscopic dynamical regimes, each characterized by distinct statistical properties. Motivated by this framework, we study whether analogous dynamical regimes can be identified in specific armed conflicts, and whether transitions between these phases are accompanied by changes in the structure of interactions between conflict actors.

We use data from the *Armed Conflict Location & Event Data* (ACLED) project, which provides georeferenced records of political violence and armed conflict events, to construct weekly conflict actor co-occurrence networks. For specified countries and time frames, we construct weekly co-occurrence signed actor networks in which interactions are classified either as cooperative or conflictual. This produces a temporal sequence of signed networks that describe the evolution of conflict interactions over time.

To identify phases of conflict activity, we use a Gaussian Hidden Markov Model (HMM) on the transformed time series of weekly reported fatalities. Candidate models with different numbers of hidden states are compared using the Bayesian information criterion, with multiple random initializations used for each candidate model. The resulting hidden states are interpreted as dynamical regimes of conflict intensity.

We then test whether the structure of actor networks changes systematically between these regimes using regression models in which network metrics are conditioned on HMM state. Because these observations form a temporal

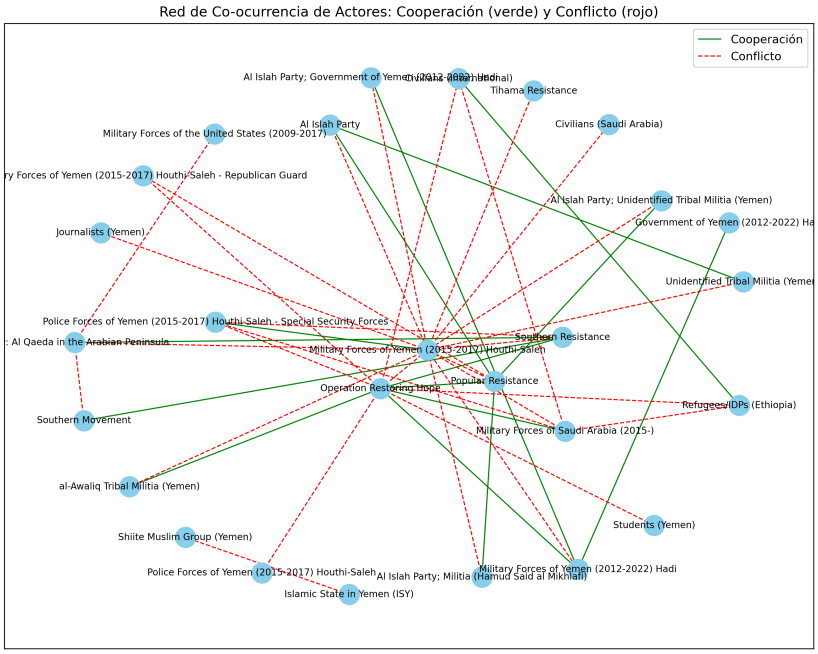


Figure 1: **Actor co-occurence network in the Syrian conflict corresponding to the week of 19/05/2015**

sequence, we employ heteroskedasticity and autocorrelation (HAC) consistent Newey–West standard errors.

The network measures considered include degree-based structural entropy, network density, clustering, connectedness, assortativity, modularity, algebraic connectivity, among others. Preliminary results for the Syrian conflict indicate that the identified dynamical regimes are associated with systematic differences in network metrics. In particular, the highest-intensity regime exhibits lower Wu structural entropy, assortativity and modularity, while average clustering coefficient, algebraic connectivity and Jaccard similarity are highest in this phase.

References

[1] Vincent August. Escalation and de-escalation. *The Handbook of social and political conflict*, pages 335–348, 2025.

[2] Dan Braha. Global civil unrest: contagion, self-organization, and prediction. *PloS one*, 7(10):e48596, 2012.

[3] Dan Braha. Phase transitions of civil unrest across countries and time. *npj Complexity*, 1(1):1, 2024.

[4] Paul F Diehl. Just a phase?: Integrating conflict dynamics over time. *Conflict Management and Peace Science*, 23(3):199–210, 2006.

[5] Joshua M Epstein. Modeling civil violence: An agent-based computational approach. *Proceedings of the National Academy of Sciences*, 99(suppl_3):7243–7250, 2002.

[6] Sergio Picoli, M del Castillo-Mussot, H Valentin Ribeiro, Ervin Kaminski Lenzi, and RS Mendes. Universal bursty behaviour in human violent conflicts. *Scientific reports*, 4(1):4773, 2014.

[7] Philip A Schrodt and Deborah J Gerner. Empirical indicators of crisis phase in the middle east, 1979-1995. *Journal of Conflict Resolution*, 41(4):529–552, 1997.