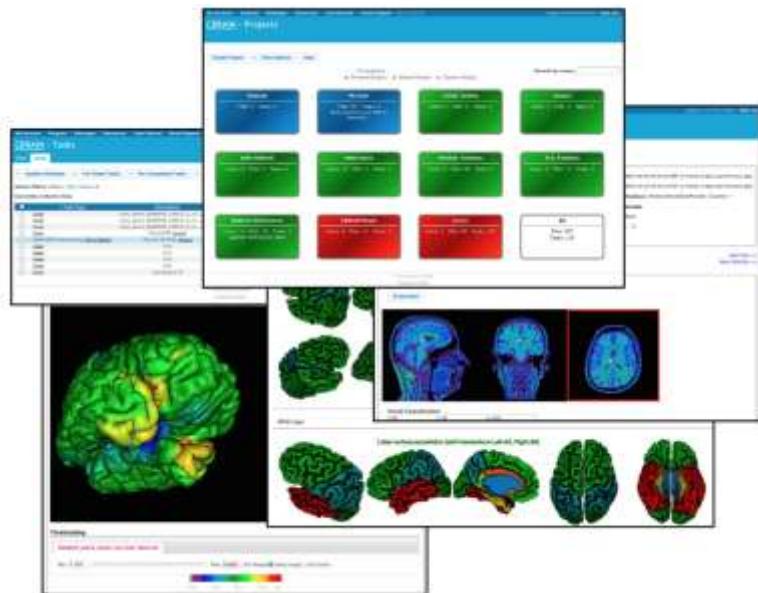




# MNI ECOSYSTEM



## database management & data-sharing



CBRAIN and LORIS are both cloud infrastructures

### CBRAIN

- cloud-based web portal
- uses Compute Canada as its cloud backbone
- interoperable with other cloud services
- uses Boutiques to describe pipelines

### LORIS

- can be served from any cloud resource
- has built-in API functionality
- incorporates standardization to facilitate cloud usage

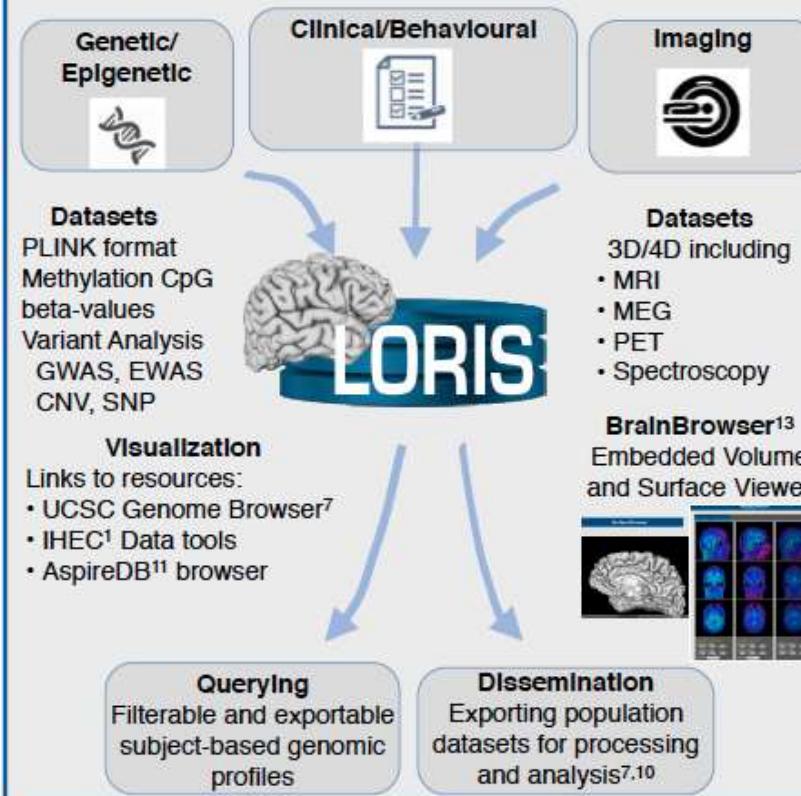


## Data Types

Imaging  
Behavior  
Genetics  
Epigenetics  
Tissue samples

### Methods

LORIS' Genomic Browser embeds display and download tools for multiple formats of analyzed genomic data, facilitating large-scale data acquisition, dissemination and analysis in imaging-genetics research. Any format of derived genetic datasets, including metadata about genetic data collection and analysis, can be loaded and seamlessly linked with multi-modal subject data in LORIS.





# International Partners



For list of 400+ measures: <https://sites.google.com/site/lorisinstrumentlist/>



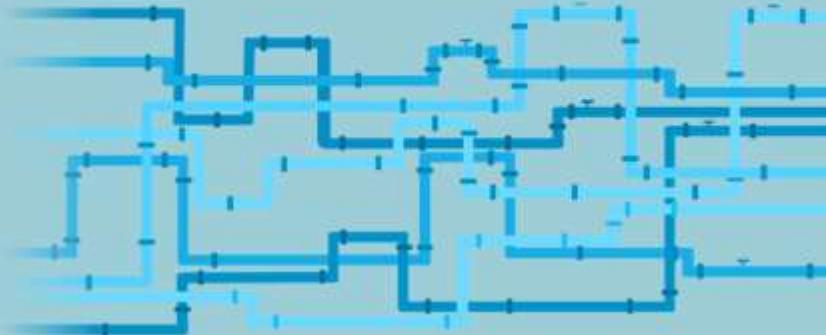
cbrain

FEATURES PROJECTS ABOUT GET STARTED LOGIN

cbrain

CBRAIN is an infrastructure that connects researchers and data from all walks of science to high performance and cloud computing in an easy to manage, reproducible, and user-friendly manner.

GET STARTED



#### Accessibility

Ability to work across multiple machines and filesystems.



#### Efficiency

Quickly moving compute and data behind the scenes.



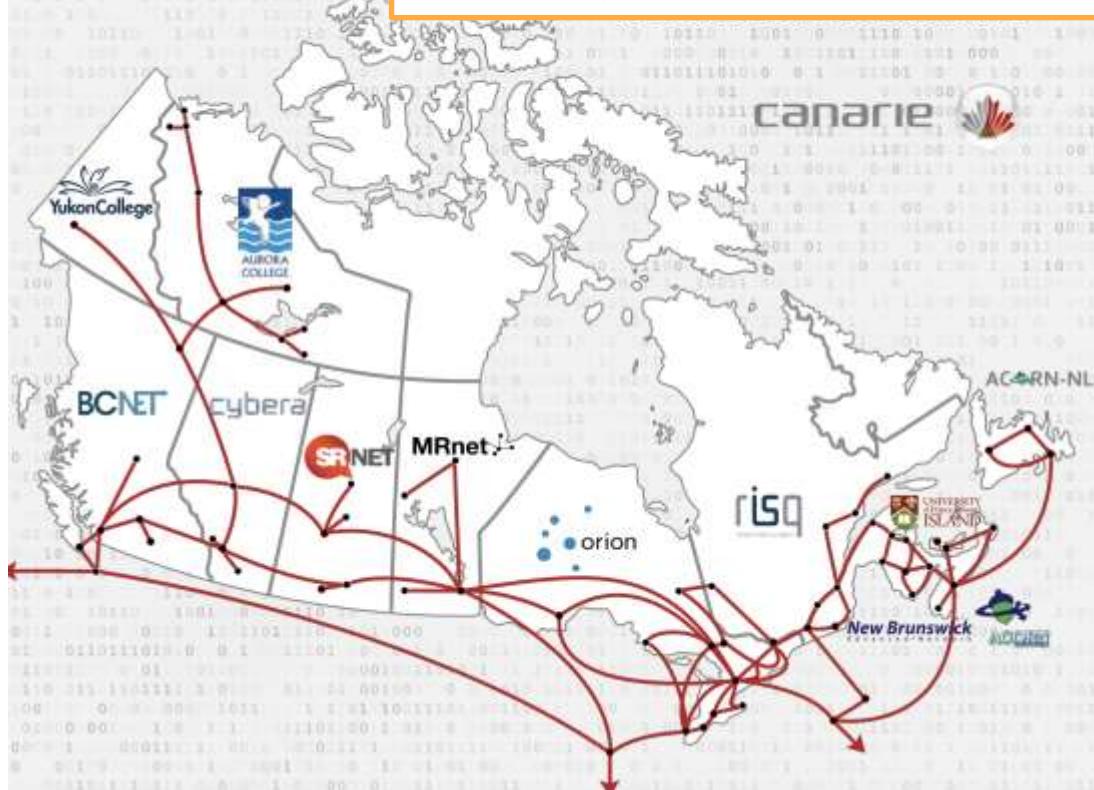
#### Reproducibility

Strict standards and pipelines allow for reproducible results.

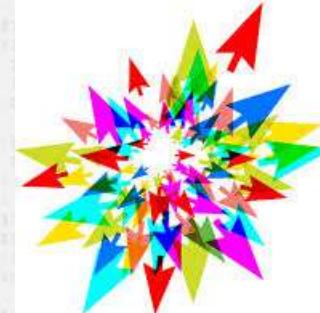
# CBRAIN National HPC Integration (300,000 processors)

**cbRAIN**

Computational Resources provided by Compute Canada  
~7 million CPU hours per year  
8 PB of storage



**compute | calcul**  
canada | canada



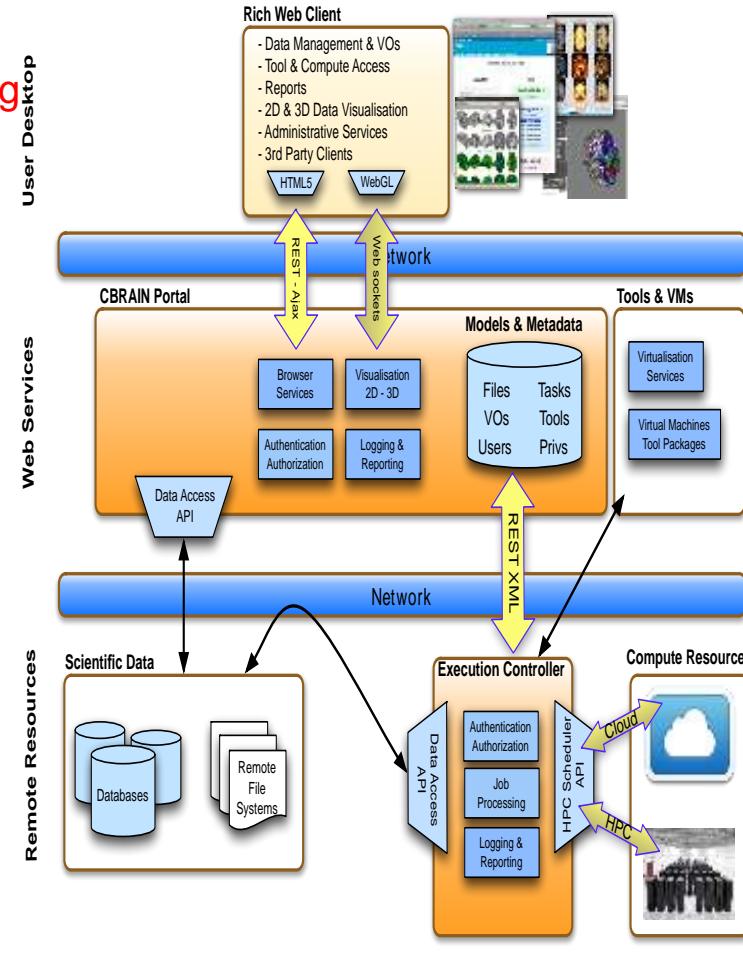
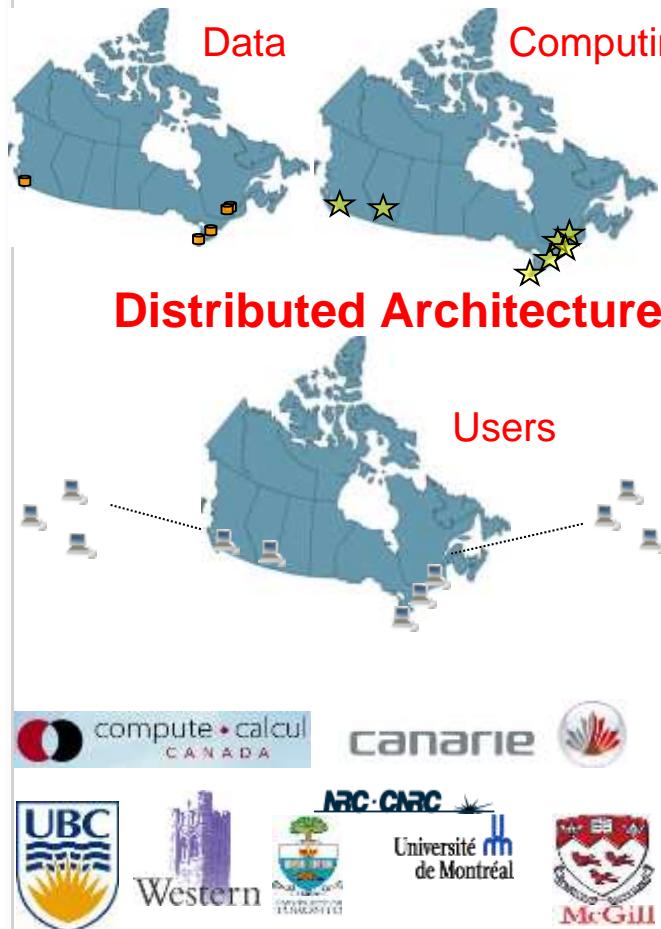
# CBRAIN / Texas Advanced Computing Center (TACC) University of Texas at Austin



## Stampede2

Largest supercomputer in the world for academic science  
18 Petaflops (~370,000 cores)

# CBRAIN Canadian Distributed Neuroinformatics Platform





- Fully-automated integration of applications
- Deployment on heterogeneous computing resources through containers
- Comprehensive input validation through a strict JSON schema
- Flexible application description through a rich JSON schema



#### TECHNICAL NOTE

## Boutiques: a flexible framework to integrate command-line applications in computing platforms

Tristan Glatard<sup>1,\*</sup>, Gregory Kiar<sup>2,3</sup>, Tristan Aumentado-Armstrong<sup>2,3</sup>, Natacha Beck<sup>2,3</sup>, Pierre Bellec<sup>4</sup>, Rémi Bernard<sup>2,3</sup>, Axel Bonnet<sup>5</sup>, Shawn T Brown<sup>2,3</sup>, Sorina Camarasu-Pop<sup>5</sup>, Frédéric Cervenansky<sup>5</sup>, Samir Das<sup>2,3</sup>, Rafael Ferreira da Silva<sup>6</sup>, Guillaume Flandin<sup>7</sup>, Pascal Girard<sup>5</sup>, Krzysztof J. Gorgolewski<sup>8</sup>, Charles R.G. Guttmann<sup>9</sup>, Valérie Hayot-Sasson<sup>1</sup>, Pierre-Olivier Quirion<sup>4</sup>, Pierre Rioux<sup>2,3</sup>, Marc-Étienne Rousseau<sup>10</sup> and Alan C. Evans<sup>2,3</sup>

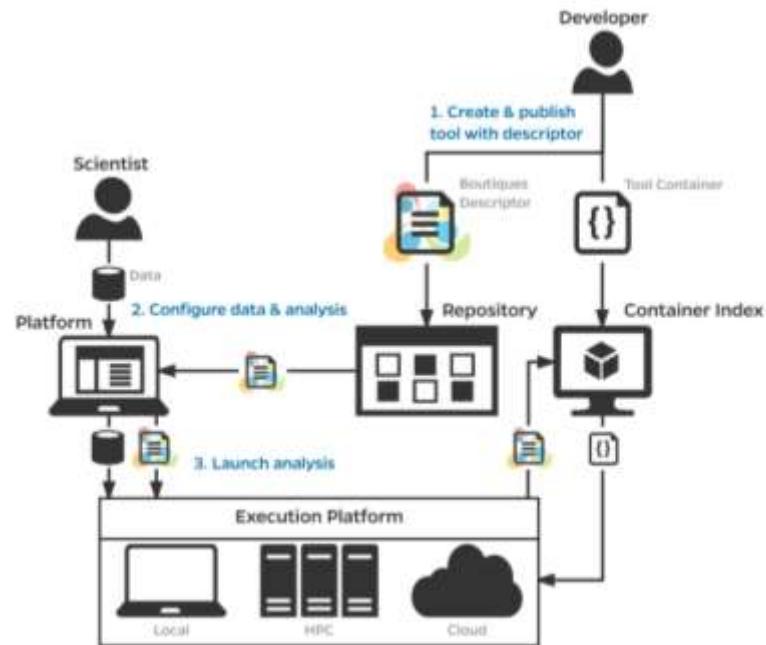


Figure 1. Publication, integration, and execution of applications with Boutiques.

# Pipelines in CBRAIN

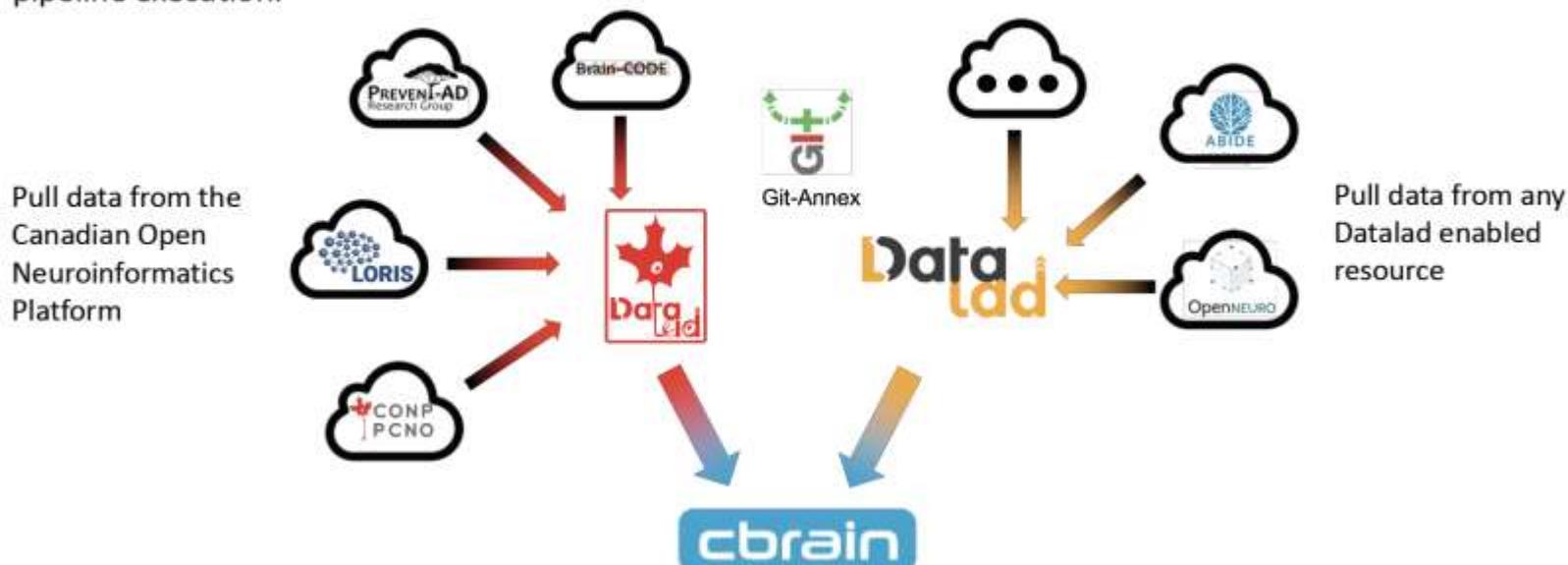
CBRAIN has over 50 execution pipelines available to users

Software	Pipelines
Civet 2.1	Civet Quality Control Tool, Civet Structural Processing Pipelines, NuCorrect
FSL 5.0	FslBedpostx, FslBet, FslFast, FslFirst, FslFlirt, FslAnat, FslRandomise, FslMelodic, FslProbboxX, FslProbboxX2, FslSub, FslFeat
FreeSurfer 6.0.0	ReconAll, ReconAll.ongl
MINCTools	Minccoverage, Minmac, Mincpik, Mincresample, Mnc2nii, Nii2mnc, Dcm2mnc, MINCBet, MincConvert, Dcm2nii
Ants 2.1.0	AntsRegistration
Niak	FRMI/T1 Preprocessing
HERMES	Supply Chain Simulation Model
PSOM	PSOM Worker Launching
INCA-AROMA	Functional MRI Pipeline
NDMG	Connectome Estimation
QEEG	EEG / MEG Analysis
pCEV	Principal Component analysis

## Datalad Integration

Datalad is a Python tool that builds on top of git-annex and extends it with an intuitive command-line interface to enable transparently operating and managing data.

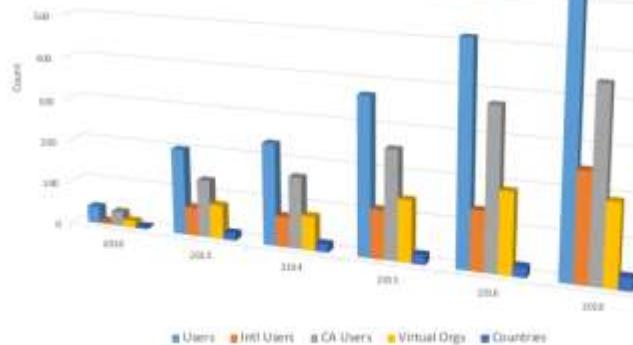
A CBRAIN Datalad DataProvider allows data from any Datalad repository to be imported into CBRAIN for pipeline execution.



If data is in Datalad, it is now automatically available in CBRAIN!

# cbRAIN

## CBRAIN Worldwide User Community



### Users

- > 900 Users (100s active at a given time)
- 193 Sites from 30 different countries
- > 30 Million CPU Hours served
- > 1 Million Files (100s TB of data)

### Development Team

- 5 Full Time Developers

### Support

- Canadian Foundation for Innovation
- CANARIE
- Healthy Brains for Healthy Lives (HBHL)
- Canadian Open Neuroscience Platform (CONP)
- Canada/Cuba/China Axis (CCCAxis)

### Collaborations

- Big Data Infrastructures in Neuroinformatics (Glatard)
- CARMIN Project
- Compute Canada
- Texas Advanced Computing Center. (TACC)
- Pittsburgh Supercomputing Center (PSC)
- PERFORM Centre
- Human Brain Project
- OpenNeuro Platform



# Become a CBRAIN User

- Sign Up for an account (completely free!)
  - <http://portal.cbrain.mcgill.ca>



compute  
canada | calcul  
canada



# MNI data-sharing and processing ecosystem

frontiers in  
NEUROINFORMATICS

TECHNICAL REPORT  
Volume 10 | Article 3022  
July 2018 | doi:10.3389/fnins.2018.003022

frontiers  
in  
neuroinformatics

Volume 10 | Article 3023  
July 2018 | doi:10.3389/fnins.2018.003023

## LORIS: a web-based data management system for multi-center studies

Samir Das<sup>1,2\*</sup>, Alex P. Zijdenbos<sup>3</sup>, Jonathan Narins<sup>4</sup>, Davis Vito<sup>4</sup> and Alan C. Evans<sup>1</sup>

<sup>1</sup> Montreal Neurological Institute, McGill University, Montreal, Canada  
<sup>2</sup> Diagnostic Radiology, McGill, Canada  
<sup>3</sup> Radiology, Columbia, New York, NY, USA  
<sup>4</sup> White-McGill Center for Neuroimaging, Montreal, Quebec, Canada

**Abstract for**  
John Evans, University of  
Catharine Aguirre, UCR

**Received by**  
David S. Witten, University of  
Massachusetts Medical School  
Joseph A. Toga, New York  
Howard, Wisconsin, USA

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Longitudinal Online Research and Imaging System (LORIS) is a modular and extensible web-based data management system that integrates all aspects of a multi-center study, from heterogenous data acquisition imaging, clinical, behavioral, and genetic to storage, processing, and ultimately dissemination. It provides a secure, user-friendly, and streamlined platform to automate the flow of clinical trials and complex multi-center studies. A subcomponent, internal organization allows researchers to capture and subsequently extract all information, longitudinal or cross-sectional, from any subset of the study cohort. Extensive programming and quality control procedures, security data management, and auditability are built into the system. LORIS is a centerpiece in a network of a number of interconnected

Keywords: data management, longitudinal, LORIS, research, study, web-based

## A Serverless Tool for Platform Agnostic Computational Experiment Management

Gregory Kiar<sup>1,2\*</sup>, Steven T. Brown<sup>3</sup>, Tristan Glatard<sup>4</sup>, and Alan C. Evans<sup>1</sup>

<sup>1</sup> Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada

<sup>2</sup> Neuroinformatics, Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada  
<sup>3</sup> Diagnostic Radiology, Columbia, New York, NY, USA  
<sup>4</sup> White-McGill Center for Neuroimaging, Montreal, Quebec, Canada

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e-mail: gkiar@mcgill.ca

**Keywords:** data management, experiment, platform, serverless, tool

## The MNI data-sharing and processing ecosystem

Samir Das<sup>1,2\*</sup>, Tristan Glatard<sup>3,4</sup>, Leigh C. Mackay<sup>5</sup>, Cedric Maturi<sup>6</sup>, Christine Rogers<sup>7</sup>, Marc L'Ecuyer-Morin<sup>8</sup>, Rehaneh Kavousi<sup>9</sup>, David MacLaren<sup>10</sup>, Zia Mekhora<sup>11</sup>, Ruth Gersbach<sup>12</sup>, Leslie Lestou<sup>13</sup>, Philippe Bourassa<sup>14</sup>, Zouhaier Souissi<sup>15</sup>, Supratik Kalioti-Makris<sup>16</sup>, Lucien Nish<sup>17</sup>, T. Murray<sup>18</sup>, Alan C. Evans<sup>1</sup>

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<sup>18</sup> MNI, Diagnostic Radiology, Columbia, New York, NY, USA

## Open-source, documented code repositories

- CBRAIN
- LORIS

<https://github.com/aces/cbrain>  
<https://github.com/aces/Loris>

frontiers in  
NEUROINFORMATICS

TECHNICAL REPORT  
Volume 10 | Article 3024  
July 2018 | doi:10.3389/fnins.2018.003024

## BrainBrowser: distributed, web-based neurological data visualization

Samir Das<sup>1</sup>, Klaesler Lecours Blaauw<sup>2,3\*</sup>, Christine Rogers<sup>4</sup>, Caroline Malouet<sup>5,6</sup>, François Chouinard-Duverne<sup>7</sup>, Nathalie Gosselin<sup>8,9</sup>, Pierre Roussin<sup>10</sup>, Shaeen T. Brown<sup>11</sup>, Zia Mekhora<sup>12</sup>, Sophie Zeeb<sup>13</sup>, Victoria Fung<sup>14</sup>, Marie Forney<sup>15</sup>, Karen J. O'Donnell<sup>16</sup>, Kristen Clark<sup>17</sup>, Michael J. Meaney<sup>18,19</sup>, Celia M. F. Greenwood<sup>20</sup> and Alan C. Evans<sup>1</sup>

<sup>1</sup> Montreal Neurological Institute, McGill University, Montreal, QC, Canada  
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<sup>20</sup> Diagnostic Radiology, Columbia, New York, NY, USA

## Integration of "omics" Data and Phenotypic Data Within a Unified Extensible Multimodal Framework

Samir Das<sup>1,2\*</sup>, Klaesler Lecours Blaauw<sup>2,3\*</sup>, Christine Rogers<sup>4</sup>, Caroline Malouet<sup>5,6</sup>, François Chouinard-Duverne<sup>7</sup>, Nathalie Gosselin<sup>8,9</sup>, Pierre Roussin<sup>10</sup>, Shaeen T. Brown<sup>11</sup>, Zia Mekhora<sup>12</sup>, Sophie Zeeb<sup>13</sup>, Victoria Fung<sup>14</sup>, Marie Forney<sup>15</sup>, Karen J. O'Donnell<sup>16</sup>, Kristen Clark<sup>17</sup>, Michael J. Meaney<sup>18,19</sup>, Celia M. F. Greenwood<sup>20</sup> and Alan C. Evans<sup>1</sup>

<sup>1</sup> MNI, Diagnostic Radiology, Columbia, New York, NY, USA  
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## TECHNICAL NOTE

**Boutiques: a flexible framework to integrate command-line applications in computing platforms**

Tristan Glatard<sup>1,2\*</sup>, Gregory Kiar<sup>2,3</sup>, Trista Aumentado-Armstrong<sup>2,3</sup>, Natacha Beck<sup>1,2</sup>, Pierre Bellec<sup>2,3</sup>, Rémi Bernard<sup>2,3</sup>, Axel Bonnet<sup>2,3</sup>, Shawn T. Brown<sup>2,3</sup>, Sorina Camarasu-Pop<sup>2</sup>, Frédéric Cervenansky<sup>2</sup>, Samir Das<sup>2,3</sup>, Rafael Ferreira da Silva<sup>2,3</sup>, Guillaume Flandin<sup>2</sup>, Pascal Girard<sup>2</sup>, Krzysztof Gorolewski<sup>2,3</sup>, Charles R.G. Guttmann<sup>2</sup>, Valérie Haout-Sasson<sup>2</sup>, Leigh Fenton<sup>1,2</sup>, Michael J. Meaney<sup>1,2</sup>, Zia Mekhora<sup>1,2</sup>, Sophie Zeeb<sup>1,2</sup>, Victoria Fung<sup>1,2</sup>, Marie Forney<sup>1,2</sup>, Karen J. O'Donnell<sup>1,2</sup>, Kristen Clark<sup>1,2</sup>, Michael J. Meaney<sup>1,2</sup>, Celia M. F. Greenwood<sup>1,2</sup> and Alan C. Evans<sup>1,2</sup>

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<sup>3</sup> Diagnostic Radiology, Columbia, New York, NY, USA

## Cyberinfrastructure for Open Science at the Montreal Neurological Institute

Samir Das<sup>1,2\*</sup>, Kristen Blaauw<sup>1</sup>, Christine Rogers<sup>3</sup>, John Soglio<sup>4</sup>, Santiago Pons<sup>1,5</sup>, Leigh MacLaren<sup>6</sup>, Zia Mekhora<sup>7</sup>, Caroline Malouet<sup>8</sup>, Nathalie Gosselin<sup>9</sup>, Jonathan Stirling<sup>10</sup>, Marc L'Ecuyer-Morin<sup>11</sup>, David MacLaren<sup>12</sup>, Pierre Roussin<sup>13</sup>, Pierre Aloush<sup>14</sup>, Cedric Maturi<sup>15</sup>, Xavier Lescure-Blaauw<sup>16</sup>, Sophie Zeeb<sup>17</sup>, René Jolani<sup>18</sup>, Pierre Aloush<sup>19</sup>, Zia Mekhora<sup>20</sup>, Sophie Zeeb<sup>21</sup>, Sophie M. Durcan<sup>22</sup>, Valerie Fung<sup>23</sup>, René Jolani<sup>24</sup>, Jennifer Morris<sup>25</sup>, Michael Degroot<sup>26</sup>, Thomas M. Durcan<sup>27</sup>, Tara Campbell<sup>28</sup>, Jeremy Morris<sup>29</sup>, Alan Siegler<sup>30</sup>, D. Louis Collins<sup>31</sup>, Jason Remouchamps<sup>32</sup>, Amit Dan<sup>33</sup>, Edward A. Fawcett<sup>34</sup>, Sylvain Baile<sup>35</sup>, Day Routhier<sup>36</sup> and Alan C. Evans<sup>1,2</sup>

<sup>1</sup> MNI, Diagnostic Radiology, Columbia, New York, NY, USA  
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<sup>36</sup> Diagnostic Radiology, Columbia, New York, NY, USA

## National Neuroinformatics Framework for Canadian Consortium on Neurodegeneration in Aging (CCNA)

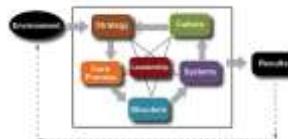
Zia Mekhora<sup>1,2\*</sup>, Samir Das<sup>1,2</sup>, Rita Abu-Hamdiya<sup>1,2</sup>, Mouna Zell-Harabi<sup>1,2</sup>, David Blaauw<sup>1,2</sup>, Jennifer Calligaris<sup>1,2</sup>, Charlie Henni-Belliveau<sup>1,2</sup>, Jing-Jie Fu<sup>1,2</sup>, Ming Tang<sup>1,2</sup>, Leigh Fenton<sup>1,2</sup>, Tara Campbell<sup>1,2</sup>, Derek Lu<sup>1,2</sup>, Pierre-Emmanuel Marin<sup>1,2</sup>, Victor Whitcher<sup>1,2</sup>, Howard Cheung<sup>1,2</sup> and Alan C. Evans<sup>1,2</sup>

<sup>1</sup> MNI, Diagnostic Radiology, Columbia, New York, NY, USA  
<sup>2</sup> Diagnostic Radiology, Columbia, New York, NY, USA



# Canadian Open Neuroscience Platform

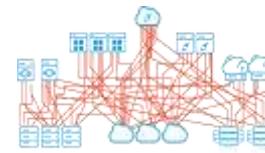
<https://conp.ca/>



Organizational Design



Scalability



Interoperability



Analysis Packages



Training



International Partnerships



Ethics and Data Governance



Communications Platform



Public Release of Prospective AD cohort



# Global Brain Consortium

Focused on **EEG**, behaviour, interoperability, outreach to LMIC

GBC workshop in Q2, 2019 (~50 people)

World Health Organization (OHBM-WHO Geneva meeting, 2017)



GBC Steering committee



Gary Egan  
Monash U.  
Australian  
Brain Alliance



Maryann Martone  
UCSD  
INCF, NIF



Jean-Baptiste Poline  
McGill U.  
CONP, INCF



Katrin Amunts  
Julich  
HBP



Alan Evans  
McGill U.  
CONP, INCF



Jane Roskams  
UBC, CONP,  
Cascadia Data  
Alliance



Pedro Valdez-Sosa  
UESTC/CNEURO  
China/Cuba/CCC



Bartha Knoppers  
McGill U.  
CONP, GA4GH

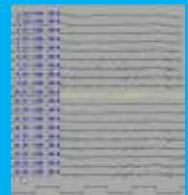


Paul Thompson  
USC  
ENIGMA



Greg Farber  
NIH  
US Brain Initiative

4D spatiotemporal dynamics



LMIC applications



## Interoperability with the cloud is key

- Our platforms have the capability to already interact with the cloud

## Fully documented APIs are imperative !

- Our platforms have fully documented RESTful APIs
- Using our APIs can fully interact with the cloud for storage

## Standardization is key to facilitating cloud based initiatives

- Independent of where data is stored, but needs to be done

## Using cloud resources can be \$\$ (i.e. redundant data transfers)

- Depends on the use-case (cost of maintaining storage vs. cloud)
- Once we get to the PB level, cloud storage becomes attractive
- Neuroimaging datasets are made up many small files (ideal for object stores)

## Containerization is a best practice (e.g. Docker, Singularity)

- Can take advantage of more scalable technologies (e.g. Kubernetes)

## Neuroscience workflows are amenable to cloud computing

- Many small memory (4-16GB) naturally parallel processes
- Requires a large amount of data movement and orchestration

## Having data storage close to processing can be efficient

- If cloud computing is used, data transfer will be cheaper
- If compute is outside the cloud, transfer much more expensive

Important  
cloud  
considerations

# Potential cloud risks and limitations

## Security is outsourced to provider to some degree

- Cloud providers provide differing levels of secured storage

## Privacy might be in the fine print

- Must be careful the provider doesn't suddenly own data (e.g. Dropbox)

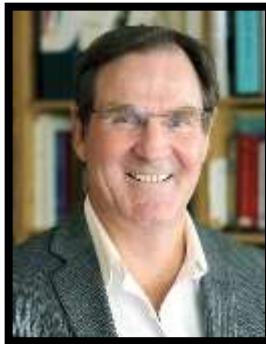
## Prohibitively expensive for very large memory workflows

- Still more cost-effective to perform on traditional HPC resources

## Cost structure is much more complex

- Users left to their own devices could rack up large bills
- Poorly implemented infrastructures could lead to large costs for users
- Funding agencies will now have every grant paying for computing
- Should explore large cloud purchase for the whole community

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