

# A Deep Learning Approach for Placing Magnetic Resonance Spectroscopy Voxels in Brain Tumors

Sangyoon Lee<sup>1, 2</sup> [0009-0005-8825-5175], Francesca Branzoli<sup>3</sup> [0000-0001-9792-0492], Thanh Nguyen<sup>4</sup>, Ovidiu Andronesi<sup>5</sup> [0000-0002-7412-0641], Alexander Lin<sup>6</sup>, Roberto Liserre<sup>7</sup> [0000-0003-1536-0183], Gerd Melkus<sup>4</sup> [000-0001-5387-8958], Clark Chen<sup>8, 9</sup> [0000-0001-9544-2570], Małgorzata Marjańska<sup>1</sup> [0000-0002-4727-2447], and Patrick J. Bolan<sup>1</sup> [0000-0002-4194-3975]

<sup>1</sup> Center for Magnetic Resonance Research, Department of Radiology, University of Minnesota, MN, USA

<sup>2</sup> Department of Radiation Oncology, University of Minnesota Medical School, MN, USA

<sup>3</sup> Paris Brain Institute - ICM, Inserm U 1127, CNRS UMR 7225, Sorbonne University, Paris, France

<sup>4</sup> Department of Radiology, Radiation Oncology and Medical Physics, University of Ottawa, Ottawa, ON, Canada

<sup>5</sup> Martinos Center for Biomedical Imaging, Department of Radiology, Massachusetts General Hospital, Charlestown, MA, USA

<sup>6</sup> Center for Clinical Spectroscopy, Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

<sup>7</sup> ASST Spedali Civili University Hospital, Brescia, Italy

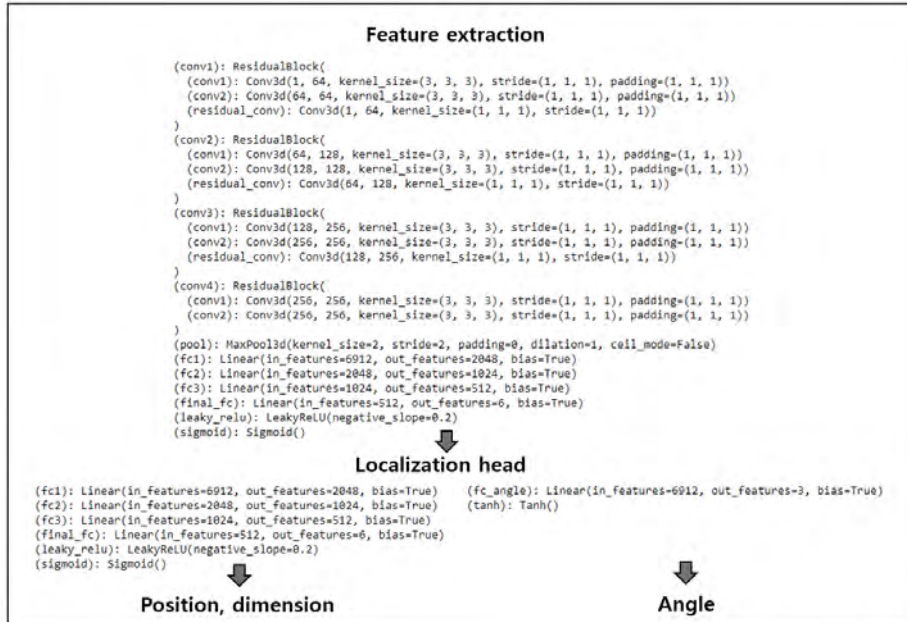
<sup>8</sup> Department of Neurosurgery, University of Minnesota, USA

<sup>9</sup> Department of Neurosurgery, Brown University, USA

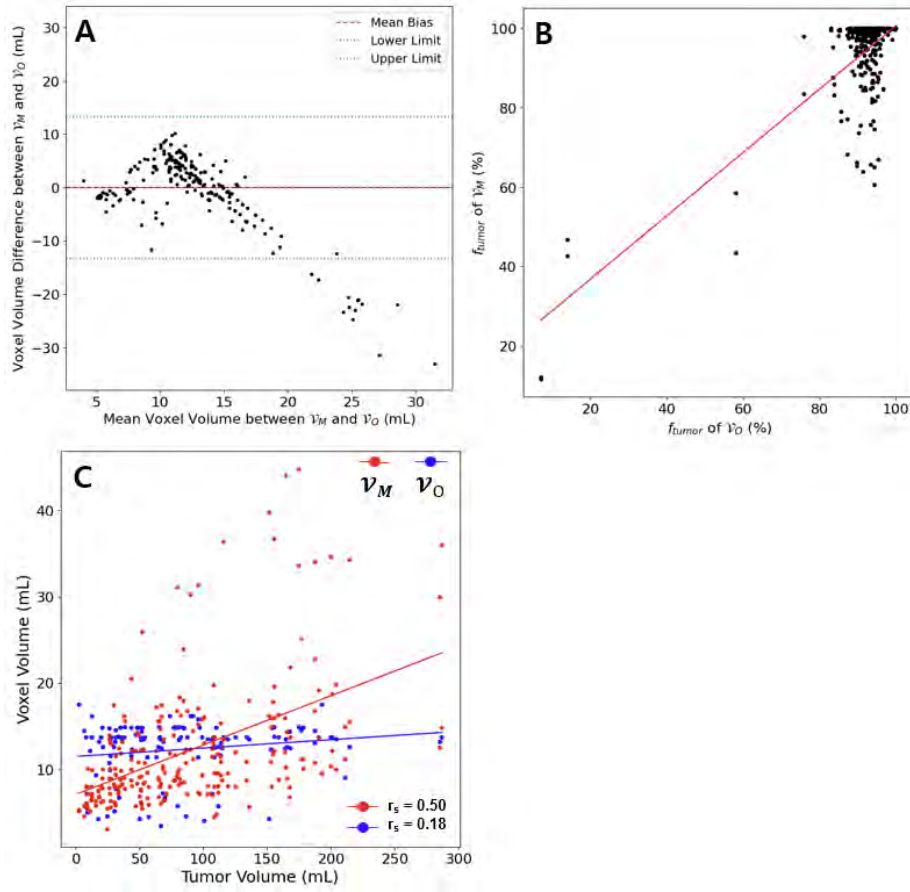
bolan0035@umn.edu

**Supplementary Table 1.** The quantitative results of voxels predicted by the regression models for each fold in cross-validation. †Value is statistically significant ( $P < .05$ ). One-way ANOVA for all  $p$ -value.

| Fold | $f_{tumor}$ (%) |                    |              | Volume (mL)     |                    |                   |
|------|-----------------|--------------------|--------------|-----------------|--------------------|-------------------|
|      | $\mathcal{V}_M$ | $\mathcal{V}_{DL}$ | $\mathbf{p}$ | $\mathcal{V}_M$ | $\mathcal{V}_{DL}$ | $\mathbf{p}$      |
| 1    | 95.9 ± 5.6      | 93.2 ± 12.5        | 0.17         | 13.5 ± 9.2      | 12.2 ± 2.6         | 0.32              |
| 2    | 93.1 ± 10.0     | 95.2 ± 6.81        | 0.24         | 11.5 ± 5.3      | 13.0 ± 5.4         | 0.18              |
| 3    | 89.2 ± 12.7     | 84.1 ± 19.1        | 0.12         | 12.5 ± 7.7      | 13.3 ± 3.6         | 0.55              |
| 4    | 93.3 ± 11.8     | 92.9 ± 13.4        | 0.89         | 14.5 ± 7.9      | 11.6 ± 2.8         | 0.01 <sup>†</sup> |
| 5    | 94.4 ± 17.3     | 92.7 ± 18.7        | 0.63         | 9.6 ± 6.6       | 10.1 ± 5.8         | 0.62              |



**Supplementary Fig. 1.** Voxel localization regression model architecture.



**Supplementary Fig. 2.** Correlation plot between voxel placement characteristics of tumor volume,  $f_{tumor}$ , and  $V_{tumor}$  between  $\mathcal{V}_M$  and  $\mathcal{V}_O$ . The grid-like pattern in (A) is due to the discrete search optimization of Ref [8].