High Accuracy Brain Tumor Classification with EfficientNet and Magnetic Resonance Images

Juan M. Medina and Javier Sánchez
Computer Science Department
IU Cibernética, Empresas y Sociedad (IUCES)
University of Las Palmas de Gran Canaria

Abstract

Automatic classification of brain tumors with EfficientNet. We use two datasets of magnetic resonance images with four labels: *glioma*, *meningioma*, *pituitary* tumors, and *no-tumor*. The experiments use transfer learning, early stopping and fine-tuning.

Brain tumor datasets

Figshare dataset: 1426 *gliomas*, 708 *meningiomas*, 930 *pituitary*

Kaggle dataset: 926 *gliomas*, 937 *meningiomas*, 901 *pituitary*, 500 *no-tumors*

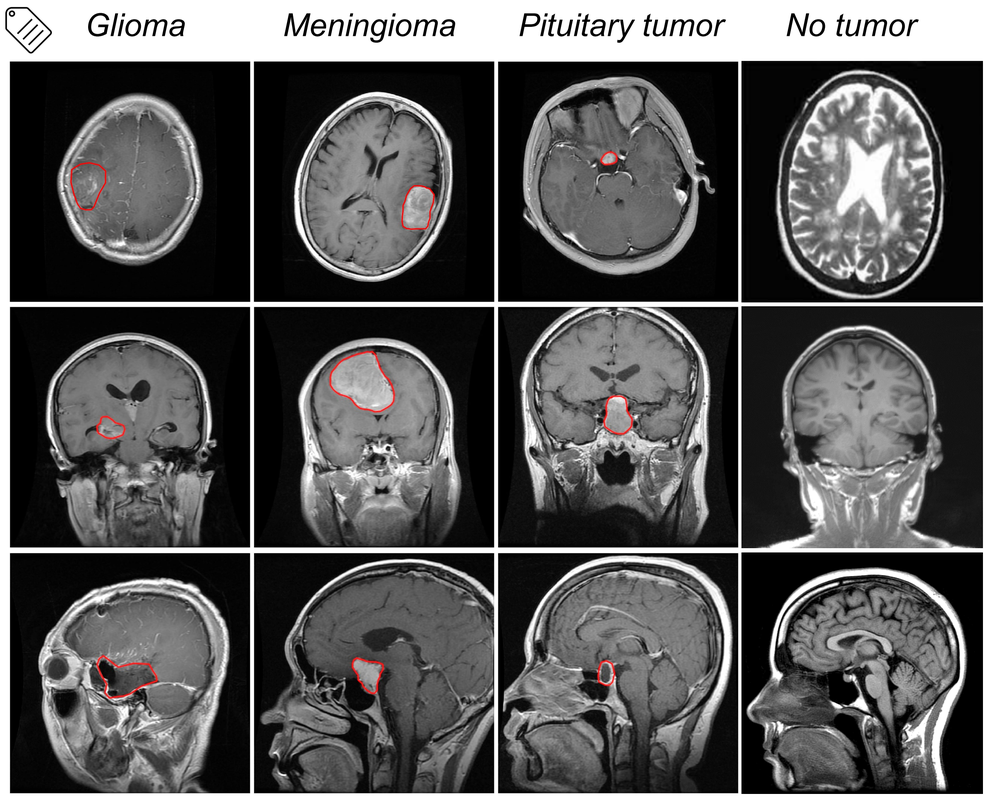

Fig. 1. Images of the Figshare and Kaggle datasets with its labels. Views from axial, coronal and sagittal planes.

EfficientNet

Trade-off between accuracy and FLOPS with compound scaling. Based on the MnasNet architecture.

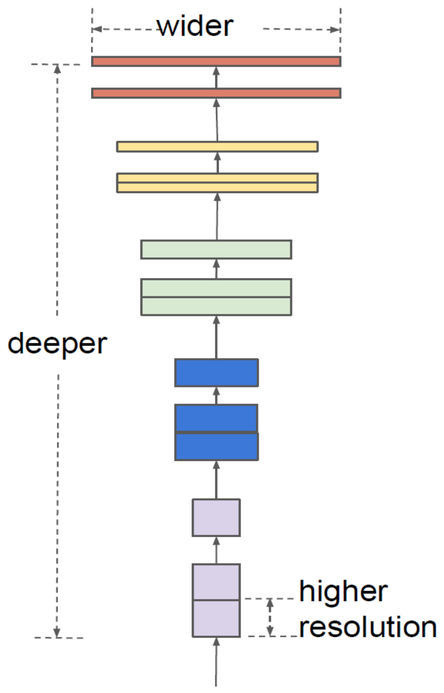

Fig. 2. EfficientNet design. Source: Tan & Le, EfficientNet

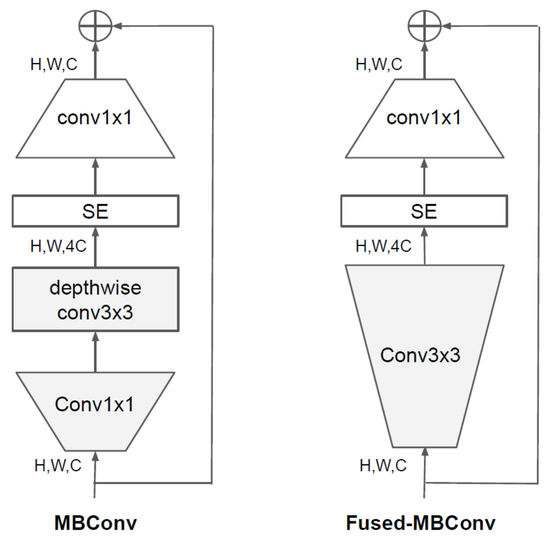

Fig. 3. Structure of MBConv and Fused-MBConv. Source: Tan & Le, EfficientNet2

Results

Implementation with `TensorFlow` and `Keras`. Size of the images: 256×256×3 normalized between -1 and 1. Hardware: Intel Core i9-10940X CPU @3.30GHz processor with 32GB RAM, NVIDIA GeForce RTX 3060 GPU with 12GB RAM. Transfer learning with ImageNet and early stopping with patience of 10. Adam optimizer, batch size 32, maximum number of epochs 50. Fine-tuning with a learning rate of 10^{-4} and 20 epochs. Unfroze the last five convolutional layers.

Table 1. Accuracy of the models with both datasets.

Method	Figshare Accuracy	Kaggle Accuracy
EfficientNetB0	98.4%	97.5%
EfficientNetB3	98.0%	96.9%
EfficientNetSmall	97.7%	96.0%

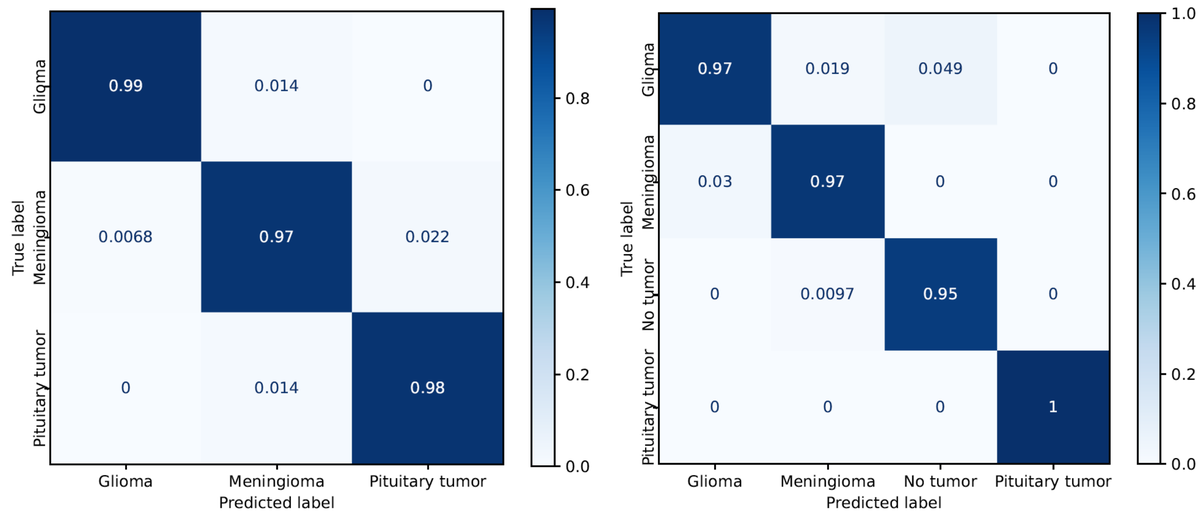

Fig. 4. Confusion matrices for EfficientNetB0 using the Figshare dataset on the left and the Kaggle dataset on the right.

Comparison with state-of-the-art

Table 2. Comparison using Figshare.

Method	Accuracy
Pashaei *et al.*	93.7%
Ayadi *et al.*	94.7%
Phaye *et al.*	95.0%
Ghassemi *et al.*	95.6%
Shaik *et al.*	96.5%
Badža *et al.*	96.6%
Kumar *et al.*	97.1%
EfficientNetSmall	**97.7%**
Amin *et al.*	98.0%
Bodapati *et al.*	98.0%
EfficientNetB3	**98.0%**
Tummala *et al.*	98.2%
EfficientNetB0	**98.4%**
Polat *et al.*	99.0%

The best method with Figshare uses ResNet50. However, it has 23,2M parameters, whereas EfficientNetB0 has 6,2M. The best with Kaggle uses Xception but includes many more images.

Table 3. Comparison using Kaggle.

Method	Accuracy
EfficientNetSmall	**96.0%**
Hossain *et al.*	96.5%
Goutham *et al.*	96.9%
EfficientNetB3	**96.9%**
EfficientNetB0	**97.5%**
Saleh *et al.*	98.8%

5th International Conference on Advances in Signal Processing and Artificial Intelligence (ASPAI' 2023)
7-9 de junio de 2023, Costa Adeje, Tenerife, Spain