Summary

- What is CBRAIN?
  - What is it for?
  - Who uses it and how much?
  - A Few Special Projects

- What can it do for you?

- Can I get access? Can I get involved?
Funded by CANARIE
CANADA'S ADVANCED RESEARCH AND INNOVATION NETWORK
http://www.canarie.ca
Canadian Brain Imaging Research Network
2009-2010
Global Brain Imaging Research Network
2010-2012
What is CBRAIN?
What is Neuro-Imaging?

- Clinical Expertise
- Basic Neuroscience
- Imaging Technology
- High Performance Computing
- Physical Sciences

Brain Imaging Techniques:
- Magnetic Resonance Imaging (MRI)
- Functional MRI (fMRI)
- Position Emission Tomography (PET)
- Magnetoencephalography (MEG)
Neuro-Imaging Applications

**Population Studies:**
- Alzheimer’s Disease
- Multiple Sclerosis
- Autism
- Schizophrenia
- Normal brain development

![Alzheimer loss of cortical thickness](image1)
![Multiple Sclerosis lesions](image2)
![Normal Brain Development in Children](image3)
A Processing Pipeline: CIVET

- Hundreds of MRI per study
- GBs of data
- Thousands of CPU hours
Removing Obstacles to Compute

Scientist
Vancouver
Montreal

Data
Vancouver & Montreal
10 GB

Computing
Sherbrooke
4000 CPU hours

Results
Vancouver & Montreal
100GB
Challenges: Users

Most Neuroscientists are not IT experts
- Don’t want to deal with networks, HPC processing, UNIX, etc.
- Just want to use specific tools with their data and get the results.
- They want to share, but they want to control their data.
- Research requirements are unclear and unstable.
Challenges: Heterogeneous HPC

Scientists
With HPC expertise

HPC Site 1

HPC Site 2
CBRAIN: An Integrative Platform
CBRAIN: Simple Web Interface
CBRAIN: Simple Web Interface

File & Project Management (inputs & results)
CBRAIN: Simple Web Interface

Task Parameters (Help):

- Pipeline Options
  - Template: 1.00
  - Modul: [cbm152n]

- CIVET options
  - Interpolation: trilinear
  - N3 distance: 0
  - Degrees of freedom for linear registration: 9
  - Do NOT build surfaces: [ ]
  - Thickness method: tlink, and kernel size: 20
  - Resample surfaces: [ ]
  - Combine surfaces: [ ]

- VBM Options
  - Process VBM files: [ ]
  - Blurring kernel size in mm for volume: 8
  - Run symmetry tools: [ ]
  - Keep cerebellum in VBM maps: [ ]

- MINC file input list
  - Launch CIVET?
  - Pre AA_2071574_mprage.20050926.0001.niflip.mnc

Tool configuration

Compute Job status and Management
CBRAIN: Simple Web Interface

Results, QC, Provenance and Visualisation
CBRAIN
Transparent Compute Access
Transparent Data Grid
Interactive Scientific Visualisation
Community Portal

[Diagram showing a network of users connected to a central CBRAIN resource, with箭头 pointing to HPC and Tools & Compute services.]
Generic Research Platform
CBRAIN
International Platform
Current Worldwide Distribution
CBRAIN Users
CBRAIN Platform Statistics

Usage

- Jobs Launched: 4000 (Aug. 2010), 125,000 (Dec. 2011)
CBRAIN Platform Statistics

Workload

(Official Compute Canada Resources Only)

<table>
<thead>
<tr>
<th>Year</th>
<th>Allocated</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.3M</td>
<td>0.4M</td>
</tr>
<tr>
<td>2011</td>
<td>1.1M</td>
<td>1.3M</td>
</tr>
<tr>
<td>2012</td>
<td>3.7M</td>
<td></td>
</tr>
</tbody>
</table>
HPC Integration 2012
(11 compute installations, 80,000+ core)
outGRID – GBRAIN
(EGI Tech Forums 2011, Lyon: Best live demonstration)
BrainBrowser – Web3D
Planes, brains and automobiles

MACCAC Maps

Mesh and Fibertracks

DLR-F6 Model

Aston Martin
Big Brains
- Drs. Zilles & Amunts -
Post-Mortem High-Resolution Histology

- Rip & Tear correction
  - ~5000 CPU hours

- Non-linear slice alignment, 50 iterations
  - ~370,000 CPU hours

- Conversion: 1TB 3D data structure
  - HPC ~160 CPU hours

- 1TB of data per brain
- 7408 Slices
- 11500x8800 pixels

- Animal studies will generate a few dozens per year

Goal: Collaborative, Real-Time 3D Visualization
Big Brains – Atelier3D
Histology – Neuroimaging – HPC – Modeling/Visualisation

Atelier3D
VIT - NRC
Large Animal Datasets (Dr. Bedell)

CBRAIN
BrainBrowser

Atelier 3D
What can CBRAIN do for you?
Typical Usage

- Access to pre-installed tools, converters, pipelines.
- Access to large amounts of compute power (project speedup).
- Long distance collaborations / data sharing.
- Web based visualisations.
- Do things you could not easily do before!
Illustrative Performance Comparison

NIH-Pediatric-Obj1: up to 3 visits per subject

866 CIVET pipeline runs to generate cortical thickness maps
Input: 866 x 3 x 5Mb = 15Gb
Output: 866 x 250 Mb = 211Gb

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Total CPU-hrs</th>
<th>Maximum Performance</th>
<th>Typical Performance</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td># cores</td>
<td>Execution time</td>
</tr>
<tr>
<td>mammouth-ms2 (RQCHP -Sherbrooke)</td>
<td>866 x 4 = 3464</td>
<td>~500</td>
<td>3hr</td>
</tr>
<tr>
<td>CLUMEQ-Krylov (McGill)</td>
<td>866 x 6 = 5196</td>
<td>~90</td>
<td>2.5d</td>
</tr>
<tr>
<td>BIC (MNI)</td>
<td>866 x 8 = 6928</td>
<td>~100</td>
<td>3d</td>
</tr>
</tbody>
</table>

In general, studies which use to take 1 week to 1 month now take 1 day.
Available Tools
Based on Community requests!
Come talk to us, we will see what we can do.

CIVET
NIAK (Dr. Bellec)
FSL (some tools)
Minc tools (some tools)
FreeSurfer recon-all
SPM Batch
Format conversion (minc, nifty, dicom, analyze…)
Cw5
Can the tools be complex?

Dynamic Flowchart for fMRI pre-processing (NIAK) – 2 subjects
Patterns of cortical thickness and surface area in early Parkinson’s disease

Thomas Joubaurd, Jean-François Gaet, C. Evans, Oury Monchak

Integration of a neuroimaging processing pipeline into a pan-canadian computing grid


Virtual imaging laboratory for marker discovery in neurodegenerative diseases

Shahab A. Fizuli, Alberts Neufeld, David Macdonald, Marco Echizen, Arthi Tang and Paul Zanzer

Introduction

Research in neurodegenerative diseases is occurring in a very fast and active environment, where access to a wide range of resources is essential. The availability of computational resources is crucial to supporting research in this field. The virtual imaging laboratory (VIL) is a distributed computing infrastructure that provides a platform for researchers to process and analyze neuroimaging data. The VIL is built on an open-source framework that allows for easy integration of new tools and resources. It provides a scalable and flexible environment for researchers to collaborate and share data. The VIL is designed to support a wide range of research projects, including clinical trials, basic research, and translational research. The VIL is also designed to be user-friendly, with a web-based interface that allows researchers to access and manage their data. The VIL is a powerful tool for researchers working on neurodegenerative diseases, and it is continually being expanded to meet the needs of the research community.
Selected Conferences and Press


EGI User Forum 2011, Vilnius, Lithuania, Invited Speaker, GBRAIN Project (a CANARIE NEP Project).


HPCS 2011, Montreal, Canada, Invited Speaker, CBRAIN: Canadian Neuroinformatics Platform.


Rapport Annuel RISQ 2009-2010: Le Project CBRAIN

Colloque RISQ 2009: Highest Satisfaction level (from public vote)

CBRAIN technologies produced a cover page for Ducharme & al in Biological Psychiatry (see Publication: Biol Psychiatry. 2011 Aug 1;70(3):283-90. Epub 2011 Apr 30.)


CANARIE opens the “ultra-fast lane”. Telemanagement. http://www.tele-management.ca/content/23481-canarie_opens_the_%E2%80%9Cultra_fast_lane%E2%80%9D

Selected 2011 Publications


Gong G, He Y, Chen ZJ, Evans AC. **Convergence and divergence of thickness correlations with diffusion connections across the human cerebral cortex.** Neuroimage. 2011 Aug 22. [Epub ahead of print]


Operation and Support

- Compute Canada Support (3.7M hours for 2012)
- Creation of a Center for Neuroinformatics
- CFI Application
  - 5 PB Datacenter, part of Compute Canada environment
  - Obtained Server Room support for 5 years from McGill
  - Obtained Compute Canada and CLUMEQ-ETS support
- Partner Projects
  - Small contracts to support specific CBRAIN projects (Julich, outGRID…)
- CANARIE & Compute Canada next round (in 2012)
  - National Research Platform Initiative.
Can I get access?
Can I get involved?
cbrain.mcgill.ca
Contact Our Team

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CBRAIN Architecture

CBRAIN Portal

- Databases
- Remote File Systems

Web Services

- CBRAIN Portal
- Network
- Data Access API
- REST - Ajax
- Web sockets

Scientific Data

- HTML5
- WebGL

Remote Resources

- User Desktop
- Cloud

Tools & VMs

- Virtualisation Services
- Virtual Machines
- Tool Packages

Compute Resources

- HPC
- HPC Scheduler API

Execution Controller

- Data Access API
- Authentication Authorization
- Job Processing
- Logging & Reporting

Models & Metadata

- Files
- Tasks
- VOs
- Tools
- Users
- Privs

Rich Web Client

- Data Management & VOs
- Tool & Compute Access
- Reports
- 2D & 3D Data Visualisation
- Administrative Services
- 3rd Party Clients

Authentication

Authorization

Job Processing

Visualisation 2D - 3D

2D & 3D Data Visualisation

Administrative Services

3rd Party Clients

Browser Services

Authentication Authorization

Logging & Reporting

REST

XML

Web sockets

Data Management & VOs

Tool & Compute Access

Reports

2D & 3D Data Visualisation

Administrative Services

3rd Party Clients

Authentication Authorization

Logging & Reporting

REST

XML

Web sockets

Data Management & VOs

Tool & Compute Access

Reports

2D & 3D Data Visualisation

Administrative Services

3rd Party Clients

Authentication Authorization

Logging & Reporting

REST

XML

Web sockets

Data Management & VOs

Tool & Compute Access

Reports

2D & 3D Data Visualisation

Administrative Services

3rd Party Clients

Authentication Authorization

Logging & Reporting

REST

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REST

XML

Web sockets
CBRAIN Project Team & Partners

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  McGill Office of Technology Transfer (OTT): François Labonte
  Canada National Research Council: Louis Borgeat
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  Developers: Anda Pacurar, Anita Ode, Jacques Waller

Robarts Research Institute, University of Western Ontario
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  Developers: Martyn Klassen, Ronghai Tu

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  Developer: Mathieu Desrosiers

Division of Neurology, University of British Columbia
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CBRAIN acknowledges the contributions of IBM Canada
  Jonathan Harlap and Sebastian Muehlboeck.
Contact Our Team

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Project Manager:
Reza Adalat – reza.adalat@mcgill.ca
CBRAIN
Technical Overview
HPC Scheduling
(SCIR: Simple Cluster Interface in Ruby)
Flexible Resource Access
Julich Forschungszentrum, Germany

Large dataset assembly pipeline (current and future Big Brains)
Remote visualization of Big Brains (A3D)
MRI study
Operations in 2012