

Mitacs Globalink Research Award: Final Report

Once all signatures have been obtained, please submit the final copy via email to international@mitacs.ca.

PRIVACY STATEMENT

Please note that Mitacs may share this information with government funding agencies or other groups to assess or promote the Mitacs Globalink Research Award. Do not include confidential, proprietary, or sensitive information within this Final Report.

CHECKLIST

- All sections are completed
- All participants have signed and agreed to the content of this report

FURTHER PROGRAM INFORMATION

Are you interested in speaking with a Mitacs Staff Member for information about our other programs?

- Yes
- No

PROJECT INFORMATION

Please indicate which award you received:

- Globalink Research Award for senior undergraduate and graduate student research at a university outside Canada*
- Globalink Research Award for graduate student research at a university in Canada*

Project Title:

Host Institution:

Research Project Location (City, Country):

Period of Travel:

The Travel Start Date is when the student left his/her home country to start the Globalink research project and the Travel End Date is when the student returned to his/her home country.

Student Travel Start Date:

Student Travel End Date:

RESEARCH PROJECT OVERVIEW, OUTCOMES AND IMPACT



1. Briefly describe the research project. *Please include any necessary background information.*

In recent years there has been a growing focus on evaluating the reproducibility of scientific findings. In neuroimaging this has been explored with respect to the impact specific choices in analysis software have on the resulting claims and their ability to be replicated across datasets or other tools. The focus of my Ph.D. involves the characterization of various tools and their relative stability, in other words, how significantly minor changes (such as noise in data, specific analysis choices, or computer hardware) affect the eventual results.

2. Describe the research goals and whether or not they were achieved.

The goal of this project was to a) collect and perform quality control on large collections of functional parametric imaging maps, b) create a neural network deep architecture that could reconstruct images from these maps, c) train that network on the large collection of maps, and then d) refine this training on pre-processed data coming from various pipelines to try and minimize the between-tool difference. The first three of four goals were accomplished.

3. Please summarize the research outcome(s).

The outcomes of this project have thus far been several publicly-available open-source pieces of software:

1. The creation of a neural network architecture that can reconstruct functional parametric imaging maps
2. The creation of a crawler which can download and validate maps from Neurovault, the largest public database of functional activation maps.

4. Describe the methods and techniques applied.

This project involved several techniques across computational science. The curation of data included the development of a RESTful API crawler in Python, and data science scripts for performing quality control. The network created for reconstructing maps included the construction of a three-dimensional convolutional neural network auto encoder. This involved numerical programming, machine learning, and advanced knowledge of linear algebra.

5. Describe how the time you spent at the host institution impacted the direction of your research.

Time was spent during this project learning about and refining the techniques and methods employed towards the aims of the project.

6. What benefits did this research project provide to the host academic supervisor?

This research project was an the opportunity for the host academic supervisor to engage in a new line of research in collaboration with researchers from the home (Tristan Glatard, Jean-Baptiste Poline, Alan Evans) and host (Elisa Fromont) institutions. The host supervisor also learnt about ongoing research projects at the home institution related to her research. Being a junior faculty, this research project was also a chance for the host supervisor to co-supervise a PhD student from another lab and to compare practices for data processing and lab management across the two institutions.

7. What benefits did this research project provide to the home academic supervisor?

This collaboration helped to bridge the gap in standardization and tool evaluation efforts across these two disparate institutes. With

8. What benefits did this research project provide to the student?

This project afforded the student the opportunity to travel abroad and participate in research and workshops that he would otherwise not have had an opportunity to participate in. The supervision and instruction given helped the student extend their knowledge into a new area of computational science, and gained experience in machine learning and deep learning.

9. Discuss any future research plans resulting from this project.

This project will continue to complete the fourth and final aim of the project. This work will compare the differences introduced by different processing software libraries, and try to mitigate them. This will also be extended to evaluate and mitigate the differences present in data processed with noise.

10. List any publications, patents, abstracts, conference presentations, and/or licenses which resulted, or that you anticipate will result, from this research project. *Please include any additional comments.*

Several software contributions have been made open source and publicly available as a result of this project. This project is ongoing and will be submitted to MICCAI 2020, a prestigious workshop on medical image analysis and processing.

COLLABORATION DETAILS

1. Was this project connected to an existing international collaboration, or did the project lead to the creation of a new international collaboration? *Please describe.*

While no formal collaboration previously existed between the labs, both groups have participated and led various efforts as a part of global communities aiming for the standardization of methods and tools in neuroimaging. This is the first formal collaboration between these two teams.

2. Do you anticipate further development to your current international collaboration, or the creation of additional international collaboration(s) as a result of this project? *Please describe.*

While no joint-funding plans currently exist, our two labs plan to continue to collaborate on this and future efforts for tool evaluation and standardization.

EXECUTIVE SUMMARY (300 word maximum)

Please describe using language understandable to a layperson:

- The nature of the problem the project addressed
- Goals achieved
- Benefits to all applicants
- Any positive outcomes from the project, including: papers published, patents obtained, etc.

The project undertaken here attempts to evaluate the trustworthiness of any given scientific claim made using data processed by one of the several popular packages for functional neuroimaging analysis. While it has been demonstrated on multiple occasions that processing libraries used in an experiment will lead to differently-characterized datasets, the underlying quantitative differences between these methods and how to account for them remains unexplored. This project involved the application of deep learning to construct a convolutional neural network, the adoption of the massive Neurovault public dataset consisting of thousands functional statistical parametric maps, and the Human Connectome Project dataset consisting of 1200 individuals' worth of high-fidelity neuroimaging data. These resources were combined to explore the effect of processing steps and pipelines on underlying results, and minimize the differences between their results. The successful completion of this project will meaningfully mitigate the importance of "the art of choosing a pipeline" from neuroimaging, and enable scientists to have more harmonized datasets. This work will be submitted to the MICCAI 2020 workshop.