

Brain signal analysis using graph convolutional networks

1. General Info

Project Title: Brain signal analysis using graph convolutional networks

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Outcome: The result of the project will potentially be published in MICCAI 2021.

2. Project Abstract

In medical research, multi-modal datasets from large-scale population-based studies are an essential tool towards better diagnosis and treatment of disease. Multimodal data comprises imaging and non-imaging data and is available in many domains. In technical research, such datasets serve as enablers of Computer-Aided Diagnosis (CADx) with machine learning (ML). In this project, we will be focusing on two such multi-modal dataset HCP dataset and UK Biobank for the application of age and gender prediction.

Graph Convolutional Networks (GCNs) are a subset of models in Geometric Deep Learning (GDL) and have made a remarkable impact on the usage of such data in various non-medical domains, e.g. in computer vision, natural language processing or chemistry. However, GCNs are still to be explored to full extent for medical applications. Recently, it was discovered that it is greatly beneficial to model an entire patient population as a graph, using disease-relevant patient characteristics taken from clinical health records (CHR). GCNs can natively integrate this graph to analyze multimodal data across neighborhoods of patients, similar to concepts in social network analysis. In this project, we will aim at brain graph learning using GCNs. Along with learning the graph the task will be age and gender prediction.

3. Background and Motivation

In recent literature, it can be seen that GCNs provide a principled and dynamic way to integrate imaging and non-imaging modalities in the medical domain. So far, GCNs have been explored for a wide variety of applications such as disease prediction, segmentation, and matrix completion by using massive, multi-modal datasets. In this project, we want to explore how GCN would react to the brain graph dataset.

4. Technical Prerequisites

- Good background in statistics and deep learning
- Familiar with MRI and fMRI.
- Very Good skills in Python
- Good skills in PyTorch / Keras.

5. Benefits:

- Learn about medical image reconstruction using deep learning.
- Possibility of Participating in the MIDL challenge
- Possibility of writing a scientific paper.

6. Students' Tasks Description

Students' tasks would be the following:

Group 1:

- Literature review on graph convolutional network
- Implement conventional GCN methods for age and gender prediction on HCP dataset.
- Implement proposed method
- Compare the results of both tracks of the challenge
- Discuss the limitation of methods and prepare final report

Group 2:

- Literature review on graph convolutional network
- Implement conventional GCN methods for age and gender prediction on UKBB dataset.
- Implement the proposed method
- Compare the results of both tracks of the challenge
- Discuss the limitation of methods and prepare final report

7. Work-packages and Time-plan:

	Description	#Students	From	To
WP1	Understanding GCNs and literature review	4	01.11	
WP2	Familiarize with tensorflow/ pytorch	4		
WP3	Group 1: Get handons HCP data set, we simple ML methods for the task Group 2: Get handons UKBB data set, we simple ML methods for the task	2/2		
WP4	Group 1: implement SOTA GCN methods for understanding Group 2: implement SOTA GCN methods for understanding	2/2		
M1	Intermediate Presentation II	4	17.12.2020	
WP5	Implement GCN for HCP dataset	4		
WP6	Implement GCN for UKBB dataset	4		
WP7	Prepare final results and compare implemented possible comparative methods.	4		
WP8	Prepare Final Documentation	4		



M2	Final Presentation	4	26.02.2021
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