

Brainhack ATL 2019 - Project Tracks

Project Track 1: Building Scalable Elastic Frameworks for Neuroimaging Pipelines

*Can you engineer a fast and affordable MRI processing pipeline
using cloud-based technology?*

Abstract

Before brain images collected from an MRI scanner become ready for statistical analysis, they go through a processing pipeline, preparing them for use in further neuroscientific research. These processing pipelines consist of a set of well defined, computationally intensive tasks, such as brain matter segmentation, spatial warping, voxel smoothing, and more. The resources these tasks demand, place a burden on traditional, serial approaches, especially when applied on large data sets. To solve these problems, researchers are turning to innovative solutions using cloud-based technology to process data quickly and at scale. Due to the ability to process many subjects quickly, and in parallel, elastic cloud solutions seem to provide especially attractive options for speeding up overall pipeline runtime and enabling quick reprocessing of large datasets when different settings are desired or an issue is identified. At the same time, however, the cost of using such resources must also be considered, and should not become prohibitively high when large data sets are accumulated. With all of this in mind, your task is to build an MRI processing pipeline using Amazon Web Services that elastically scales with the data available and computational demand, while controlling the growing costs that using such resources can accrue.

As a bonus, let's find metrics for detecting when to call for human attention on the subjects that can potentially be fixed, before the analysis.

Given a list of pipeline steps provided by the organizers, the team that implements the greatest number of processing steps that complete in the shortest time on the same amount of data for the cheapest price wins. Winning strategies may include clever scaling to multiple nodes, or reserving larger nodes on spot prices and releasing them quickly (price is a factor in winning), GPUs are an option too, as long as they do not hurt the overall metric.



Project Track 1 (cont.)

.Maximum number of participants per team: 5

Is this project track competitive?

Yes! There will be prizes given to the team with the best & most efficient solution to this project.

Relevant skills to take part in the project:

- **Required:**
 - Programming skills in Python and/or MATLAB
- **Helpful, but not required:**
 - Programming in bash/shell scripting
 - Familiarity with neuroimaging processing pipelines
 - Familiarity with AWS technologies

Skills and competences you can learn during the project:

- Gaining a wealth of knowledge about the complexities of processing fMRI data.
 - Familiarity with the processing pipeline is helpful for anyone working with neuroimaging data. In practice, processing steps will affect analysis and clinical results, so understanding the steps involved has extremely important practical and theoretical value.
- The structure and the bottlenecks of the neuroimaging pipeline
 - In a practical setting, it is useful to know what the stages of the pipeline are in detail, and where slowdowns can and will happen. This can help with project planning, understanding peculiarities in processing runtime and results, and other useful applications.
- How to efficiently use cloud resources for large-scale data processing.
 - Neuroimaging data presents a scaling problem that requires interesting tools and solutions to processing at scale. The skills learned wielding these tools should be useful in developing large-scale solutions for many other applications in neuroimaging and data science.

Is there a plan for extending this work to a paper in case the results are promising?

Yes! A promising pipeline may be developed into a workflow put into use in real analysis settings at TRenDS. One or multiple journal or conference papers describing the methodology will also be possible, depending on the methods applied and their success.



Brainhack ATL 2019 - Project Tracks

Project Track 2: Automated Quality Control Tool to Identify Poorly Preprocessed MRI Scans

Can we build an automated quality control tool to identify poorly preprocessed MRI scans?

Abstract

There are multiple pipelines available to assess data quality prior to preprocessing imaging data. However, there are few available methods outside of visual inspection to assess the success of preprocessing steps (e.g. slice time correction, masking, normalization). In an era of increasingly large datasets, some of which are over tens of thousands of subjects, visual inspection becomes less optimal, increasing the risk of erroneous, poorly processed data to find its way into analysis pipelines. This project track is dedicated to the development of a pipeline and/or approach for identifying errors in brain normalization without visual inspection in order to streamline data correction and analysis. Creation of an automated quality control tool to detect poorly preprocessed images can make the quality control processes of the MRI preprocessing pipeline much more efficient, especially in large datasets.

This project track involves creating an automated quality control tool to identify MRI scans that are preprocessed correctly and incorrectly. This tool will sort the MRI scans into these two categories. Success is evaluated based on the accuracy and confidence delivered by the detection approach to identify poor normalization/registration in a novel dataset.



Project Track 2 (cont.)

.Maximum number of participants per team: 5

Is this project track competitive?

Yes! There will be prizes given to the team with the best & most efficient solution to this project.

Relevant skills to take part in the project:

- Some experience in Machine Learning (basic understanding of feed forward NNs, CNNs and classifiers)
- Programming skills in Matlab or Python, Scikit-learn, Tensorflow, PyTorch, or Keras

Skills and competences you can learn during the project:

- You will gain access to data representing good and failed MRI normalization attempts. These will inform you of the types of erroneous outcomes that can be observed in real datasets.
- MRI datasets are very high dimensional as compared to the number of samples (subjects) that need to be classified. Clever use of the information contained in each scan to train a classifier without overfitting will give you insight into the characteristics of various classifier options.
- Data augmentation may play an important role in overcoming the limitation of small sample sizes. Adversarial networks and its combination with other architectures/models offer an opportunity to generate additional samples, which could extend to similar challenges in other applications in data science.

Is there a plan for extending this work to a paper in case the results are promising?

Yes! A paper AND a toolbox/workflow may be developed and put into use in real analysis settings at TReNDS.



Brainhack ATL 2019 - Project Tracks

Project Track 3: Pitch-A-Project

Have an idea other than the Project Tracks for a neuroscience project? Pitch your own project via the Pitch-A-Project Track!

Abstract

If you are interested in working on projects other than those listed above, you can join the Pitch-A-Project track! Pitch-A-Project Abstracts can be (1) other computational neuroscience projects that fit with Brainhack's ATL overall goals, or (2) non-computational projects that contribute to the field of neuroimaging in some way.

Examples of Pitch-A-Project project pitches: Using fMRI images to create neuroscience art, designing an infographic to explain fMRI preprocessing, etc.

Projects can be pitched anytime via the Pitch-A-Project Abstract Submission form linked below. Submissions will be accepted up until *Wednesday, November 13th at 5pm*.

Once a project is pitched, you can get Brainhack ATL attendees to join your project during the Lunch & Ideation Session on Wednesday or anytime during Open Hacking up until the project submission deadline.

Submit a Pitch-A-Project Idea here!

<https://tinyurl.com/yxxsar5f>

You will be able to pitch your project ideas on the first day of Brainhack ATL - **Wednesday, November 13 at 5PM**. During this time, you will pitch the project idea and introduce the project team that will be working on the project.

