White matter hyperintensities (WMH) are regions of increased pixel intensity in T2-weighted MRI which are correlated with several neurodegenerative diseases. Human segmentation of WMH is time consuming and inconsistent, motivating automation of WMH segmentation.

While many algorithms for this task have previously been proposed, few have been validated on MRI from different sources, despite the sensitivity of most algorithms to source-specific image features.

This thesis presents a segmentation algorithm called “Voxel-Wise Logistic Regression” (VLR), which provides both good interpretability and segmentation performance. VLR uses FLAIR MRI to estimate the WMH class probability image using spatially varying logistic parameters . These “parameter images” also concisely summarize the model class discrimination.

Additionally, a validation framework called “Leave-One-Source-Out Cross Validation” (LOSO-CV) is introduced, which provides more realistic estimation of model performance on “never-before-seen” MRI sources. Segmentation performance of the VLR model under LOSO-CV is presented using 96 open-source images from 7 MRI sources.