NIPS 2011
Causal Graphs Workshop
Popular Causality Measures

- Weiner – Granger Causality
  - Based on training a VAR model

- Transfer Entropy
  - Based on information theoretic approaches
  - Can capture non-linear relations
  - Michael Wibral

- Methods were shown to be equivalent for Gaussian variables
Stephano Panzeri
Inter-band Causality

- Applied to macaque visual cortex
- Movie vs. Blank
- Using transfer entropy
- Inter/Intra band
- Inter/Intra electrode
- Phase/Envelope
Inter-band Causality

Besserve et al. J Comput Neurosci, 2010
(a) gamma envelope, local interactions

(b) gamma envelope, distant interactions

c) gamma phase, local interactions

d) gamma phase, distant interactions

ILFP, L. gamma, H. gamma, MUA

cause

effect

delay $\tau$ (ms)

NTE maximal amplitude (%)

Spontaneous
Movie
Movie>Spor
Movie<Spor
$P_{err}<5\%$
$P_{err}<1\%$
$P_{err}<5\%$
$P_{err}<1\%$
Stefan Haufe
Source Reconstruction

Haufe et al. Neuroimage, 2011
Markus Kaiser
Human Conectome

A Erdős-Rényi random
B Scale-free
C Regular
D Small-world
E Modular
F Hierarchical

Kaiser, Neuroimage, 2011
Connection Length

A: Human DTI
B: Human rsMRI
C: Macaque cortical
D: Rat neuronal
Neuron growth of C. Elegans

- Analyze neural birth and connection establishment
- Most long range connections are done early on
- Early neurons are much more connected than later ones
- Random networks do not show these properties
Granger Causality – Anil Seth

- Multivariate and Conditional G-Causality
  - Does X cause Y given Z?

- Ensemble G-causality
  - Causality on groups of nodes

- Causal Flow
  - Difference between incoming and outgoing nodes

- Causal Density
  - How much information is in the causal network
Granger Causality – Anil Seth

- **G-Autonomy**
  - Is a node or group of nodes autonomous?

- **G-Emergence**
  - A group that is both autonomous and caused by its members

- **fMRI and G-Causality**
  - Hemodynamic response is not the problem
  - Noise and down-sampling of scanner are

- **ASSC Meeting** [http://theassc.org/](http://theassc.org/)
  - July-2012, Brighton, UK (Deadline Feb 15)
Other interesting lectures

- Pieter van Mierlo
  - Causality based on Kalman Filters
  - Find source of epileptic seizures
- Bert Kappen
  - $\ell_0$ regularization for regression
  - No application for Neuroscience
NIPS 2011
Machine Learning and Interpretation in Neuro-Imaging Workshop
Highlights

- **Interpretability**
  - Looking at the weights of the classifier is not always correct
  - Is brain location always necessary?
    - Basic Science – yes, Clinical – not always

- **Deal with individual differences**
  - Take into account expected differences
  - While keeping signal level (no smoothing)
  - Better normalization
  - Bayesian modeling
Elia Formisano – Neural Correlates in Nonprimary Auditory Cortex

Reicke et al., J. Neuroscience, 2011
Polina Golland
Daniel Rueckert
(1) Embed images  
(2) Select images for propagation

(3) Register atlases  
(4) Propagate labels and refine

(b) direct  
(c) direct, GC

(d) LEAP, no GC  
(e) LEAP  
(f) manual
Defining the normal growth morphology

Aljabar et al. IEEE Medical Imaging, 2011
4D Development Atlas

Serag et al., Neuroimage, 2011
Mark Cohen – Real Time EEG-fMRI

MRI Radio Signal → MRI Scan Control → MRI-Compatibile EEG

EEG Signal → Subject in Magnet → Subject Responses

Image Feedback to Subject → Statistical Detection of Signal Changes

Cognitive State Instance

IC Maps

SVM

Online

ROI Full

ICs Full

ROI Demeaned

ICs Demeaned

Test

0.8552

0.7370

0.5420

0.7038

0.9446

0.9452

0.9451

0.9454

0.5256

0.7125

0.9651

0.7041

0.8142

0.9465

0.9004

0.9535

Average Accuracy