DPABINet: Statistical Analysis and Results Viewing

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Outline

• Statistical Analysis
• Results Viewing

Statistical Analysis

One-Sample T-Test

One-Sample T-Test

Wang, Yan et al., 2011, Hum Brain Mapp

T Statistic Matrix  No Mask Needed!
Two-Sample T-Test

T Statistic Matrix: positive corresponds to the mean of Group 1 is greater than the mean of Group 2

Two-Sample T-Test with covariates: e.g. other matrix parameters can be used: other matrices, e.g. head motion (mean FD), age, sex etc.

Paired T-Test

 Condition 1 – Condition 2
 Please make sure the correspondence

ANOVA or ANCOVA

Wang, Yan et al., 2011, Hum Brain Mapp.

Yan et al., 2009. PLoS ONE

Wang, Yan et al., 2011, Hum Brain Mapp.

PLoS ONE

[Diagram images related to statistical tests and brain imaging analyses]
ANOVA or ANCOVA

Wang, Yan et al., 2011, Hum Brain Mapp.

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ANOVA or ANCOVA

F Statistic Matrix

ANOVA: e.g. other matrices.
Other covariate can be also specified as text files.
(E.g. age, brain size, IQ etc.)

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ANOVA or ANCOVA

Post-hoc procedures: the corrected p values under a given control procedure for comparing group means of any pairs were calculated (e.g., through Studentized Range statistic for Tukey-Kramer correction) with the same route as MATLAB command multcompare. The p maps were then converted to Z maps according to the Normal inverse cumulative distribution function (norminv), with the sign of group mean differences applied.

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Correlation Analysis

The imaging measure:
FC matrices

Traits: e.g. MMSE.txt

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Mixed Effect Analysis

Correlation Analysis

Yan et al., 2016. Translational Psychiatry

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Mixed Effect Analysis

The imaging measure should be:
- `Group1Condition1`
- `Group1Condition2`
- `Group2Condition1`
- `Group2Condition2`

**Mixed Effect Analysis**

- \( \_\_\text{ConditionEffect}_{\text{T}}.\text{mat} \) - the T values of condition differences (corresponding to the first condition minus the second condition) (WithinSubjectFactor)
- \( \_\_\text{Interaction}_{\text{F}}.\text{mat} \) - the F values of interaction (BetweenSubjectFactor by WithinSubjectFactor)
- \( \_\_\text{Group}_{\text{Two}}.\text{T}.\text{mat} \) - the T values of group differences (corresponding to the first group minus the second group).

Of note: the two conditions will be averaged first for each subject. (BetweenSubjectFactor)

Statistical Analysis

\([\text{DPABI}_\text{Dir}}/\text{StatisticalAnalysis}/\_\_\text{GroupAnalysis}\_\text{Image.m}\)

Get p: Parametric vs. non-parametric

- **Parametric**
  - \( p \)-value
  - Frequency
  - Test statistic

- **Non-parametric**
  - Permutation
  - Test statistic

Non-parametric: permutation

- We can permute the data itself to create a distribution that we can use to test our statistic.
- We can use the data for any test statistic.
- Makes very few assumptions about the data.
- Good for any test statistic.

Winkler et al., 2016. *NeuroImage*; Converted from FSL course

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Winkler et al., 2016. *NeuroImage*. Converted from FSL course
Non-parametric: permutation

- We can permute the data itself to create a distribution that we can use to test our statistic.
- It can be used for more robust results, particularly when sample sizes are small.
- Makes very few assumptions about the data, unlike more traditional tests.
- Works for any test statistic, not just the usual ones.

Of the 5000 re-labelings, only 90 had a t-value > 2.27 (the original labelling).

If you estimate that there is a 1.8% chance of obtaining a t-value > 2.27 if there is no difference between the groups.

C.f. p(1.8%) = 1.79% for t4.

5000 re-labelings. Phew!

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Get p: Parametric vs. non-parametric

<table>
<thead>
<tr>
<th>Assumed distribution</th>
<th>Parametric</th>
<th>Non-parametric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed variance</td>
<td>Normal</td>
<td>Any</td>
</tr>
<tr>
<td>Typical data</td>
<td>Ratio or Interval</td>
<td>Ordinal or Nominal</td>
</tr>
<tr>
<td>Data set relationships</td>
<td>Independent</td>
<td>Any</td>
</tr>
<tr>
<td>Usual central measure</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Benefits</td>
<td>Can draw more conclusions</td>
<td>Simplicity; Less affected by outliers</td>
</tr>
</tbody>
</table>

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Get p: Parametric vs. non-parametric

### Parametric

- Test statistic: Frequency, p-value
- Non-Parameter: Permutations

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Non-Parametric

- Not for GTA!!!
- Parametric, can be used for FDR

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Non-Parametric, Permutation-based, can be used for FDR

Multiple Comparison Correction

Statistical Analysis

... I estimate about 15,000 papers use cluster size inference with correction for multiple testing; of these, around 3,500 use a CDT of $P=0.01$. So, are we saying 3,500 papers are "wrong"? It depends....

-- Thomas Nichols
July 06, 2016
Multiple Comparison Correction

Bonferroni correction: $p = 0.05/5 = 0.01$

FDR Theory

- False discovery rate $Q_e = E(V/(V+S)) = E(V/R)$

Benjamini and Hochberg, 1995, Journal of the Royal Statistical Society
**FDR Theory**

- Let $H_1, \ldots, H_m$ be the null hypotheses and $P_1, \ldots, P_m$ their corresponding p-values. Order these values in increasing order and denote them by $P(1), \ldots, P(m)$. For a given q, find the largest k such that $P(k) \leq qk/m$.
- Then reject (i.e. declare positive) all $H_i$ for $i = 1, \ldots, k$.

**Get p: Parametric vs. non-parametric**

- Parametric, can be used for FDR
- Non-Parametric, Permutation-based, can be used for FDR

**Outline**

- Statistical Analysis
- Results Viewing
Further Help

The R-fMRI Course V3.0
Chao-Gan Sun, Ph.D.
http://rfmri.org/wiki
The R-fMRI Journal Club
Official Account: RFMRILab
http://rfmri.org/Course

DPABI/DPABISurf/DPARSF特训营

第九届DPABI/DPABISurf/DPARSF
脑影像基础特训营（云端）通知
2021.3.27～3.29

第一届DPABISurf/DPABINet
脑网络进阶特训营（北京现场）通知
2021.4.24～4.26

定期举办，请关注http://rfmri.org

DPABISurf皮层数据预处理业务

特训营学员：99元/例次

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