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Preferred Presentation Type: Oral or poster presentation

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Study Group:

Introduction:
Identifying MS lesions in the spinal cord (SC) is crucial for accurate diagnosis and disease monitoring. Existing segmentation methods are typically tailored to specific MRI contrasts and often fail to generalise to previously unseen contrasts or imaging protocols. Moreover, segmentations of small or diffuse lesions are affected by high inter/intra-rater variability, leading to noisy labels.

Objectives/Aims:
1) To develop a robust model for the segmentation of MS lesions on MRI scans that generalises across different contrasts and imaging parameters. 2) To evaluate the performance of a subsequent model that was recursively trained using the ground truth labels generated by the first model, instead of from the expert raters, as a means to mitigate noisy labels.

Methods:
A multi-site dataset (20 sites, 1850 people with MS, 4430 scans) was selected based on the heterogeneity in acquisition parameters and sequences: T1w spin echo (n=23), T2w (n=3061), T2*w (n=548), PSIR (n=363), STIR (n=92), MP2RAGE (n=343) acquired at 1.5T and 3T on GE, Siemens and Philips systems. The field-of-view coverage varied across sites (brain and upper SC, or SC only), and acquisitions were either 2D (axial: n=2895, sagittal: n=1169) or 3D (n=366), with voxel dimensions ranging from 0.2x0.2x5 mm^3 to 0.8x0.8x9 mm^3. A 5-fold nnUNet ResEnc (model 1) was trained on manual segmentations of SC MS lesions. A subsequent supervised model (model 2) with the same architecture was trained using the outputs of model 1 (5-fold predictions averaged and binarised). Performances were compared with existing contrast-specific methods currently available in Spinal Cord Toolbox v6.4: (i) sct_deepseg_lesion (T2w, T2*w), (ii) sct_deepseg (STIR/PSIR), (iii) sct_deepseg (MP2RAGE-UNI). The overall quality of the models' predictions was assessed by 3 neuroradiologists using a Likert score (0=worst, 5=best).

Results:
Overall, model 1 performed best across all MRI contrasts and resolutions, yielding an average Dice score of 0.43 compared to 0.36, 0.22 and 0.21 for methods (i), (ii) and (iii). Neuroradiologists' evaluation of the predictions of model 2 showed significant improvement compared to manual segmentations for 2 of 3 raters ($p<0.05$ and $p<0.01$). Comparison of the predictions of models 1 and 2 showed a significant ($p<0.05$) decrease in lesion segmentation quality, showcasing the limitations of recursive training.

Conclusion:
The proposed model, trained on multi-site and multi-contrast MRI data, provides a robust and generalisable solution for segmenting SC MS lesions. Future development will further extend the generalisability of the model. The model will be available in SCT.

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Travel / Abstract Grant Application and Young Scientific Investigators' Session: Yes -I would like to apply for both

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Addition Grant Request: