香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Detect the disrupted brain connectivity in type-II diabetes patients

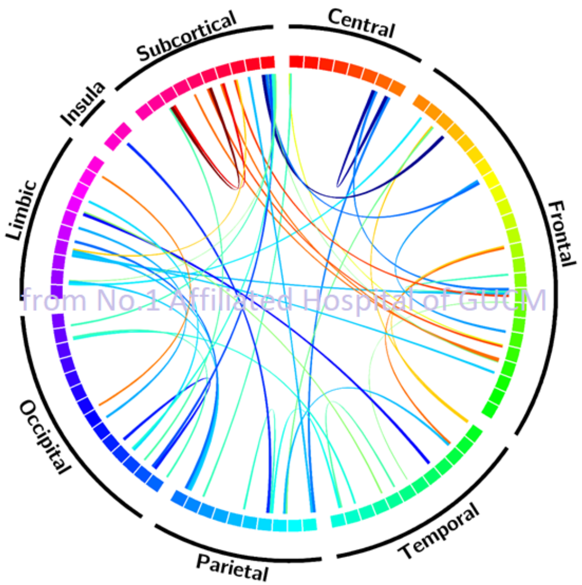
MATH 5470 project
WEI, Yue & XIE, Weiyan

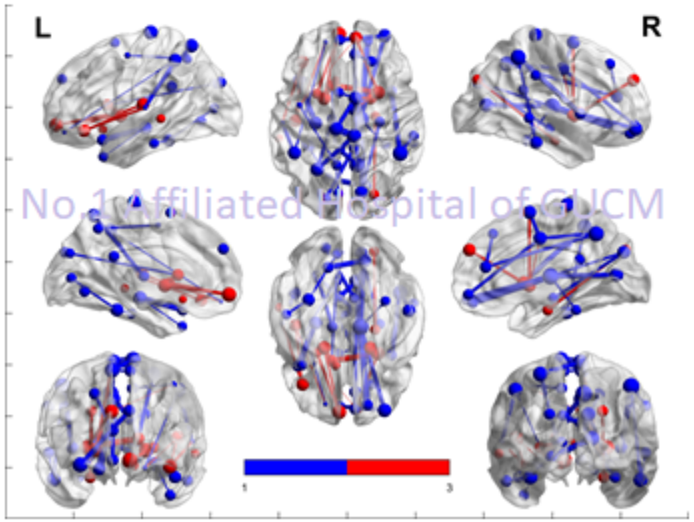
THE DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
計算機科學及工程學系

Background

- **Type-II diabetes and Alzheimer's disease**
  - ✓ It is confirmed that **Type-II diabetes patient** has higher risk of getting **Alzheimer's disease**
  - ✓ Research revealed that the **brain connectivity strength changed** in Type-II diabetes patients even before they showed impairment in cognition
  - ✓ MRI can collect the **brain connectivity strength** between each pair of brain regions
  - ✓ Following figure showed the brain connectivity strength changes in Type-II diabetes patient (from data collected by No.1 Affiliated Hospital of GUCM, unpublished work)

Permutation test with FWA correction:
Red – patient > control, p<0.025
Blue –patient < control, p<0.025





Scientific questions

1. Can we use brain connectivity features to distinguish type-II diabetes and healthy people in control group?
2. Can we use brain connectivity features to predict clinical symptoms of type-II diabetes?
3. With so many connectivity features, which are the top 5/10 features that contributed most to the classification & symptom prediction of type-II diabetes?

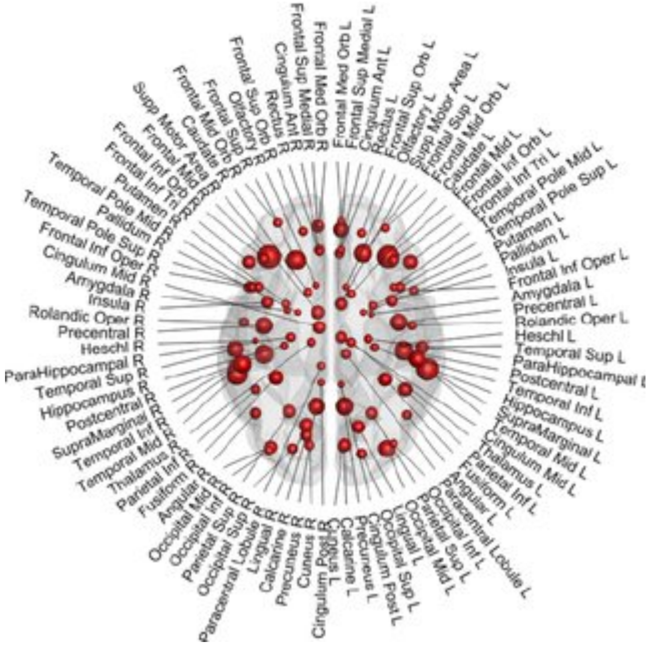
Data structure (X)

Brain connectivity feature (for each subject):

- Pairwise connection between AAL90 brain regions
- Weighted by Fractional anisotropy (FA): f1=90*90=8100
- Weighted by fiber number (FN): f2=90*90=8100

Brain nodal feature(for each subject):

- ROI surface size: f3=90
- ROI voxel size:f4=90



*This is a dataset collected by No.1 Affiliated Hospital of GUCM which co-worked with WEI Yue, we have one under reviewing paper on this dataset, not published yet.

Data structure (Y)

Subject groups (G=2):

- Patient (N1=47)
- Control (N2=47)

Clinical symptoms (continuous data):

- duration
- FBG
- BMI
- HbA1c

*This is a dataset collected by No.1 Affiliated Hospital of GUCM which co-worked with WEI Yue, we have one under reviewing paper on this dataset, not published yet.

Methods

- Dimension Reduction:
  - Principal Component Analysis (PCA)
  - Canonical Correlation Analysis (CCA)

- Building Classification and Prediction Models:
  - Logical Regression (with Subset Selection: Forward/Backward Stagewise)
  - Decision Tree
  - Adaboost
  - Random Forest
  - Support Vector Machine
  - A small neural network

Methods

- Explaining the "black-box" methods:

  We expect that the methods with higher flexibility, like SVM and Neural Network, may give better classification performance. The issue with these methods is that they are ”black-box’’ and not self-explainable.

  As our final goal is not only to train a model with good classification performance, we are also interested in what features are important to the classification. Therefore, some Explainable AI (XAI) methods will be used to explore the feature importance in the ‘’black-box’’ methods.

  XAI methods planned to use:
  Local Interpretable Model-Agnostic Explanations (LIME);
  SHapley Additive exPlanations (SHAP).

Plan

- Stage 1 – Data Visualization and Some Basic Data Explorations
- Stage 2 – Dimension Reduction
- Stage 3 – Model Buildings and Comparisons
- Stage 4 – Understanding the Models
- Stage 5 – Report and Presentation