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The BIRN Project: Distributed Information Infrastructure and Multi-scale Imaging of the Nervous System (BIRN = Biomedical Informatics Research Network)

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The grand goal in neuroscience research is to understand how the interplay of structural, chemical and electrical signals in nervous tissue gives rise to behavior. Experimental advances of the past decades have given the individual neuroscientist an increasingly powerful arsenal for obtaining data, from the level of molecules to nervous systems. Scientists have begun the arduous and challenging process of adapting and assembling neuroscience data at all scales of resolution and across disciplines into computerized databases and other easily accessed sources. These databases will complement the vast structural and sequence databases created to catalogue, organize and analyze gene sequences and protein products. The general premise of the neuroscience goal is simple; namely that with “complete” knowledge of the genome and protein structures accruing rapidly we next need to assemble an infrastructure that will facilitate acquisition of an understanding for how functional complexes operate in their cell and tissue contexts. Our U.C. San Diego-based group is leading several interdisciplinary projects around this grand challenge. We are evolving a shared infrastructure that allows for mapping molecular and cellular brain anatomy in the context of a shared multi-scale mouse brain atlas system, the Cell-Centered Database (CCDB). Complementary to these neuroinformatics activities at the National Center for Microscopy and Imaging Research in San Diego (NCMIR) we have developed new molecular labeling methods compatible with advanced ultra-wide field laser-scanning light microscopy and multi-resolution 3 dimensional electron microscopy. These new labeling and imaging methods are being used to populate the CCDB, using as a driver mouse models of neurological and neuropsychiatric disorders. The informatics framework is facilitating cooperative work by distributed teams of scientists engaged in focused collaborations aimed to deliver new fundamental understanding of structures on the scale of 1 nm3 to 10’s of μm3, a dimensional range that encompasses macromolecular complexes, organelles, and multi-component structures like synapses and the cellular interactions in the context of the complex organization of the entire nervous system. This is a unique and pioneering effort that links new neuroscience techniques and revolutionary advances in information technology. Database federation tools are critical to the scalability of these efforts and future development plans will be described in the context of the NIH-supported project to create a new framework for collaboration and data integration in the Biomedical Informatics Research Network (BIRN). BIRN is the leading example of a virtual database effort that is using the challenge of federating multi-scale distributed data about the nervous systems to help guide the evolution of an International Cyberinfrastructure serving all science disciplines, including biomedicine.

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