Politecnico di Torino

Bioinformatics project:

Medical Segmentation

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Brain Tumor Statistics

84.000 people
will be diagnosed with a primary brain tumor in 2021.

18.000 people
This year will die as a result of a malignant brain tumor.

From **2013-2017**,
malignant brain tumors were the 3rd most common cancer among those aged 15-39.

CV can make a difference!

Brain Tumor FAQs - Learn More or Donate Today! | ABTA

Purposes

Implement segmentations architectures

UNet **DeepLabV3** **BiSeNetV2**

Test on

Implement and Evaluate
MC Dropout
Inside networks

Contributions

Comparisons among networks

Compare the performance of deep heavy and light network to find the best trade-off.

Lightweight portable networks

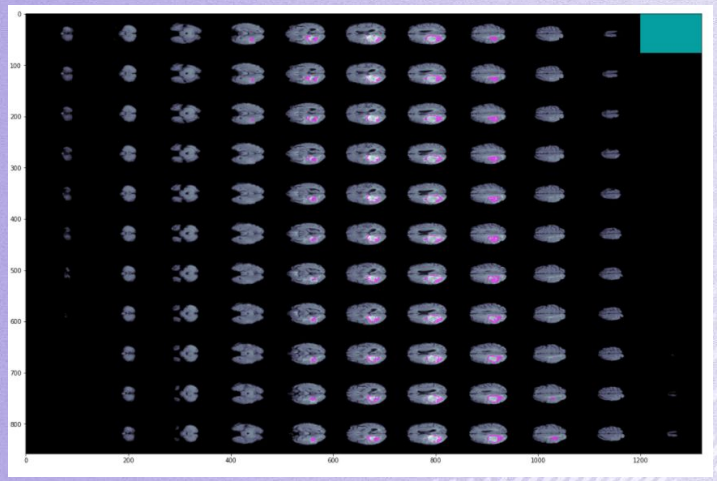
To load medical support devices onto low-powerfull processor and little memory machines.

Dataset: BraTS2020

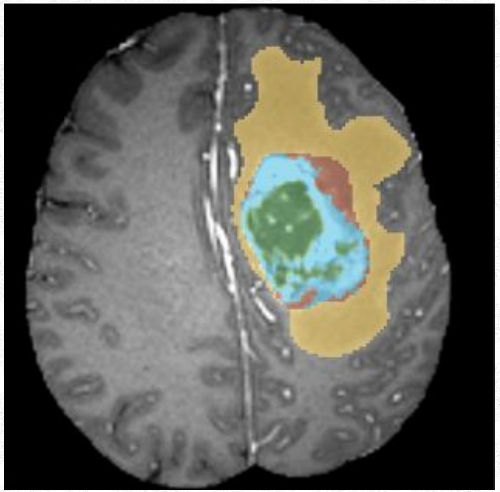
369 images

269 train | 50 test | 50 validation

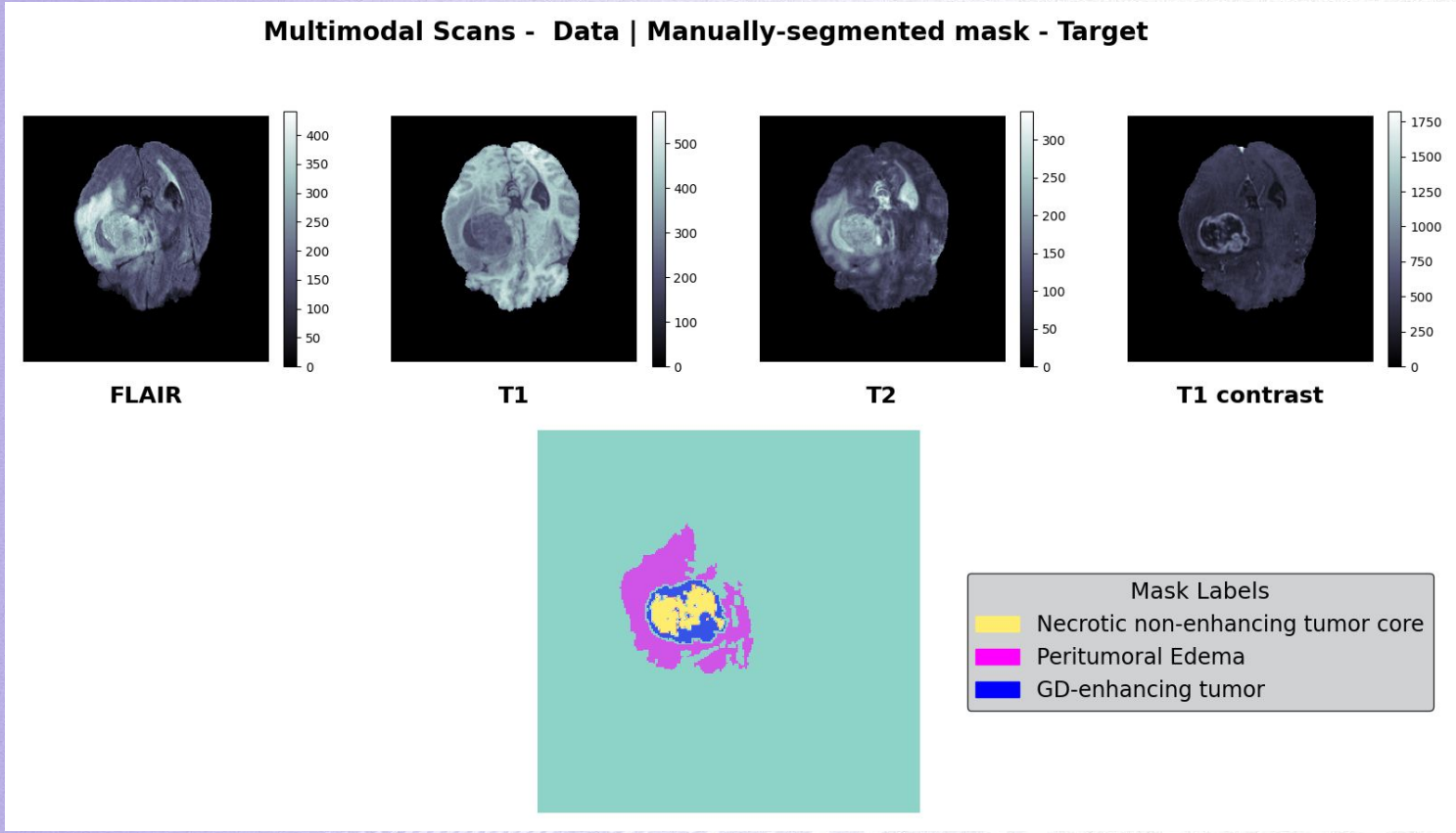
3D images



2D image

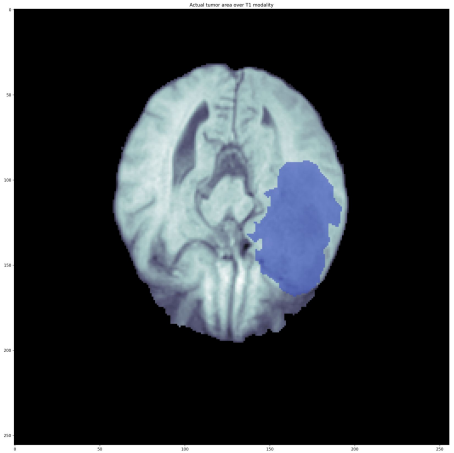


Multimodal images

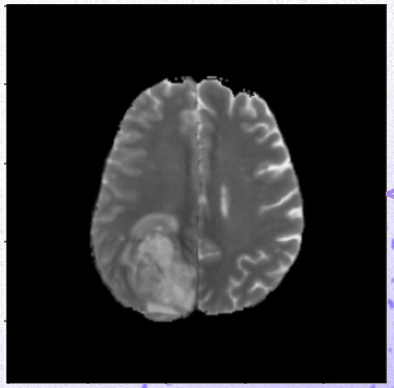


Data PreProcessing

- Tumor and non-tumor class
- Four channel images
- Padding
- Augmentation → Rotation 90°
- Normalization

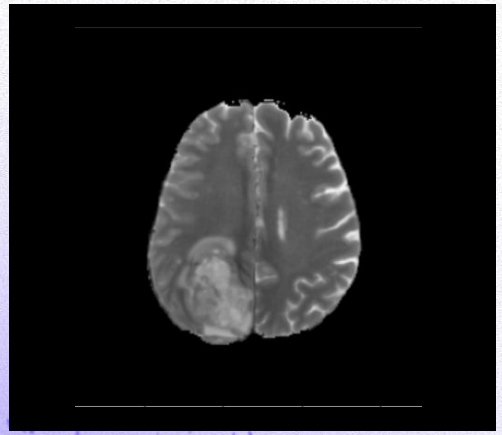


240x240



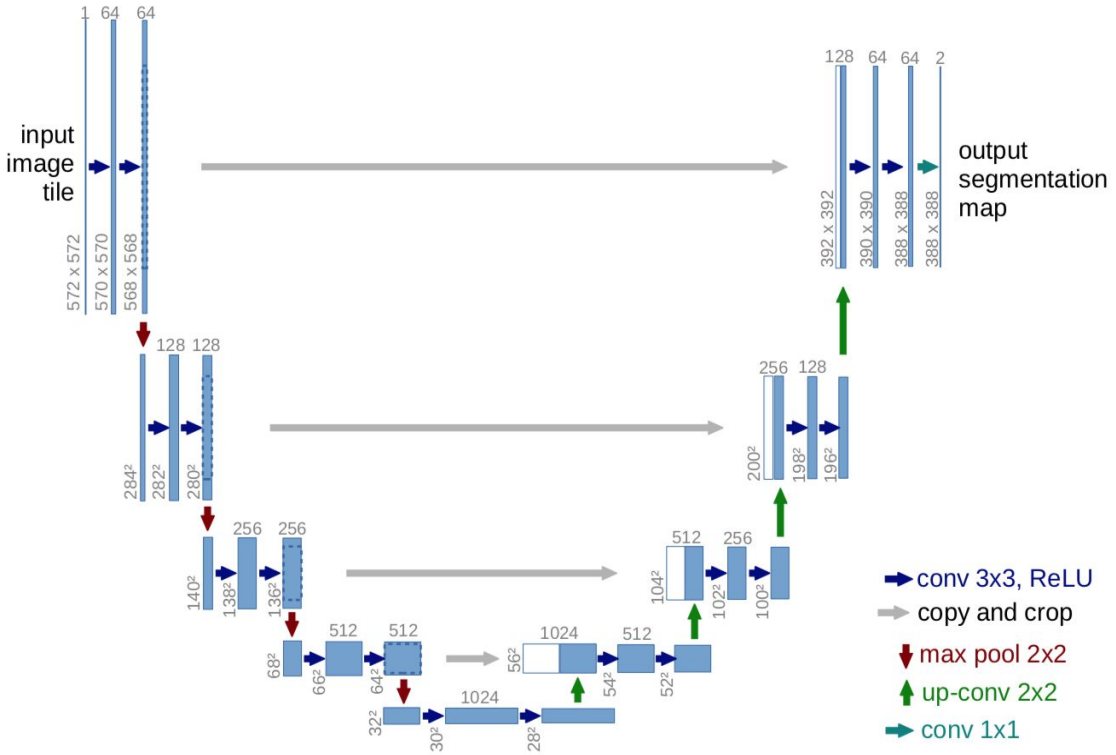
PADDING

256x256



U-Net

Architectures

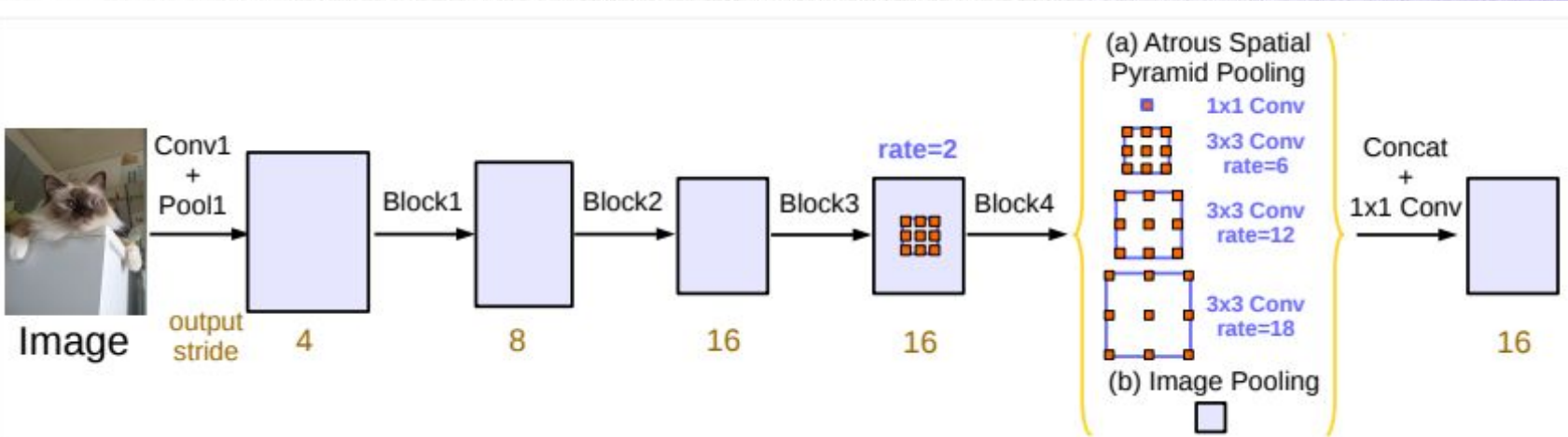


- Contracting path + symmetric expanding path
- Concatenation of corresponding feature maps
- Good for medical images
- Good result even with few images and augmentation

DeepLabV3

Architectures

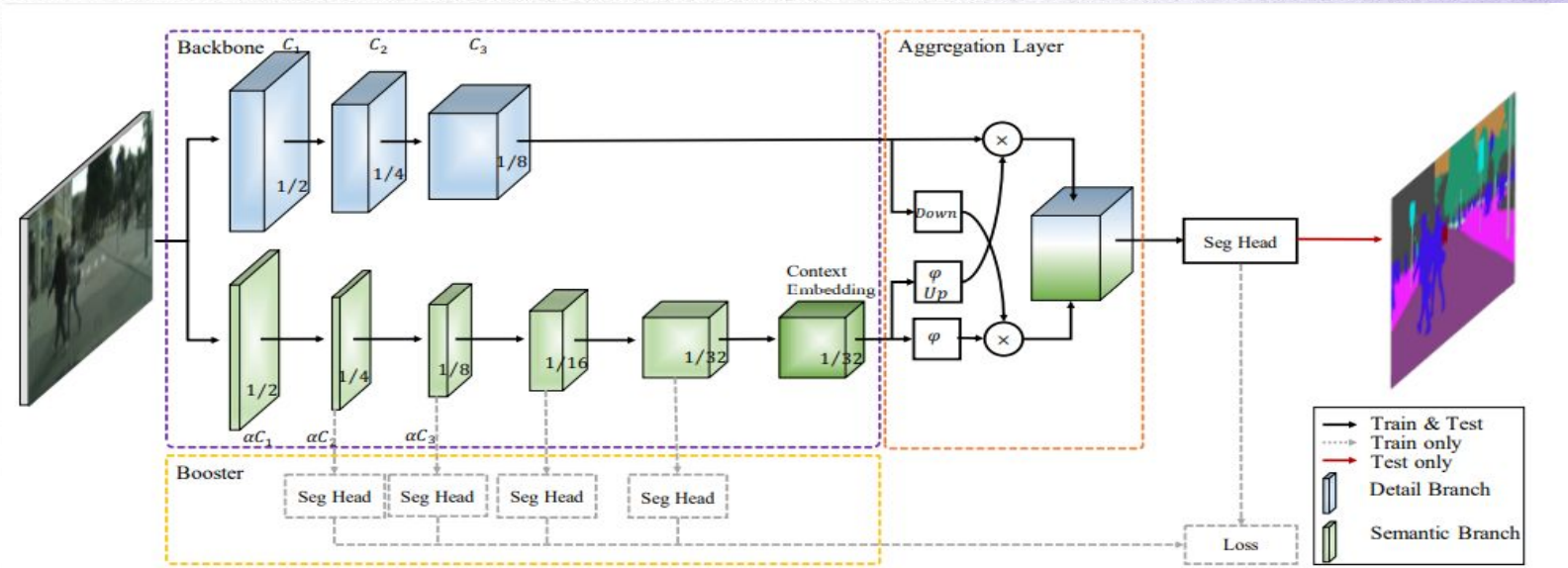
- Deep and heavy
- Backbone ResNet18 pretrained on ImageNet
- Atrous Spatial Pyramid Pooling (ASPP) with Dilatation [6 - 12 - 18]
- Atrous convolutions + Global Average Pooling



BiSeNetV2

Architectures

- Recent network (2020)
- Lightweight net
- Detail Branch + Segmentation Branch
- Bilateral Guided Aggregation Layer
- Booster training strategy



Training setting

Class Trainer

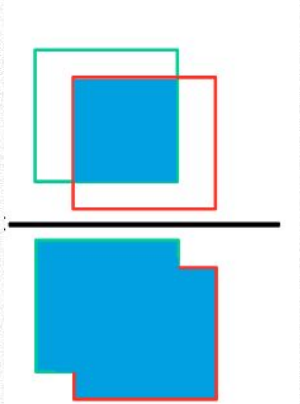
Initialization
- Model
- Optimizer → SGD with momentum
- Scheduler → StepLR
- Criterion → Cross Entropy Loss by pixels

$$L = -\frac{1}{n * p} \sum_{i=1}^{n} \sum_{j=1}^{p} \sum_{k=1}^{K} y_k^{i,j} \log(p_k^{i,j})$$

- Validation every 10 epochs
- Final test

Evaluation metric

Mean Intersection Over Union



Results

700 Total Epochs

Hyperparameters
Cross-Validation

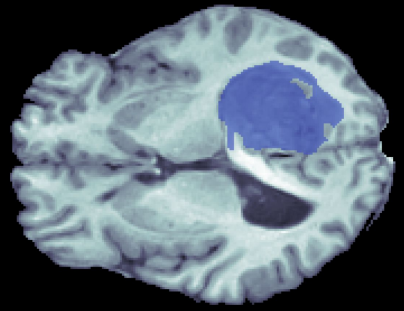
lr	Batch size	Step	Decay	Time	mIoU	0 IoU	1 IoU
U-Net							
0.01	16	50	0.6	162	0.7832	0.9748	0.5916
0.05	32	100	0.7	145	0.8186	0.9900	0.6472
0.08	32	100	0.7	131	**0.8234**	0.9909	0.6559
DeepLabV3							
0.01	16	200	0.5	356	0.8168	0.9747	0.6589
0.05	32	100	0.7	347	0.8290	0.9904	0.6676
0.08	32	50	0.6	338	**0.8527**	0.9942	0.7112
BiSeNetV2							
0.01	16	100	0.7	62	0.7652	0.9875	0.5429
0.05	16	100	0.7	58	**0.7976**	0.990	0.6052
0.08	32	100	0.7	55	0.7117	0.9838	0.4396

Test Results

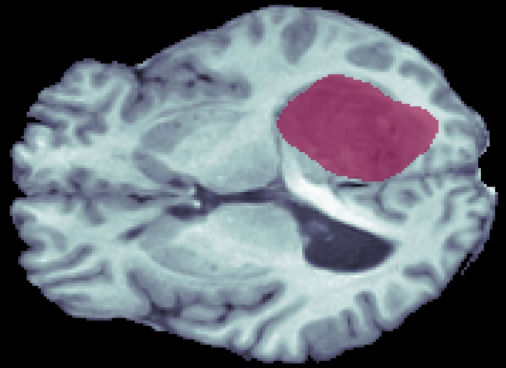
Network	lr	Batch size	Step	Decay	mIoU	0 IoU	1 IoU
U-Net	0.08	32	100	0.7	0.7880	0.9674	0.6086
DeepLabV3	0.08	32	50	0.6	0.8313	0.9946	0.6680
BiSeNetV2	0.05	16	100	0.7	0.7798	0.9708	0.5888

Test Results

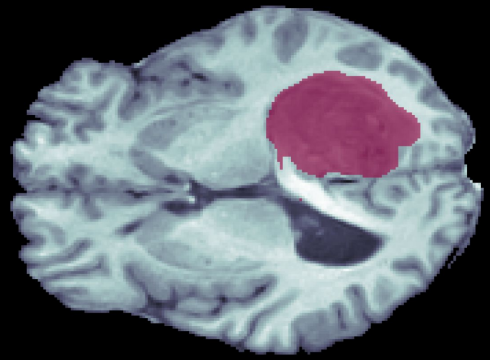
Ground Truth Label



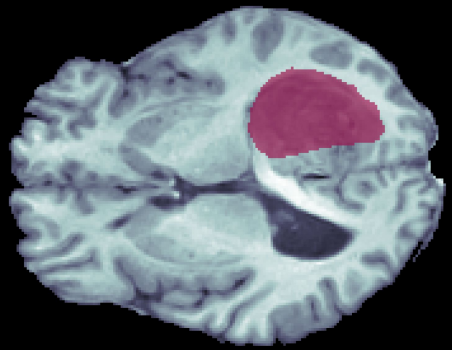
U-Net mIoU 0.7880



DeepLabV3 mIoU 0.8313

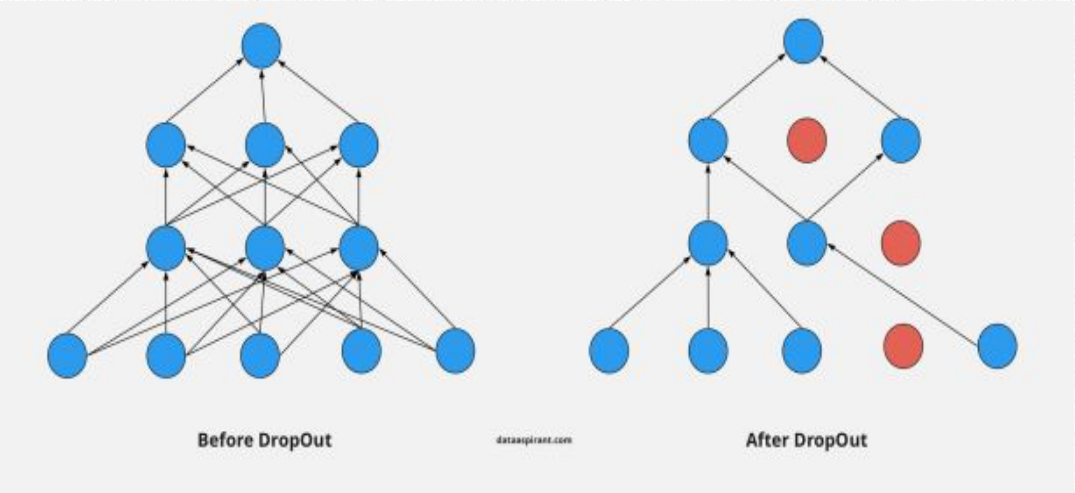


BiSeNetV2 mIoU 0.7798



Monte Carlo Dropout

Dropout at training time → Dropout at testing time → Getting many predictions by slightly different models → Seen as Monte Carlo samples from the space of all available models



Averaging the results we obtain more accurate performances and an idea of uncertainty of the result

Monte Carlo Dropout

pipeline

1. Train each network with the best parameter previously obtained

2. Made the test 100 times enabling the dropout

3. Calculate mean and standard deviation of the results

Monte Carlo Dropout

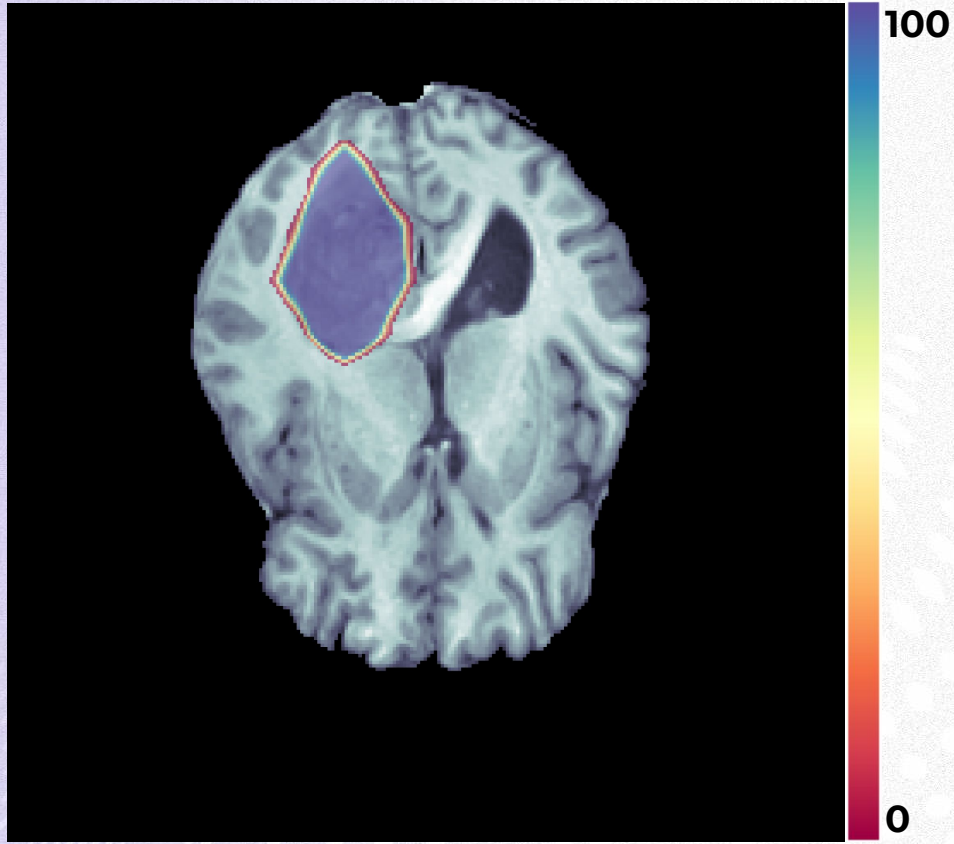
Results

		MC dropout	
Network	mIoU	Averaged mIoU	Standard deviation
U-Net	0.7980	0.7611	0.00916
DeepLabV3	0.8313	0.8031	0.00449
BiSeNetV2	0.7798	0.7446	0.0174

Monte Carlo Dropout

Uncertainty Regions

evaluate the certainty of the network in predicting the correct zone



Conclusions

DeepLabV3

Accurate but too heavy and slow

BiSeNetV2

Best trade-off between performance and speed

For online diagnosis

we need this kind of characteristics

MC Dropout

gave a more reliable results

Uncertainty regions

increases confidence of medical staff in the devices

Thank you for your attention!