UMDNJ SCHOOL OF HEALTH RELATED PROFESSIONS
University of Medicine & Dentistry of New Jersey
Department of Health Informatics

# OPPORTUNITIES FOR INVOLVEMENT IN RESEARCH

Graduate students in Biomedical Informatics have unusual opportunities for involvement in research from early on in their graduate career and can participate in a wide variety of on-going research projects on campus. A list of current or recent projects within the Department of Health Informatics or within other Schools of UMDNJ upon request can be made available to the students.

**PUBLICATIONS:**
The department strongly urges students who may be considering professional careers in Biomedical Informatics within academia and pharmaceutical industries to begin as early as possible to present papers at conferences and workshops, both within the department and without. They are also urged to prepare papers for publication in refereed journals. Conference participation and publication serve a number of important functions and play a crucial role in the professional development of the student, and should therefore be seen as an integral part of the program, even if not a requirement of the curriculum per se. Students are advised to consult the appropriate faculty of the Department regarding publication and presentation of papers, and to seek additional advice and guidance from the advisor and/or other faculty members.

**EXAMPLES OF INFORMATICS RESEARCH**

- Research on databases, querying approaches, and information retrieval, the diversity of data types in neuroscience research will require unique databases and graphical interfaces that can accommodate varied data types (e.g., numerical, textual, graphic, image, time series).
- Research on querying approaches that will allow varied databases to be accessed with a single query, and retrieval and analysis of different types of data into a common interoperable informational space.
- In addition, databases, querying, retrieval, and integrated analytical tools will need to be extensible and easily reconfigurable to adjust to the rapidly changing domain of health sciences and biomedical research. New approaches and capabilities will need to be researched and created in order to deal with the dynamically changing data structures in medicine.
- Research on data visualization and manipulation, the high level of complexity and high interconnection of data about brain functions requires novel approaches to manipulate, visualize, and analyze large interconnected data sets. These are necessary to be able to reliably represent and analyze the multiple dimensions across and within levels of analysis, and reflecting the complexity of data (e.g., in neuroscience) that may later be cross-validated. Both clinical and animal brain data require the development of interactive, multi-resolution capabilities for representation and visualization of tens to hundreds of gigabytes of imaging data at specified levels of resolution.
- Research on tools for electronic collaboration, the capacity to quickly assemble teams, independent of geographic location, to address specific scientific questions would greatly

accelerate the pace of discovery. The creation of the capability or shared virtual reality space through the use of advanced forms of "groupware" with tools for data acquisition, display, interoperability, querying and manipulation would facilitate this goal.

- Research that builds bridges across existing informational tools and resources, the tools and approaches developed through the support of the BioMedical Informatics field will prove to be most useful if and when they are combined in tandem with one another, and can access other databases and tools, such as those associated with the Human Genome Project and the Macromolecular Structure Database, etc.
- The Biomedical Informatics research component should be future-oriented and seek to exceed the current state-of-the-art.

- Research on data integration and synthesis, modeling and simulation environments various models are sought to integrate and synthesize different types of data to comprehend complex brain structure and function relationships.

- Computational models are advantageous since they: require the user to make explicit their theory, identifying any inconsistencies or hidden assumptions; can help identify what data are missing, and guide the collections of data appropriate for testing a theory; provide a medium for the discovery of new principles of neural function, by supplementing intuitions that are limited by the complex, dynamical, and non-linear character of neural systems; and provide a clear and precise mechanism for communicating specific theories with other scientists.

- All levels of models are appropriate, ranging from and between subcellular and molecular levels, to morphological, neuronal, and neural circuit levels, up to large-scale networks responsible for mediating normal behavior (e.g., cognition, emotions, etc.), and various brain disorders. Research in this area is heavily driven by the results of experimental studies and, reciprocally, provides a theoretical framework for the development of innovative, testable concepts that clarify current experimental observations that help to guide new experimental studies.

- Research to develop structural models, better models are needed at both the neuronal levels (e.g., three-dimensional structures of neuropil and dendritic trees, distributions of synaptic contacts, etc.), as well as at the level of the whole brain. In addition, better morphometric models are needed for motion correction within subjects, for cross-subject comparisons (e.g., for studies of normal individual variability as well as group differences in patient populations), and for cross-modal registration of datasets (e.g., for Magnetic Resonance Imaging (MRI)-based localization of Event-Related Potentials (ERP) signals).

- Research to develop functional models, models are needed at all levels of function to improve understanding of subcellular, cellular, circuit, and network level mechanisms. For example, the mechanisms underlying active dendritic conduction or coincidence detection are still poorly understood at the subcellular/cellular level, as are the mechanisms underlying temporal binding or sustained activity at the circuit/network level, and those underlying sequential behavior or instructed (versus associative) learning at the cognitive level. Under the category of research to develop integrative models, such models are needed to address two domains: neural function, and data analysis. With regard to neural function, new integrative models are needed to bridge between findings at multiple scales, by simultaneously addressing findings at each, and translating from one scale to another. For example, models are needed that can help link understanding at the level of gene expression to that at the level of receptor function and synaptic transmission; from that at the level of synaptic transmission to that at the level of circuit function; from circuit function to network activity; and from network activity to whole brain or its regional components that mediated cognitive, emotional and behavioral processes. Integrative models are also needed for more complete and effective analyses of data about the brain, generated by measurements made at different scales (e.g., direct neurophysiological recordings and functional neuroimaging), or using complementary modalities (e.g., spatially resolved positron emission tomography (PET) or functional Magnetic Resonance Imaging (fMRI) studies with temporally resolved (ERP) or magnetoencephalography (MEG) studies, or with MEG and fMRI studies).

# Meta-analysis of Observational Studies in Epidemiology (*JAMA.* 2000;283:2008-2012)

**Table.** A Proposed Reporting Checklist for Authors, Editors, and Reviewers of Meta-analyses of Observational Studies

Reporting of background should include
- Problem definition
- Hypothesis statement
- Description of study outcome(s)
- Type of exposure or intervention used
- Type of study designs used
- Study population

Reporting of search strategy should include
- Qualifications of searchers (eg, librarians and investigators)
- Search strategy, including time period included in the synthesis and keywords
- Effort to include all available studies, including contact with authors
- Databases and registries searched
- Search software used, name and version, including special features used (eg, explosion)
- Use of hand searching (eg, reference lists of obtained articles)
- List of citations located and those excluded, including justification
- Method of addressing articles published in languages other than English
- Method of handling abstracts and unpublished studies
- Description of any contact with authors

Reporting of methods should include
- Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested
- Rationale for the selection and coding of data (eg, sound clinical principles or convenience)
- Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)
- Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)
- Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results
- Assessment of heterogeneity
- Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated
- Provision of appropriate tables and graphics

Reporting of results should include
- Graphic summarizing individual study estimates and overall estimate
- Table giving descriptive information for each study included
- Results of sensitivity testing (eg, subgroup analysis)
- Indication of statistical uncertainty of findings

Reporting of discussion should include
- Quantitative assessment of bias (eg, publication bias)
- Justification for exclusion (eg, exclusion of non–English-language citations)
- Assessment of quality of included studies

Reporting of conclusions should include
- Consideration of alternative explanations for observed results
- Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)
- Guidelines for future research
- Disclosure of funding source