Functional brain imaging (e.g. fMRI, PET, EEG) data is a 4-dimensional time series representing changes in brain activity over time.
Structrual imaging (e.g. MPRAGE, DTI, CT) also has been increasingly more common to have a longitudinal component, where participants/subjects are scanned multiple times.
Visualization and presentation of these data can be improved with the use of 3D tools.
NEEDED: pictures of brains - a lot - DTI ex, MRI

2D vs. 3D

2D Picture

2D vs. 3D

3D Picture

What kind of data do we have?

- Structural MRIs
- Functional MRIs
- CT
- DTI
- EEG
- PET

Current methods of visualizing/EDA

- Time series of individual voxels/regions of interest (ROI)
- Look at data by slice over time
- Look at data cross-sectionally within slice

Overall, most methods keep temporal or 2D spatial components fixed and vary the other.

How do we view results:

- Time series of individual voxels/regions of interest (ROI)
- Look at a subset of cross-sectional slices over time
- Present spatial map summarizing temporal information
  - Projection, mean, differrence
  - Statistical Parametric Map (SPM) - Color as “activation level”

Why use this for EDA

- Respects true nature of data (brains are not slices!)
- Can get more of an overview
- Motion - can look and interact to see if there are problems
- Some things become more apparent in 3D

Things Hiding in 2D

Real Life Example:
SubLIME is a MS lesion detection algorithm [3]. MS - SUBLIME - before 3D rendering - didn't notice misregistration

Why are we still 2D?

- We do EDA mainly only in 2D
- Some investment in new software - how many languages is enough!?
- 3D Figures in Papers/Presentations are not generally accepted
  - Software exists to embed 3D in pdf - but not as smooth for large data
  - "Tradition!" [2]

What makes a good figure

- 3-4D Interactive - Easy to use - quick to render - Transparency (opacity) - subcortical structures - No (or very limited) 3rd Party software (Note - curent figures do not have all these qualities)

3D rendering tools

- 3D Slicer - `http://www.slicer.org/`
- Paraview - `http://www.paraview.org/`
- RGL [1] using `R` - `http://cran.r-project.org/`
- Freesurfer - `http://surfer.nmr.mgh.harvard.edu/`
- AFNI - `http://afni.nimh.nih.gov/afni`
- MIPAV - `http://mipav.cit.nih.gov/`
- Matlab, etc.

RGL - Use R!

- Why choose as the main tool? (Other than the fact I'm at a statistics conference)
- Open - source (read Free)
- REPRODUCIBLE (R Markdown as Hadley will discuss)
- Scriptable
- Exportable
- It works (I've seen it!)

Conclusion

- Currently - very good for internal reports/EDA
- Not accepted as figures in publication
- Need journals that can handle
- You can still include snapshots
- Available methods allow for reproducibility

Visualizing Brain Imaging in Interactive 3D

Who? John Muschelli

When? March 5, 2013

What's the problem

- With the explosion of high dimensional data
- Areas - genomics, neuroscience, astronomy (not astrology), large networks
- Focus - 4D data, and specifically neuroscience
- Currently - show orthogonal slices with colors proportional to intensity - "flat brains"
  - Have alpha blending
- Have no "hurdle" with software

- Overall Goals
- Why we need them
- Why we should push for them to be done
- Journal
- Discuss how to make these figure

What do we want it to do?

- Have 2D presents - colors, shapes, axes
- Be able to be manipulated/rotated
- Present multiple meshes
  - Have alpha blending
- Have no “hurdle” with downloading software for end users

What are the options for rendering?

Software	Pros	Cons
Slicer	Lightweight rendering, export to multiple formats	Python Scriptin (Pro?)
Slicer		Import all type of formats
Paraview	Lightweight Rendering	
Paraview	Lightweight Rendering	Import all type of formats
RGL, WebGL, OpenGL		Scripting (Pro?)
MeshLab	Converts Multiple formats	Not easy alph blending, Nc much brain dat import
Asymptote		Scripting lar guage
Adobe Presenter		Cost

Where to Render

	Pros	Cons
Web	Updatable Many tools available	Need Internet Not linked to paper Some html may be required
PDF	Embedded all in one document - linked Embedded all in one document	Need Adobe Only certain format (u3d, prc, etc) Javascript may be possible

Problems

- We're not movie directors: Camera angle/position may convey the wrong idea

Here are the steps. Need a structure 4D - over time or multiple ROIs

rgl: 3d visualization device system (opengl).r package version 0.65,.
CRAN.R-project.org, 2005.

Joseph Stein, Norman Jewison, Topol, Norma Crane, Leonard Frey, Molly Picon, Paul Mann, Oswald Morris, Sheldon Harnick, John Williams, et al.
Fiddler on the Roof.
Crown, 1964.

EM Sweeney, RT Shinohara, CD Shea, DS Reich, and CM Crainiceanu.
Automatic lesion incidence estimation and detection in multiple sclerosis using multisequence longitudinal mri.
American Journal of Neuroradiology, 2012.