Michael Samuel Albergo: Stochastic Interpolants: A unifying framework for flows and diffusions

Abstract:
I will discuss recent work on unifying flow-based and diffusion based methods through a generative modeling paradigm we call stochastic interpolants. These models enable the use of a broad class of continuous-time stochastic processes called `stochastic interpolants' to bridge any two arbitrary probability density functions exactly in finite time. These interpolants are built by combining data from the two prescribed densities with an additional latent variable that shapes the bridge in a flexible way. The time-dependent probability density function of the stochastic interpolant is shown to satisfy a first-order transport equation as well as a family of forward and backward Fokker-Planck equations with tunable diffusion. Upon consideration of the time evolution of an individual sample, this viewpoint immediately leads to both deterministic and stochastic generative models based on probability flow equations or stochastic differential equations with an adjustable level of noise. The drift coefficients entering these models are time-dependent velocity fields characterized as the unique minimizers of simple quadratic objective functions, one of which is a new objective for the score of the interpolant density. Remarkably, we show that minimization of these quadratic objectives leads to control of the likelihood for any of our generative models built upon stochastic dynamics. By contrast, we establish that generative models based upon a deterministic dynamics must, in addition, control the Fisher divergence between the target and the model. We also construct estimators for the likelihood and the cross-entropy of interpolant-based generative models, discuss connections with other stochastic bridges, and demonstrate that such models recover the Schr\"odinger bridge between the two target densities when explicitly optimizing over the interpolant.