

EP07.04

Automatic Detection of the Mid-Sagittal Plane in Fetal MRI Using Deep Learning

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Introduction

The mid-sagittal plane (MSP) is crucial for fetal brain morphometric analysis in MRI. Manual identification is time-consuming, subjective, and prone to inter-observer variability. We propose an automated deep learning pipeline to detect the MSP using a multi-structure co-occurrence criterion (genu, splenium, vermis, pons) and a meta-classifier for robust slice-level and case-level decision-making.

Methods

Dataset: 432 sagittal fetal brain MRI stacks (135 MSP-present, 297 MSP-absent) from a single-center 1.5T SSFSE T₂-weighted scanner.

Ground Truth: MSP defined by simultaneous presence of 4 midline structures.

Training: Two-stage strategy (heatmap → joint training), 5-fold GroupKFold CV.

Evaluation: Slice-level and case-level AUC, accuracy, sensitivity, specificity, F1-score, and localization accuracy.

Results

Our method achieved robust case-level performance with an AUC of 0.81 and an accuracy of 0.74. It demonstrated high sensitivity (0.81) in detecting MSP-present cases, with specificity at 0.70. The model localized the exact MSP slice in 75% of cases and within ± 1 slice in 100% of cases, reflecting strong spatial precision.

Conclusion

We present an automated method for fetal brain MRI MSP detection, achieving high case-level performance with precise localization (± 1 slice: 100%). The anatomically interpretable enables standardized fetal biometry for clinical use.

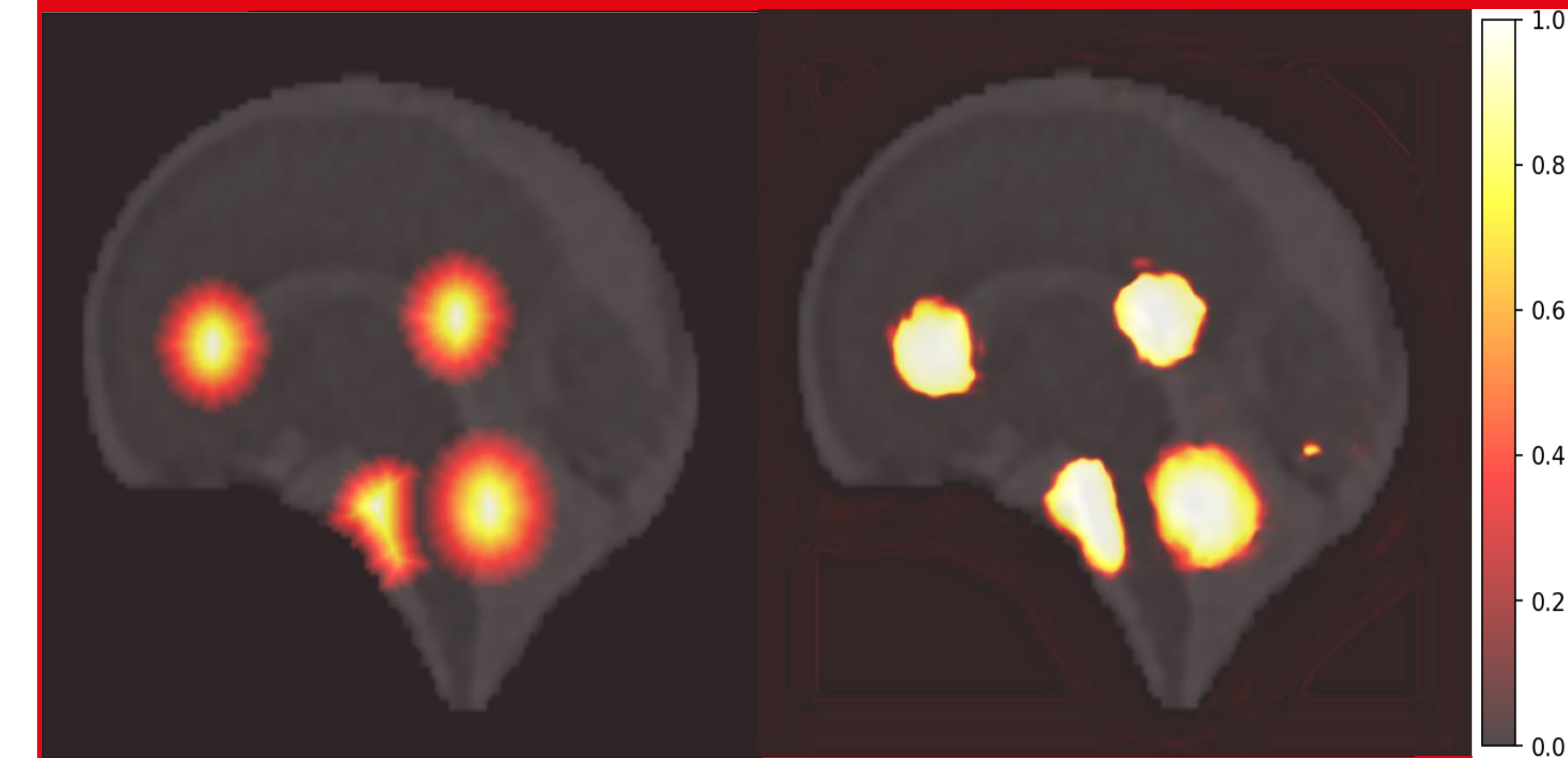


Figure 1. GT (left) and predicted (right) heatmaps

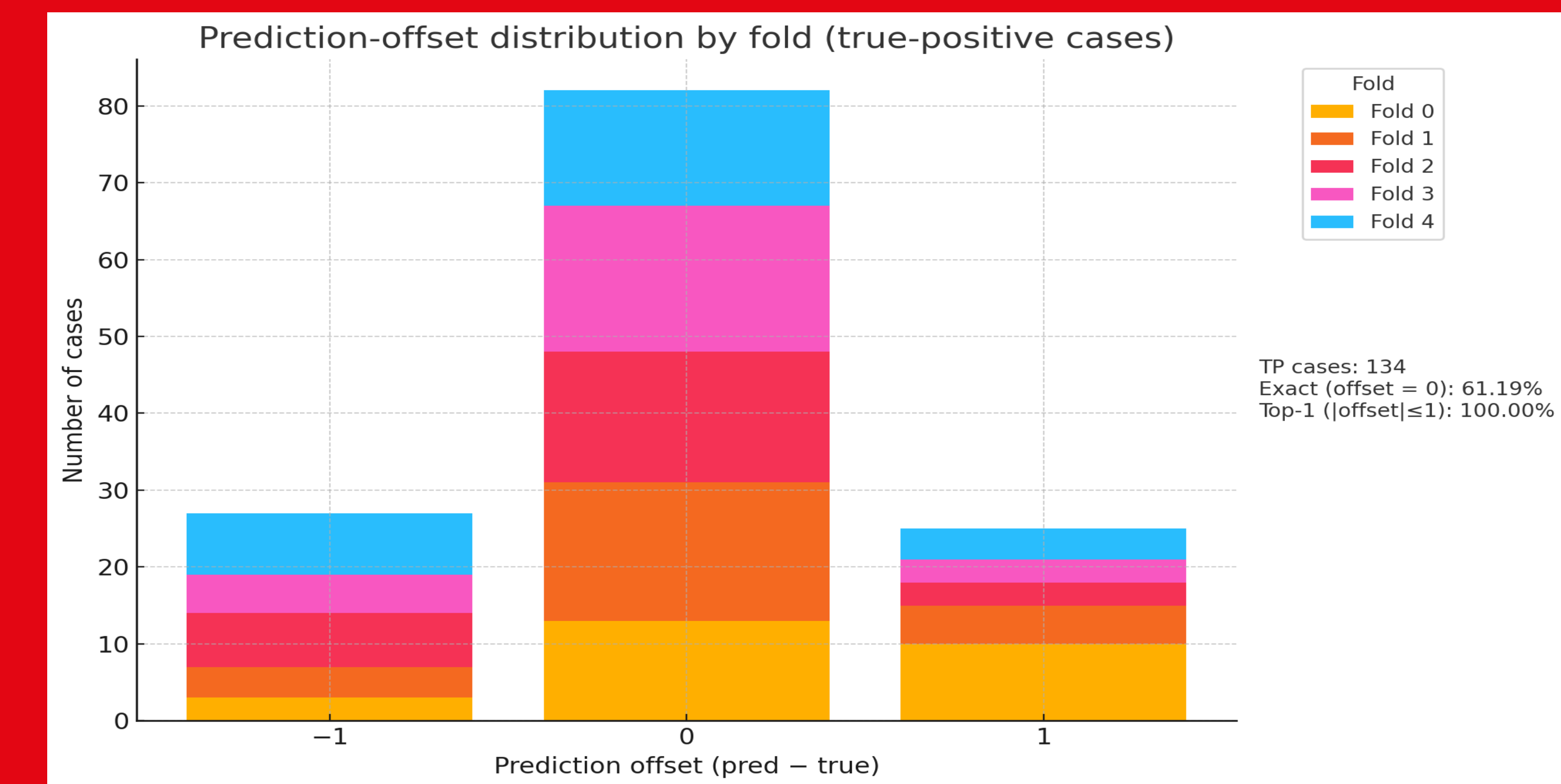


Figure 2. Histogram of TP localisation offsets

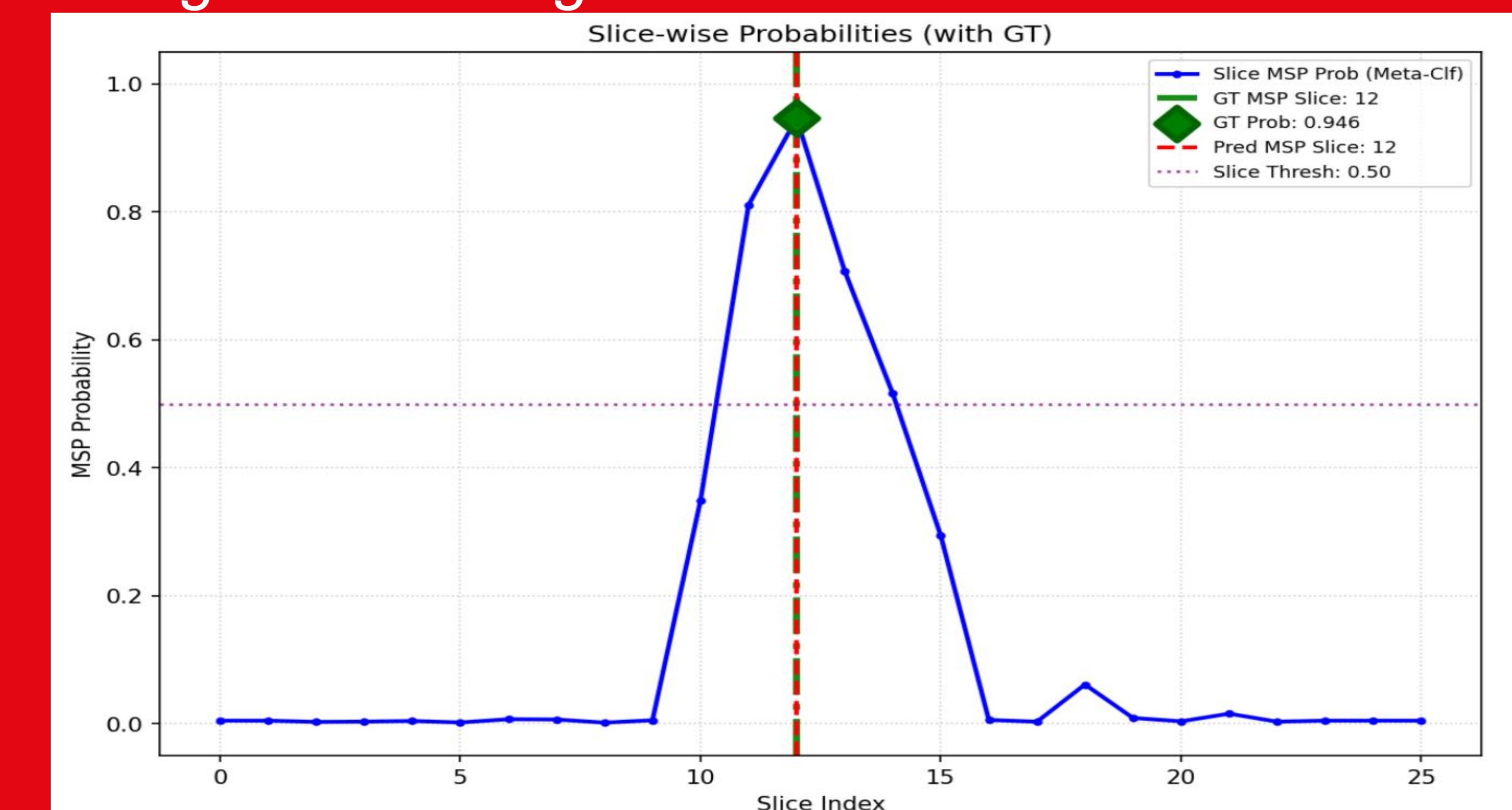


Figure 3. Slice-wise probabilities