MULTIMODAL BRAIN TUMOR SEGMENTATION USING DEEP CONVOLUTIONAL NEURAL NETWORKS

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INTRODUCTION

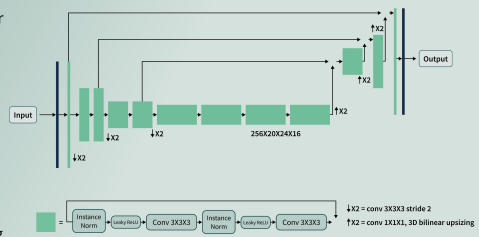
- Gliomas are the most prevalent brain tumours.
- Early treatment or therapy necessitates early diagnosis and segmentation.
- Current methods of segmentation have drawbacks, including the need for specialised support, a long run-time, and the need to choose the right feature extractor.
- We recommend a convolutional neural network-based method for simultaneously predicting and segmenting a cerebral tumour using multimodal structural magnetic resonance data (T1w, FLAIR and Post contrast T1w) to get over these challenges.

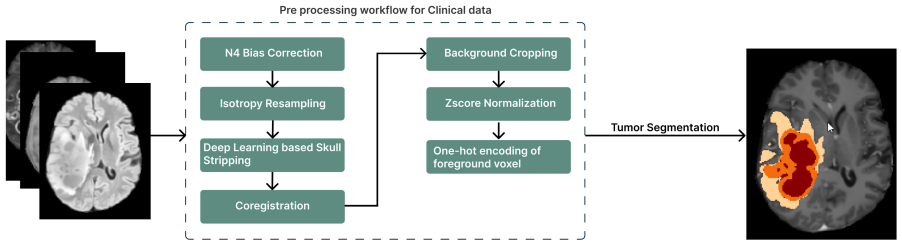
OBJECTIVE

To reduce the number of modalities required for glioma segmentation

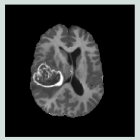
METHODOLOGY

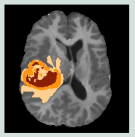
- Data was obtained from Brain Tumor Segmentation (BRATS 2021) dataset.
- Three classes were included in the scan annotation for each image: Enhancing Tumour, Peritumoral Edematous Tissue, and Necrotic Tumour Core.
- Our Method was developed by training deep neural networks(DNN) using only 3 Modalities- T1w, FLAIR and Post contrast T1w for generating tumour segmentation masks.





Manual Annotation Process


Original Image


Manual Annotation


After Radiologists Feedback

RESULTS

We are able to achieve a **dice score of .89** on Brats21 training data set and a dice score of 0.88 on manually annotated 50 scans randomly taken from BraTS20 validation set using just 3 modalities which are comparable to the results obtained from other SOTA deep learning models using 4 modalities.

Table 1: Average Dice Scores of Enhancing Tumor(ET), Tumore Core(TC) and Whole Tumor(WT) region classes for different models.

	Radiologist Validated Set			Brats21 Validation set		
Region	Enhancing Tumor(ET)	Tumor Core(TC)	Whole Tumor(WT)	Enhancing Tumor(ET)	Tumor Core(TC)	Whole Tumor(WT)
Dice Score	0.84	0.92	0.9022	0.872	0.9032	0.92
Mean Dice Score	0.8875			0.8987		

Table 2: Validation set results. Predictions made on Brats21 validation set and expert verified manually annoted set of 50 scans

Model	U-net	UNETR	SegResNetVAE	**SegResNet_3Modal**
Mean Dice	0.913	0.9031	0.9118	0.8987

IMPLICATIONS

- This study indicates that deep convolutional neural networks can swiftly and accurately distinguish between different tumour subregions. This finding has significant therapeutic ramifications for the early identification, prognosis, treatment, and preoperative planning of brain tumours.
- The impact of tumours on network mapping and tractography can also be understood using this information.
- By using these segmentation masks, one may better capture brain activities, account for a general shift in the brain's tissues, and create an Eloquent cortex mapping that is more accurate.

CONCLUSIONS

We have been able to generate a CNN based model to segment gliomas from only three modalities (T1w, FLAIR, and post-contrast T1w scans) as opposed to most studies which make of four modalities (T1w, T2w, FLAIR, and post-contrast T1w scans)

References

- Isensee, F., Jaeger, P. F., Full, P. M., Vollmuth, P., & Maier-Hein, K. H. (2020). NnU-Net for Brain Tumor Segmentation (arXiv:2011.00848). arXiv. http://arxiv.org/abs/2011.00848
- Futrega, M., Milesi, A., Marcinkiewicz, M., & Ribalta, P. (2021). Optimized U-Net for Brain Tumor Segmentation (arXiv:2110.03352). arXiv. http://arxiv.org/abs/2110.03352
- NVIDIA DALI Documentation—NVIDIA DALI 1.18.0 documentation. (n.d.). Retrieved October 31, 2022, from https://docs.nvidia.com/deeplearning/dali/user-guide/docs/
- Menze, B. H., Jakab, A., Bauer, S., Kalpathy-Cramer, J., Farahani, K., Kirby, J., Burren, Y., Porz, N., Slotboom, J., Wiest, R., Lanczi, L., Gerstner, E., Weber, M.-A., Arbel, T., Avants, B. B., Ayache, N., Buendia, P., Collins, D. L., Cordier, N., … Van Leemput, K. (2015). The Multimodal Brain Tumor Image Segmentation Benchmark (BRATS). IEEE Transactions on Medical Imaging, 34(10), 1993–2024. https://doi.org/10.1109/TMI.2014.2377694
- Official BrATS site: http://braintumorsegmentation.org/
- Dataset for training the deep learning model was taken from BraTS21 competition. It can be downloaded from below link -
- https://www.kaggle.com/datasets/dschettler8845/brats-2021-task1

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