Analysis of Influence of Convolutional Neural Network Parameter Variations on Classification Accuracy in a Limited Brain Lesion Dataset

RESEARCH SEMINAR
MENTOR: PROF. PETER ROGELJ

ŽAN PETERNELJ, 89212061

Research problem

- Extension of collaborative research with the University of Basel.
  - Developed a convolutional neural network (CNN) to classify brain lesions types.
- Research the effect of different CNN configurations on accuracy of certain lesion type against the others.
- Different combinations of classifications.
- Existing studies show that parameters, do indeed effect the accuracy of classification, but in both cases they were classifying it only on one combination of classes.

CNN architecture

- Baseline architecture based on results from previous research.
- Simple architecture, 8 layers.
- Parameters:
  - Number of convolution kernels
  - Size of convolution kernel
  - Number of convolution layers
- In total 8 different architectures used.

#	Layer	Parameter
1	3-D Image Input	[35x35x35] x 3
2	Convolution	[5x5x5] x 10
3	Batch Normalization	
4	ReLU	
5	3-D Max Pooling	[2x2x2]
6	Fully Connected	
7	Softmax	
8	Classification Output	

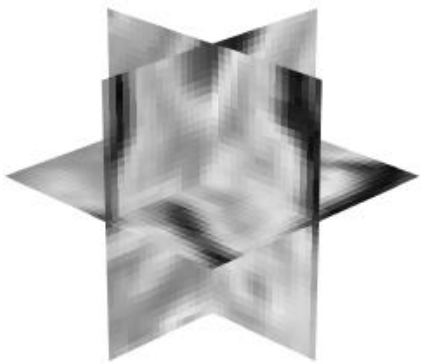
CNN architecture

#	Architecture	Description
1	baseline	Baseline architecture.
2	conv[3,3,3]	Convolution kernel size decreased to [5,5,5].
3	conv[7,7,7]	Convolution kernel size increased to [7,7,7].
4	filter 5	Number of convolution kernels decreased to 5.
5	filter 20	Number of convolution kernels increased to 20.
6	filter 30	Number of convolution kernels increased to 30.
7	2 conv	Two convolution layers with same parameters as baseline.
8	3 conv	Three convolution layers with same parameters as baseline.

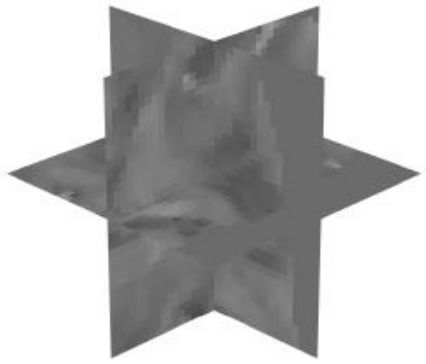
Table of all configurations.

Data

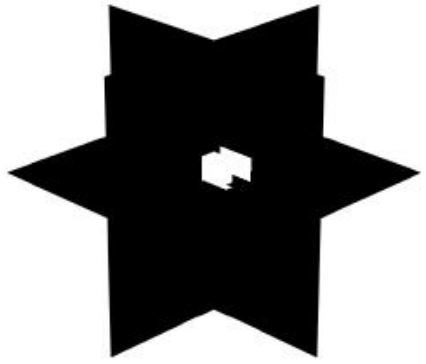
- 3D MRI images of brain lesions.
- 35 x 35 x 35 voxles in size.
- Represented with 4 dimension data object.
- FLAIR, QSM and mask.



Channel 1 - FLAIR



Channel 2 - QSM



Channel 3 - Mask

Data classification

- Classified based on intensity difference between inner and outer part of the lesion.
- 6 types in total, where 1 type is excluded.
- Relatively small and imbalanced dataset.
- Each class is compared against all the others.

Lesion type	Number of cases
1	3664
2	460
3	214
4	19
5	841
6	71
Sum	5269

#	Lesion type	Definition
1	/	Lesion can not be classified.
2	Isointense	A lesion, but inside and around the lesion the values are the same.
3	Hyperintense rim	The border of the lesion has higher valuescompared to inside and outside the lesion
4	Hypointense rim	The border of the lesion has lower values compared to inside and outside the lesion.
5	Hyperintense lesion	The value inside the lesion has higher values compared to the surrounding, no specific delineation of the border is present
6	Hypointense lesion	The value inside the lesion has lower values compared to the surrounding, no specific delineation of the border is present