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

Răzvan V. Marinescu[a,b], Daniel C. Alexander[b], Polina Golland[a]

[a] *Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, USA, MA 02139*
[b] *Centre for Medical Image Computing, University College London, Gower Street, London, United Kingdom, WC1E 6BT*

Abstract

We present BrainPainter, a software that automatically ...

1. Introduction

Visualisation of brain structure, function and pathology is crucial for understanding the mechanisms underlying certain neurodegenerative diseases and eases the interpretation of results in brain medical imaging. This is especially important in populations studies, where two or more populations are compared for any group differences in biomarkers derived from e.g. Magnetic Resonance Imaging, Positron Emmission Tomography (PET) or Computer Tomography (CT). However, for traumatic brain injury or rarer neurodegenerative diseases such as Parkinson's disease or Multiple Sclerosis, the visualisation of statistical results is sometimes not performed due to the inability to register images to a common template or lack of robust registration software, hence many studies [**coughlin2015neuroinflammation**, **mak2014subcortical**, **schoonheim2012subcortical**, **chard2002brain**] only report differences between patients and controls in tables or as box plots.

When alignment to a common population template is possible, e.g. in Alzheimer's disease, excellent 3D visualisation software exists (e.g. 3D slicer [**pieper20043d**], Freeview [**fischl2012freesurfer**] or SPM [**penny2011statistical**]) which allows interactive visualisation of population differences e.g. the output of voxel-based morphometry (VBM). However, such software have several inherent limitations. First, such software (e.g. Freesurfer[1]) generally requires inputs in their own data format, which is usually difficult and time-consuming to create without using their pipeline. Secondly, for highlighting complex patterns of pathology, authors need to show multiple slices from the same 3D image (generally from 4 ([**seeley2009neurodegenerative**]) up to 8 slices ([**migliaccio2015mapping**]), which ends up taking too much space on the academic paper being publised. While Freesurfer solves this using a cortical surface-based representation that

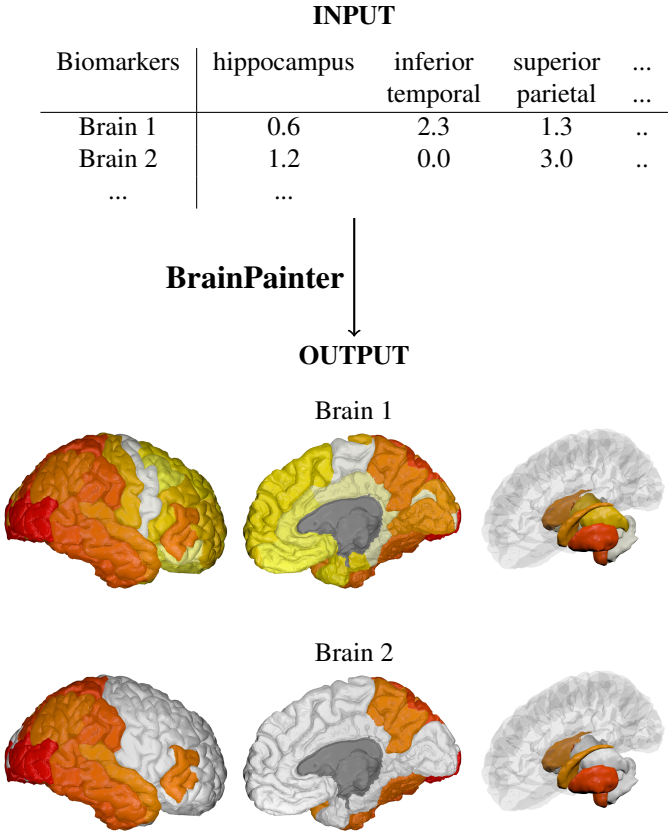

Figure 1: Given a .csv file with biomarkers corresponding to different brain regions, we automatically generate brain images with the cortical surface (left and middle), along with subcortical structures (right).

Email address: razvan@csail.mit.edu
URL: https://github.com/mrazvan22/brain-coloring

[1] We actually refer to Freeview, which is the visualisation software bundled with Freesurfer

captures all the complexity of pathology patterns in a single image, it cannot visualise subcortical structures. Third, current software cannot be easily used to generate a movie showing a dynamic process, e.g. propagation of pathology within the human brain.

We present BrainPainter, a software for easy visualisation of structures, pathology and biomarkers in the brain. As opposed to previous visualisation software, the input data is a simple list of numbers in a .csv file representing colours to be assigned to each brain structure. Secondly, it can visualise patterns on both cortical and subcortical structures using a surface repreentation, removing the need to show multiple slices. Third, the images are generated automatically from pre-defined view-points, allowing one to create a movie showing e.g. the propagation of pathology, without the need to write any extra software code. BrainPainter is open source and available on Github: https://github.com/mrazvan22/brain-coloring.

2. Design

BrainPainter works

3. Use case: Show progression of pathology

4. Conclusion

5. Acknowledgements

RVM is supported by the EPSRC Centre For Doctoral Training in Medical Imaging with grant EP/L016478/1. NPO, FB, SK, and DCA are supported by EuroPOND, which is an EU Horizon 2020 project. ALY is currently supported by an EPSRC Doctoral Prize fellowship and was previously supported by EPSRC grant EP/J020990/01. DCA is supported by EPSRC grants J020990, M006093 and M020533. Data collection and sharing for this project was funded by the Alzheimer's Disease Neuroimaging Initiative (ADNI) (National Institutes of Health Grant U01 AG024904) and DOD ADNI (Department of Defense award number W81XWH-12-2-0012). FB is supported by the NIHR UCLH biomedical research centre and the AMYPAD project, which has received support from the EU-EFPIA Innovative Medicines Initiatives 2 Joint Undertaking (AMYPAD project, grant 115952). This project has received funding from the EU Horizon 2020 research and innovation programme under grant agreement No 666992.

bibliography

References

bibliography