BrainPainter: A software for the visualisation of brain structures, biomarkers and associated pathological processes

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Pathology progression in Alzheimer's disease

Benzinger et al., PNAS, 2013

Creating a movie showing pathology progression is difficult

One needs to:

- Create special input files for neuroimaging software (Freesurfer, SPM, 3D slicer, etc ...)
- Need to interface via API, or launch GUI for every frame
- Find the right parameters:
  - viewing angles
  - color thresholds
  - etc ...
- Read documentation ...

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Could easily take 1 week!!!

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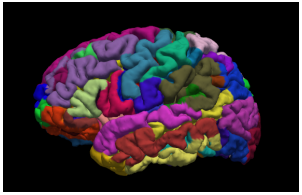
BrainPainter can create the movie in 30 minutes.

Towards a brain visualisation software that is easy to use

Need to simplify input data, which is voxelwise!

- Idea: Color entire regions based on atlas, instead of voxelwise patterns



- This enables us to provide the input as a list of colours for each region:

Hippocampus	Superior Parietal	Inferior Occipital	...
(R,G,B)	(R,G,B)	(R,G,B)	...

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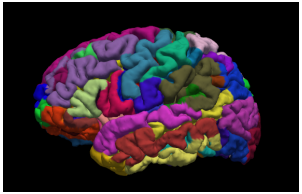

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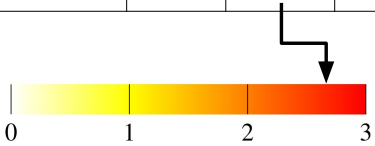
Hippocampus	Superior Parietal	Inferior Occipital	...
(R,G,B)	(R,G,B)	(R,G,B)	...

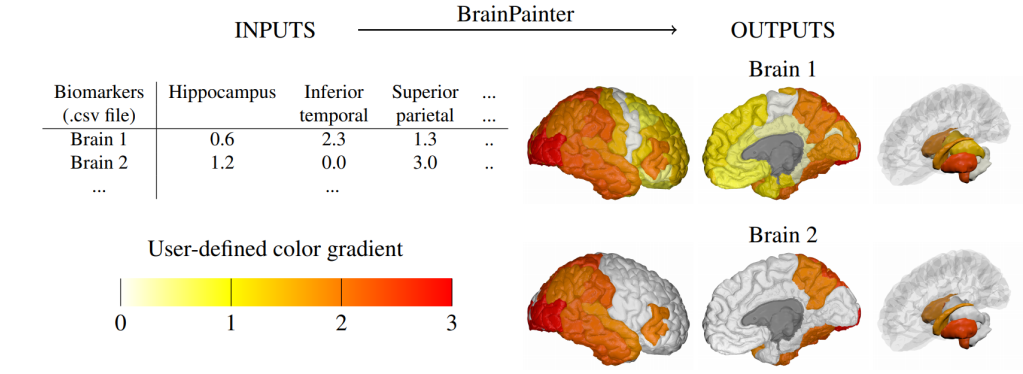
- Even better: use a gradient of colours

Hippocampus	Superior Parietal	Inferior Occipital	...
0.2	1.0	2.7	...



- Can now generate input file from a spreadsheet program (MS Excel)

BrainPainter: How it works

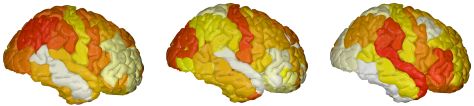


- Uses Blender to generate images from pre-defined templates

BrainPainter is customisable

- supports three atlases:

Desikan-Killiany Destrieux Tourville



- supports three pre-defined viewpoints

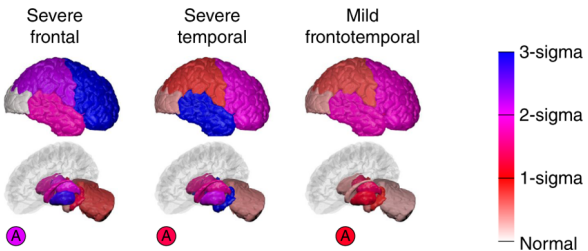
Outer Cortical Inner Cortical Subcortical

- supports different surfaces

pial inflated white matter

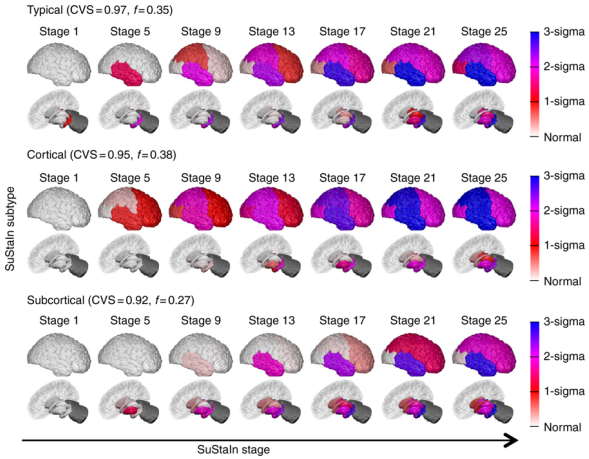
- user-defined colour gradient
- resolution
- background color
- ...

Example Use 1: Visualise degree of atrophy in Alzheimer's disease



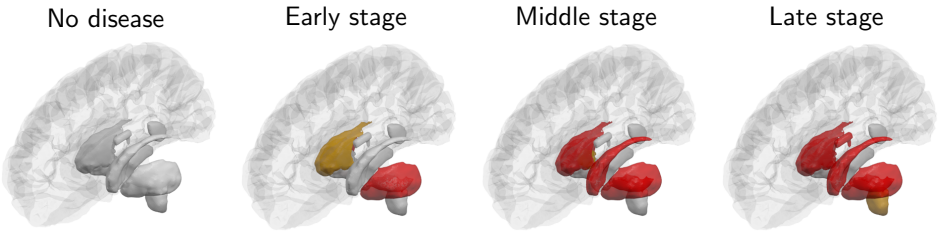
Young et al, Nature Comms., 2018

Example Use 2: Visualise temporal progression of atrophy in Alzheimer's subtypes



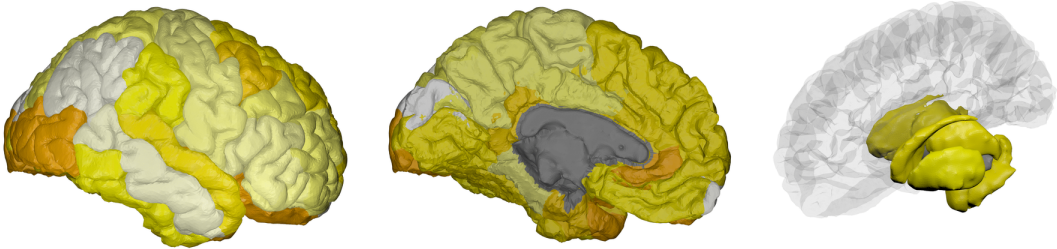
Young et al, Nature Comms., 2018

Example Use 3: Visualise subcortical atrophy in Huntington's disease



Wijeratne et al., Ann. Clin. Neurol., 2018

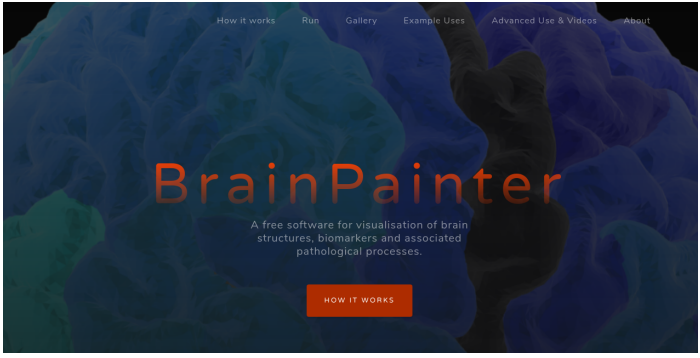
Example Use 4: Animate the progression of amyloid spread in Alzheimer's disease



Garbarino and Lorenzi, IPMI, 2019

BrainPainter runs straight from the browser - Live Demo

- https://brainpainter.csail.mit.edu/



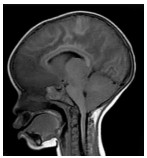
- can also run from source: https://github.com/mrazvan22/brain-coloring
  - requires no installation, run straight from docker container

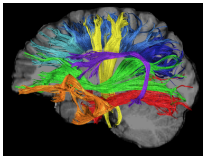
Conclusion

- Created a software that allows easy generation of multiple brain images
- Runs from browser
- Enables quick movie creation
- Supports multiple atlases
- Useful pre-defined settings: viewpoints, surfaces, etc ...
- Turned Blender, a powerful graphics software, into a brain visualisation tool for neuroscience

Future work

- improve robustness of website, add error messages for wrong input
- more atlases: e.g. Hammers
- support for other brain templates: e.g. infants, mice
- other visualisations: e.g. white-matter tracts





- Blender allows much more: e.g. animating spread of toxic proteins through particle dynamics, fly-overs, ...

Acknowledgements

Collaborators

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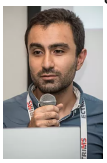

- Alexandra Young
- Sara Garbarino
- Peter Wijeratne
- ...

Funders

NAC

EPSRC
Pioneering research and skills

Anders Winkler for the 3D brain templates

- https://brainder.org/research/brain-for-blender/