



Karlstad Applied Analysis Seminar (2026)

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From Bulk to Boundary: Heterogeneity in Non-local Models

Abstract

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.

A central theme will be the role of heterogeneity and boundary interactions, modeled through spatially varying operators and nonlocal boundary conditions. For these systems, I will discuss recent analytical results (including in the nonlinear regime) obtained with students and collaborators.

Particular emphasis will be placed on the limiting behavior of heterogeneous nonlocal systems as the interaction horizon tends to zero. In this regime, we identify the corresponding local (differential) models, clarify their physical interpretation, and highlight open problems and future directions motivated by applications in continuum mechanics, biology, image processing, and beyond.