Nonlocal Frameworks: Analytical, Modeling, Geometrical, and Computational Aspects

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The emergence of nonlocality as a successful framework for capturing a variety of different physical phenomena has catalyzed research in many directions at the applied, computational, as well as at the theoretical levels. While models formulated with the classical continuum mechanics theory have brought huge developments in technology and science over the last century, the new frontier requires tackling discontinuous, singular, or irregular behavior encountered in many applications such as deformations and damage of solid bodies, phase transitions and image processing. To this end, the study of systems that allow low-regularity (possibly discontinuous) solutions becomes the critical center-piece. In this talk I will present basic nonlocal formulations for elasticity, diffusion, conservation laws, as well as some geometric aspects for studying curvature for boundaries that lack (classical) C^2 regularity. For the corresponding nonlocal systems of equations we will discuss recent results (most of them belonging to the nonlinear realm) that we have obtained with our students and collaborators, as well as ongoing problems and future directions.