The QDECR package

A flexible, extensible vertex-wise analysis framework in R

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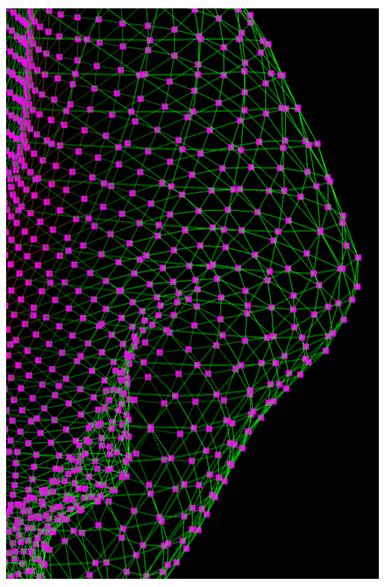
Introduction

- The cerebral cortex is integral to brain function and dysfunction.
- Differences in cortical properties such as cortical thickness can be studied with surface-based vertex-wise analyses.
- Existing surface-based analysis tools were build for that specific purpose and tend to lack procedures/features commonly used in social and medical sciences such as handling of imputed data and assessing bias.
- We developed QDECR, an extensible package in R, a programming language for statistics. Currently, QDECR can perform linear regression.



Running QDECR

A full tutorial on how to run QDECR can be found at: **https://www.qdecr.com**

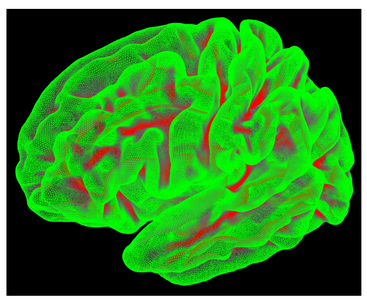
The following code performs an analysis on how cortical thickness is influenced by sex and age:

```
library(QDECR)
vw <- qdecr_fastlm(qdecr_thickness ~ sex + age,
                   data = pheno, id = "id",
                   hemi = "lh", project = "test")
summary(vw)
```

T_1-weighted scans

Phenotype data

Run Freesurfer

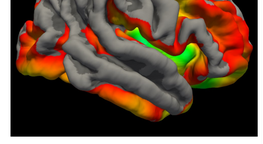


Load into R

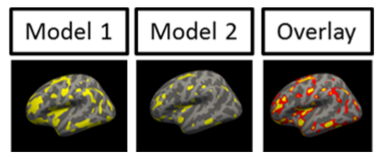
R Package
QDECR

Summarize: Get information on data provenance, number of clusters, cluster-specific information, etc.

Plot: QDECR calls Freeview to plot the clusters, for visual presentation.



Compare: Overlay any two maps to understand model differences.



Formulas

QDECR uses R formula objects and can thus handle:

- **Polynomials**: qdecr_thickness ~ age + age^2
- **Splines**: qdecr_thickness ~ ns(age, 3)
- **Interactions**: qdecr_thickness ~ sex * age
- **No intercept**: qdecr_thickness ~ age – 1

It can also handle “as-is” treatment, which allows for modification of variables inside the formula, for example:

- **Standardizing**: qdecr_thickness ~ I(scale(age))
- **Computations**: qdecr_thickness ~ I(weight / height^2)
- **Any function**: qdecr_thickness ~ I(cut(age, 3))

Data handling

QDECR has been designed with common practices related to data handling in mind:

- **Imputed data**: Missingness of data can be handled with multiple imputation. QDECR automatically recognizes most imputed data formats (like `mids` objects from `mice`).
- **Parallel processing**: R is single-threaded, but several packages exist to use multiple cores. QDECR utilizes those packages to speed up performance.
- **Big data**: QDECR uses file-backed matrices to handle big datasets (shared memory required). We use QDECR in-house to run analyses on datasets with thousands of individuals and hundreds of imputed datasets.

Adding features

QDECR is modular and acts as a framework for developers to implement new types of vertex-wise analyses.

By default, QDECR checks the input, provides tools to load the vertex-wise data, apply functions per vertex, provides tools to do multiple-testing correction, etc.

To add new methods, two functions need to be written:

1. **Prep function**: A function that takes the input and does most preparations that can happen before going vertex-wise.
2. **Analysis function**: A function that takes the output of the prep function and runs one analysis per vertex.

Further details

- **For cluster-wise corrections QDECR currently relies on Monte-Carlo simulations as provided in the Freesurfer distribution.**
- **Any vertex-wise measure can be used: cortical thickness, cortical surface area, cortical volume, etc.**
- **Previous QDECR analyses can be reloaded with qdecr_load().**
- **Go to www.qdecr.com for more information.**
- **Visit the QDECR software demo at OHBM, 12 June 2019 (#4860)**

Contact and contribute

The package is actively being developed.

All contributions, ideas and suggestions by anyone are welcome. Instructions on how to contribute to the project can be found on the website.

QDECR is open-source (GPL-3 license).

www.qdecr.com

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