Recent and upcoming developments

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Giessen 2014
Modality agnostic
sensitivity analysis
Modality-independent: EEG

Hanke et al. (2009) (Daten: Fründ et al., 2008)

86.2% 89.6% 91.8%
Modality-independent: EEG Temporal Profile

B

Normalized Sensitivity

-0.2
-0.1
0.0
0.1
0.2
0.4

C

C

Total
150 ms
200 ms
250 ms
370 ms

ANOVA

SMLR

IGPR

iCSVM

H₂ (Dartmouth; Magdeburg)
Modality-independent: Spikes

Hanke et al. (2009)

$H_2$ (Dartmouth; Magdeburg)
Modality-independent: Eye movements

![Diagram showing eye movements in inverted and upright conditions.](image)

- Gaze Position (X) and Gaze Position (Y) for different screen coordinates.
- SVM Sensitivity for peristimulus time (s).

H2 (Dartmouth; Magdeburg)

Advanced methods

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Similarity structure analysis
2nd-order isomorphism
similarity of similarity structure

Kriegeskorte et al., Frontiers in Systems Neuroscience, 2008
2nd-order isomorphism
similarity of similarity structure

Kriegeskorte et al., Frontiers in Systems Neuroscience, 2008
Representational spaces across species

Kriegeskorte et al., COSYNE, 2008

average of 4 subjects
fixation-color task
316 voxels

man

monkey

average of 2 monkeys
fixation task
>600 cells

dissimilarity

H₂ (Dartmouth; Magdeburg)
Similarity Analyses

Connolly et al. (2012)

$H_2$ (Dartmouth; Magdeburg)
Similarity Analyses: V1 vs behavioral models

A. Behavioral ratings DM

B. Similarity searchlight: Behavioral DM

C. V1 model DM

D. Similarity searchlight: V1 model DM

Connolly et al. (2012)
Similarity Analyses: Cross-subject agreement

A. SVM searchlight

B. Cross-subject similarity correlation searchlight

Connolly et al. (2012)
Similarity structure analysis works with any kind of model and across data modalities
But if 2nd-order is not enough?
Localization – the end is near!

S1

S2

4 mm
Localization – the end is near!

H₂ (Dartmouth; Magdeburg)

Advanced methods

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Localization – the end is near!

S1

S2

4 mm  3 mm  2 mm

H₂ (Dartmouth; Magdeburg)
Localization – the end is near!

S1

S2

H₂ (Dartmouth; Magdeburg)
Challenge: Idiosyncratic brain activity patterns

Example: Diagnostic voxels for perception of tools vs. dwellings

Mitchell et al. (2008)
Spatial alignment

$H_2$ (Dartmouth; Magdeburg)
Functional alignment

- Have: spatial/anatomical reference (MNI152; 3-dimensional)
- Want: functional/"brain state" reference (n-dimensional)

$H_2$ (Dartmouth; Magdeburg)
Functional alignment

Have: spatial/anatomical reference (MNI152; 3-dimensional) vs. Want: functional/“brain state” reference (n-dimensional)
Concept: brain state space
Natural stimulation
Approach: high-dimensional functional alignment
Hyperalignment: a common representational space
Movie time series similarity and pattern discriminability

Guntupalli & Haxby, OHBM, 2013

H₂ (Dartmouth; Magdeburg)       Advanced methods
Hyperalignment: object representation similarity in VT

Haxby et al., Neuron, 2011
Hyperalignment: pattern normalization

A Measured polar angle map

B Hyperalignment predicted polar angle map

C Anatomical alignment predicted polar angle map

D Between-subject correlation

Guntupalli & Haxby, OHBM, 2013
Starting point: auditory representational spaces

- 2 h audio movie
- story narration
- verbal scene descriptions
- "shared memory"
- wide spectrum of music
- real emotions
Real-life cognition challenge

- 20 participants (plus phantom)
- 2 hours of fMRI (7 Tesla Siemens Magnetom, 2 s TR, 1.4 mm)
- 0.3 mm ToF angiography
- Simultaneous physiological data (respiratory, cardiac)
- 0.7 mm T1w, T2w, DWI, SWI (Philips Achieva)
- Reproducible stimulus
- 12-page methods description
Real-life cognition challenge

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Everything available at

http://studyforrest.org
and 5000 EUR on top!
Inter-subject
correlation

L

100%
Percentile

50%

R

Linear alignment
Non-linear alignment

>99% percentile

Hanke et al., Scientific Data, 2014

Pernet et al., submitted; avail. at NeuroVault.org
Hanke et al., Scientific Data, 2014  Pernet et al., submitted; avail. at NeuroVault.org

H₂ (Dartmouth; Magdeburg)  Advanced methods  Giessen 2014  27 / 35
Exploration: Using the movie itself for analysis

Complete dialog annotation will be published
Hyperalignment test

Inter-subject correlation

![Brain imaging data visualizations](image)

Movie time segment classification

<table>
<thead>
<tr>
<th></th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSC (ANAT)</td>
<td>0.2</td>
</tr>
<tr>
<td>BSC (HYPAL)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Movie genre classification

Linear alignment  >99% percentile  Non-linear alignment
Hyperalignment test

Inter-subject correlation

Inter-subject correlation

Movie time segment classification

Musical genre classification

Task fMRI is scheduled for release Q4/2014

H₂ (Dartmouth; Magdeburg)
More public data

Phase 1 (complete)

7T auditory

Phase 2 (in progress)

3T audio-visual eye-tracking

Phase 3 (est. Oct. 2014)

3T audio-visual eye-tracking, EEG

Dedicated eye-tracking with GSR and facial expressions is in the works.
Simultaneous 3T fMRI and 1000 Hz eye-tracking

Watch data preview...

14 participants overlap with phase 1 data; watch data preview
RSA analysis for temporal eye-gaze synchronicity

“where is fMRI signal more similar when subjects’ eye-gaze is synchronous”

→ large parts of the fronto-parietal attention network

n=10; cluster threshold (t=2.7, p=.05): FEF, SEF, IPS, hMT+, Precuneus
Datamanagement

- sizable dataset: initial release $\approx$ 10000 files; 355Gb
- longitudinal changes: currently at post-publication-revision 3; three more major additions planned
- multiple hosting locations: OvGU, OpenFMRI, NITRC-IR, . . .
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DataGit*

- version control for data: track everything
- distributed: obtain, modify, re-publish – without a central gatekeeper
- a tool, not a service – built atop of git-annex
- facilitate incremental research on a data-level

Name needs to change because of people with lawyers...
