KATHOLISCHE UNIVERSITÄT EICHSTÄTT-INGOLSTADT

Mathematisches Kolloquium

A Discrete Perspective on Variational Problems (or, The Importance of Being Discrete)

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Abstract: In the last thirty years the analysis of discrete systems on a diverging number of sites has seen a great development. The interest towards these problems was fostered at first by a number of applications ranging from Computer Vision, to Quantum Systems and Computational Mechanics, and more recently to other problems such as Machine Learning, involving in an essential fashion non-convex atomistic potentials. In a variational framework, these discrete problems are approximated by continuum ones involving energies with properties that highlight the effects of the discrete variables, such as microscopic oscillations and incommensurability effects, or concentration at a microscopic level leading to the formation of macroscopic singularities. The description of interfacial energies has parallels in Statistical Physics and Convex Geometry, while periodic and almost-periodic microscopic patterns remind of structures appearing in Homogenization and Dynamical Systems.

Most of the discrete systems considered are parameterized on Bravais lattices. For physical applications, this is justified by the so-called Crystallization phenomenon, but for some descriptions, such as those pertaining to Percolation and Machine Learning problems, it is necessary to use parameterizations on random environments (in problems connected to Combinatorics the environment is even more abstract, leading to the use of the theory of Graphons).

The most relevant change in perspective with respect to classical continuum asymptotic problems has been the use of non-local and geometrically non-linear arguments, which seem to have a potential for a much wider range of applications.

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