A Survey on Uncertainty Quantification Techniques in Deep Learning: Methods, Challenges, and Applications

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Abstract

Deep learning has accomplished tremendous success in almost every field. But it is deterministic and often does not capture the uncertainties in complex data and decision-making tasks. The present survey intends to offer a panoramic view of Uncertainty Quantification (UQ) methods for deep learning, classified into Bayesian methods, ensemble methods, and test-time methods. Each method's theoretical basis, relative performance, and practical constraints are examined, along with their applications in safety-critical areas such as autonomous driving, healthcare, and finance, where reliable and interpretable models are in utmost demand. We will also discuss the challenges in existence and future research paths in uncertainty-aware deep learning systems.

Keywords

Deep learning, uncertainty, survey.