DenoiSeg: Joint Denoising and Segmentation

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Abstract. Microscopy image analysis often requires the segmentation of objects, but training data for this task is hard to obtain. Here we propose DenoiSeg, a new method that can be trained end-to-end on only a few annotated ground truth segmentations. We achieve this by extending Noise2Void [11], a self-supervised denoising scheme that can be trained on noisy images alone, to also predict dense 3-class segmentations. The reason for the success of our method is that segmentation can profit from denoising especially when performed jointly within the same network. The network becomes a denoising expert by seeing all available raw data, while co-learning to segment even if only a few segmentation labels are available. This hypothesis is additionally fueled by our observation that the best segmentation results on high quality (virtually noise free) raw data are obtained when moderate amounts of synthetic noise are added. This renders the denoising-task non-trivial and unleashes the co-learning effect. We believe that DenoiSeg offers a viable way to circumvent the tremendous hunger for high quality training data and effectively enables few-shot learning of dense segmentations.

Keywords: segmentation · denoising · co-learning · few shot learning

1 Introduction

The advent of modern microscopy techniques has enabled the routine investigation of biological processes at sub-cellular resolution. The growing amount of microscopy image data necessitates the development of automated analysis methods, with object segmentation often being one of the desired analyses. Over the years, a sheer endless array of methods have been proposed for segmentation [10], but deep learning (DL) based approaches are currently best performing [4, 15, 19]. Still, even the best existing methods offer plenty of scope for improvements, motivating further research in this field [22, 24, 8].

* Equal contribution (alphabetical order).