THE CREATION OF A CONDITIONALLY ADAPTIVE LOSS FUNCTION FOR MEDICAL SEGMENTATION TASKS

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INTRODUCTION

- Segmentation algorithms play a crucial role in isolating regions of interest from medical images, enabling disease diagnosis, biomarker discovery, and predictive analysis
- Challenges lie in the amount of high quality data for training, annotation precision, and imbalance
- Existing loss functions offer some solutions to handle class imbalances, but are influenced by the format of the training annotations
- Our project focuses on developing a statistically driven adaptive loss function tailored for imbalanced medical imaging datasets
- 4 large datasets focusing on brain tumor MRI scans

OBJECTIVES

- Develop a statistically driven adaptive loss function
- Explore brain tumor datasets and preprocess
- Benchmark against popular loss functions on different segmentation models
- Develop a user interface for experimenting

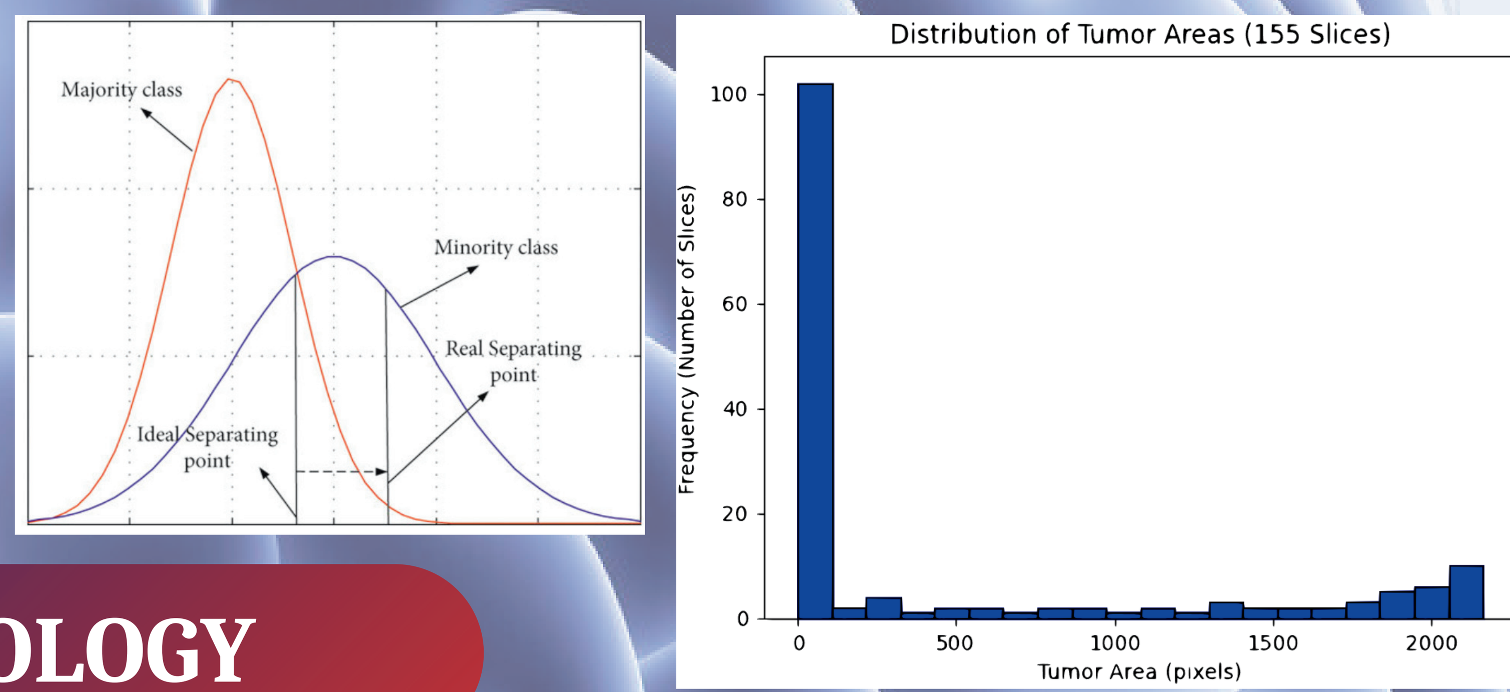
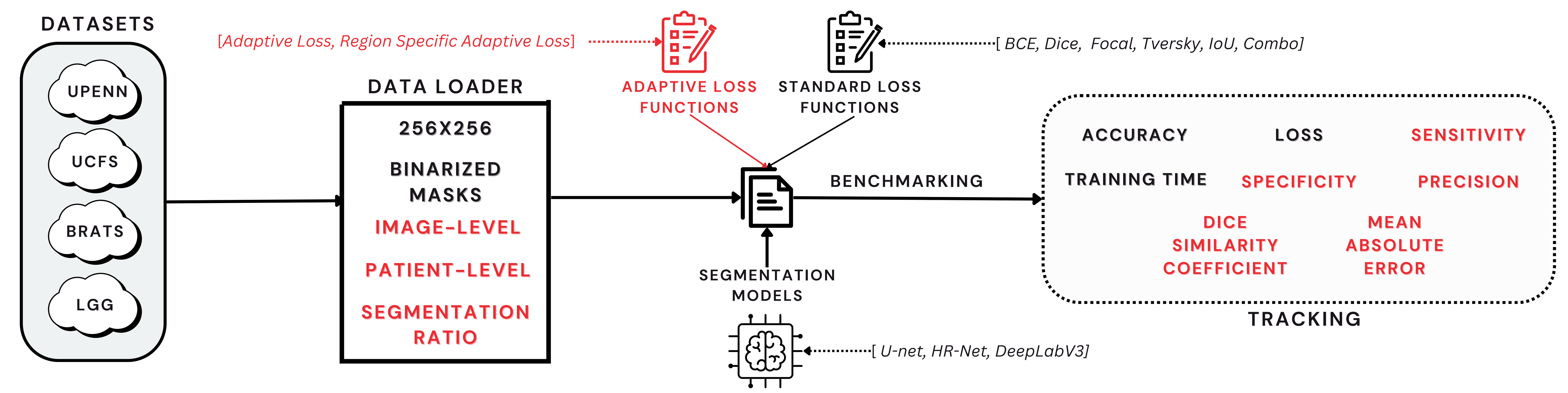


Fig 1. Class imbalance

METHODOLOGY



RESULTS

- BCE tends to oversegment, while adaptive loss can undersegment if not sure
- Adaptive loss can segment small tumor regions which are not part of the main tumor
- Focal loss and bce are the biggest competitors
- Not all models work well with all loss functions -> some loss functions are not consistent
- All have a high dice similarity coefficient, but make some crucial mistakes for extreme imbalance and small brain and tumor regions

Table 1. Results for different loss functions - U-net

Loss	Dice Coef	Specificity	Sensitivity	Precision	MAE
BCE	0.9589	0.9995	0.9546	0.9634	0.0008
Adaptive	0.9577	0.9997	0.933	0.9787	0.0009
Focal	0.9552	0.9996	0.9448	0.9711	0.0009

Fig 2. Predictions from different loss functions - U-net

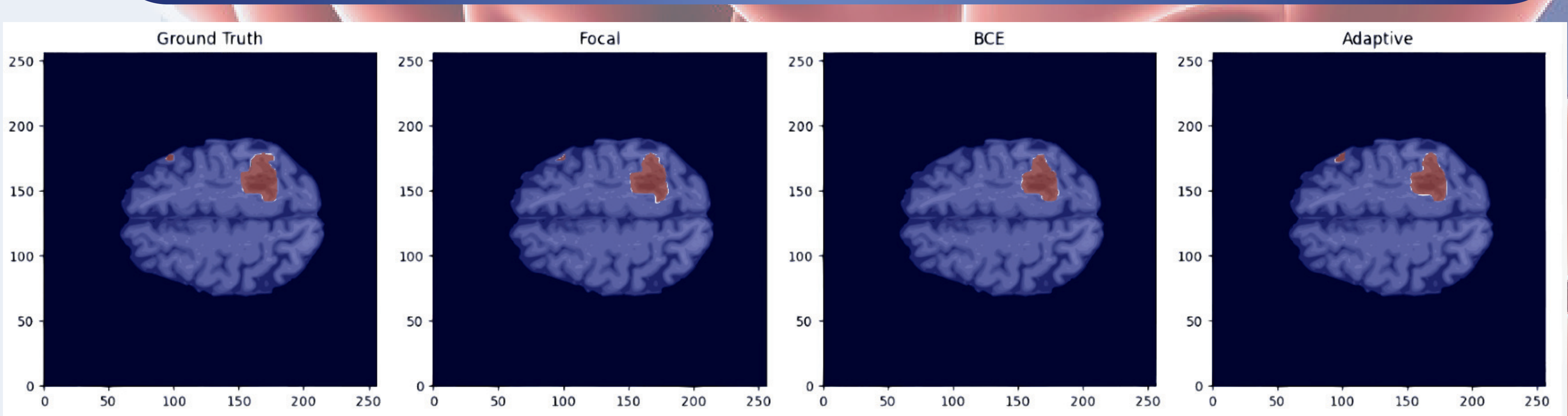
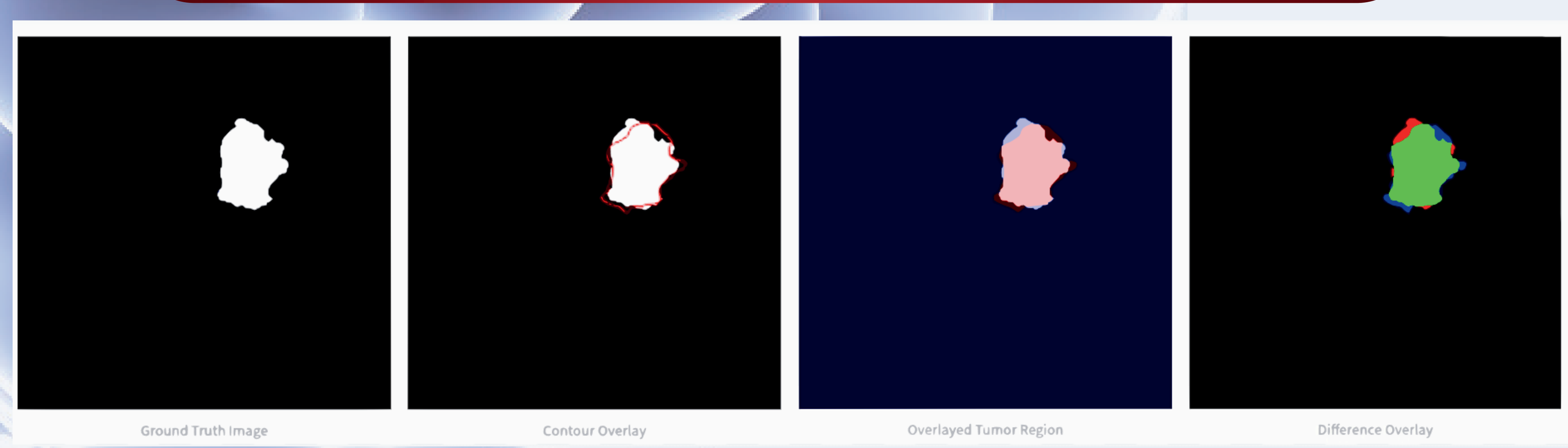


Fig 3. User interface - model prediction and overlays

Fig 4. User interface - model prediction analysis



CONCLUSION

- Most popular functions imitate the shape of training annotations, leading to false positives
- Being consistent with true positives is crucial
- Oversegmenting is debatably a bigger issue than undersegmenting

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