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Efficient Bayesian inference using physics-informed invertible neural networks for inverse problems

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In the talk, we will introduce a novel approach for solving Bayesian inverse problems with physics-informed invertible neural networks (PI-INN). The architecture of PI-INN consists of two sub-networks: an invertible neural network (INN) and a neural basis network (NB-Net). The invertible map between the parametric input and the INN output with the aid of NB-Net is constructed to provide a tractable estimation of the posterior distribution, which enables efficient sampling and accurate density evaluation. Furthermore, the loss function of PI-INN includes two components: a residual-based physics-informed loss term and a new independence loss term. The presented independence loss term can Gaussianize the random latent variables and ensure statistical independence between two parts of INN output by effectively utilizing the estimated density function. Several numerical experiments are presented to demonstrate the efficiency and accuracy of the proposed PI-INN, including inverse kinematics, inverse problems of the 1-d and 2-d diffusion equations, and seismic traveltime tomography.