Krajowa Konferencja Zastosowań Matematyki w Biologii i Medycynie

Jugowice, 11th–15th September 2017

APPLICATION OF CONVOLUTIONAL NEURAL NETWORK - DEEP LEARNING - AS AN EFFICIENT TECHNIQUE FOR AUTOMATED SEGMENTATION OF HIGH GRADE GLIOMAS.

Szymon Kocot[1], **Franciszek Binczyk**[1]

[1]Silesian University of Technology
Faculty of Automatic Control, Electronics and Computer Science,
Institute of Automatic Control
ul. Akademicka 16, 44-100 Gliwice, Poland
[1]franciszek.e.binczyk@polsl.pl

ABSTRACT

The convolutional neural networks are rather new technique of machine learning. They are a natural evolution of classical neural network enriched by the additional hidden layers containing a cascade of convolution filters. This approach makes them very useful in the context of image processing. In this work an application of convolutional neural network for a segmentation of high grade brain tumours (gliomas) is proposed. The main difficulty of the given task is the fact that each tumour is different so it is challenging to find a set of features that are common for all tumours. The proposed network architecture consists of 10 layers and results in automated segmentation of sensitivity:89%, specificity:88% and F1 score 81% obtained during analysis of BRATS 2015 dataset. In comparison to other methods (Havaei - 89% and Tustison - 88.5% [4]) evaluated on the same dataset, proposed network architecture seems to give a good result. By this it was proven that deep neural networks are efficient tool for automated brain tumour segmentation.

ACKNOWLEDGMENTS

The work was performed as a part of student SK project in whom FB was a supervisor, FB was financed by BKM/514/RAU1/2015/18. All calculations were carried out using IT infrastructure of GeCONiI Upper Silesian Centre for Computational Science and Engineering (POIG.02.02.01-24-099/13).

REFERENCES

[1] Franciszek Binczyk, Bram Stjelties, Christian Weber, Michael Goetz, Klaus Meier-Hein, Hans-Peter Meinzer, Barbara Bobek-Billewicz, Rafal Tarnawski, and Joanna Polanska: *MiMSeg-an algorithm for automated detection of tumor tissue on NMR apparent diffusion coefficient maps.*, Information Sciences **384** (2017), 235–248.

[2] Minakshi Sharma and Saourabh Mukherjee: *Fuzzy c-means, anfis and genetic algorithm for segmenting astrocytoma-a type of brain tumor*, Information Sciences **3** (2014), 16.

[3] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E Hinton: *Imagenet classification with deep convolutional neural networks*, Advances in neural information processing systems (2012), 1097–1105.

[4] Bjoern H Menze, Andras Jakab, Stefan Bauer, Jayashree Kalpathy-Cramer, Keyvan Farahani, Justin Kirby, Yuliya Burren, Nicole Porz, Johannes Slotboom, Roland Wiest, and others: *The multimodal brain tumor image segmentation benchmark (BRATS)*, IEEE transactions on medical imaging **34** (2015), 1993–2024.

[5] Léon Bottou: *Large-scale machine learning with stochastic gradient descent*, Proceedings of COMPSTAT'2010 (2010), 177–186.

[6] Warren S. McCulloch and Walter Pitts: *A logical calculus of the ideas immanent in nervous activity*, The bulletin of mathematical biophysics **5** (1943), 115–133.

[7] Adriano Pinto, Sérgiov Pereira, Higino Correia, Jorge Oliveira, Deolinda MLD Rasteiro, and Carlos A Silva: *Brain tumour segmentation based on extremely randomized forest with high-level features*, Engineering in Medicine and Biology Society (EMBC), 2015 37th Annual International Conference of the IEEE (2015), 3037–3040.

[8] Dave Steinkraus, I Buck, and PY Simard: *Using GPUs for machine learning algorithms*, IEEE, Document Analysis and Recognition, 2005. (2005), 1115–1120.

[9] Steve Lawrence, C Lee Giles, Ah Chung Tsoi, and Andrew D Back: *Face recognition: A convolutional neural-network approach*, IEEE transactions on neural networks **8** (1997), 98–113.

[10] Alan F Murray: *Applications of neural networks*, Springer, 1995.

[11] J Stephen Judd: *Neural network design and the complexity of learning*, MIT press, 1990.

[12] Nicholas J Tustison, Brian B Avants, Philip A Cook, Yuanjie Zheng, Alexander Egan, Paul A Yushkevich, and James C Gee: *N4ITK: improved N3 bias correction*, IEEE transactions on medical imaging **29** (2010), 1310–1320.