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Standardization in Rodent Atlas Mapping: Waxholm Space (WHS)

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The organization and understanding of today's massive amounts of data requires powerful tools. Digital atlases are starting to be used as a data sharing informatics hub and to manage this information. This infrastructure must be expanded such that researchers anywhere in the world may use this to share their data, find and analyze data from others, and to share their findings regardless of where they or the data are located.

To facilitate this atlas-based data sharing infrastructure, we are constructing a canonical atlas space, entitled Waxholm Space (WHS), which provides a common spatial standard allowing translation between different digital atlasing efforts. WHS is simply a continuous Cartesian coordinate system and is essentially the equivalent of the Talairach space for humans. We are in the process of defining and building this standard canonical atlas space with a standard MRI and Nissl acquisition procedure. After we have created WHS with the best dataset possible, we will then bring key reference atlases (especially those with associated data) into it. Atlases in WHS will make their registration transformations and associated data available to external groups.

Additionally, other infrastructure needs to be built that supports flexible and extensible interoperability between atlases and data sharing. Underlying standards for these atlases must exist; however, a system must be built that can keep track of the information about the different atlases, and convert it in a tool-accessible manner. The INCF digital atlasing infrastructure (INCF-DAI) is envisioned as a collection of distributed services that support publication, discovery and invocation of heterogeneous atlas resources. INCF-DAI will reference remote and autonomously supported and updated resources, and host or mirror some resources that are critical for the operation of the infrastructure. The resources will include: atlasing datasets of different types, compute resources, applications, and workflows. INCF-DAI will establish common access mechanisms for resources of each type, and provide and govern respective standard API development, to ensure syntactic interoperability within the system.

Many challenges exist for this international digital atlas data integration effort, but the potential for discovery is tremendous as the pure bulk of data grows at a phenomenal rate. It is clear that this infrastructure and its pieces must be built and vetted by members of the scientific community. Multiple opportunities exist for participation in this program by interested parties, including volunteers for ad hoc task forces and participation in a reference group.

NeuroTools: analysis, visualization and management of real and simulated neuroscience data.

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NeuroTools is an open-source toolkit, written in Python, for neuroscience simulations. It is not a simulator, but rather provides tools to support all the tasks associated with a simulation project, including setup, parameterization and instrumentation of a simulation, and management, storage, analysis and visualization of output data. The data-related tools are equally suited to analysis of experimental data, although that is not the primary motivation for their development.

NeuroTools aims (i) to increase the productivity of individual modelers by automating and/or simplifying common tasks, (ii) to increase the productivity of the neuroscience modelling community by reducing the amount of duplication in code written by the community, (iii) to increase the reliability of data analysis tools on the principle that the more people use a given piece of code, the fewer bugs it will ultimately contain.

Development is open, and anyone who is interested is welcome to contribute. NeuroTools may be obtained from http://neuralensemble.org/NeuroTools

The Inverse Current Source Density (iCSD) method: Precise estimation of CSD from multi-electrode recordings with one, two and three dimensional contact grids

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Growing availability of multi-electrode recordings has brought up the issue of efficient extraction of transmembrane currents (current source density, CSD) from the measured extracellular potentials. The classical CSD analysis involves extraction of a CSD depth profile from LFP recordings with linear (laminar) multielectrodes [1]. The traditional method suffers from a number of drawbacks, most notably the assumption of infinite laminar planes of homogeneous neural activity and the discarding of boundary points [2]. For recordings with two- and three dimensional grids the discarding of boundary points becomes particularly problematic since the majority of data may lie at the boundary [3]. These shortcomings are amended by the Inverse Current Source Density (iCSD) method [2,3].

We show that CSD can be estimated faithfully from measurements with one, two and three dimensional Cartesian grids. We apply this method to:

1) simulated extracellular potentials generated by a population of L5 pyramidal neurons [4] (two dimensional data, Fig. 1),

2) the responses of the rat subiculum to electrical stimulation of alveus above CA1 (two dimensional data, Fig. 2),

3) potentials evoked by deflection of several whiskers, recorded in a slab of the rat forebrain [3] (three dimensional data, Fig. 3).

We compare the efficiency of the traditional CSD and variants of iCSD methods in 2D and 3D using several fidelity measures on different test data. We also investigate how the free parameters (transverse profile of the assumed CSD distribution in 2D) should be chosen.

We further demonstrate the MATLAB toolbox CSDplotter for iCSD analysis, available from http://software.incf.org/.

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Finding hidden treasures: a related document search for SfN annual meeting abstracts

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The interest in neuroinformatics is greatly increasing as noticed not only from the presentations at the last year's annual meeting of the Society for Neuroscience (SfN), but also from the comments by the former president published on the Society's quarterly spring 2007 edition. A tool for visualization of neuroscience documents, the 3D-SE viewer, has been introduced (Naud et al., Front. Neuroinform., 1:7, 2007). Based on the same algorithm and in conjunction with technologies offered by the Google Maps API, we have implemented an improved abstract search tool offering extraordinary capabilities. Words were extracted (Usui et al., Biosystems 88:334-342, 2007) from abstracts of the Society's 2007 annual meeting poster sessions. We have chosen bigrams as extracted keywords, since these are combination of monograms and, at the same time, the basic component of trigrams. Extracted bigrams were further refined based on Fisher probability. Thus, the keyword utilized for the visualization process should account for all possible keywords. Visualization of the 19,318 extracted keywords and 14,667 abstracts using the 3D-SE viewer interactively requires powerful computational resources. To solve this problem, we have adopted the Google Maps API, compressing the three dimensional (3D) sphere into a two dimensional (2D) plane. The drawback of this technique is that the distance between nodes increases as it gets closer to the poles. We have neglected this effect since it is also observed in the familiar world map. In this tool, results of a keyword search are displayed not only as a list of abstracts (key abstracts), but also graphically by placing flags over the abstracts (nodes) in the map. And the key feature of this tool is that, based on the similarity index calculated from the spherical embedding (SE) algorithm, it can provide a list of abstracts related to a single or multiple chosen key abstracts (related abstracts). More surprisingly, this feature could provide several users with interesting related abstracts which did not contain any keyword utilized for the key abstract search. We call them "hidden treasure". Moreover, a list of extracted keywords is also provided for each listed abstract. Such information may provide users with candidates of keywords regarding their research interest. These keywords may be useful for searching information over the web, and also in other databases. This neuroinformatics tool, which may serve as a sophisticated document search framework for the many upcoming databases in the neuroscience field, may also provide a novel and powerful itinerary planner for future SfN annual meetings.

NEST 2: A Parallel Simulator for Large Neuronal Networks

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NEST is a simulation environment for large heterogeneous networks of point-neuron models or neuron models with a small number of compartments. It supports spike based as well as continuous (e.g., rate, currents) interaction between the nodes of the network.

We present NEST 2 with pyNEST, a Python-based user interface (www.python.org), which makes it easier to learn and use NEST. Together with analysis packages like Scientific Python (www.scipy.org), users can now simulate networks and analyze results in a single interactive Python session. Pre-releases of NEST 2 have already been used with great success and appreciation at European summer schools since 2007.

Other new features of NEST 2 include support for synaptic plasticity, a wide range of model neurons, and parallel simulation on multi-processor (core) computers as well as computer clusters, with excellent scaling properties up to hundreds of processors. Users can add new neuron and synapse models, as well as new connection functions, by writing their own NEST modules in C++.

We will demonstrate the capabilities of NEST 2 and invite visitors to try it interactively. For more information, please see the Scholarpedia article on NEST at http://www.scholarpedia.org/article/NEST.

NEST is released under an open source license for noncommercial use.

Tuesday, November 18

INCF Japan Node (J-Node) and neuroinformatics platforms

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As a national node of INCF, Japan Node (J-Node) was organized at the Neuroinformatics Japan Center (NIJC) (http://nijc.brain.riken.jp/), RIKEN BSI in April 2005. J-Node (http://www.neuroinf.jp/) facilitates Japanese activities in neuroinformatics research and also participates in the international coalition of INCF. Under the advice of J-Node Committee, J-Node promotes domestic neuroinformatics (NI) together with the NIJC Steering Committee, the Platform Coordinating Committee, and BSI laboratories. Our missions are mainly as in the following: providing links and smooth integration of the NI Platforms (Portal site for NI platforms in Japan), supporting the NI Platforms, supplying and supporting NI tools and system such as the base-platform "XooNIps" (http://xoonips.sourceforge.jp/) in cooperation with BSI NI lab, and providing documents in Japanese on the activities of INCF. Several NI platforms have developed and operated in public, providing unique databases, tools and services as in figure 1.

Visiome: A web-based database system with a variety of digital research resources in vision science. This platform features Visual Neuron Simulator for computing and generating action potentials based on a visual neuron model in real time; Neocognitron, an artificial neural network model; Psychlops, an OpenGL-based visual stimulus generation system.

Neuron-Glia: Shares new findings and ideas among experimental and theoretical neuroscientists. This platform's functions are: (1) publicize & archive models, related data and tools regarding Neuron-Glia functions, (2) provide workspace for sharing models, data, tools and memos privately among group members of registered users.
Brain-Machine Interface (BMI): Allows all registered users to share experimental data, mathematical models, tools for various researches such as neuroscience, computational theory, and robotics etc.

Invertebrate Brain (IVB): Provides Invertebrate brain & behavior images, Models for neuron simulator, LSM images of neuron, Models of 3D neural structure and Research tools.
Neuro-Imaging (NIMG): Has become one of the most important key technologies for studying human brain mechanisms. NIMG's free standalone software, sBrain, was developed to display 3D-brain images and to search papers that include activations at the locations specified by pointing on the images.

Integrative Brain Research (IBR): A grant group of neu-

roscientists including about 300 PIs funded by MEXT, a Japanese Ministry. This PF has introduced three major programs: Neuroscientist Database, Neuroscientist SNS, and Mouse Phenotype database.
Cerebellum: Based on the concepts of the cerebellum, references and images, experimental data for the modeling, source codes of neural network models and other tools for the study in this field are available.
XooNIps and Visiome, NIMG, IVB platforms will be presented at the poster session during the congress.
The members of each platform are gathered from different universities and institutes all over Japan to be united and fulfill their responsibilities for developing Neuroinformatics community.

Matching spatial with ontological brain entities using the CoCoMac-Paxinos-3D tool

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Brain atlases are widely used in experimental neuroscience as tools for locating and targeting specific brain structures. Delineated structures in a given atlas, however, are often difficult to interpret and to interface with database systems that supply additional information using hierarchically organized vocabularies (ontologies). Here we discuss the concept of volume-to-ontology mapping in the context of macroscopical brain structures. We present Java tools with which we have implemented this concept for retrieval of mapping and connectivity data on the macaque brain from the CoCoMac database in connection with an electronic version of "The Rhesus Monkey Brain in Stereotaxic Coordinates" authored by George Paxinos and colleagues. The software, including our manually drawn monkey brain template, can be downloaded freely under the GNU General Public License. It adds value to the printed atlas and has a wider (neuro-)informatics application since it can read appropriately annotated data from delineated sections of other species and organs, and turn them into 3D registered stacks. The tools provide additional features, including visualization and analysis of connectivity data, volume and centre-of-mass estimates, and graphical manipulation of entire structures, which are potentially useful for a range of research and teaching applications.