Modern Experience of Dementia Classification

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Abstract. Experience of recognition Alzheimer`s dementia at the earliest stage needs attention of a wide range of information of the practicing staff, involved in diagnostics and treatment. Using Convolutional Neural Network provides additional possibilities for clear and detailed recognition of the actual stage of the disease, comparison with another objective data present in the database. The medical procedure needs complex implementation of the described experience into clinical practice. The main aim of this article is to develop an alternative approach of using modern technical data, new methods in recognition and treatment of Alzheimer`s dementia explained in scientific literature and practical activities using Convolutional Neural Network to provide further development of medical science. This paper focused on comparing Converted and Nondemented patients and used the ensemble learning methods to the development of the diagnosis of Alzheimer's Disease.

Keywords: Alzheimer's Disease, Classification, Convolutional Network, Diagnosis, Model

I. INTRODUCTION

Development of a new network provides patients with Alzheimer`s dementia with a possibility to obtain a clear and detailed diagnostic of the effective status, that has special impact on further progress of the disease, methods of treatment, quality of patient`s life etc.

Convolutional neural network is a modern effective tool for at-site recognition and deep learning of actual status of patients with diagnosis of Alzheimer`s dementia. As we noted in our previous publications, this disease has common features with another psychological and neurological diseases, thus resulting into incomplete diagnostics and inadequate treatment. Modern tools of Convolutional neural network provide additional technical and statistical data providing effective recognition of Alzheimer`s dementia at the earliest stage, that has special importance for the patient. Convolutional neural network constitutes a type of computerized deep learning, that provides analysis of effective data obtained and classified according to the main groups of patients, using objective data: MRI images of different stages of Alzheimer`s dementia, images of patients without such status for objective comparison, video, sound and text information describing the mentioned data. Application of Convolutional neural network algorithms let us as professionals not only to participate in deep learning of actual patient`s status, but also to contribute to effective recognition and further treatment of a patient.

II. RELATED WORK

Practical side needs special attention, as the network unites objective information not only of general character: these are important images data, fixing date-to-date progress of Alzheimer`s dementia patients, as well as information about qualitative and quantities changes in objective data. It may include images, sound fixed information and documents, faces and scenes, that gathered together constitute a unique database for further research and analysis. Convolutional neural network provides information about the most important aspects of recognition in case of Alzheimer`s dementia, these are as follows: object recognition; computer vision; self-driving vehicles; face-recognition application etc. These data provide the researcher with objective data and sources for further treatment and progress of disease. Convolutional neural network uses special models, such as scratches, pre-trained models. These models may be applied to different databases, built on examples, uniting patients from different countries, age etc.[1]

Convolutional neural network is a modern tool for sharp recognition not only of Alzheimer dementia, it may be effectively used for many other cases and incidents. As Convolutional neural network eliminates the need for writing, sending, manual exam, that is substituted by computer analysis and technical data recognition. The obtained results have a very high level of trust, as are built on objective data, fix up-to-date progress and shows exact changes in the patient`s status. Moreover, modern facilities provide the possibility to change recognition tasks, databases.

"Convolutional neural network provides an optimal architecture for image recognition and pattern detection. Combined with advances in GPUs and parallel computing, Convolutional neural networks are a key technology underlying new developments in automated driving and facial recognition" [1, p.2].

General feature of Alzheimer`s disease was described by scientists S. Sarraf, G. Tofighi and J. Anderson in publication devoted to classification of the considered features using convolutional neural networks, that contain results necessary for distinguishing classification criteria and significant features taken into consideration for the patients with the mentioned disease. Authors stated, that "early detection and classification of Alzheimer`s disease are critical for proper treatment and preventing brain tissue damage. Alzheimer's disease has a certain progressive pattern of brain tissue damage. It shrinks the hippocampus and cerebral cortex of the brain and enlarges the ventricles" [2].

Convolutional neural networks are used in different approaches, for example there exist special recourses R-CNN – Regions with Convolutional neural networks, that unite knowledge, data and methodology for object detection, recognition and deep learning. For example, nowadays methodology for Alzheimer`s dementia recognition includes such tools as: Parallel computing toolbox, neural network toolbox, statistics and machine learning toolbox etc.

"Instead of classifying every region using a sliding window, the R-CNN detector only processes those regions that are likely to contain an object. This greatly reduces the computational cost incurred when running a CNN." [1, p.2]

In Ukraine effective recognition of Alzheimer`s dementia is usually performed using MRI, as cortical atrophy leads to such a state of patient`s brain, that it`s volume becomes smaller. "On MRI, this is manifested by an increase in the ventricles and fissures of the hemispheres. And although MRI in Alzheimer's disease reveals changes, mainly in the moderate and severe stages of the disease, already in the early stages of Alzheimer's

on MRI, a decrease in the size of the hippocampus is revealed. And if in half a year there is an increase in the atrophy of the cortex and the hippocampus - this is a sign of the progression of the disease" [3].

III. METHODS

For this research, Kaggle's data about patients Nondemented and Demented was used. We want to focus on what could be important causes which are lead to AD and find the methods for early diagnosis with high accuracy. By using the GLM analysis, there was a statistically significant difference according to MMSE values between the three mentioned groups. In the GLM analysis (table 1), there was a statistically significant difference according to MMSE values between the three mentioned groups. [5]

TABLE 1

GLM ANALYSIS OF MINI-MENTAL-STATE-EXAMINATION

GLM MMSE	SS	Degr. Of Freedom	MS	F	P
Intercept	69701.16	1	69701.16	13542.23	0.00
Group	556.36	2	278.18	54.05	0.00
Error	756.60	147	5.15		

TABLE 2

NUMBER OF PATIENTS FOR EACH GROUP

Group	Count	Cumulative Count	Percent	Cumulative Percent
Nondemented	72	72	48.00000	48.0000
Demented	64	136	42.66667	90.6667
Converted	14	150	9.33333	100.0000
Missing	0	150	0.00000	100.0000

In contrast, Newman-Keuls post hoc comparison revealed significantly lows MMSE values in demented groups vs. Nondemented groups, while the converted group data were not significantly different from nondemented group data (table 3):

TABLE 3

COMPARING THREE DIFFERENT GROUPS IN POST-HOC NEWMAN-KEULS

Post-hoc Newman-Keuls	Group	{1} 29,194	{2} 25,328	{3} 29,357
1	Nondemented		0.000009	0.782223
2	Demented	0.000009		0.000022
3	Converted	0.782223	0.000022	

IV. RESULTS

Based on the results and Random Forest Algorithms, we determined three important features for diagnosis AD:

- Gender;
- Age;
- Education.

Practical aspects of application of Deep Learning algorithm. This algorithm provides grounds for classification into main groups of data gathered from the examined patients. It has particular role for improvement of modern diagnostic of Alzheimer`s dementia in clinics and hospitals as unites clear and detailed data about all recorded patients and stages of the disease.

Deep Learning can be considered as an important approach in computer learning developed for human brain analysis. The applied technologies combine algorithms and neural network architecture for further neuroscience based research.

Deep Learning or Deep machine learning "focuses on computational models for information representation which exhibits characteristics like those of the neocortex (Jia et al., 2014) (Ngiam et al., 2011)" [6]. To perform Deep Learning there are applied special methods, divided into separate stages: pre-processing; data conversion stage and classification stage.

In practice, recognition of patients with Alzheimer's dementia features can be made using different methods, that requires analysis of objective status at the above-mentioned stages, and involves machine learning of the defined features, that makes it possible to reveal functional and structural dissimilarities in human brains and disease progress.

As described in publication of Saman Sarraf, Ghassem Tofighi "DeepAD: Alzheimer's Disease Classification via Deep Convolutional Neural Networks using MRI and fMRI", In current paper, there were demonstrate and provide two strong pipelines and reproducible results. Inside the early block, intensive knowledge preprocessing was performed against fMRI and magnetic resonance imaging knowledge, that removed potential noise and artifacts from the information. Next, a convolutional layer of CNN design consisting of a collection of learnable filters, and that conjointly is a shift and scale in-variant operator, extracted low- to mid-level options (as well as high-level options in GoogleNet). Within the fMRI pipeline, each adopted LeNet and GoogleNet design were trained and tested by a huge variety of pictures created from 4D fMRI statistic. moreover, removal of non-functional brain pictures from knowledge improved the accuracy of recognition [6, p.9].

V. DISCUSSION

To conclude the performed analysis, we would like to make the following recommendations as to development of using Convolutional neural network tools for early recognition of Alzheimer`s dementia:

1. The combination of study of anamnesis, psychological testing, laboratory and instrumental research methods allows to recognize Alzheimer's disease with great accuracy. Using Convolutional neural network provides new research tools and practical possibilities for detection of concrete stage of disease, to evaluate its progress and further treatment proposals.
2. Based on research, there are three main factors, which could be used for diagnosis AD. Although, genetic, healthy lifestyle and medical history are not less important factors.
3. Unfortunately, in Ukraine studies on Convolutional neural networks are a rare example, so we would recommend to the Government to implement special program oriented on complex integration of new methods for computerized recognition of Alzheimer`s dementia in clinical practice.
4. The explained statistical basis and Convolutional neural network database sources might constitute grounds for future theoretical and practical research of new methods, tools, positive and negative experience of patient's treatment at different stages of Alzheimer's dementia progress.
5. Another important conclusion refers to establishing modern registries and databases in Ukraine, containing actual information and MRI results regarding different groups of patients, classified according to the defined criteria into: non-demented, early demented (very mild), mild, moderate Alzheimer`s disease. Such registries play the leading role in clinical practice, as provide exact information as to the quantity of patients, qualitative changes fixed in their disease progress, it also provides a necessary basis for comparison with close examples and possible consequences.

REFERENCES

1. Convolutional Neural Network. 3 things you need to know. P.1-4. https://www.mathworks.com/solutions/deep-learning/convolutional-neural-network.html

2. S. Sarraf, J. Anderson, and G. Tofighi, “Deepad: Alzheimer’s disease classification via deep convolutional neural networks using mri and fmri,” bioRxiv, p. 070441, 2016.

3. Альцгеймера болезнь. Диагностика. Анализы и инструментальные исследования. URL: http://demenciya.com

4. J. Islam, Y.Zhang. An Ensemble of Deep Convolutional Neural Networks for Alzheimer's Disease Detection and Classification, Computer Vision and Pattern Recognition. https://arxiv.org/pdf/1712.01675.pdf

5. Jacob Boysen. Magnetic Resonance Imaging Comparisons of Demented and Nondemented Adults. URL: https://www.kaggle.com/jboysen/mri-and-alzheimers

6. Saman Sarraf, Ghassem Tofighi. DeepAD: Alzheimer's Disease Classification via Deep Convolutional Neural Networks using MRI and fMRI, Alzheimer's Disease Neuroimaging Initiative2016, p.2

7.T. Brosch, R. Tam. Manifold learning of brain mris by deep learning, International Conference on Medical Image Computing and Computer-Assisted Intervention.Springer,2013, pp. 633–640.

8.A. Gupta, M. Ayhan, and A. Maida, Natural image bases to represent neuroimaging data, International Conference on Machine Learning, 2013, pp. 987–994.