Automated diagnosis of neurodegenerative diseases from PET images of the brain

A proof of concept

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Why?

Parkinsonian disorders are irreversible and exhibits similar symptoms as those of Parkinson's disease. However, the causes vary greatly implying that a wrong diagnosis and treatment could cause severe side effects. Finding an early and unambiguous diagnosis for these disorders is hence vitally important. Clinical practise is for a medical professional to examine both medical images such as PET, SPECT, MRI or CT, with supplementary information. The ambition by using machine learning in an automated diagnosis is that the diagnosis can be set earlier and perhaps with greater precision. This project aims to prove that an automated diagnosis is possible using a convolutional neural network.

How?

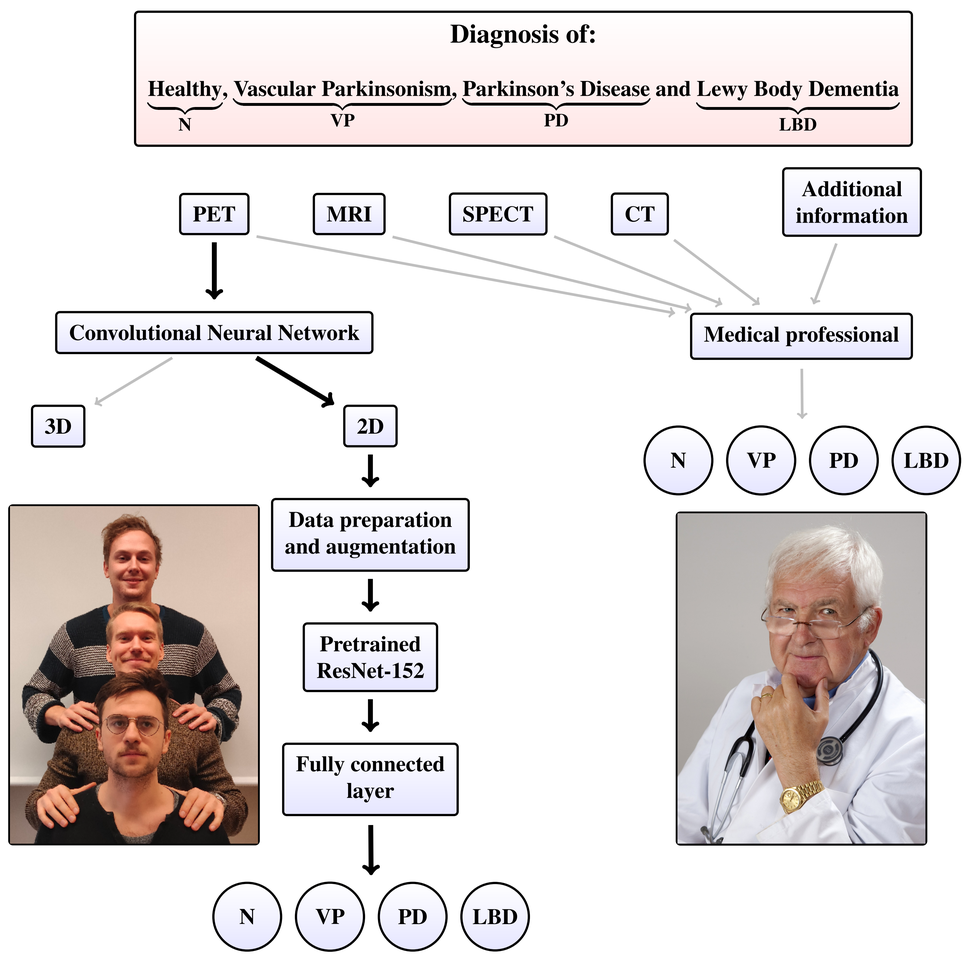

Figure 1: The left side illustrates the process of an automated diagnosis and the right side describes clinical practise. The bold arrows indicates the chosen path of the project.

The data: ^{11}C-PE2I PET

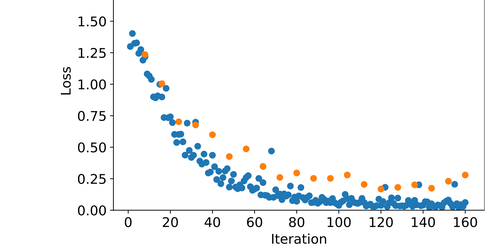

Figure 2: One slice from a ^{11}C-PE2I PET scan of a healthy patient, DAT to the left and CBF to the right.

- **20 patients divided into 4 classes. 7 N / 4 VP / 4 PD / 5 LBD**
- **Volumetric shape 128x128x128.**
- **The ^{11}C-PE2I PET images yields information about dopamine activity (DAT) and cerebral blood flow (CBF) from one scan.**
- **Spatially normalized and fitted into a template brain.**

Results

Table 1: Summary of the sensitivity measure calculated from 10 5-fold cross-validations.

Disease	Sensitivity[%]
Healthy	81.4 ± 6.5
VP	75.0 ± 11.2
PD	57.5 ± 11.5
LBD	92.0 ± 13.3

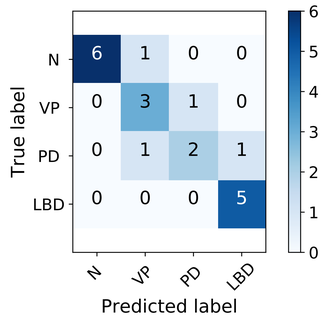

Figure 3: Confusion matrix of an entire 5-fold cross-validation.

Figure 4: The cross-entropy loss of a single fold showing that the model captures features in the data.

Important to note is that the results obtained may not disclose the behaviour on fully unseen data as the data is not of sufficient size to be representative of all variances.

Conclusions

With a limited data set, utilizing the data in a 2D fashion generated the best results as it made it feasible to exploit accessible machine learning techniques such as transfer learning and data augmentation. Conclusively, an automated diagnoses with this approach using the ^{11}C-PE2I PET scan method has great promise for a future aid on a reliable diagnosis.