Neonatal Brain White Matter Development Evaluation using dMRI
An Introduction to Python-based Medical Image Analysis

(A 10-week Mini-Project Summary)

Introduction

White matter development in neonates is a crucial period for brain development, and diffusion magnetic resonance imaging (MRI) can provide valuable insights into this process. This mini-project aims to help the interns explore the development of white matter in neonates between 34 and 40 weeks of gestational age using diffusion MRI.

This mini-project is ideal for those interested in medical image analysis and looking to gain hands-on experience in Python-based scientific research.

Methods

The project will focus on the use of Python-based medical image analysis to process and analyze the diffusion MRI data from the open-source dataset.

The project will involve several stages:

1. exploring the diffusion MRI data of neonatal age groups (week 1);
2. pre-processing the images (week 2 to week 3);
3. developing reconstruction algorithm (or part of algorithm according to the intern's skills) (week 4 to week 6);
4. analyzing the reconstructed data (week 7 to week 8);
5. build GitHub repository and report (week 9);
6. and presenting the findings in a scientific report (week 10).

Dataset: 30 brain data select from dHCP dataset 2.

Tools: Python, Jupyter Notebook, Markdown, Dipy, Nibabel, FSL, ITKSNAP.

Expected results

1. Get output of each data processing step: data after denoising, mask after denoising;
2. shows two diffusion template maps of 34-week and 40-week neonates;
3. bar plots: diffusion metrics comparison (with statistic results) between two groups in each region of interests;
4. Color-coded FA (derived from diffusion MRI) maps with different b tables.

Deliverables & Expectations

By the end of the mini-project, interns will 1) gain practical experience in medical image analysis using Python; 2) learn the basics of MRI scanning, image loading, operating, and saving; 3) their first diffusion model from scratch; 4) written a well-structured scientific report, 5) created a GitHub repository, 6) and delivered an oral presentation. They will also gain a basic understanding of scientific statistics.