# Rubik-Net: Learning Spatial Information via Rotation-Driven Convolutions for Brain Segmentation

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**Abstract.** Due to lack of spatial information between slices, 2D convolutions cannot perform accurate segmentation. Although 3D convolutions capture more features, they require high computing resources and may lead to overfitting in the case of insufficient training data. In order to address those problems, we propose a novel convolutional mechanism, termed Rubik convolution, to capture multi-dimensional information between MRI slices. Rubik convolution rotates the axis of a set of consecutive slices, which enables the 2D convolution kernel to extract features of each axial plane simultaneously. Then, the feature maps are rotated back to fuse multi-dimensional information. We propose an efficient 2D network, namely Rubik-Net, where the residual and bottleneck structure are utilized to enhance information transmission and reduce parameters of the network, respectively. The entire training time of Rubik-Net is about 1 hours, and it only has 1.4 million trainable parameters. It costs 13s to conduct segmentation of one subject. 4 subjects are selected for training and 1 subject for validation.

**Keywords:** Infant brain segmentation · 2D convolution · Fully convolutional network · Rubik convolution.