

Online Regularization by Denoising with Applications to Phase Retrieval

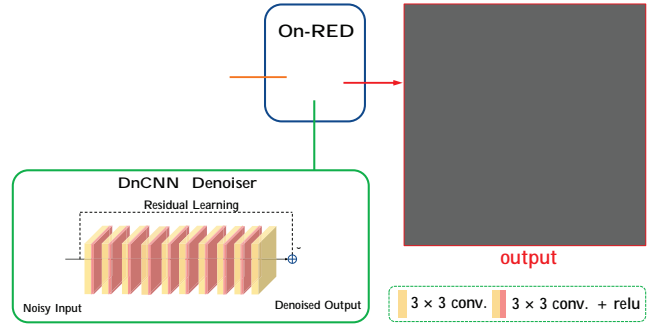
Zihui Wu Yu Sun Jiaming Liu Ulugbek S. Kamilov
Washington University in St. Louis

{ray.wu, sun.yu, jiaming.liu, kamilov}@wustl.edu

<https://cigroup.wustl.edu>

Abstract

Regularization by denoising (RED) is a powerful framework for solving imaging inverse problems. Most RED algorithms are iterative batch procedures, which limits their applicability to very large datasets. In this paper, we address this limitation by introducing a novel online RED (On-RED) algorithm, which processes a small subset of the data at a time. We establish the theoretical convergence of On-RED in convex settings and empirically discuss its effectiveness in non-convex ones by illustrating its applicability to phase retrieval. Our results suggest that On-RED is an effective alternative to the traditional RED algorithms when dealing with large datasets.¹



1. Introduction

The recovery of an unknown image $\mathbf{x} \in \mathbb{R}^n$ from a set of noisy measurement is crucial in many applications, including computational microscopy [44], astronomical imaging [38], and phase retrieval [11]. The problem is usually formulated as a regularized optimization

$$\mathbf{x} = \arg \min_{\mathbf{x} \in \mathbb{R}^n} \{f(\mathbf{x})\} \quad \text{with} \quad f(\mathbf{x}) = g(\mathbf{x}) + h(\mathbf{x}), \quad (1)$$

where g is the data-fidelity term that ensures the consistency with the measurements, and h is the regularizer that imposes the prior knowledge on the unknown image. Popular methods for solving such optimization problems include the family of proximal methods, such as proximal gradient method (PGM) [3, 4, 14, 19] and alternating direction method of multipliers (ADMM) [1, 7, 16, 30], due to their compatibility with non-differentiable regularizers [17, 18, 35].

Recent work has demonstrated the benefit of using denoisers as priors for solving imaging inverse problems [8, 12, 23, 26, 27, 37, 40, 41, 43, 49]. One popular framework, known as plug-and-play priors (PnP) [46], extends

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