Automatic cerebral hemisphere segmentation in rat MRI with lesions via attention-based convolutional neural networks

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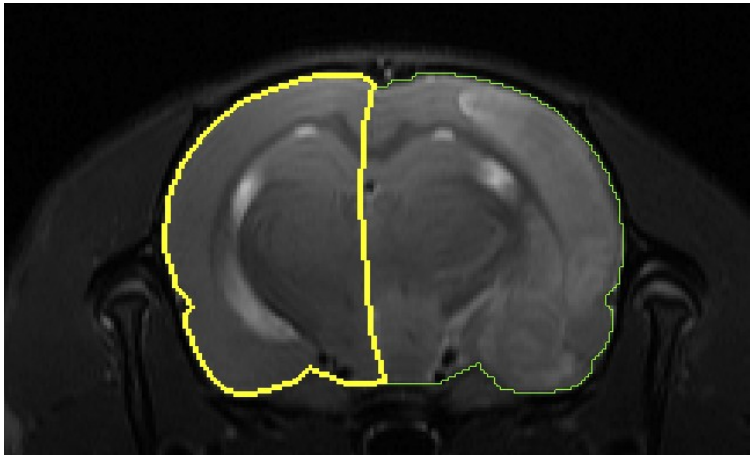
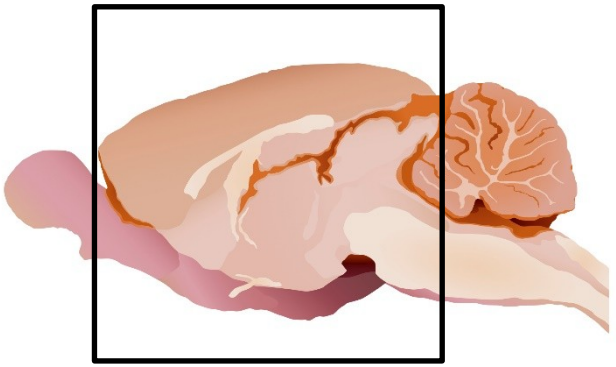
Why hemisphere segmentation?



Region of interest

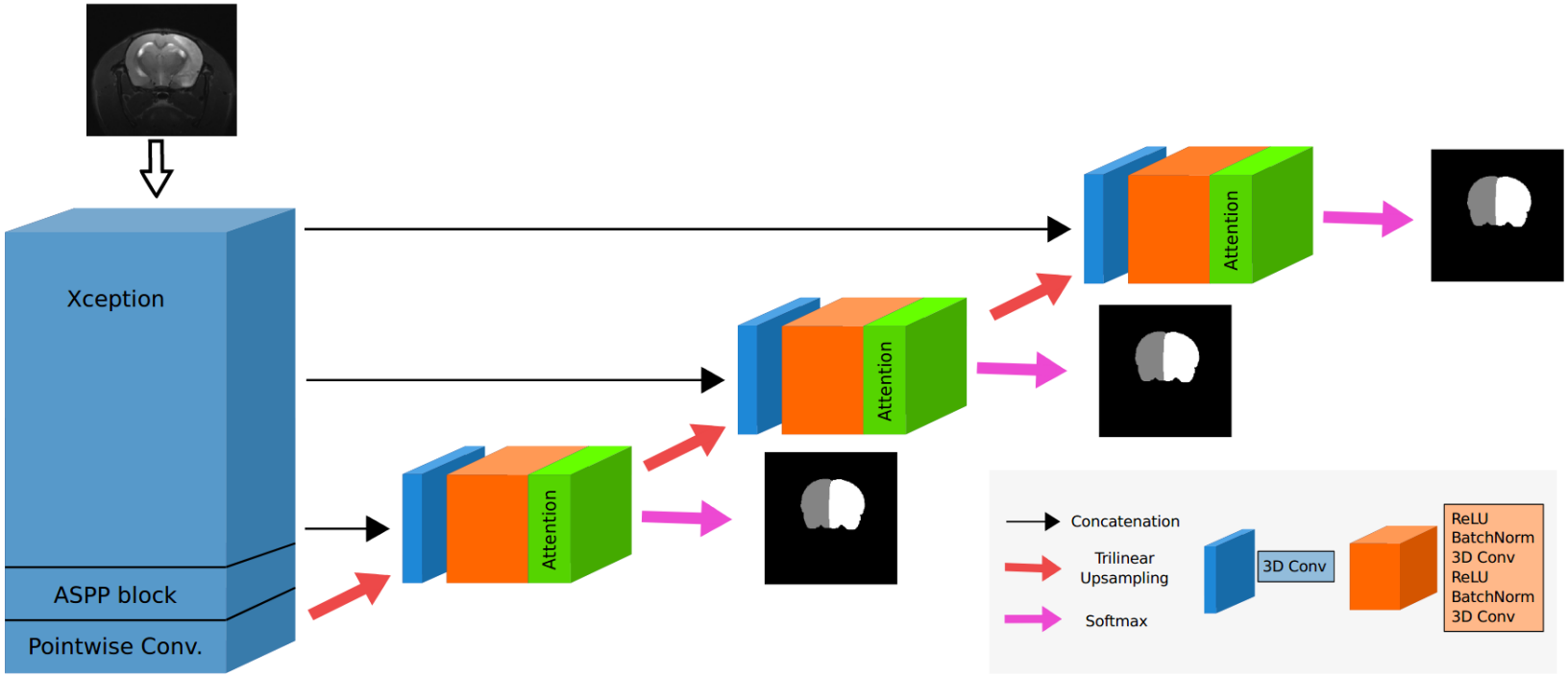


Source: https://neuroscience-graphicdesign.com/2017/08/01/post-1-rat-brain-gallery/

The ratio $\frac{\text{contralateral hemisphere volume}}{\text{ipsilateral hemisphere volume}}$

is an important **biomarker** for acute stroke.

MedicDeepLabv3+ (convolutional neural network)



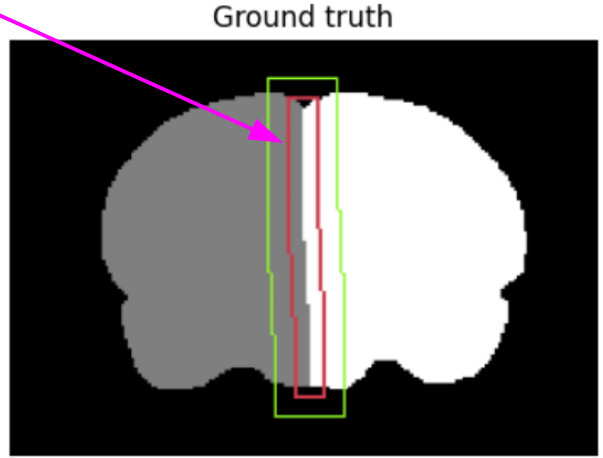
Experiments

1. Comparison with eight other methods

VoxResNet, HighRes3DNet, V-Net, UNet, DeepLabv3+, Demon, RATS, RBET

Convolutional Neural Networks | Brain extraction

2. Brain midline volume



3. Hemispheric ratio

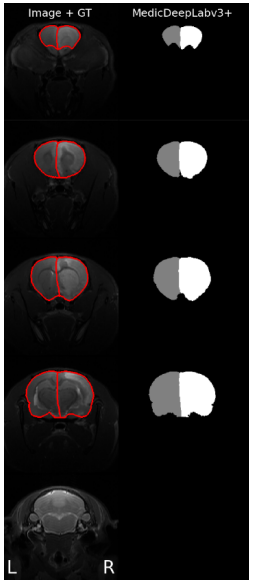
Are the hemispheric ratios in the ground truth significantly different from the automatic segmentations?

- Effect size (Cohen's d)
- Confidence interval

Results

1. Comparison

	Approach	Dice	HD
Brain	MedicDeepLabv3+	**0.952 ± 0.04**	**1.856 ± 0.91**
	VoxResNet	0.951 ± 0.04	2.042 ± 1.02
	HighRes3DNet	0.949 ± 0.04	1.858 ± 1.04
	V-Net	0.948 ± 0.04	1.920 ± 1.05
	UNet **(2D)**	0.947 ± 0.05	3.477 ± 1.20
	DeepLabv3+	0.936 ± 0.04	2.149 ± 1.02
	Demon **(2D)**	0.934 ± 0.04	3.621 ± 1.17
	RATS	0.913 ± 0.01	2.221 ± 0.51
	RBET	0.781 ± 0.10	3.628 ± 0.46
CH	MedicDeepLabv3+	0.944 ± 0.04	**2.064 ± 1.85**
	VoxResNet	0.944 ± 0.04	2.265 ± 1.86
	HighRes3DNet	0.942 ± 0.04	2.205 ± 1.86
	V-Net	0.940 ± 0.04	2.218 ± 1.86
	UNet **(2D)**	0.941 ± 0.05	3.689 ± 1.64
	DeepLabv3+	0.921 ± 0.04	2.411 ± 1.80



2. Brain midline volume

- MedicDeepLabv3+ outperformed the baseline DeepLabv3+.
- UNet provided slightly higher (0.02) Dice coefficients.

3. Hemispheric ratio

Approach	Cohen's d	Confidence Interval
MedicDeepLabv3+	0.008	[-0.013, 0.035]
VoxResNet	-0.042	[-0.060, -0.025]
HighRes3DNet	-0.102	[-0.125, -0.080]
V-Net	0.003	[-0.042, 0.022]
UNet	-0.038	[-0.054, -0.021]
DeepLabv3+	0.050	[-0.008, 0.099]

👍 Small d
Zero-centered C.I.

Discussion / Conclusion

➢ Our method provided **excellent** and **more accurate** segmentations than the other methods.

➢ Our method takes **one second** to segment 3D volumes.

➢ 3D convolutional neural networks achieved better segmentations than 2D.

Acknowledgments

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