Neural Network Surrogates for Inverse Problems

Christian Jimenez Beltran, Antonio Vergari, Aretha L. Teckentrup, Konstantinos C. Zygalakis

Abstract

Inverse problems in differential equations are central to many scientific and engineering applications, requiring the estimation of model parameters based on noisy or incomplete observations. Traditional numerical methods for solving these problems are computationally expensive, especially when evaluating the likelihood in a Bayesian approach that involves high-dimensional parameter spaces. In this work, we investigate neural networks as surrogates to address these challenges. By incorporating a Laplace Approximation, our method efficiently approximates the forward model and provides reliable uncertainty estimates. Compared to traditional methods, this approach significantly reduces computational costs while maintaining accurate posterior approximations. These findings underscore the potential of neural networks for scalable and reliable solutions to inverse problems in complex systems.