Uncertainty and interpretability in convolutional neural networks for semantic segmentation of colorectal polyps

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Abstract:

Colorectal polyps are known to be potential precursors to colorectal cancer, which is one of the leading causes of cancer-related deaths on a global scale. Early detection and prevention of colorectal cancer is primarily enabled through manual screenings, where the intestines of a patient is visually examined. Such a procedure can be challenging and exhausting for the person performing the screening. This has resulted in numerous studies on designing automatic systems aimed at supporting physicians during the examination. Recently, such automatic systems have seen a significant improvement as a result of an increasing amount of publicly available colorectal imagery and advances in deep learning research for object image recognition. Specifically, decision support systems based on Convolutional Neural Networks (CNNs) have demonstrated state-of-the-art performance on both detection and segmentation of colorectal polyps. However, CNN-based models need to not only be precise in order to be helpful in a medical context. In addition, interpretability and uncertainty in predictions must be well understood. In this paper, we develop and evaluate recent advances in uncertainty estimation and model interpretability in the context of semantic segmentation of polyps from colonoscopy images. Furthermore, we propose a novel method for estimating the uncertainty associated with important features in the input and demonstrate how interpretability and uncertainty can be modeled in decision support systems for semantic segmentation of colorectal polyps. Results indicate that deep models are utilizing the shape and edge information of polyps to make their prediction. Moreover, inaccurate predictions show a higher degree of uncertainty compared to precise predictions.

Keywords:

dropout, xai, Monte Carlo guided backpropagation