Research Objective

- Geometric and topological methods applied to develop theory, algorithms and techniques for structural and behavioral classifications and decisions in dynamic or evolving networks
  - Adapt novel mathematical concepts (e.g., curvature, homology) on network manifolds derived from real data for application to processes on networks
  - Use higher-dimensional representations of networks (e.g., simplicial complexes) to capture group interactions and relationships

Challenges

- Meaningful interpretation of discovered concepts for multidisciplinary network science
- Higher complexity is inherent to problem space due to combinatoric nature of beyond pair-wise interactions

ARL Facilities and Capabilities Available to Support Collaborative Research

- Network Science Research Laboratory
  - Integrated framework for experimentation on networks
- Code for visualization and computation (MATLAB/Python)
- Results:
  - Power law in facet (group) degree distribution
  - Jaccard-inspired approximation of Ollivier-Ricci curvature
  - Topological data analysis used to detect temporal network signatures and classify networks
  - Strong collapsing theory (e.g., preservation of minimal-cycle homology generators) applied to hole localization and sparse coverage in location-unaware sensor networks

Comparisons of Ollivier-Ricci (OR) curvature with Forman (F) curvature and two Jaccard curvatures (JC, gJC) on several network datasets using Pearson’s r and Kendall’s τ correlation coefficients

Challenges

- Meaningful interpretation of discovered concepts for multidisciplinary network science
- Higher complexity is inherent to problem space due to combinatoric nature of beyond pair-wise interactions

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Expertise in advanced topology, geometry, or combinatorics theory with applications
- Currently exploring potential extensions of persistent homology and differential geometry approaches in social network dynamics

Publications:

- Moore, “Greedy approaches to finding a sparse cover in a sensor network without location information,” GlobalSIP 2016
- Wilkerson, Moore, Swami, Krim, “Simplifying the homology of networks via strong collapses,” ICASSP 2013