Biomedical Informatics Research Network

National Center for Research Resources

Every day, scientists connected by the NCRR-funded Biomedical Informatics Research Network (BIRN) are working with their colleagues across the country to develop and refine imaging and analytic tools that can be used for multi-site data integration. BIRN tools are available to researchers around the world as they pursue the causes of Alzheimer's disease, schizophrenia, major depression, Attention Deficit Hyperactivity Disorder, and autism, and develop effective treatments. Researchers in other medical fields, including cardiology and cancer, recognize the value these tools have to their research and their wide applicability throughout biomedical research.

Overview

BIRN uses emerging technology advances to enhance collaborative efforts that integrate data, expertise, and unique technologies from research centers across the country. The first three years of the project have led to significant contributions with the promise of further development and wider applicability. Accomplishments include publicly available tools and datasets as well as building network infrastructure.

Large-scale collaborations are dependent on the capabilities of the national cyberinfrastructure of high-speed networks, distributed high-performance computing and the necessary software and data integration capabilities. These technologies are changing rapidly, in part because of how they are being used by large biomedical projects. Thus, collaborations within BIRN include scientists in a large number of biomedical sub-disciplines as well as computer scientists and engineers who are creating this cyberinfrastructure.

Currently, BIRN involves a consortium of 20 universities and 30 research groups participating in projects on brain imaging of human neuropsychiatric disease and associated animal models. Some groups are working on large-scale, cross-institutional imaging studies on Alzheimer's disease, depression, and schizophrenia using structural and functional magnetic resonance imaging (MRI). Others are studying animal models relevant to multiple sclerosis, attention deficit disorder, and Parkinson's disease using MRI, whole brain histology, and high-resolution light and electron microscopy. These projects present practical and immediate requirements for performing large-scale biomedical informatics studies and provide multiple usage cases for distributed computation and the handling of heterogeneous data. Incorporation and harmonization of multiple neuro-ontologies across datasets, which is critical for the long range goal of data mining through this infrastructure, is just one of the many practical issues that BIRN is addressing.

Summary of BIRN—Coordinating Center presentation

This presentation focuses on the development and deployment of key infrastructure components for immediate and long-range support of the scientific goals pursued by biomedical scientists. These components include high-bandwidth inter-institutional connectivity via Internet2, a uniformly consistent security model, grid-based file management and computational services, software and techniques to federate data and databases, data caching and replication techniques to improve performance and resiliency, and shared processing, visualization and analysis environments. As a core component of the BIRN infrastructure, Internet2 provides a solid foundation for the future expansion of the infrastructure as well as the stable high-performance network required by researchers in a national collaborative project. Researchers are also benefiting directly from the connectivity to high-performance computing resources, such as TeraGrid. Currently researchers are performing advanced shape analyses of anatomical structures to gain a better understanding of diseases and disorders. These analyses, run on TeraGrid, have produced over 10TB of resultant data which have been stored on the BIRN Data Grid.

As the requirements of the biomedical community become more specific through large biomedical projects, the national cyberinfrastructure being assembled to enable large-scale science projects will also evolve. As these technologies mature, the BIRN program is uniquely situated to serve as a major conduit between the biomedical research community of NIH-sponsored programs and the information technology development programs, mostly supported by other government agencies (e.g., NSF, NASA, DOE, DARPA) and industry.

For more information, contact Mark Ellisman, BIRN-CC Principal Investigator at 858-534-2251 or at mark@ncmir.ucsd.edu

Summary of Morphometry BIRN presentation

This presentation describes the scientific goals, methods, preliminary results and long-term vision for the Brain Morphometry BIRN (mBIRN). The overall goal of the Morphometry BIRN is to develop the capability to collect, analyze and mine data acquired at multiple sites, using processing and visualization tools developed at multiple sites, to study the neuroanatomical correlates of neuropsychiatric illnesses in such disorders as unipolar depression, mild Alzheimer's disease, and mild cognitive impairment. Through large-scale analyses of patient population data acquired and pooled across sites, mBIRN scientists are investigating whether brain structural differences correlate to symptoms such as memory dysfunction or depression, and whether specific structural differences distinguish diagnostic categories.

The mBIRN effort is divided into four broad categories of effort: Calibration, Analysis & Visualization, Computational Informatics, and Utilization. The mBIRN has now developed and validated procedures which allow data to be acquired on multiple vendor platforms, at multiple time points, to be analyzed as a single dataset, and is working on extending this paradigm to a broad variety of imaging techniques. Working with the BIRN-CC, data analysis and visualization tools developed at different sites have now been integrated to process clinical data in unique ways, and application of informatics tools have allowed mBIRN investigators to make fundamental new

discoveries on the relationships between brain anatomy and clinical symptoms. Several mBIRN developments have been adopted and utilized by investigators in Function and Mouse BIRN and, importantly by other national consortium groups throughout the country.

For more information, contact Bruce Rosen, Brain Morphometry BIRN Principal Investigator at 617-726-5122 or bruce@nmr.mgh.harvard.edu

Summary of Function BIRN presentation

This presentation describes what many considered improbable just a few years ago: the ability to do multi-site functional imaging studies on the most vexing neuropsychiatric diseases and disorders afflicting mankind. Measures of brain activities involved in thinking and emotion are by their very nature subtle and functional imaging measurements are not made in the same ways in different centers.

Function BIRN (FBIRN) computer and clinical scientists have shown for the first time that differences in measurement can render multi-center imaging studies worthless or even misleading. Further, FBIRN has developed methods of standardization and calibration to reduce variability between sites – a major breakthrough for multi-site imaging studies. To share these techniques, FBIRN developed a distributed infrastructure that includes standardization protocols, a human imaging database, quality assurance methods, and protection of subject confidentiality.

Coupled with improved methods for 3D alignment of brains for accurate comparisons and automated image analysis pipelines, these developments will rapidly create the required but unusually large datasets critical to understanding the subtlety of schizophrenia and other neuropsychiatric diseases and brain disorders. FBIRN is developing new methods to further decrease between-site variation, new cognitive tasks that tap the important interaction between cognition and emotion, and cutting-edge methods for image analysis and display.

For more information, contact Steven Potkin, FBIRN Principal Investigator at 949-824-8040 or sgpotkin@uci.edu

Summary of Mouse BIRN presentation

This presentation provides an overview of the objectives, status and scientific applications of the Mouse BIRN. Its goals are to develop tools that enable sharing and mining of multi-scale structural and functional mouse brain data.

An enormous worldwide effort to understand the relationship between mouse genotype, phenotype and behavior is well underway. Numerous studies collect data about genes and their expression in the mouse, including many specifically constructed strains some of which model diseases that afflict humans. Surprisingly, to date, there is no real infrastructure to share data and compare and contrast observations about gene expression, neuroanatomy or other observations within a quantitative and visual framework. The focus of the Mouse BIRN is to create and distribute such a capability.

Building upon considerable progress from previously independent groups, Mouse BIRN scientists have created an integrated, networked system that maps data from different animals, different data types at different scales from multiple

laboratories into a unified measurement and display package. Data can be distributed or remain local. Image and data manipulation tool sets to make them comparable are part of the package. It is adaptable and extensible, accepting new modules that identify structures, ie., new anatomic templates.

Mouse BIRN scientists have collected and created a database of high-field MR data, histology, gene expression and other data describing the mouse brain. Our scientists have also identified three disease model test beds (Alzheimer's disease, Multiple Sclerosis and Parkinson's disease) to evaluate the infrastructure.

For more information, contact Arthur Toga, Mouse BIRN Principal Investigator at 310-206-2101 or toga@loni.ucla.edu.

Bios of the presenters

Mark Ellisman is Professor of Neurosciences and Bioengineering at the University of California, San Diego. He is the co-leader of the National Science Foundation-supported National Partnership for Advanced Computing Infrastructure (NPACI) and coordinates the Interdisciplinary and Neuroscience activities for NPACI and the San Diego Supercomputer Center (SDSC).

Bruce Rosen is Professor of Radiology and Health Sciences Technology at the Harvard Medical School and Massachusetts General Hospital (MGH.) He is Director of the Athinoula A. Martionos Center for Biomedical Imaging, a joint laboratory between MGH and the Harvard-M.I.T. Division of Health Sciences and Technology.

Steven Potkin is Professor of Psychiatry and Human Behavior at the University of California, Irvine School of Medicine. He is the Robert R. Sprague Director of the Brain Imaging Center (BIC), director of the Transdisciplinary Imaging Genetics Center (TGIC) and director of the Clinical Neuropsychiatric Research program.

Arthur Toga is Professor of Neurology at the University of California, Los Angeles School of Medicine. He is the director of the Laboratory of Neuro Imaging (LONI), director of the Computational Neuroscience Program in the Center for Cognitive Neuroscience and co-director of the Division of Brain Mapping.

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