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Title: Updated loss function for accurate tumor segmentation from breast MRIs

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We present Focal Boundary Dice, a new segmentation evaluation measure focused on boundary quality and class imbalance. We perform an extensive analysis across different error types and object sizes of imaged tumors from MRI scan and show that Focal Boundary Dice is significantly more sensitive than the standard Focal and Dice measures to boundary errors for imaged tumors from MRI scans and does not over-penalize errors on division of the boundary, including smaller imaged objects. The new quality measure displays several desirable characteristics, like higher accuracy in the selection of hard samples, prediction/ground truth pairs, and balanced responsiveness across scales, which makes it more suitable for segmentation evaluation than other classification focused measures such as combined IoU and BCE loss, Boundary BCE loss and Shape-aware Loss.

Methods: Based on Boundary Dice, we update the standard evaluation protocols for tumor segmentation tasks by proposing the Focal Boundary Dice. We mainly solve the contradiction between target and background area and the contradiction between the importance and attention of boundary features. Meanwhile, a boundary attention module is introduced to further extract tumor edge features.

Results: Our experiments show that the new evaluation metrics allow boundary quality improvements and image segmentation accuracy that are generally overlooked by current Mask Dice based evaluation metrics and deep learning models. The adoption of the new boundary-sensitive evaluation metrics leads to rapid progress in segmentation methods that enables the improvement of boundary quality. The optimal configuration of focal boundary dice loss is performed for the resultant segments of imaged tumors as shown in [Figure 1]. This focal boundary dice loss enables the construction of the deep learning network for good segmentation performance in all tested MRIs. The quantification results are listed in [Table 1].

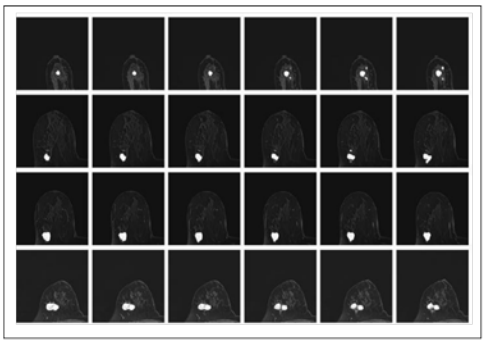

Figure 1. The resultant segments of imaged tumors under the Focal boundary dice loss. The segmented tumors are overlayed on the original data.

Model	Dice	Precision	Specificity
U-Net	0.73	0.81	0.99
ResUNet	0.76	0.82	0.99
Pix2pix	0.58	0.78	0.99
Att-UNet	0.76	0.80	0.99
2D-VNet	0.74	0.84	0.99
DenseUNet	0.76	0.80	0.99
Our	0.82	0.94	0.98

Conclusion: The proposed deep learning model enables to achieve efficient discrimination between healthy and diseased tissues, and paves the way for the automatic diagnosis of breast cancer.

Biography

Xiao-Xia Yin received the PhD degree in electronics engineering from The University of Adelaide, Australia. She was a Visiting Scholar with the University of Reading, Reading, U.K., under the supervision of S. Hadjiloucas and with the University of Cambridge, Cambridge, U.K., under the supervision of L. F. Gladden. She involved in tumor detection via DCE-MRI with The University of Webinar, under the supervision of Prof. Kotagiri. She has an existing collaboration with Prof. M.Y. Su with the Center for Functional Onco Imaging, University of California at Irvine, USA, and with Prof. T. Kron with the Peter MacCallum Cancer Centre, Australia. She is currently a professor in University of Guangzhou, China and her major is in high-dimensional medical image analysis. Her research interests include multi resolution analysis, segmentation, image reconstruction and classification and their applications to high-dimensional medical imaging. She received the Postdoctoral Research Fellowship from the Australian Research Council in 2009. She was a member of the Organizing Committee and the Publication Chairperson of the 3rd International Conference of Health Information Science and a member of the Organizing Committee and the Program Co-Chairperson of the 4th and 5th International Conference of Health Information Science.