Neuroinformatics database for visualization and analysis of anatomical data from the rat brain

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1. INTRODUCTION

The management of data collected from serial sections through the brain represents a considerable challenge in many neuroscience projects. We present a novel system for storing, querying and manipulating section-oriented data. The system is prepared for storage of point- and line-coded 3-D data, image data, and associated metadata. Data are co-registered to a common spatial framework, based on local coordinate systems.

An example implementation is the database application Functional Anatomy of the Cerebro-Cerebellar System in rat (FACCS). This application holds axonal tracing data from the rat cerebro-cerebellar system, but is extensible to other circuits and other categories of image data.

2. DESIGN

The database is built on a three-tier paradigm, providing a web-based interface. An Oracle relational database management system provides a framework for storage and complex querying. A suite of embedded tools (applets) allow users to query, visualize and perform analysis operations.

3. TECHNOLOGIES

- Oracle Designer database / application design
- Oracle JDeveloper - integrated development environment
- Oracle 9iAS - application server
- Oracle 9i database
- Database 9i (misc. tools)
- Oracle development framework - BC4J
- Sun’s J2EE - Infrastructure
- Log4j logging framework
- MVC Model for structured handling of presentation layers
- Cactus/Unijit: Automated test-framework

4. DATABASE ARCHITECTURE

The Oracle relational database management system provides the ability to store a variety of objects, and provides the framework for complex querying of data. The suite of tools is intimately tied into the application infrastructure, allowing the user to not only query and visualize the data, but also to perform analyses.

5. LOCAL AND GLOBAL RAT BRAIN COORDINATE SYSTEMS

Conceptual overview of local (pontine nuclei) coordinate system (A-C) in relation to a standard global (skull based) coordinate system for the rat brain (D, Paxinos and Watson, 2005). The diagram in E defines the translation between the local and global coordinate systems. The local coordinate system is applied using histological criteria. Data are co-registered to a common spatial framework using affine transformation procedures.

6. EXAMPLE SEARCH, VISUALIZATION AND ANALYSIS USING FACCS

Q1: What is the size and location of projections from the entire SI cortex?
Q2: What is the size and location of projections from the SI upper lip representation?
Q3: How do they compare?

CASE R113: small BDA injection in SI upper lip representation
Density = 57.432 point / mm³
# points inside surface = 6186
Surface volume = 0.108 mm³
Fraction of points enclosed by surface = 98%

CASE R102: multiple BDA injections in whole SI cortex
Density = 112.225 point / mm³
# points inside surface = 73175
Surface volume = 0.652 mm³
Fraction of points enclosed by surface = 98%

7. SUMMARY AND CONCLUSIONS

The present release, FACCS, available via The Rodent Brain Workbench (www.rbwb.org), is targeted at the Functional Anatomy of the Cerebro-Cerebellar System in rats, and holds axonal tracing data from these projections.

The system is extensible to other circuits and projections and to other categories of image data and provides a unique environment for analysis of rodent brain maps in the context of anatomical data.

The FACCS application assumes standard animal brain atlas models and can be extended to future models. The system is available both for interactive use from a remote web-browser client as well as for download to a local server machine.

MORE INFORMATION

URLs: www.rbwb.org, www.nesys.uio.no
PDF copy of poster available at www.nesys.uio.no
Extensive documentation of underlying concepts and requirements are provided at www.rbwb.org.

To contribute data, please contact: j.g.bjaalie@medisin.uio.no

Literature:
Bjaalie et al. (2005) Neuroscience, In Press

Original publications of contributed data:
Leergaard et al. (2000), J Comp Neurol 422:246–266
Leergaard et al. (2000), J Neurosci 20: 8474–8484
Leergaard et al. (2004), J Comp Neurol 478:306–322
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