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RANO2.0-assist: A 3D Slicer Extension for (semi-)automatic Assessment of Response to Glioma Treatment

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Summary

The Response Assessment in Neuro-Oncology (RANO) criteria (Wen et al., 2023) are widely used to assess the treatment response of glioma patients in clinical trials. RANO was introduced to improve reliability and reproducibility of response assessment, classifying patients into four categories: complete response, partial response, stable disease, and progressive disease. The classification is primarily based on the change in tumour size and typically requires the identification of all tumour regions and the measurement of their dimensions on MRI scans. While manual assessment is time-consuming and prone to inter- and intra-observer variability, automated methods can provide more consistent and efficient response assessment. We present RANO2.0-assist, a 3D Slicer extension for (semi-)automatic assessment of response to glioma. 3D Slicer is a free open-source software application for medical image computing (Fedorov et al., 2012). RANO2.0-assist allows for fully automatic response assessment while also providing interactive tools for manual correction and validation of the results.

Statement of need

Tools for automatic response assessment based on RANO criteria have been developed, for example Chang et al. (2019) and Nalepa et al. (2023). For a comprehensive review of existing methods, we refer the reader to Shi et al. (2025). However, existing tools do not support the most recent RANO criteria (Wen et al., 2010) and do not allow for the interactive correction and validation of results. Moreover, some tools are proprietary and not freely available to the research community. RANO2.0-assist is based on the recently updated RANO 2.0 criteria and provides a user-friendly interface for the assessment of treatment response. The interactive tools allow the user to modify, add, and remove bi-dimensional measurements of tumour regions, specify measurable and non-measurable lesions, and provide additional information such as the patient's clinical status, steroid dose, and other relevant information that influence the response assessment according to the RANO 2.0 criteria. While the current pipeline is designed for enhancing glioblastoma, it can easily be adapted to other types of brain tumours by training new segmentation models, for example, for non-enhancing low-grade glioma or meningioma.

State of the field

Commercial imaging platforms such as mint Lesion (Mint Medical GmbH, 2025) support configurable RANO 2.0 criteria for clinical-trial reads, including automated tumor burden tracking. Additionally, an AI-based algorithm developed by Graylight Imaging (Graylight

Imaging Sp. z o.o., 2026) demonstrates automated tumour segmentation, bidimensional and volumetric assessment aligned with RANO principles. These efforts reflect a trend toward integrating advanced automated image analysis into standardized response assessment to support clinical research and trial endpoint evaluation. In this context, RANO2.0-assist represents a non-commercial tool with the aim to facilitate further development in research and commercial applications. To the best of our knowledge, RANO2.0-assist is currently the only fully automatic tool for classification based on RANO 2.0 criteria that allows for interactive correction of tumour measurements.

Overview of RANO2.0-assist

The key components of the RANO2.0-assist pipeline are shown in Figure 1.

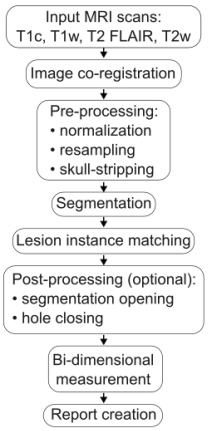

Figure 1: RANO2.0-assist pipeline.

A snapshot of the user interface is shown in Figure 2.

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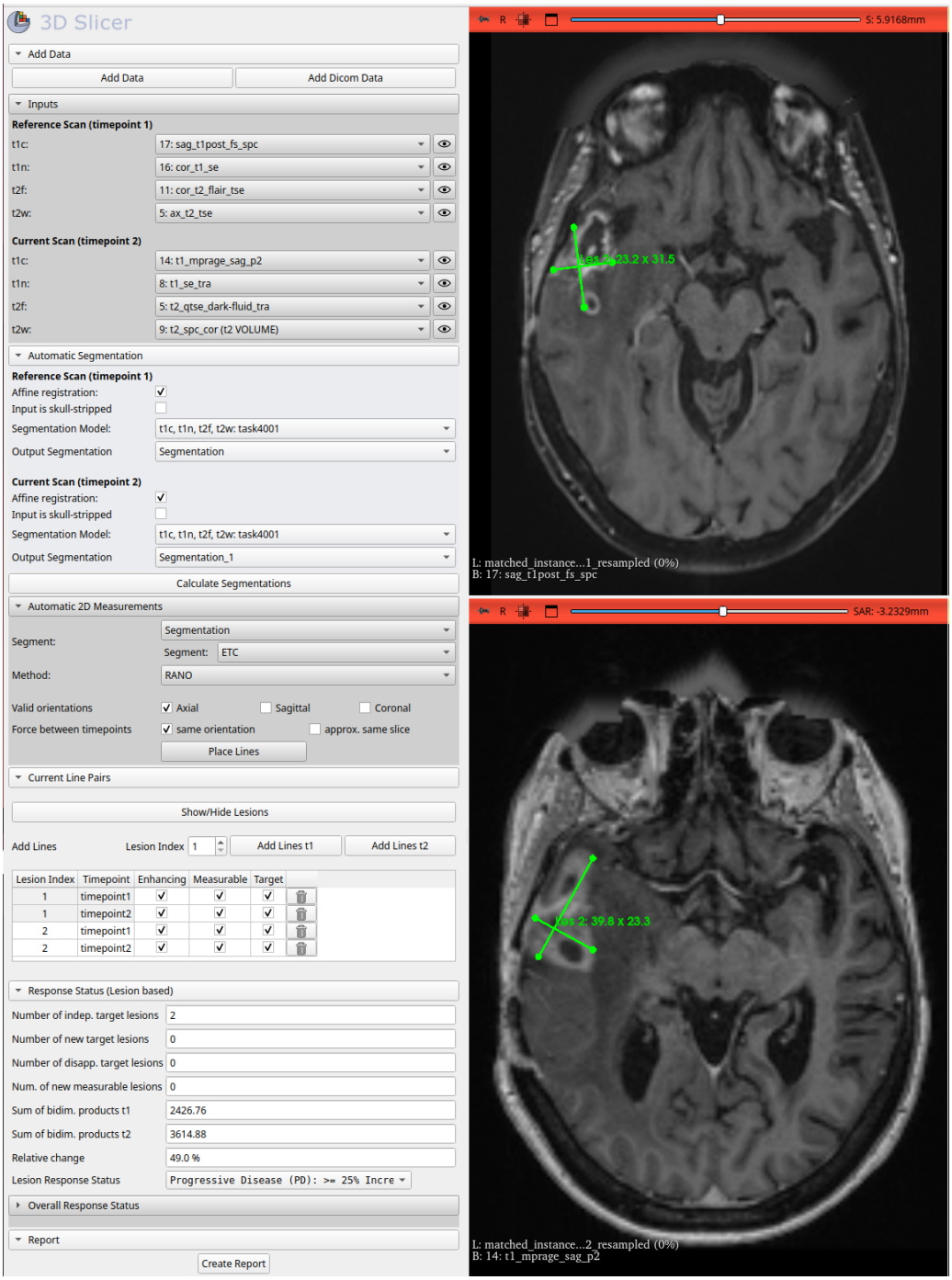

Figure 2: RANO2.0-assist user interface.

RANO2.0-assist includes a model for automatic segmentation of glioblastoma, which requires T1-contrast, native T1, T2-FLAIR, and T2-weighted MRI scans as input and returns output segmentations containing up to 4 regions as specified in the Brain Tumour Segmentation (BraTS) challenge (Verdier et al., 2024): enhancing tumour, edema, necrosis, and resection cavity. These inputs have to be provided for both time points (baseline and follow-up scan). The model was trained on the BraTS challenge dataset (Verdier et al., 2024). Other segmentation models can be added to RANO2.0-assist by the user. After loading the image files (any formats supported by 3D Slicer), the user can select the corresponding scans and the segmentation

model from the drop-down menu and start the automatic segmentation process.

Based on the output segmentation, RANO2.0-assist automatically places orthogonal line pairs representing the bi-dimensional measurements of the tumour regions.

The default method "RANO", exhaustively searches for the optimal line pairs that maximize the bi-dimensional product. "RANOopen 2D" and "RANOopen 3D" are alternative methods that apply a post-processing step to the selected segment by performing a morphological opening operation in 2D or 3D, respectively.

Optionally, the user can restrict the orientation of the line pairs to specific anatomical directions, i.e., axial, sagittal, or coronal. In addition, the user can enforce that line pairs in the second time point are confined to the same anatomical direction as the corresponding line pairs in the first time point. Similarly, the user can confine line pairs in the second time point to slices that are within a certain distance from the corresponding slice in the first time point.

The user can interactively modify the line pairs, add new, or remove existing ones. Additionally, the user can specify enhancing and non-enhancing lesions, whether they are measurable (by default, only lesions of at least 10mm in both dimensions are measurable), and whether they are to be considered as target lesions according to the RANO 2.0 criteria.

Based on the bi-dimensional measurements, RANO2.0-assist calculates the percentage change in tumour size and classifies the patient's response according to the thresholds specified in the RANO 2.0 criteria. The user can review the classification and manually adjust the response category if necessary.

According to the RANO 2.0 criteria, the overall response status depends on additional factors such as the patient's clinical status and steroid dose. RANO2.0-assist provides input fields for these factors and returns the final response category based on the RANO 2.0 criteria.

Finally, the user can export the results as a PDF report that includes bi-dimensional measurements with screenshots of the line pairs, longitudinal changes in tumour size, additional information such as the patient's clinical status and steroid dose, and the response classification.

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References

Chang, K., Beers, A. L., Bai, H. X., Brown, J. M., Ly, K. I., Li, X., Senders, J. T., Kavouridis, V. K., Boaro, A., Su, C., & others. (2019). Automatic assessment of glioma burden: A deep learning algorithm for fully automated volumetric and bidimensional measurement. *Neuro-Oncology*, *21*(11), 1412–1422. https://doi.org/10.1093/neuonc/noz106

Fedorov, A., Beichel, R., Kalpathy-Cramer, J., Finet, J., Fillion-Robin, J.-C., Pujol, S., Bauer, C., Jennings, D., Fennessy, F., Sonka, M., & others. (2012). 3D slicer as an image computing platform for the quantitative imaging network. *Magnetic Resonance Imaging*, *30*(9), 1323–1341. https://doi.org/10.1016/j.mri.2012.05.001

Graylight Imaging Sp. z o.o. (2026). *Automated RANO solution for clinical trial*. https://cdn.graylight-imaging.com/project/automated-rano-solution-for-clinical-trial/.

Mint Medical GmbH. (2025). *Implementing RANO 2.0 for neuro-oncology clinical trials in mint lesion*. https://mint-medical.com/news/implementing-rano-20-for-neuro-oncology-clinical-trials-in-mint-lesion.

Nalepa, J., Kotowski, K., Machura, B., Adamski, S., Bozek, O., Eksner, B., Kokoszka, B., Pekala, T., Radom, M., Strzelczak, M., & others. (2023). Deep learning automates bidimensional and volumetric tumor burden measurement from MRI in pre-and post-operative glioblastoma patients. *Computers in Biology and Medicine*, *154*, 106603. https://doi.org/10.1016/j.compbiomed.2023.106603

Shi, T., Kujawa, A., Linares, C., Vercauteren, T., & Booth, T. C. (2025). Automated longitudinal treatment response assessment of brain tumors: A systematic review. *Neuro-Oncology*, noaf037. https://doi.org/10.1093/neuonc/noaf037

Verdier, M. C. de, Saluja, R., Gagnon, L., LaBella, D., Baid, U., Tahon, N. H., Foltyn-Dumitru, M., Zhang, J., Alafif, M., Baig, S., & others. (2024). The 2024 brain tumor segmentation (BraTS) challenge: Glioma segmentation on post-treatment MRI. *arXiv Preprint arXiv:2405.18368*. https://doi.org/10.48550/arXiv.2405.18368

Wen, P. Y., Macdonald, D. R., Reardon, D. A., Cloughesy, T. F., Sorensen, A. G., Galanis, E., DeGroot, J., Wick, W., Gilbert, M. R., Lassman, A. B., & others. (2010). Updated response assessment criteria for high-grade gliomas: Response assessment in neuro-oncology working group. *Journal of Clinical Oncology*, *28*(11), 1963–1972. https://doi.org/10.1200/JCO.2009.26.3541

Wen, P. Y., Van Den Bent, M., Youssef, G., Cloughesy, T. F., Ellingson, B. M., Weller, M., Galanis, E., Barboriak, D. P., De Groot, J., Gilbert, M. R., & others. (2023). RANO 2.0: Update to the response assessment in neuro-oncology criteria for high-and low-grade gliomas in adults. *Journal of Clinical Oncology*, *41*(33), 5187–5199. https://doi.org/10.1200/JCO.23.01059