Optimizing Operating Points for High Performance Lesion Detection and Segmentation Using Lesion Size Reweighting

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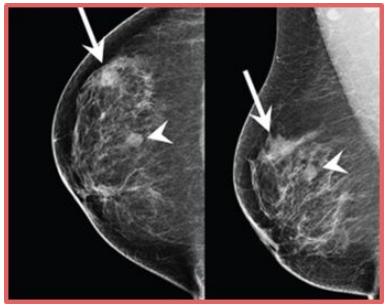
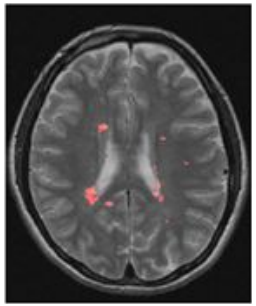
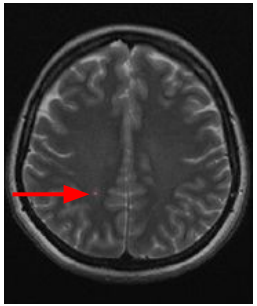
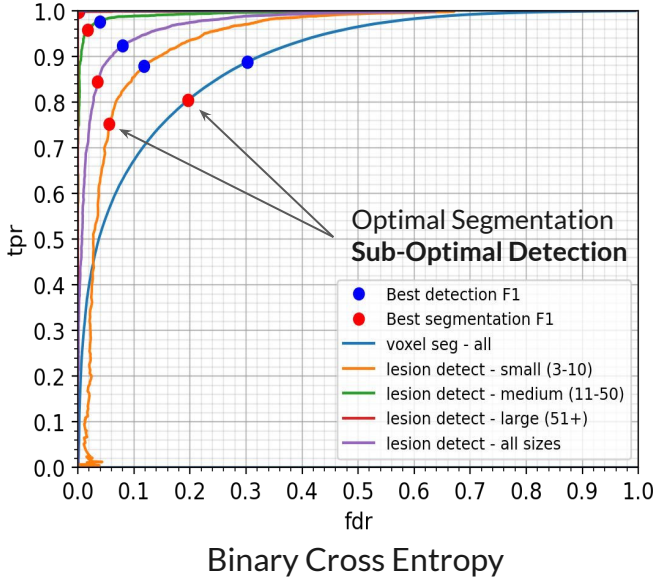
Motivation

- In many contexts, lesions can span a wide range of sizes
- Standard loss functions better segment large lesions at the expense of missing small lesions
- Trade-off between segmentation and detection
  - **How can we achieve optimal performance on *both*?**









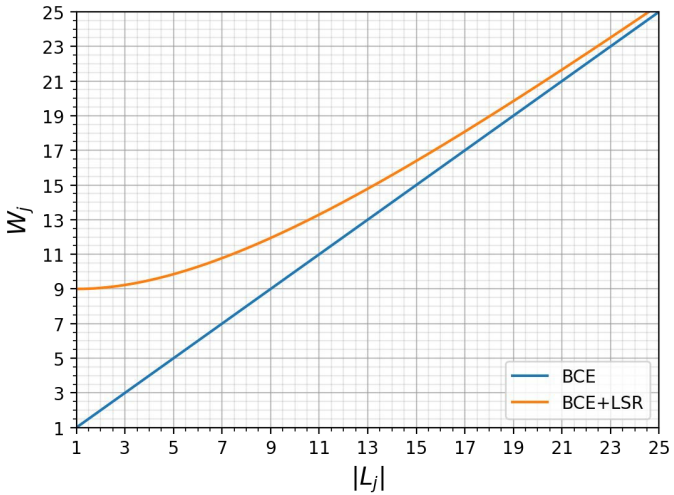
Binary Cross Entropy

https://www.sciencedirect.com/science/article/pii/S1930043315300025X

Method

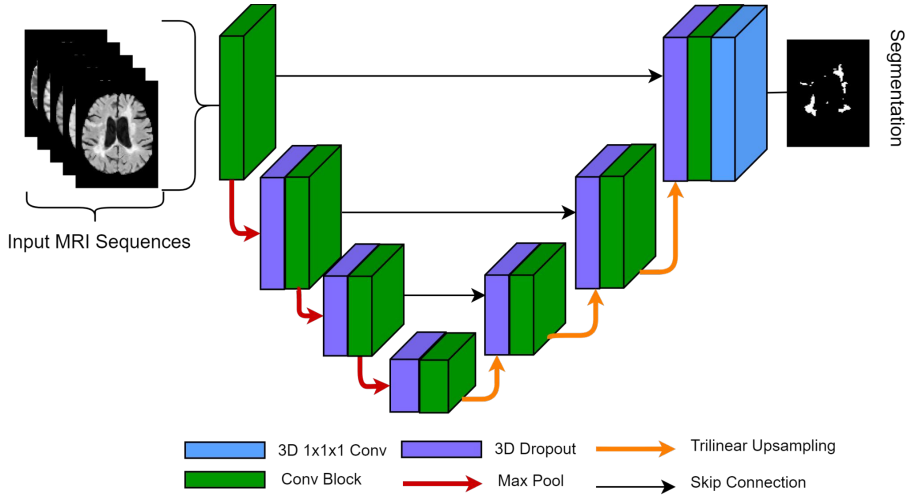
- Weight lesions as a function of their size
  - Assign additional weight to small lesions

$$W_j = |L_j| + \alpha e^{-\frac{1}{\beta}(|L_j|-1)}$$

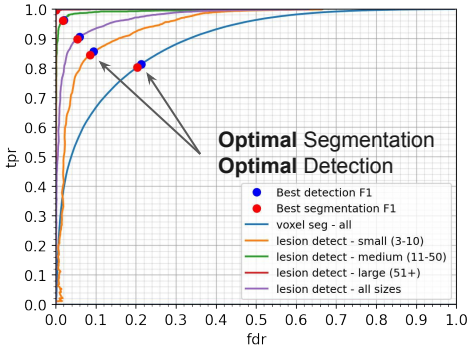


Experiments

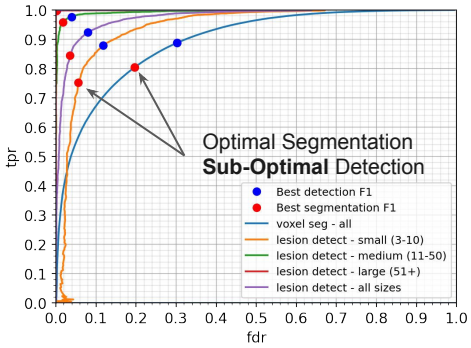
- Large-scale, multi-scanner, multi-center dataset of Multiple Sclerosis patients
  - MRI Sequences: FLAIR, PDW, T2, T1, and Gadolinium Enhanced T1
  - Target Label: T2-Weighted Lesions



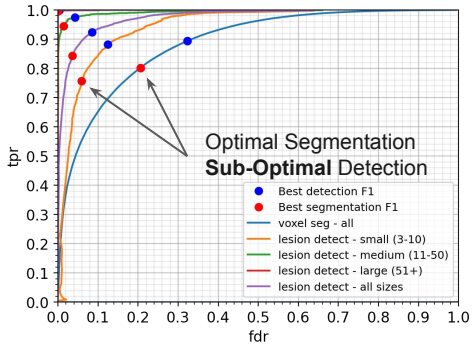
Results



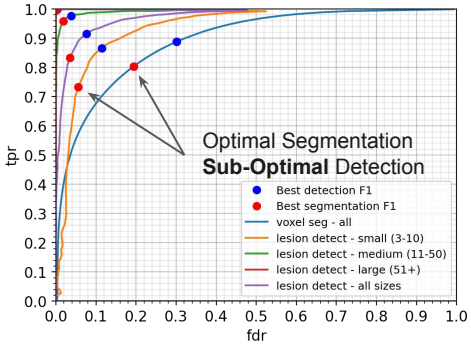
Binary Cross Entropy w/ Lesion Size Reweighting (Proposed)



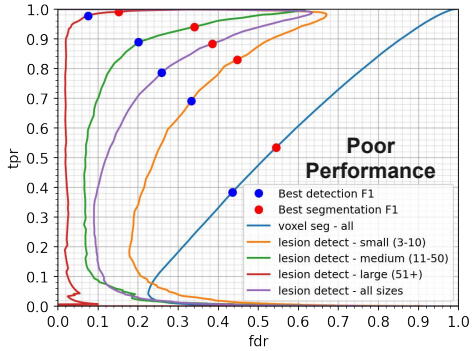
Binary Cross Entropy



Weighted Binary Cross Entropy



Focal Loss [2]



Binary Cross Entropy w/ Inverse Weighting [3]

- Optimal operating point for segmentation and detection converge
  - Optimal performance on both

[2] Lin et al., 2017; [3] Shirokikh et al., 2020