Deep Generative Priors for Quantifying Uncertainty

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Bayesian inference is used extensively to infer and to quantify the uncertainty in a field of interest from a measurement of a related field when the two are linked by a mathematical model. Despite its many applications, Bayesian inference faces challenges when inferring fields that have discrete representations of large dimension, and/or have prior distributions that are difficult to characterize mathematically. In this work we demonstrate how the approximate distribution learned by a generative adversarial network (GAN) may be used as a prior in a Bayesian update to address both these challenges. We demonstrate the efficacy of this approach by inferring and quantifying uncertainty in a physics-based inverse problem and an inverse problem arising in computer vision. In this latter example, we also demonstrate how the knowledge of the spatial variation of uncertainty may be used to select an optimal strategy of taking measurements, where information about the image is revealed one sub-region at a time.