Convolutional Neural Nets with Template-Based Data Augmentation for Functional Lung Imaging Segmentation

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Abstract

Probing lung function under a variety of conditions and/or pathologies has been significantly facilitated by the use of hyperpolarized gas imaging and corresponding quantitative image analysis methodologies. Such computational techniques permit automated (or semi-automated) quantification of spatial ventilation with increased reproducibility, resolution, and robustness over traditional spirometry or radiological readings. Although multiple well-performing algorithms have been proposed in the literature and are currently used in clinical research, recent developments in maching learning (specifically deep learning) has generated new possibilities for quantification with improved capabilities in terms of robustness and computational efficiency. However, the benefits of these approaches are realized at a cost of large data requirements. In this work, we develop and evaluate a ventilation-based segmentation framework for hyperpolarized gas magnetic resonance imaging. To satisfy the large data requirements of such a framework, we propose a novel template-based data augmentation strategy for generating simulated data consistent with the population cohort. To enhance relevance to the research community, we showcase this work in conjunction with the introduction of *ANTsRNet*—a growing repository of well-known deep learning architectures which interfaces with the Advanced Normalization Tools package and the R statistical project.

Keywords: Advanced Normalization Tools, ANTsRNet, hyperpolarized gas imaging, Markov random fields, neural networks, U-net