Optimal Thermal Diffusivity via Deep Learning for Heat Equation Image Denoising

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Abstract: Modern cameras inevitably introduce noise into images, which impacts their visual quality. As a result, various noise reduction strategies are necessary. Researchers have proposed numerous techniques for reducing noise, including approaches based on the linear and nonlinear partial differential equations. The choice of parameter values in partial differential equations plays a significant role in image denoising. Accurate tuning of these parameters can balance noise reduction and detail preservation, leading to higher quality denoised image. On the other hand, misadjusted parameters can result in either excessive smoothing or insufficient noise removal. Given these reasons, in this paper, we will concentrate on denoising the image using the heat equation and aim to identify the optimal thermal diffusivity value by solving a nonlinear inverse problem, which will allow us to achieve the best possible image denoising results. Finally, for the numerical experiments, we will employ deep learning and the Physics-Informed Neural Networks method to find this optimal value.

Keywords: *image denoising; heat equation; heat inverse problem; deep learning; physics-informed neural networks.*

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