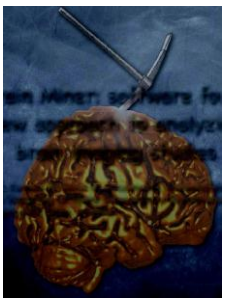
Presentation 3 – Jeffrey Spence



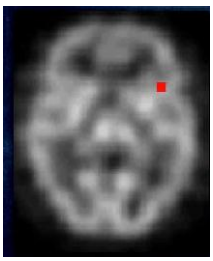
Brain Miner: software for a new approach to analyzing brain imaging studies

Spence JS, Carmack PS, Gunst RF, Schucany WR, Woodward WA, and Haley RW. "Accounting for Spatial Dependence in the Analysis of SPECT Brain Imaging Data," JASA, to appear.

UT Southwestern and SMU

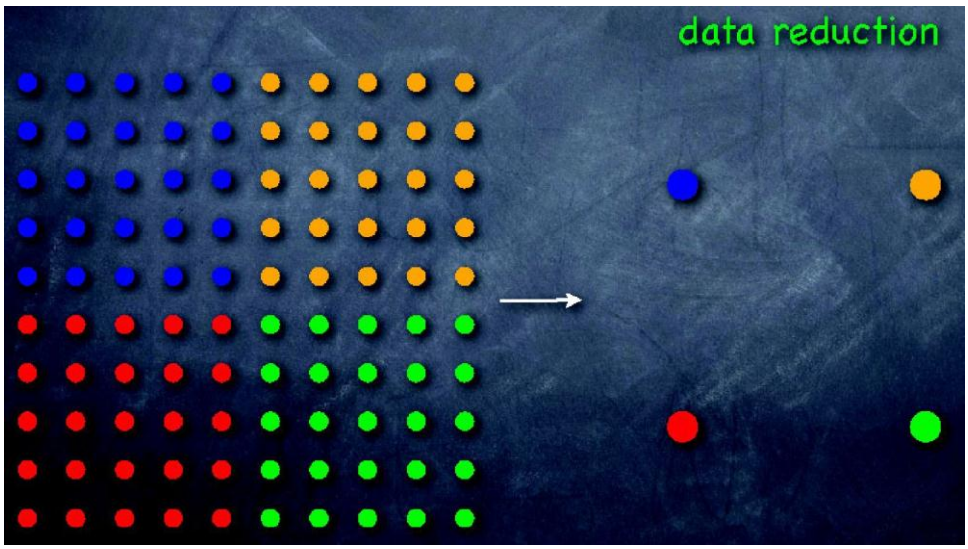
Brain Mining Development Team

What Brain Miner accomplishes

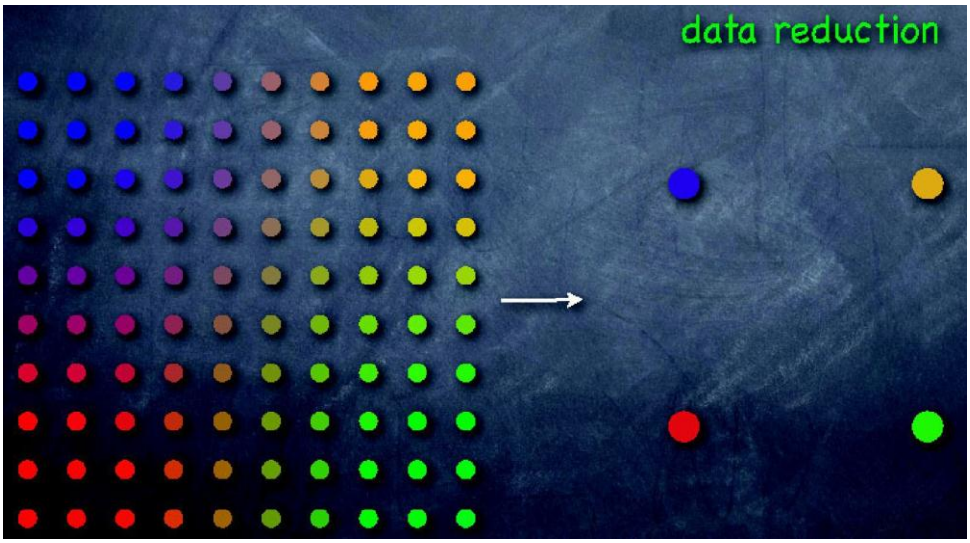


- Data reduction: due to spatial correlation, neighboring voxels give redundant information about measured signal
  - How? group voxels together and average them in a manner that is statistically optimal
  - What is gained? POWER! There is statistical power in averages
- Independence of statistical errors: the reduced data units are spatially uncorrelated
  - What is gained? Flexibility! The output can be exported to well-known software packages (e.g., SAS)

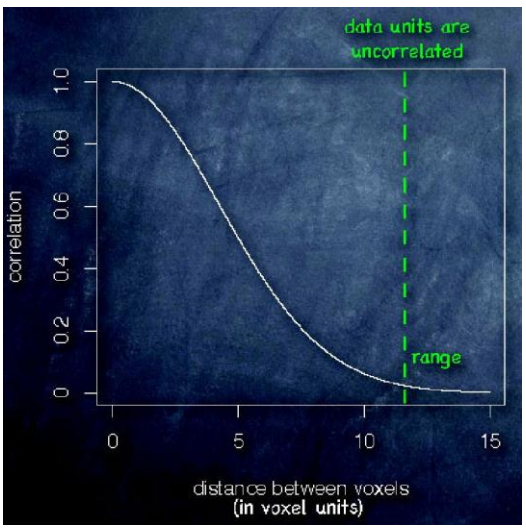
An ideal case: redundant voxels are grouped together and averaged

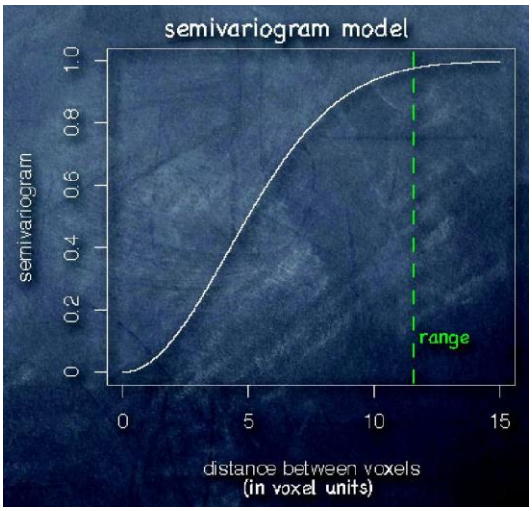


A more realistic case: similar voxels are grouped together and averaged

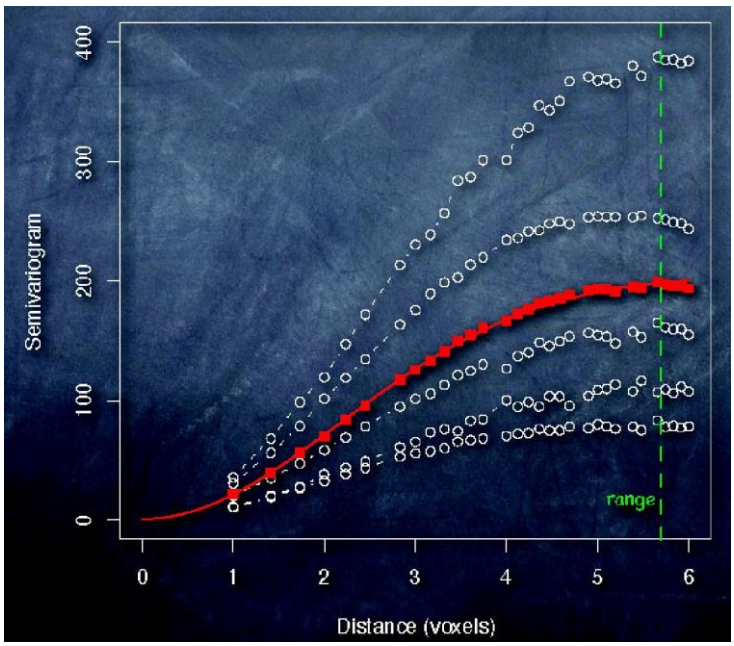


Correlation between pairs of voxels decreases as the distance between them increases





Semivariogram estimates in the right putamen from five GW veterans and the group average

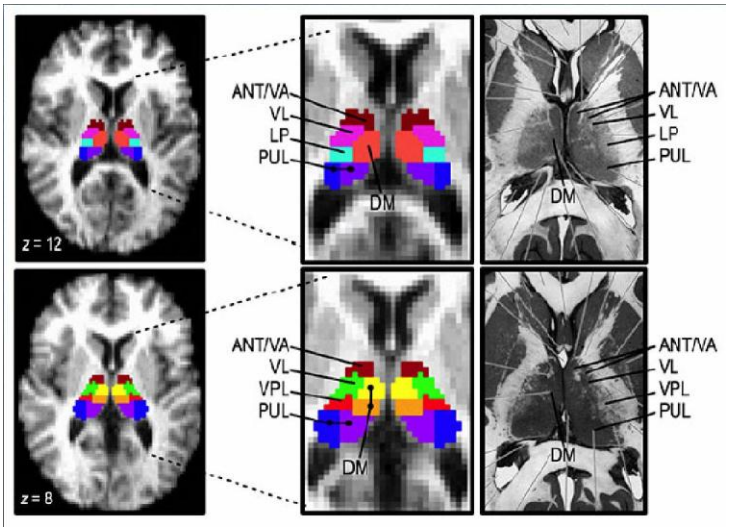


Two ways of grouping correlated voxels together

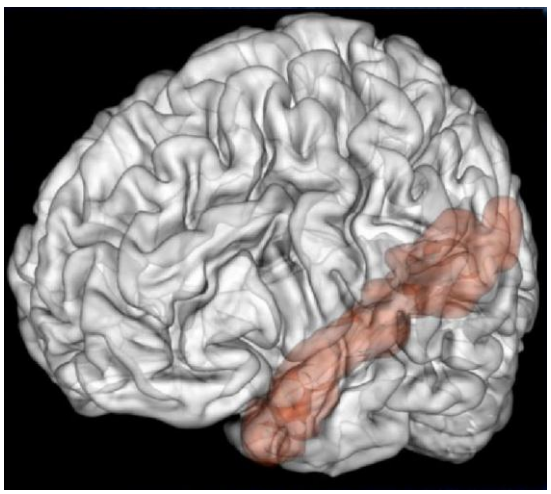
- Group voxels within a region of interest based on known functional anatomy AND range of correlation
  - e.g. anatomic grouping within the thalamus
- Group voxels within a region of interest based only on range of correlation
  - e.g. automated grouping within a cortical region

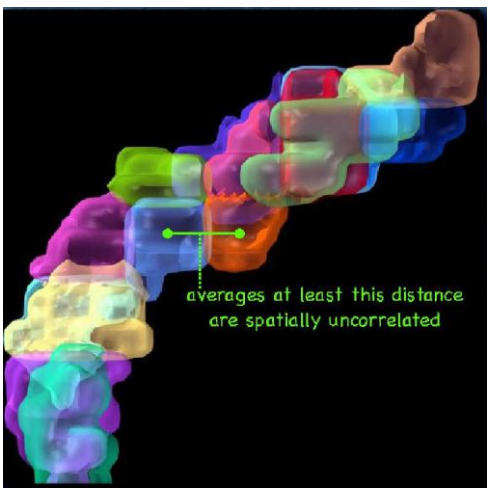
Grouping voxels together in the thalamus

Each group of correlated voxels satisfies the range criterion but also fits the nuclear substructure



Automated grouping of voxels in the superior temporal gyrus





Where there is no anatomic substructure of interest the grouping is done based on the range criterion only

Are there statistically significant group differences in resting blood flow within deep brain regions between ill GW veterans and healthy control patients?

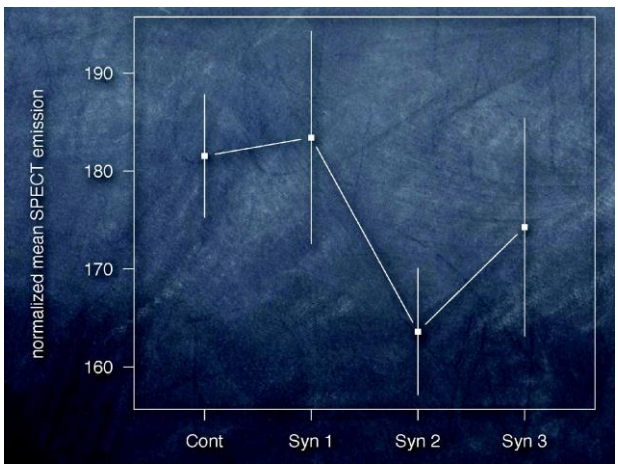
Statistically significant group differences obtained by voxel-level methods (e.g., SPM)

Brain mining also allows a broader range of statistical applications

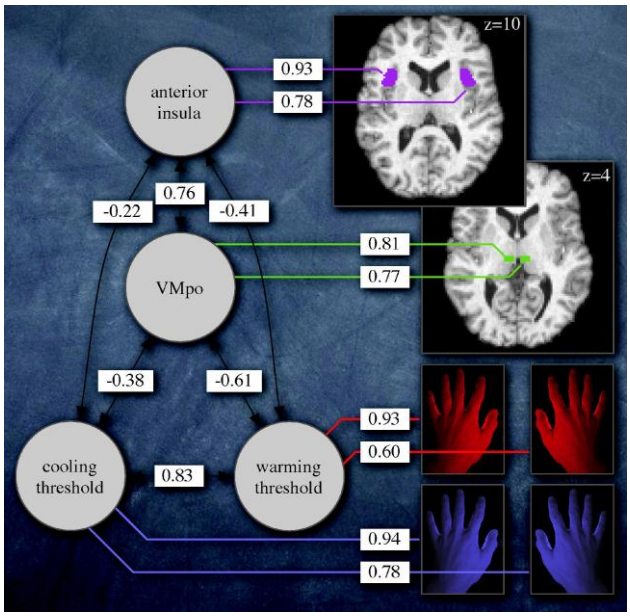
- Effect sizes and confidence intervals can be estimated correctly because spatial correlation is accounted for rather than ignored
- Reduced data units (block averages) can be incorporated into more complicated models
  - Structural equation models
  - Group discrimination methods

Example: group means and least significant intervals

Right Putamen
block 6



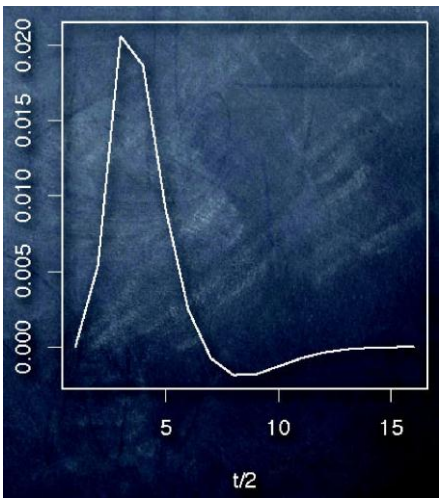
Example: structural equation models



Brain miner will also include methods to handle a fourth dimension (time) in the analysis of functional magnetic resonance images (fMRI)

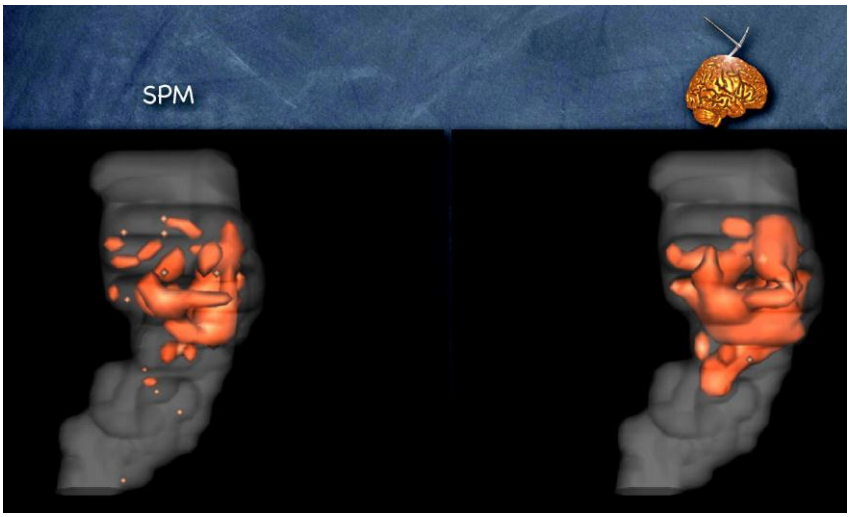
- In this setting a hemodynamic response evolves over time following a stimulus
- Grouping and averaging allow for better estimation of the hemodynamic response because neighboring voxels are giving similar information about changes in blood flow over time

HRF



Application of Brain Miner to an fMRI experiment with a large region of BOLD response

hemodynamic response to an auditory stimulus in the superior temporal gyrus



Conclusion

- Modeling spatial correlation allows optimal grouping and optimal averaging of voxels
  - minimizes redundancy
  - obtains accurate summaries of brain functional regions
  - allows flexibility in choice of statistical approach
  - maximizes power to detect small regional signal changes between groups