MATH RESEARCH AT UNC CHARLOTTE 2024

Project 8: Functional Data Analysis for Conditional Quantiles with Applications in Medical Studies

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Project description. The complexity of data structures has increased over the past few decades and functional data analysis (FDA) has gained great attention as it deals with functions on a high dimensional domain. FDA methods are particularly useful in the medical field as the data are complex (images, videos, scans, etc.) and require innovative analyses. For example, leveraging FDA allows for a more accurate representation of medical-specific data types such as functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG), where each subjet includes multiple observations for the different locations of the brain and scalp, respectively; see Figure 1.

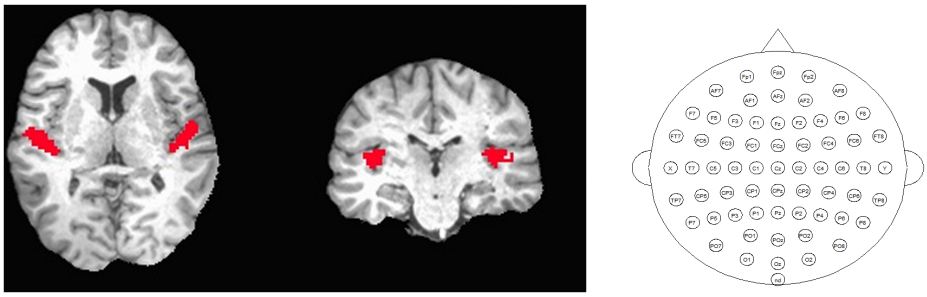

FIGURE 1. *Left: Example of an fMRI image taken at a particular point in time for an individual with a rare condition. Data can be extracted based on the neurological activity at a given location of the brain. The highlighted red region shows the significant differences from the control population (image taken from Okada et al. (2013)). Right: EEG map of 64 electrodes are placed on a subject's scalp in order to measure the brain activity.*

In this project, students will use the methodology proposed in Christou et al. (2024+) in order to investigate a medical disorder, named attention deficit hyperactivity disorder (ADHD). The methodology is based on focusing on data that are highly skewed and / or contain outliers. For that reason, Christou et al. (2024+) proposed an alternative to mean regression, that of quantile regression (QR). Moreover, although medical data are observed at discrete points, they are represented as functions in an infinite dimensional space. Due to the infinite dimensional nature of the problem, the authors proposed the use of dimension reduction techniques. To be able to disseminate the methodology and the results of the real data application, students will create a publicly available `R` package, which will include detailed documentation and a clear vignette for the users, following the guidelines by Wickham and Bryan (2023). The students need to have **excellent programming skills in** `R`.

REFERENCES

[1] Christou, E., Solea, E., Wang, S., and Song, J. (2024+). Sufficient Dimension Reduction for Conditional Quantiles for Functional Data. *Under review*

[2] Okada, K., Venezia, J.H., Matchin, W., Saberi, K., and Hickok, G. (2013). An fMRI Study of Audiovisual Speech Perception Revels Multisensory Interactions in Auditory Cortex. *PLoS ONE*, e68959.

[3] Wickham, H., and Bryan, J. (2023) *R packages*, O'Reilly.