CRUNCH Seminars at Brown, Division of Applied Mathematics

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Invnet: Encoding Constraints in Generative Models

Ameya Joshi

Generative models such as Generative Adversarial Networks (GANs) can be effective and inexpensive surrogates to current expensive simulation-based scientific computational problems. While successful in modeling complex data distributions, the lack of flexibility of GANs to represent discrete-valued data, as well as the lack of control over physical properties of generated samples prevents them from being successfully leveraged. We propose a new conditional generative modeling approach (InvNet) that efficiently enables modeling discrete-valued images, while allowing control over their parameterized geometric and statistical properties. In this talk, we will discuss the challenges and the algorithmic aspects of Invnets. We will also illustrate the application of Invnet for several synthetic and real world problems: navigating manifolds of geometric shapes with desired sizes; generation of binary two-phase materials; and the (challenging) problem of generating multi-orientation polycrystalline microstructures. We will also discuss a coincident approach to solve PDEs, which act as concrete invariances in many scientific design problems.