Title: Progressive Deep Learning: An Accelerated Training Strategy for Medical Image Segmentation

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Purpose:

Continuous advancement in the application of deep learning (DL)-based approaches to medical tasks has seen DL achieve state-of-the-art performance in a wide range of applications including object recognition, classification, and medical image segmentation. Training DL models, however, is a computationally and time intensive process due to the complex nature of modern network architectures and the size of training datasets. Moreover, hyperparameter selection is a manual and repetitive process intended to optimize network performance. In this study, we present a novel training acceleration strategy in which training datasets are progressively fed to the network based on similarity measurements for medical image segmentation – an approach we term Progressive DL (PDL).

Materials and Methods:

PDL was evaluated in the thoracic auto segmentation task for both CT and MR images. Training datasets were ranked in dissimilarity using the mean square error (MSE), peak signal-to-noise ratio (PSNR), and structural similarity index (SSIM) metrics. Prior to training, a coarse sampling of training datasets ranked highly similar was used for hyperparameter tuning. During training, subsequently ranked samples were added after 10 epochs for CT and 20 epochs for MRI.

Results:

Adopting the PDL accelerated training strategy reduced training time by approximately 50% while achieving clinically acceptable segmentations as measured by the Dice similarity coefficient (DSC): 0.9516 and 0.9508 for CT and MRI, respectively. The time required to reach these fixed DSC scores for the conventional and PDL approaches during training was decreased from 35777 to 20386 seconds for CT and from 10160 to 4457seconds for MRI through the use of PDL.

Conclusions:

The proposed PDL accelerated training strategy for medical image segmentation offers the potential to reduce training time while maintaining task-critical performance. We expect the PDL strategy to be applicable to tasks beyond segmentation given the establishment of similarity metrics relevant to the task

Keywords:

Auto-segmentation, Auto-contouring, Deep Learning