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Machine learning for numerical PDE: fast rate, neural scaling law

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In this talk, we aim study the statistical limits of deep learning techniques for solving Elliptic partial differential equations (PDEs) from random samples using the Deep Ritz Method (DRM) and Physics Informed Neural Networks (PINNs). We establish upper and lower bounds for both methods and prove that PINN and a modified version of DRM can achieve minimax optimal bounds over Sobolev spaces, which improve upon concurrent developed upper bounds for this problem via a fast rate generalization bound. In the analysis, we find out that generalization of the gradient term is hard where need more samples for the deep ritz methods and the sparsity of neurons (number of weights) is not a good generalization complexity measure for the gradients.