

CSC 400 ITRG Miniproposal: Functional MRI-based Mild Cognitive Impairment Diagnosis

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1 Project Description

As a chronic neurodegenerative disease, Alzheimer’s Disease (AD) is mainly characterized by progressive perceptive and cognitive deficits and is unfortunately irreversible and incurable [1]. Because of neurofibrillary tangles, neurotoxicity, neurodegeneration and so forth, the disease will become severe with ageing and ultimately lead to death [2]. Nowadays, it has become the most prevalent dementia and resulted in millions of deaths per year. Although, as mentioned above, AD is incurable, it is possible to slow down the degeneration process, and thus it is of vital importance to diagnose the patients as early as possible [2,3]. Mild Cognitive Impairment (MCI) is regarded as a transitional stage between normal aging and dementia, and thus attracts more and more attentions by researchers. Studies show that the rate of progression from MCI to AD is approximately 10% to 15% per year [1]. Early detection and proper treatment of MCI is believed to be able to reduce the conversion rate.

Recently, various neuroimaging techniques have been applied to early detection of AD, including structural magnetic resonance imaging (MRI) [4], functional MRI [3], positron emission tomography (PET). Specifically, functional MRI-based methods are adopted by various literatures and the performance is really inspiring [2,3,5]. However, most of existing research on functional MRI based MCI diagnosis is based on vanilla machine learning and deep learning methods, which have no specific designs to deal with functional MRI-based MCI data and thus the results are suboptimal. To improve the diagnosis accuracy, since machine learning and deep neural network have already been successfully applied to different tasks for dealing with natural and medical images [2,3,4,5,6], we thus aim to modify existed machine learning to handle functional-MRI data. The modifications can be conducted by considering the prior knowledge of MCI pathologies and symptoms [1]. Our research will also try to develop advanced machine learning methods to improve the performance, including recently proposed graph neural network [6] and capsule network [7].

2 Intellectual Merit

The research will do some investigations on machine learning methods and MCI diagnosis. Some advanced methods on machine learning including convolutional neural network and graph neural network will also be designed and implemented [6,7].

3 Broader Impacts

Results of this research can apparently be used for MCI diagnosis and consequently enable doctors to deal with disease cases more efficiently and accurately. Moreover, the developed methods may also inspire the development of methods to deal with other diseases that are similar to MCI disease, including Parkinson's disease, cognitive disorders, and learning disabilities, etc [1].

4 Research Plan

The research will be conducted as follows:

1. We first will collect the state-of-the-art machine learning methods and implement some of them if it is necessary. Moreover, we will collect MCI data from ADNI project page as our training and testing data to develop our methods.
2. Collected machine learning methods will be firstly applied to ADNI dataset and we will modify superior methods with consideration of the above-mentioned properties of MCI data.
3. Further studies on deep neural network will be conducted. Besides, all of the developed methods will be tested on other diseases data to see performance.

5 References

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