# Generative Models: Structure and Symmetries

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The study of symmetries in physics has revolutionized our understanding of the world. Inspired by this, the development of methods to incorporate internal (Gauge) and external (space-time) symmetries into machine learning models is a very active field of research.

I will present our work on equivariant generative models and its applications to lattice-QCD and molecular dynamics simulations.

In molecular dynamics front, I'll talk about how we constructed permutation-equivariant normalizing flows on a torus for free-energy differences estimation.

In lattice-QCD, I'll present our work that introduced the first U(N) and SU(N) Gauge-equivariant normalizing flows for pure Gauge simulations and its extensions to incorporate fermions. This work led to several innovations in normalizing flows such as matrix-conjugation equivariant flows, simplicial flows and spectral flows which I will discuss as well as experimental results comparing these methods to traditional Monte Carlo techniques.