fMRI preprocessing considerations for graph theory analysis

Paul McCarthy

University of Otago

NZCSRSC 2011

Outline

Creating graphs from brains

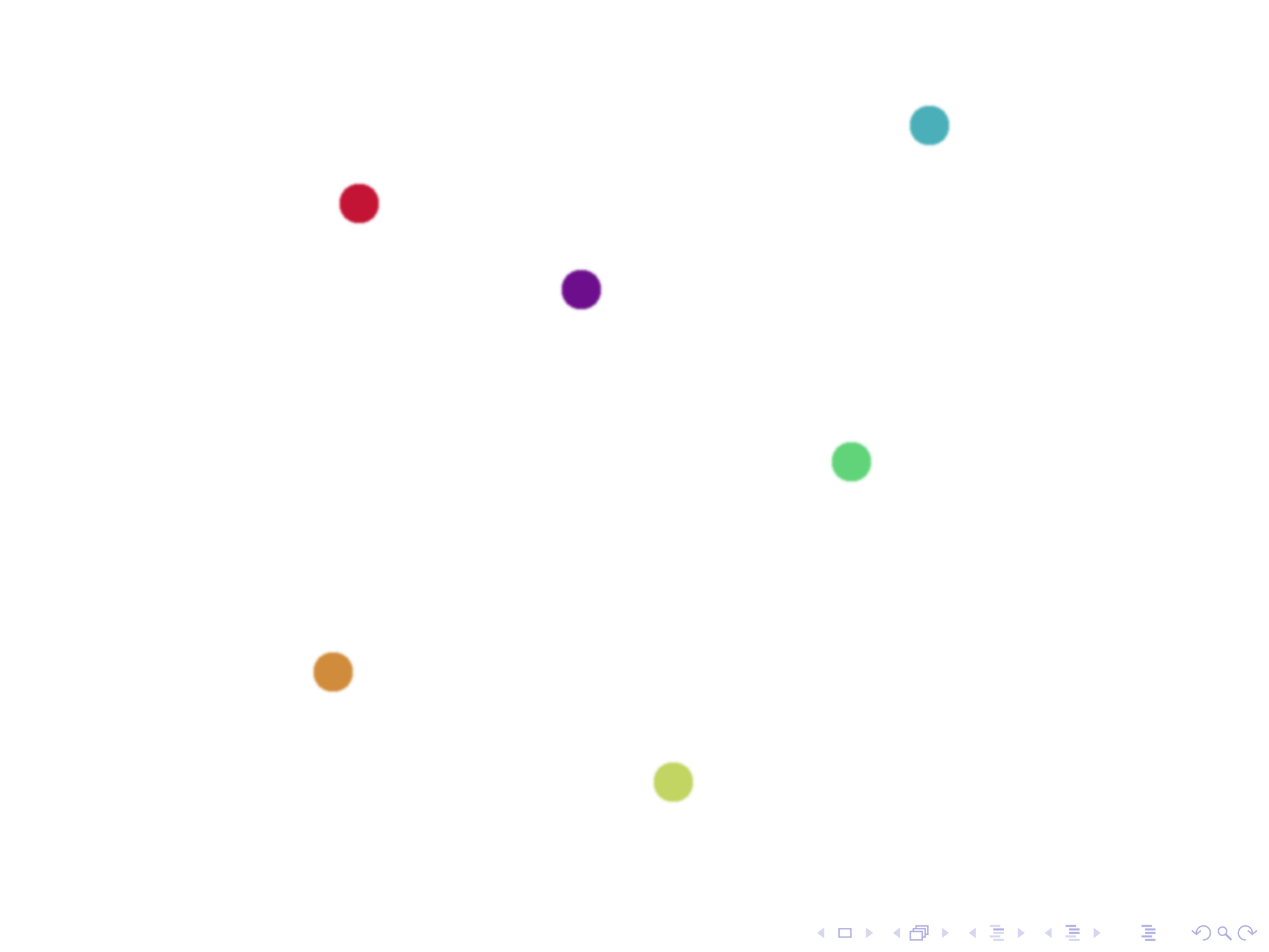
Preprocessing fMRI data

Analysis

Define your nodes

[1]

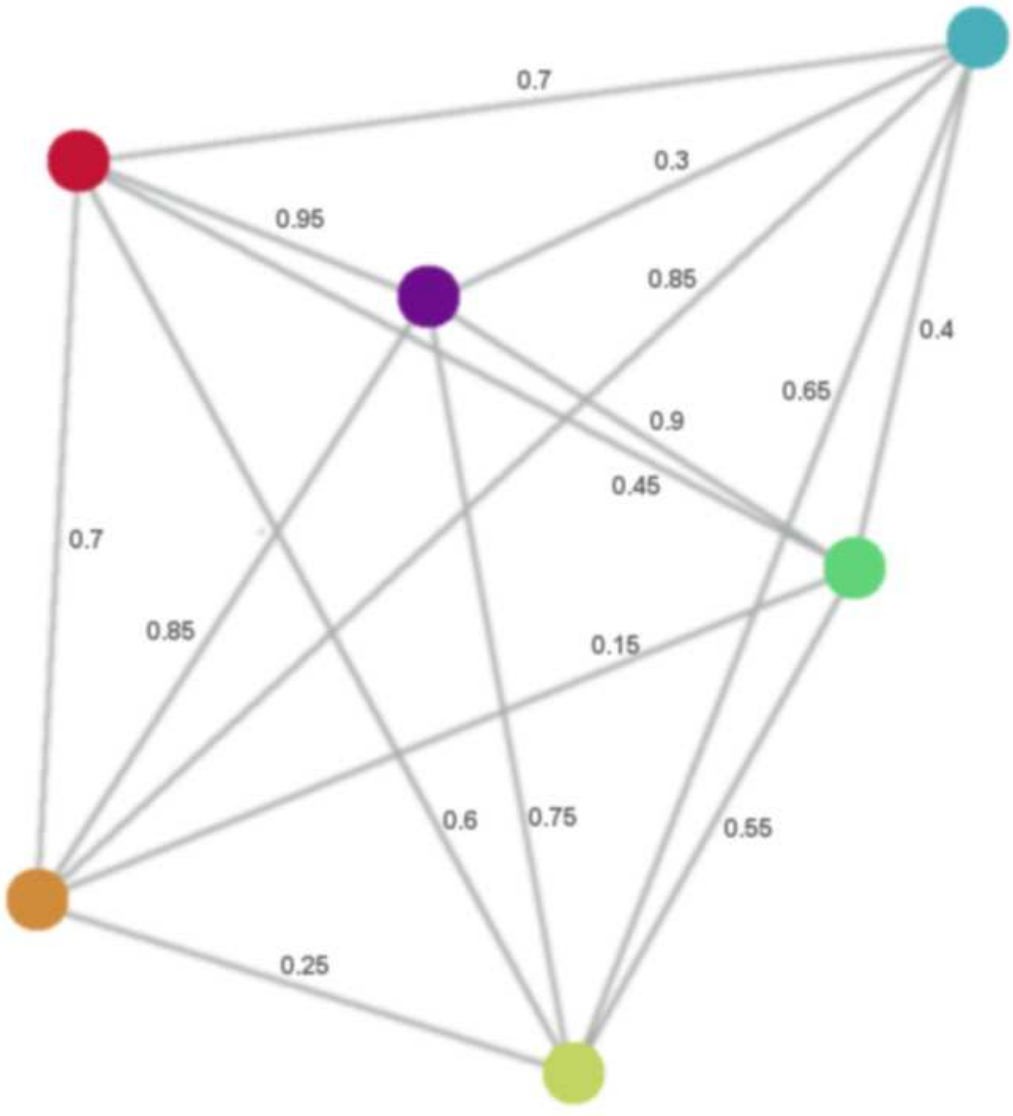
[3]



Define your edges

$$\rho(x, y) = \frac{\sum(x_i - \overline{x})\ (y_i - \overline{y})}{\sqrt{\sum(x_i - \overline{x})^2\ \sum(y_i - \overline{y})^2}}\ [2]$$

	0	1	2	3	4	5
0	0.00	0.70	0.95	0.45	0.60	0.70
1	0.70	0.00	0.30	0.40	0.65	0.85
2	0.95	0.30	0.00	0.90	0.75	0.85
3	0.45	0.40	0.90	0.00	0.55	0.15
4	0.60	0.65	0.75	0.55	0.00	0.25
5	0.70	0.85	0.85	0.15	0.25	0.00


0.7
0.3
0.95
0.85
0.4
0.65
0.9
0.45
0.7
0.85
0.15
0.6
0.75
0.55
0.25

Binarise your graph

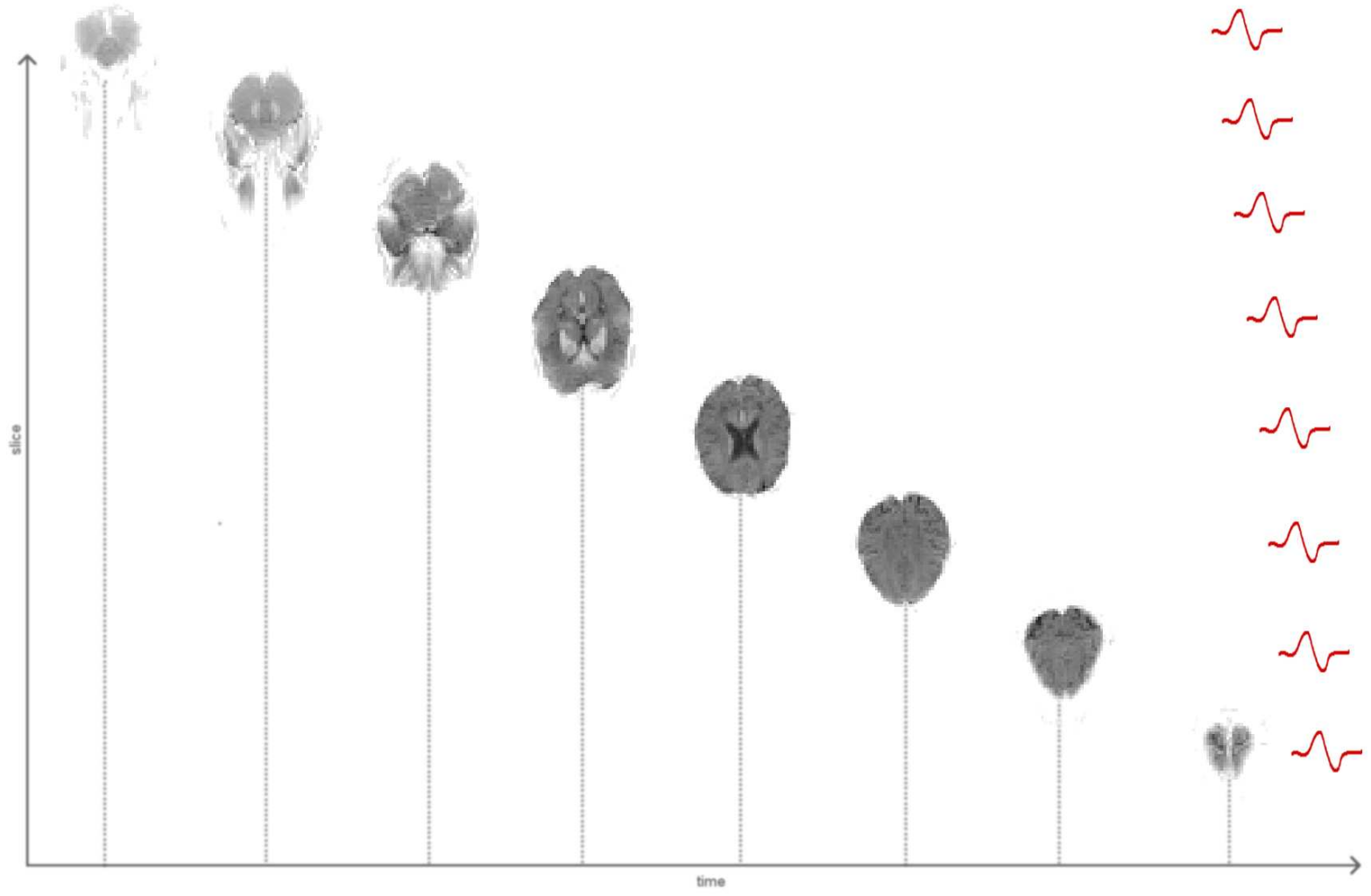
≥ 0.7

Creating graphs from brains

Preprocessing fMRI data

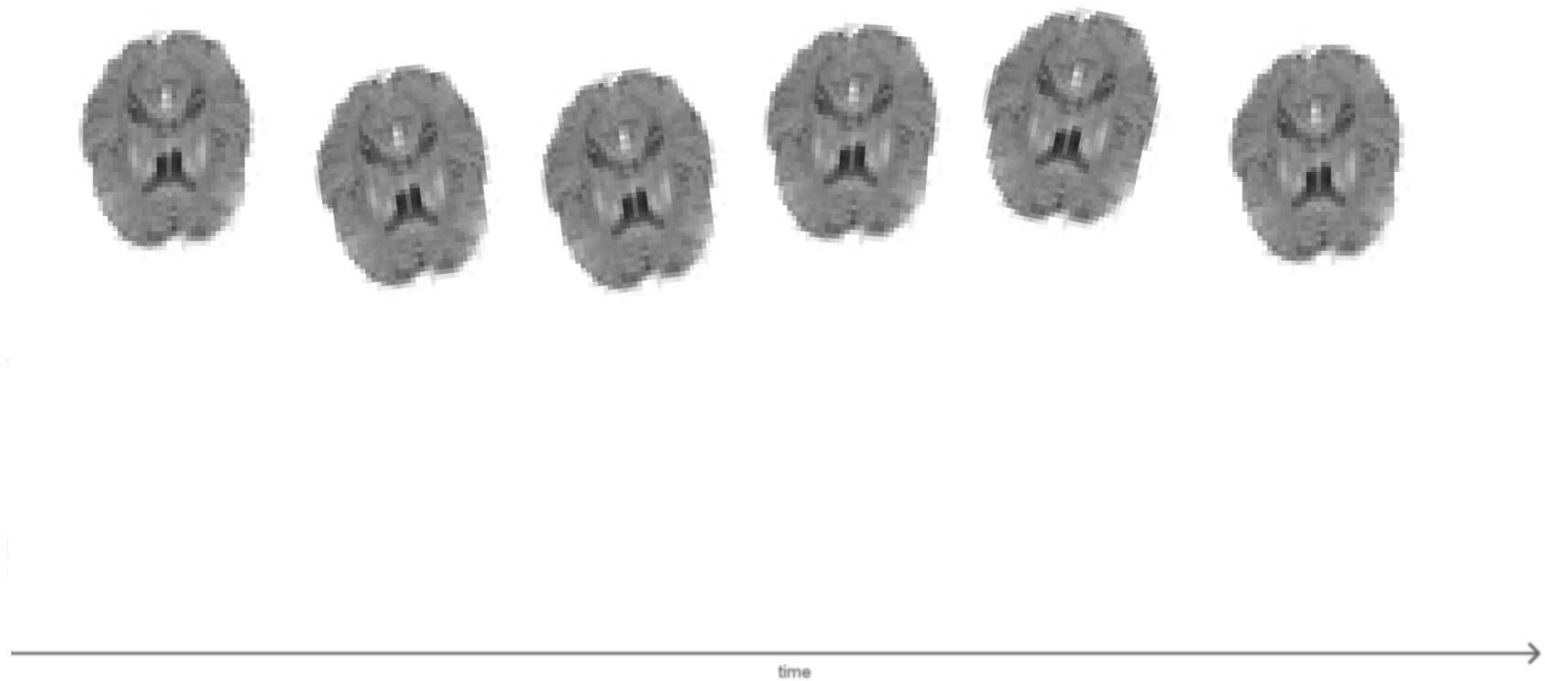
Analysis

Slice timing correction



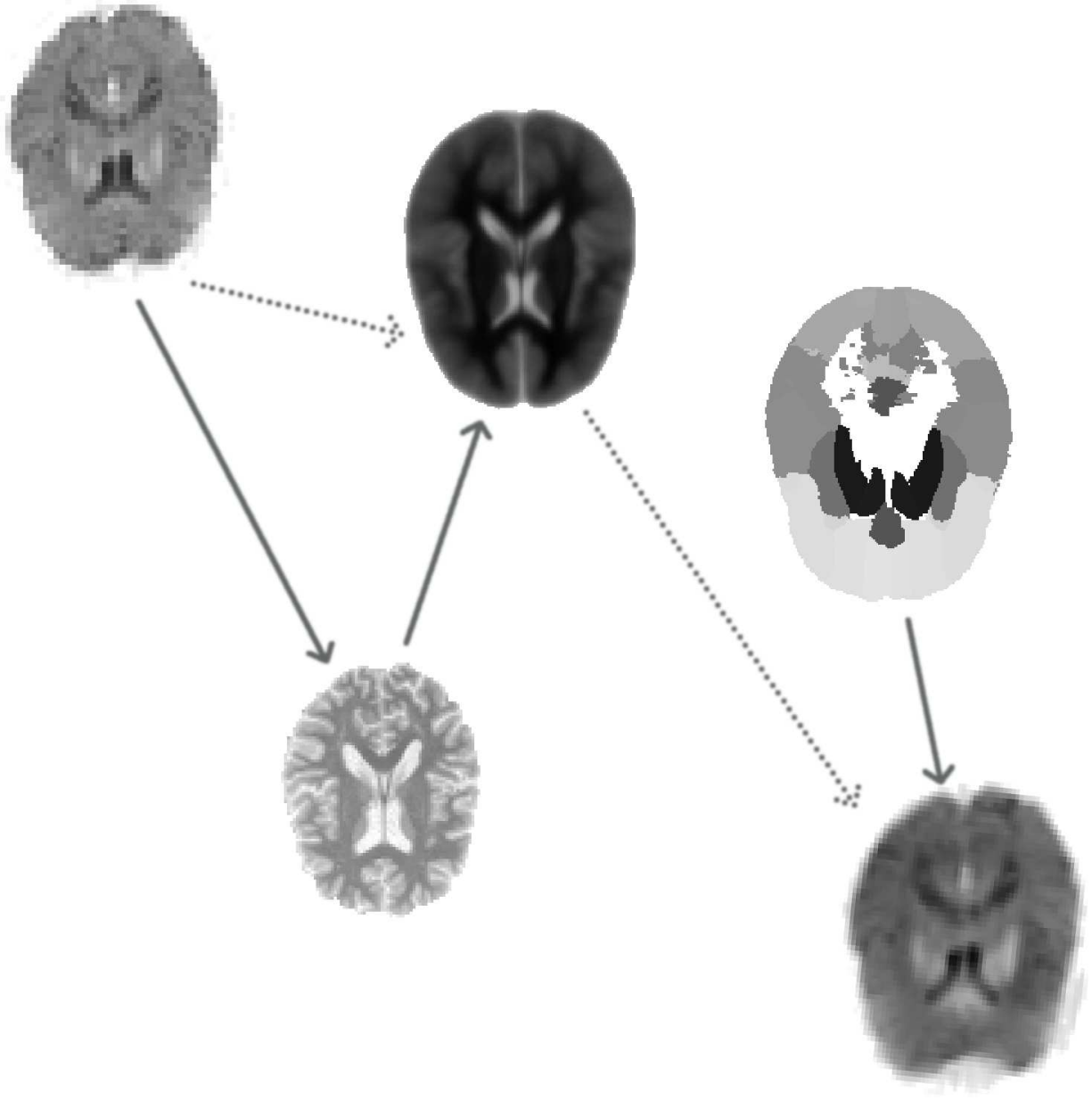
[4]

Motion correction



[5]

Normalisation



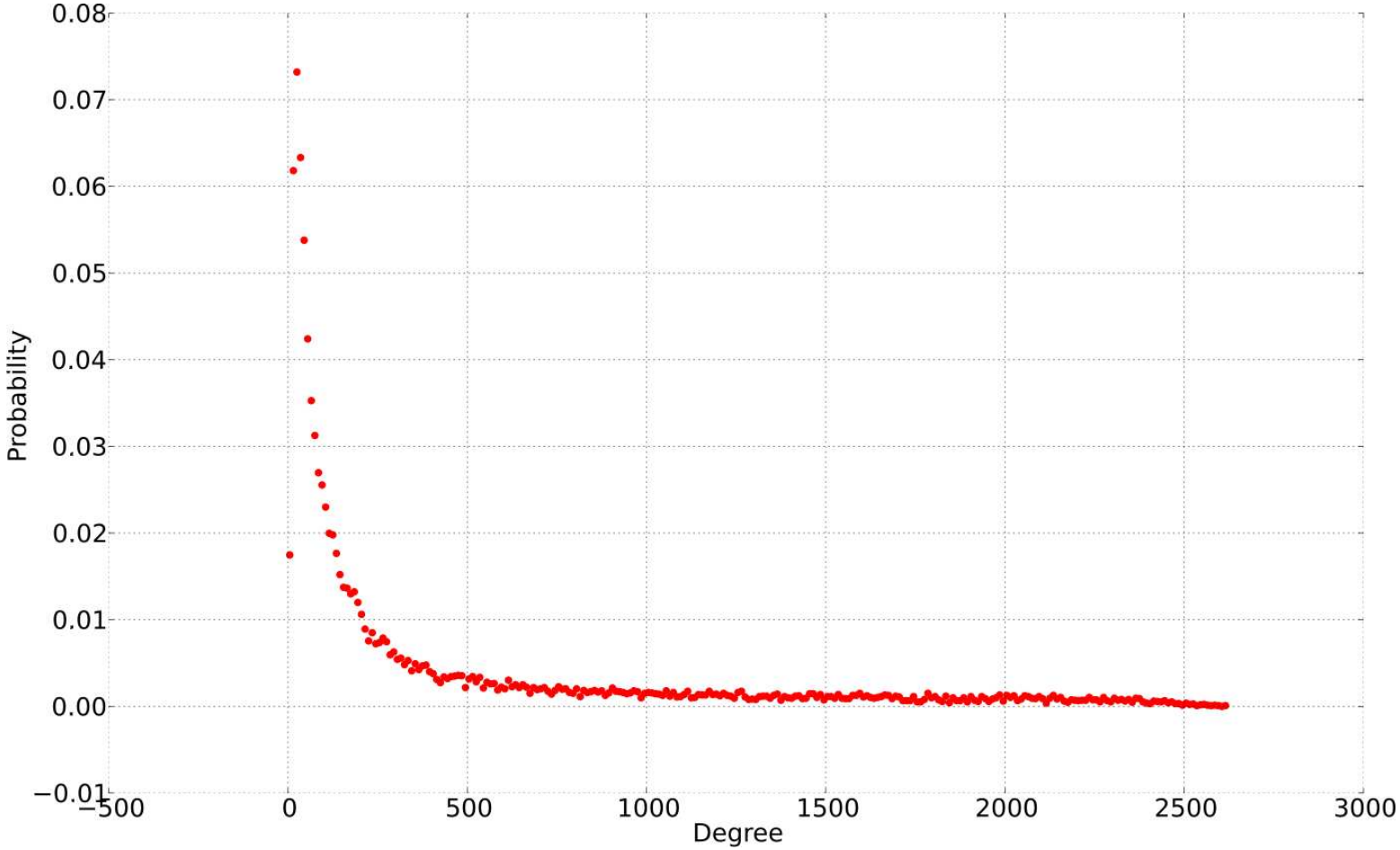
[5]

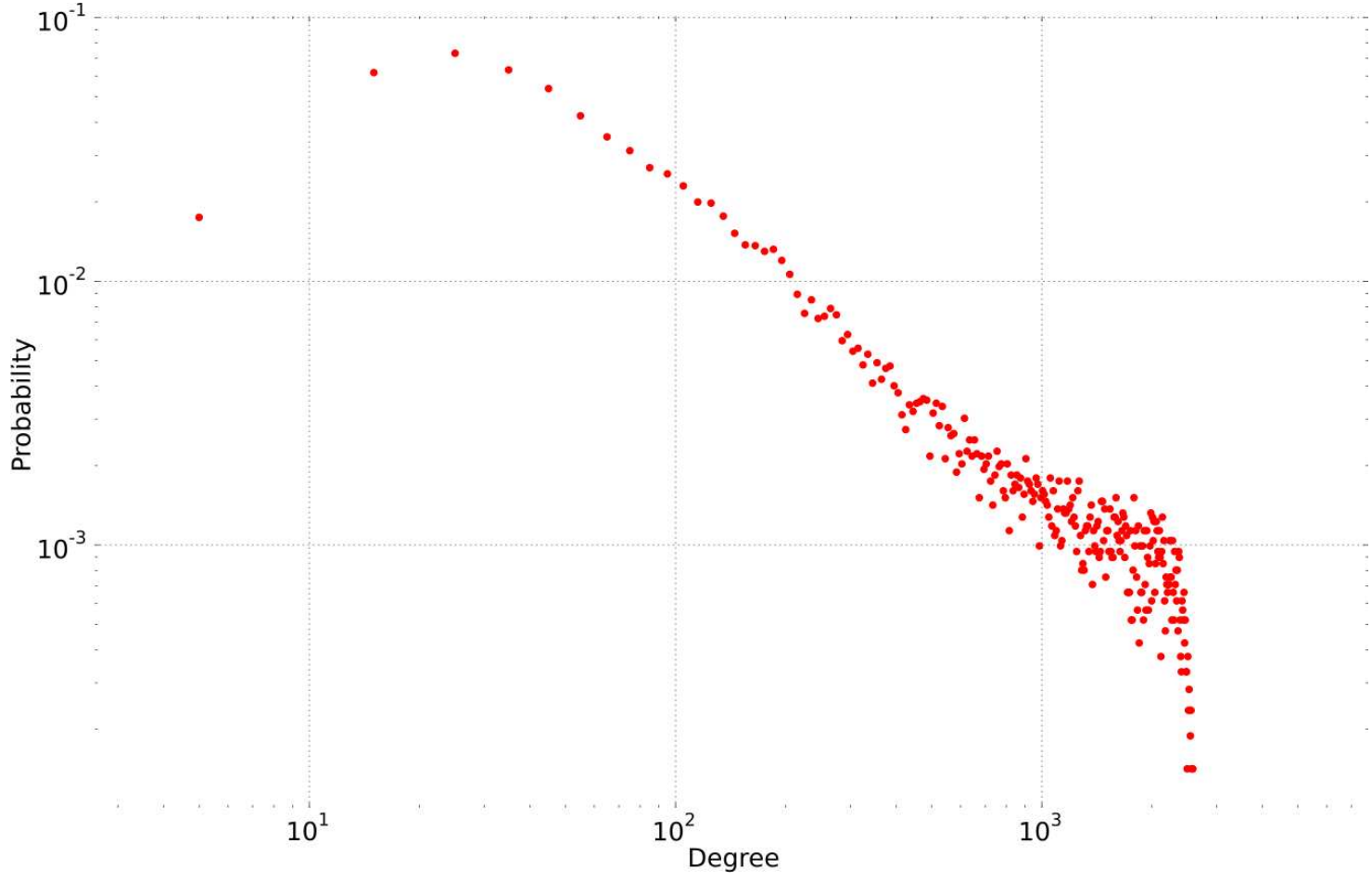
Creating graphs from brains

Preprocessing fMRI data

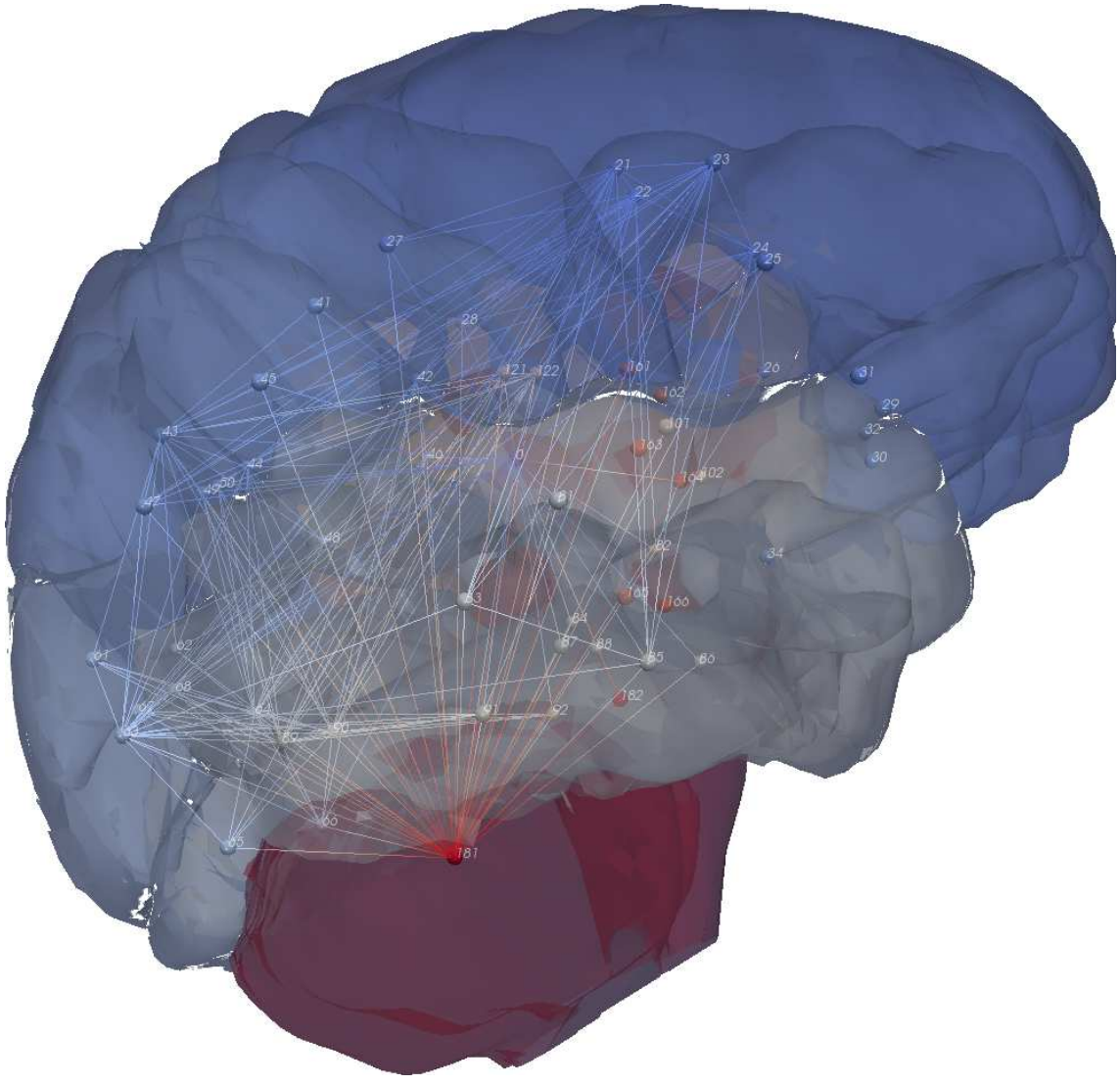
Analysis

Degree distribution

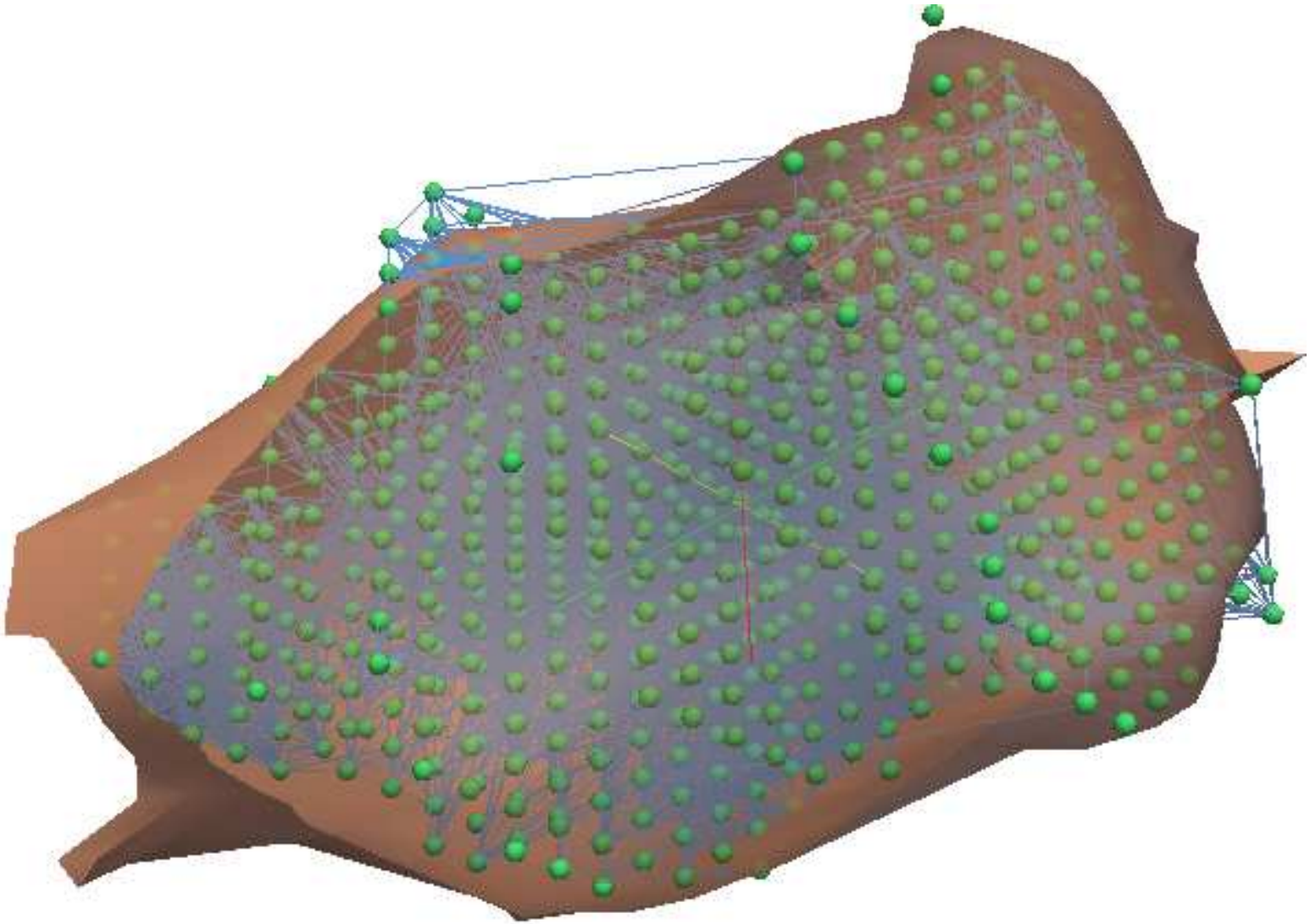



10^{-1}
10^{-2}
10^{-3}
Probability
10^{1}
10^{2}
10^{3}
Degree

Inter-regional connectivity



Intra-regional connectivity



References I


Randy L. Buckner, Abraham Z. Snyder, Amy L. Sanders, Marcus E. Raichle, and John C. Morris.
Functional Brain Imaging of Young, Nondemented, and Demented Older Adults.
Journal of Cognitive Neuroscience, 12(Supplement 2):24–34, 2000.


Joseph Lee Rodgers and W. Alan Nicewander.
Thirteen Ways to Look at the Correlation Coefficient.
The American Statistician, 42(1):59–66, 1988.


David W Shattuck, Mubeena Mirza, Vitria Adisetiyo, Cornelius Hojatkashani, Georges Salamon, Katherine L Narr, Russell A Poldrack, Robert M Bilder, and Arthur W Toga.
Construction of a 3D probabilistic atlas of human cortical structures.
Neuroimage, 39(3):1064–80, 2008.

References II


Stephen M Smith, Mark Jenkinson, Mark W Woolrich, Christian F Beckmann, Timothy E J Behrens, Heidi Johansen-Berg, Peter R Bannister, Marilena De Luca, Ivana Drobnjak, David E Flitney, Rami K Niazy, James Saunders, John Vickers, Yongyue Zhang, Nicola De Stefano, J Michael Brady, and Paul M Matthews.
Advances in functional and structural MR image analysis and implementation as FSL.
Neuroimage, 23 Suppl 1:S208–19, 2004.


RP Woods, SR Cherry, and JC Mazziotta.
Rapid automated algorithm for aligning and reslicing PET images.
Journal of Computer Assisted Tomography, 16(4):620–633, 1992.

Thanks!

Questions?

- pmccarthy@cs.otago.ac.nz
- pauld.mccarthy@gmail.com
- http://miracle.otago.ac.nz/postgrads/pmccarthy/
- http://github.com/pauldmccarthy/