MSxplain: towards integration of deep learning into diagnosis and treatment planning for multiple sclerosis

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PROJECT OVERVIEW

MSxplain aims at developing Explainable and Reliable AI1,2 tools in application to automatic methods of multiple sclerosis followup, and testing them in the clinical setting.

1. Explainability
   Insight on internal actions and/or features of a deep learning model.

2. Interpretability
   Links a deep learning model to the human observer knowledge.

3. Uncertainty
   Quantiﬁcation of the reliability of model predictions.

4. Integration
   Trustworthy and transparent decision support for patient assessment.

YEAR 2022: UNCERTAINTY QUANTIFICATION

Uncertainty quantification with deep ensembles3 for WM lesion segmentation as a proxy for the deep learning model reliability.

3D FLAIR scan → Ensemble of 3D U-Net models with different seed initialisations → Predicted probability maps → Voxel-scale uncertainty map4,5

Detection disagreement uncertainty measure
Detection disagreement uncertainty (DDU)

\[ DDU = 1 - \frac{1}{K} \sum_{k=1}^{K} \text{IoU}(\Omega_k, \Omega) \]

Notations: Ω - lesion region predicted by an ensemble of models, Ω_k - region of the same lesion predicted by the k-th model in ensemble (k = 1, 2, ... K), i.e. a connected component on the k-th model predicted binary mask with the maximum intersection over union (IoU) with Ω.

EXAMPLES OF UNCERTAINTY MAP USAGE

Voxel-scale maps
- Correction of lesion delineation
- Detection of false negative lesions
- Detection of false positive lesions

Lesion-scale maps
- Detection of missed lesions on GT
- Detection of false positive lesions

References: