

Brain Tumor Segmentation with Random Forest and U-Net

Shuhan Xiao and Alexander Kugele

Heidelberg University

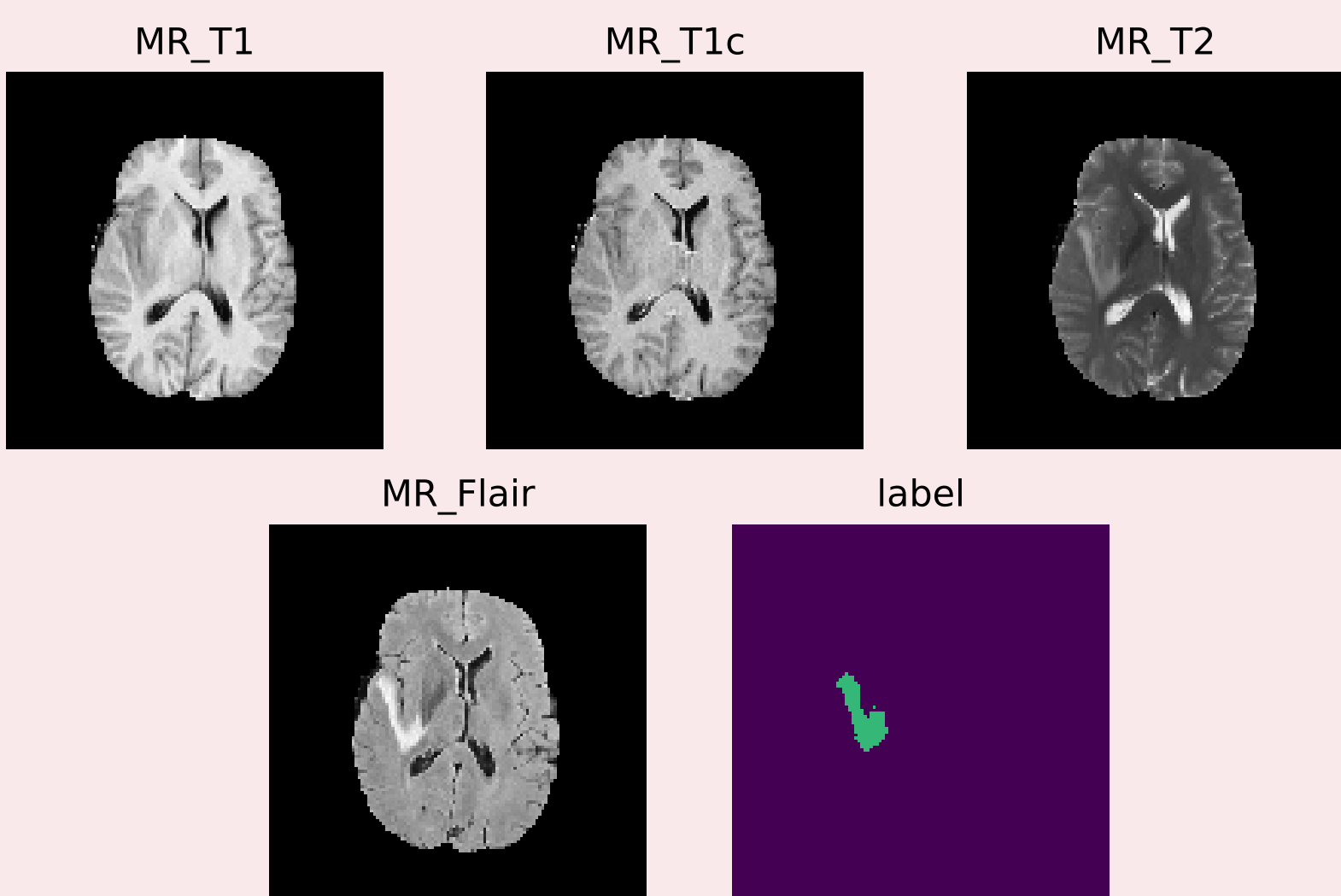
Motivation

Brain tumors need immediate treatment
Even experts can not segment perfectly
Takes time to go through a complete MR scan

Efficiently segmenting tumors automatically improves treatment planing

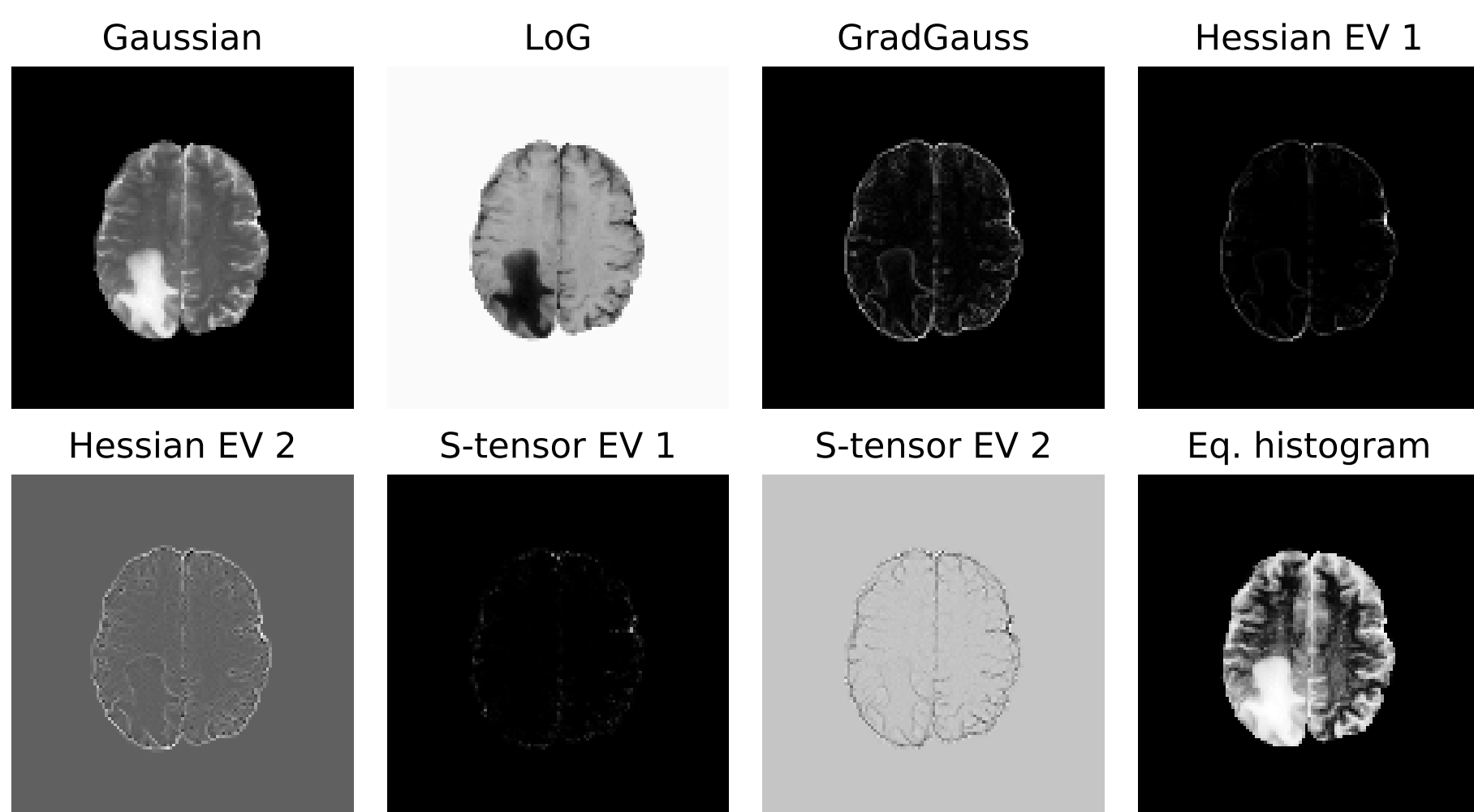
Dataset

3D MR scans of 275 human brains
4 scan types, T1, T1c, T2 and Flair
depth = 155, height = 240, width = 240
⇒ 170500 images
5 classes (we only use 2)
center-cropped to 80% of their size



Features

Gaussian, LoG, Gaussian gradient
Hessian and structure tensor eigenvalues
equalized histogram
29 features in total
1k images + features ≈ 30 GB of memory



Random Forest [1]

default settings of scikit-learn implementation
trained in batch-mode
100 estimators per batch, 3 batches of 1k images

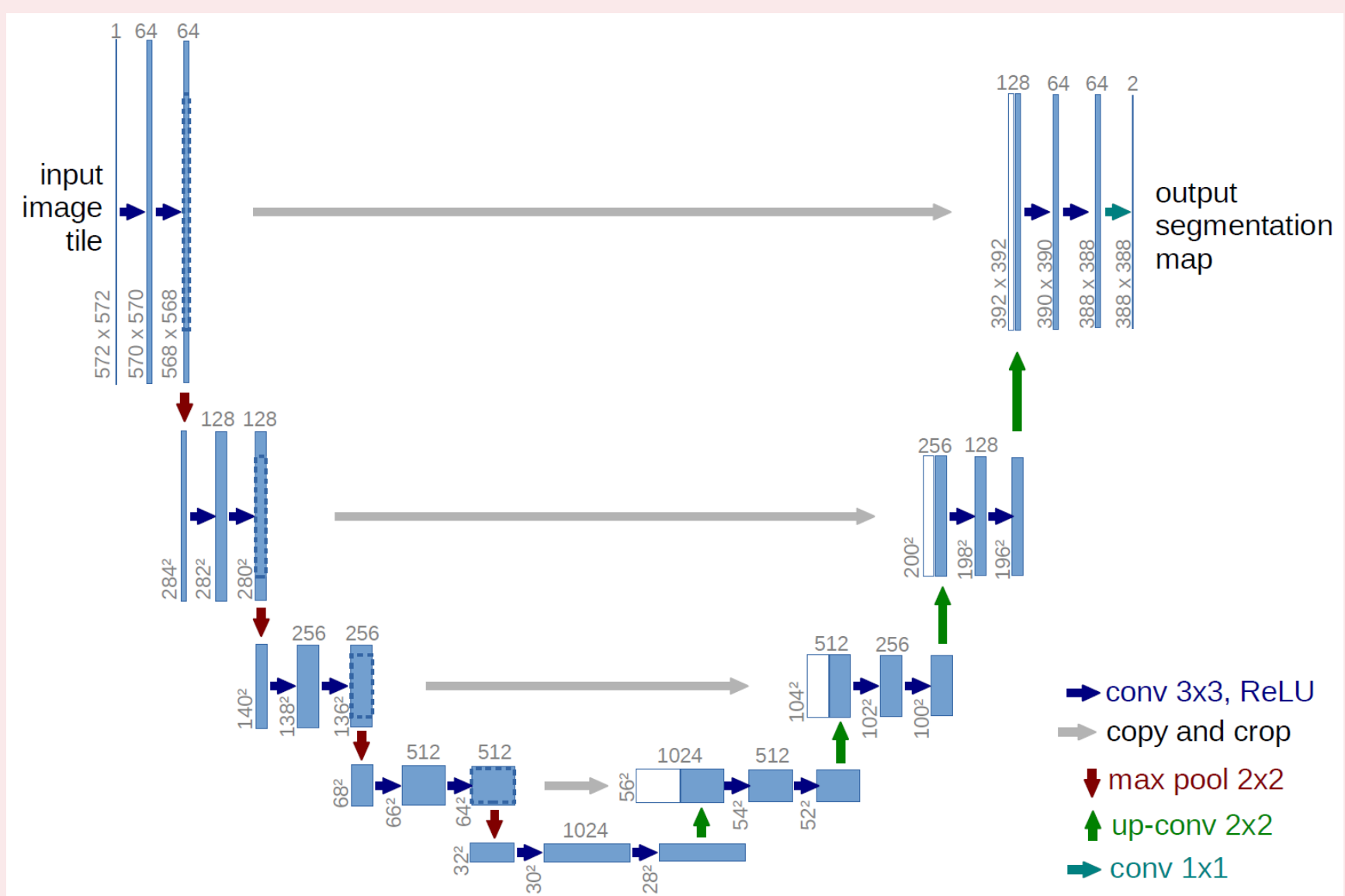
Advantages and disadvantages

- ⊕ Simple
- ⊕ Rarely overfits
- ⊕ Variable image input size
- ⊕ Optimized implementation available
- ⊖ No GPU training
- ⊖ No incremental training (for vanilla RF)
- ⊖ Features have to be hand-selected

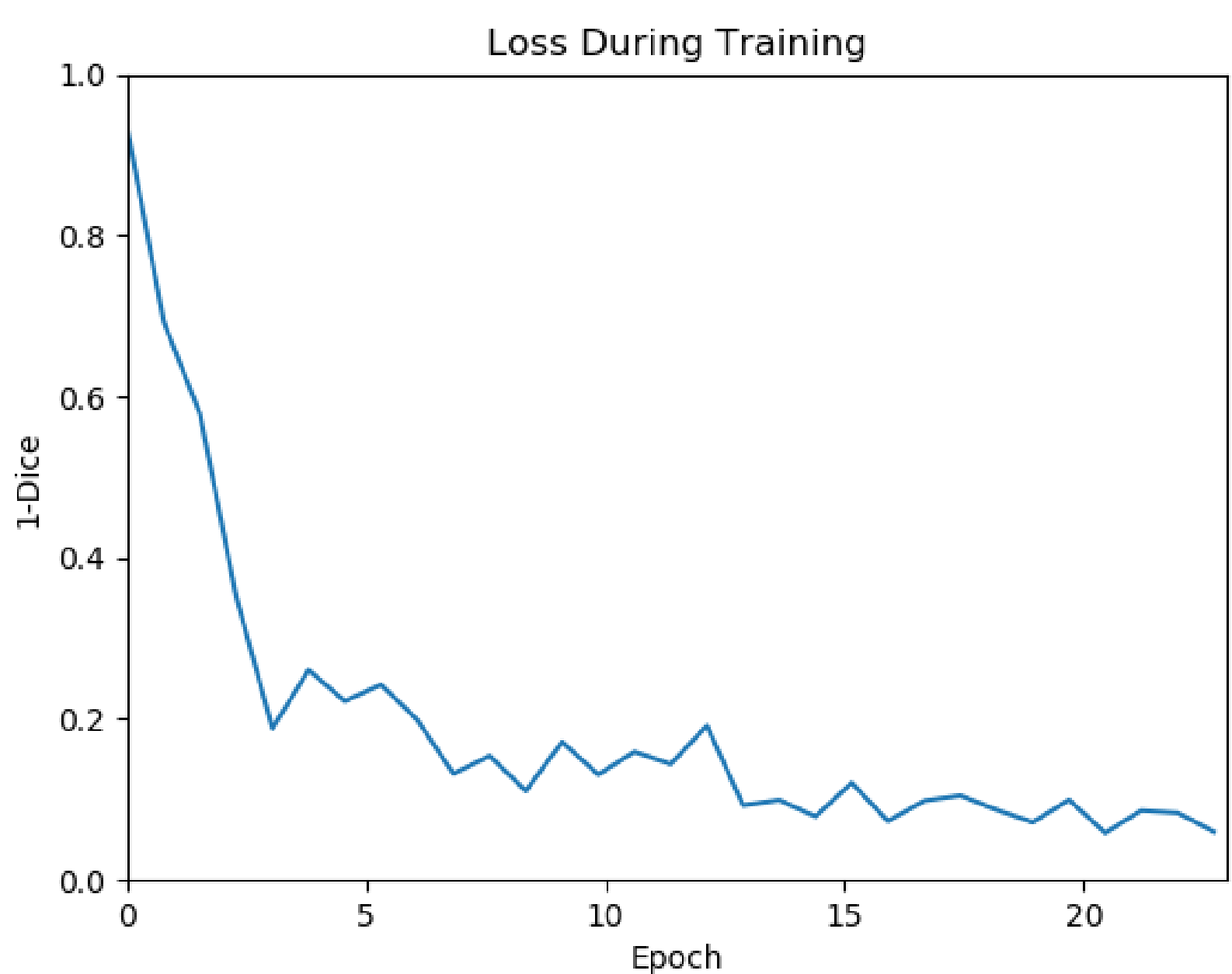
U-Net [2]

modifications: depth = 4, loss = 1 - Dice, padding

Training: 10 images/batch, 30 epochs



Loss



Conclusion

Both methods achieve similar results regarding the scores

Random Forest is easier to set up

U-Net is easier and faster to train

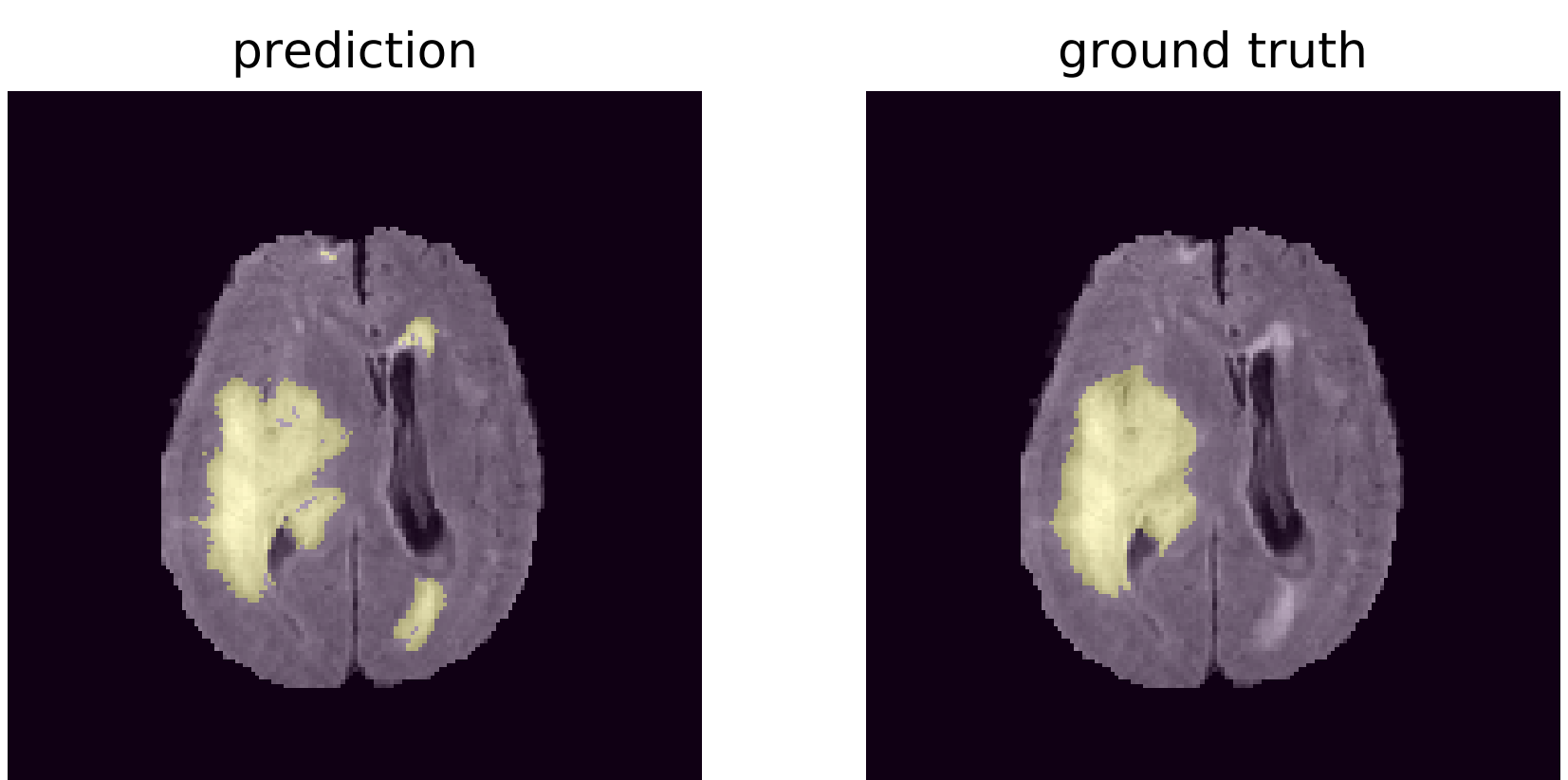
None of the two methods could achieve state-of-the-art results out of the box

Final Scores

	Dice [%]	Sensitivity [%]	Specificity [%]
Random Forest	65.9	77.1	99.1
U-Net	69.3	73.1	99.4

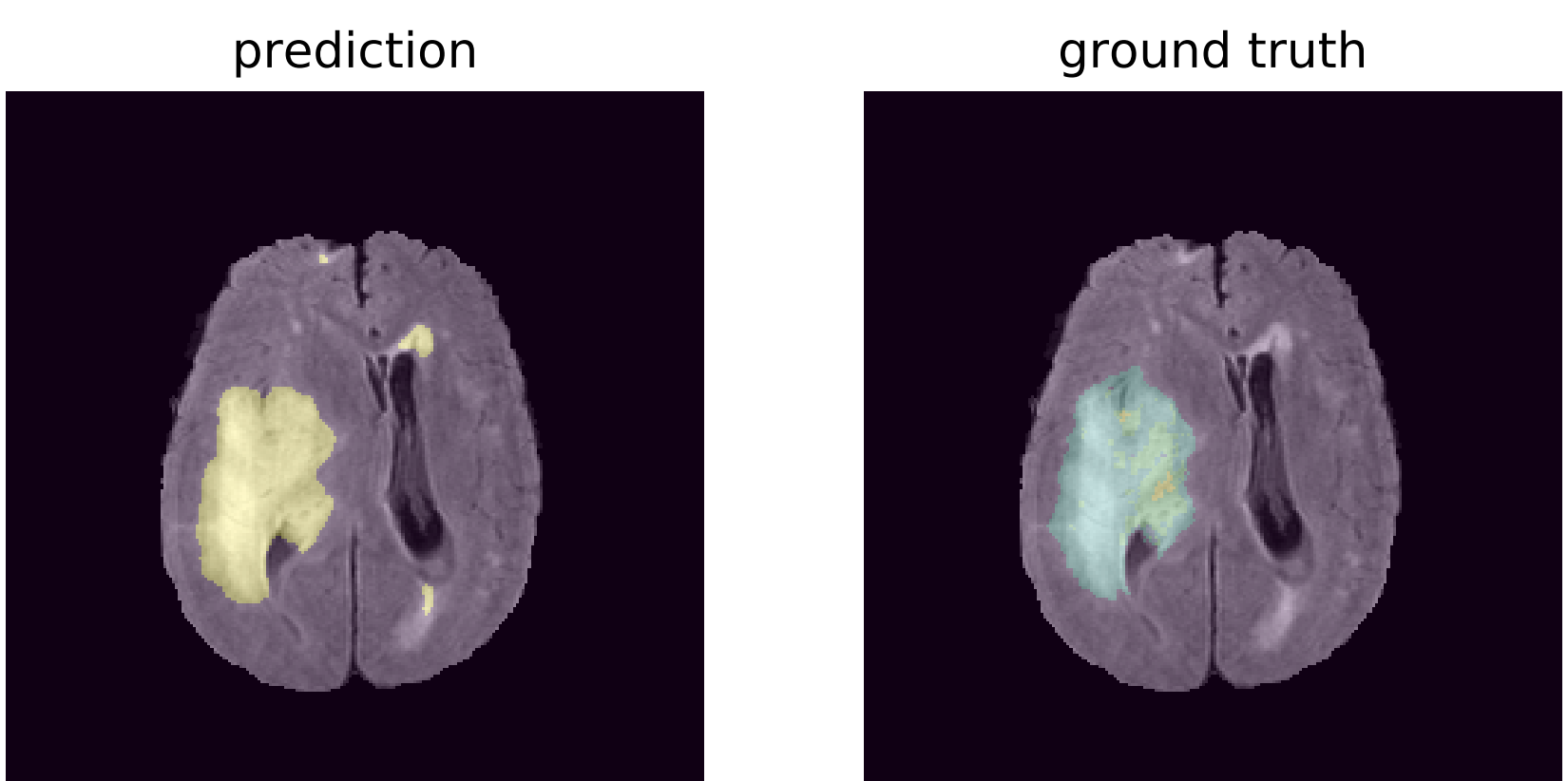
RF: Results

training time ≈ 13 h
inference time ≈ 2 – 20s per image
load time ≈ 310s
disk space ≈ 15 GB (pickled)
memory space during inference ≈ 20 GB



U-Net: Results

training time ≈ 1.5 h
inference time ≈ 0.5s per image
load time ≈ 20s
disk space ≈ 0.3 GB
memory space during inference ≈ 0.7 GB



References

- [1] M. Ristin, M. Guillaumin, J. Gall, and L. Van Gool. Incremental learning of random forests for large-scale image classification. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 38(3):490–503, March 2016.
- [2] Olaf Ronneberger, Philipp Fischer, and Thomas Brox. U-net: Convolutional networks for biomedical image segmentation. In *International Conference on Medical image computing and computer-assisted intervention*, pages 234–241. Springer, 2015.



UNIVERSITÄT
HEIDELBERG
ZUKUNFT
SEIT 1386

