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Semantic Segmentation on MRI-Data with U-Net

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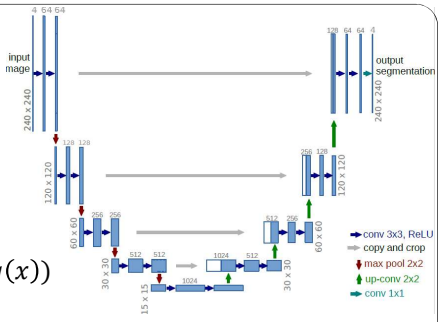
Background

- Semantic segmentation on 3D MRI scans of brain tumors for ***diagnosing*** and ***locating*** the tumor and its sub-regions.
- Because of the highly heterogeneous appearance and shape of brain tumors in MRI scans

➡ Segmentation is a big challenge in medical image analysis

Methods

U-Net architecture consists of three parts
- encoder
- decoder
- bottleneck section.



Cross-Entropy Loss:

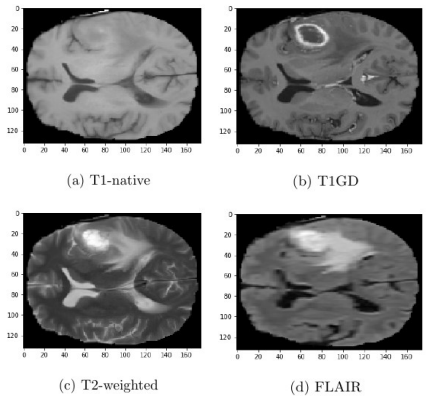
$$L(p,q) = \sum p(x)\log(q(x))$$

Metric:

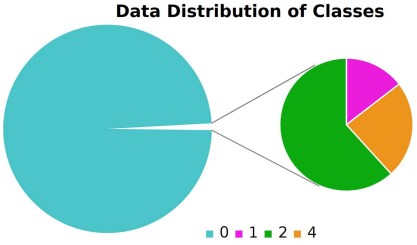
$$IoU = \frac{SR \cap GT}{SR \cup GT}$$

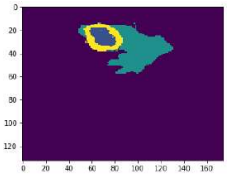
Network did not converge with SGD.
➡ Best results with ***Adam*** Optimizer

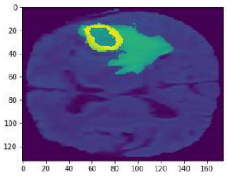
BraTS'19-Data



4 different MRIs from the same Subject and Slice:
(a) native (T1)
(b) post-contrast T1-weighted (T1Gd)
(c) T2-weighted (T2)
(d) T2 Fluid Attenauted Inversion Recovery (FLAIR)

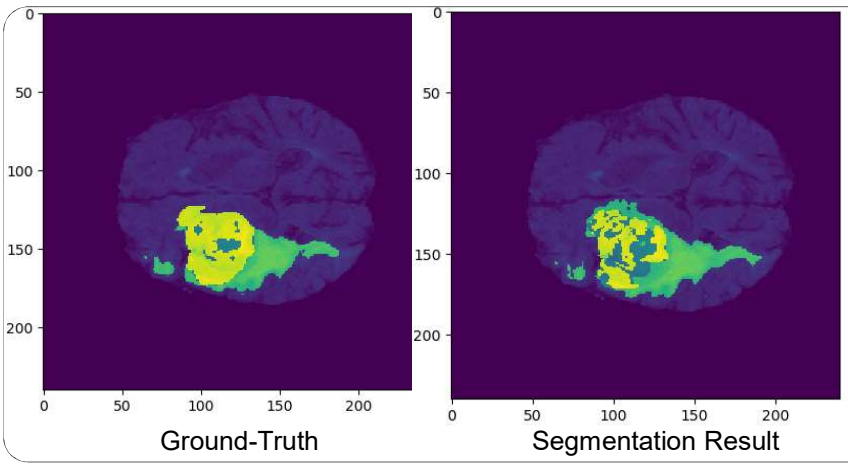



segmentation GT


GT overlay with FLAIR

- 4 different MRIs are used as ***Channels***
- Size of Volume: 240 x 240 x 155
- 1 Slice per Input
- Size of Dataset: 155 x #Subject = 35 805
- train : val : test split
  56% 14% 30%

Results



The network was trained for 100 epochs
- Train accuracy saturated
- Train loss reached plateau

IoU*			
Back ground	**Class 1 (gray-blue)**	**Class 2 (green)**	**Class 4 (yellow)**
0.998	0.550	0.695	0.683
Mean IoU*		0.799	
Mean Acc*		0.731	

* IoU and accuracy are from testing

References

[1] Menze BH et al. "The Multimodal Brain Tumor Image Segmentation Benchmark (BRATS)", IEEE Transactions on Medical Imaging 34(10), 1993-2024 (2015) DOI: 10.1109/TMI.2014.2377694
[2] Bakas S et al. "Advancing The Cancer Genome Atlas glioma MRI collections with expert segmentation labels and radiomic features", Nature Scientific Data, 4:170117 (2017) DOI: 10.1038/sdata.2017.117
[3] Bakas S et al. "Segmentation Labels and Radiomic Features for the Pre-operative Scans of the TCGA-GBM collection", The Cancer Imaging Archive, 2017. DOI: 10.7937/K9/TCIA.2017.KLXWJJ1Q
[4] Bakas S et al. "Segmentation Labels and Radiomic Features for the Pre-operative Scans of the TCGA-LGG collection", The Cancer Imaging Archive, 2017. DOI: 10.7937/K9/TCIA.2017.GJQ7R0EF

Code available on https://github.com/AmbomBee/DeepVision