MRI-based stroke outcome prediction and treatment planning

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Motivation:

The question of the therapeutic effectiveness of such courses of cognitive rehabilitation in patients with different clinical forms and the severity of aphasia remains controversial.

Research structure:

Dataset:

38 right-handed patients with motor aphasia after the first hemispheric ischemic stroke in the anamnesis 3-6 months onset. The patients were accessed with NIHSS, Barthel Index and modified Rankin Scale.

Network Architecture:

The Vox Convolutional and residual neural networks** were used. See Fig. 1-4 for architecture details. Additionally, we fitted models where value of the target parameter at the acute phase (21 days after the stroke) was concatenated to the feature vector, extracted from the image.

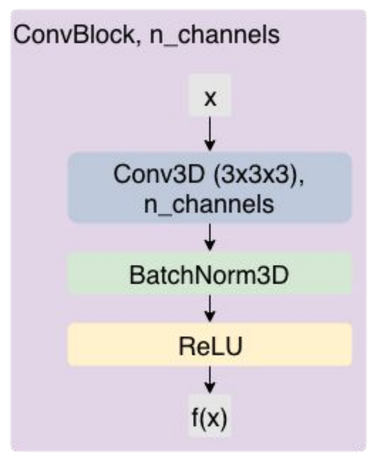

Fig.1 Convolutional block

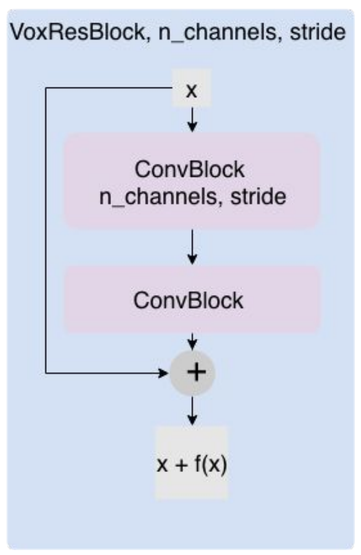

Fig.2 VoxRes block

Target	Range	MAE (SD) before treatment		MAE (SD) after treatment	
		Without acute phase value	With acute phase value	Without acute phase value	With acute phase value
Barthel	0 - 100	11.40 (3.35)	7.77 (2.22)	7.65 (2.29)	5.86 (2.12)
mRS	0 - 5	0.66 (0.12)	0.53 (0.25)	0.65 (0.17)	0.45 (0.22)
NIHSS	0 - 31	3.33 (0.91)	3.05 (1.18)	2.54 (0.99)	1.78 (0.90)

Table 1. Regression results: Mean absolute error and its standard deviation on 5-fold cross validation with two repetitions.

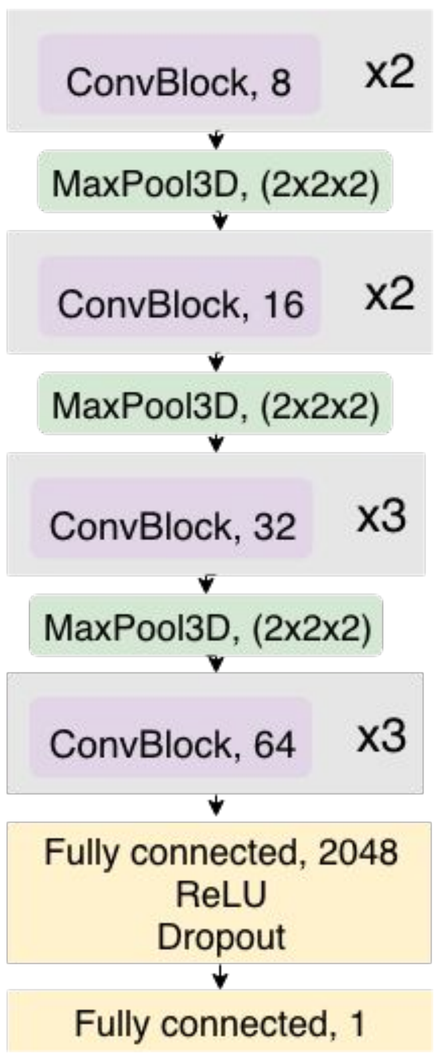

Fig.3 VoxCNN architecture

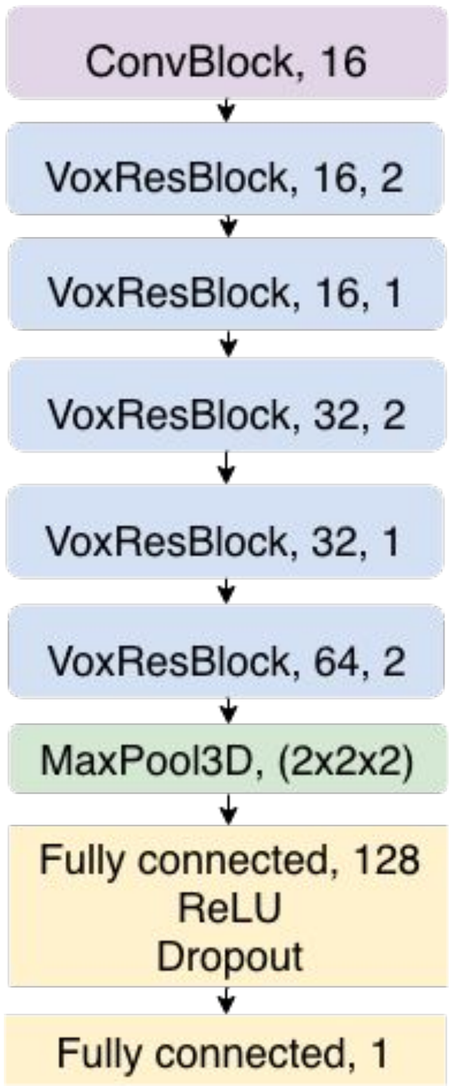

Fig.4 VoxResNet architecture

Results:

Table 1 depicts mean absolute error for all the tasks, estimated on the 5-fold cross validation with two repetitions. We observe rather low errors, which supports the hypothesis that the sMRI-based deep learning models can be considered as relevant predictive tools for the stroke outcome prognosis. It is also worth mentioning, that addition of the acute phase value increases accuracy of all the models.

*Butler, Rebecca A., Matthew A. Lambon Ralph, and Anna M. Woollams. "Capturing multidimensionality in stroke aphasia: mapping principal behavioural components to neural structures." Brain 137.12 (2014): 3248-3266.
** Korolev, S., Safiullin, A., Belyaev, M., & Dodonova, Y. Residual and plain convolutional neural networks for 3D brain mri classification. Sergey Korolev Amir Safiullin Mikhail Belyaev Skolkovo Institute of Science and Technology Institute for Information Transmission Problems (2017), 835–838.

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