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Detection of Multidimensional Structures in Granular Materials[1]
DANIELLE BASSETT, University of California Santa Barbara, KAREN DANIELS, ELI OWENS, North Carolina State University, MASON A. PORTER, University of Oxford, M. LISA MANNING, Syracuse University — Granular media display features across a range of spatial scales, from the particle scale to the force-chain scale and the bulk scale. In contrast to particulate and continuum models, network representations facilitate the simultaneous examination of microscopic, mesoscopic, and macroscopic features. We treat granular materials as spatially embedded networks in which the nodes (particles) are connected by weighted edges obtained from contact forces. Using community detection techniques, we identify local 2D geographic domains composed of particles that exert strong forces on one another. We subsequently develop and apply a novel spatial null model constrained by the contact network to extract chain-like structures reminiscent of force chains. We demonstrate that most of these chain-like structures are located close to the center of mass of the 2D geographic domains. However, a minority are located towards the edge of the 2D geographic domains, potentially forming points of instability in granular media. We explore the robustness of these detection techniques to algorithmic degeneracies, to simulation versus experimental data, and to varying pressure states.

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