INDIANA UNIVERSITY

University Graduate School
2009-2010
Academic Bulletin

Informatics

School of Informatics
Indianapolis

Associate Dean for Research and Graduate Studies; Director, Informatics Research Institute
Mathew J. Palakal*

Graduate Faculty

(An asterisk [*] denotes membership in the University Graduate School faculty with the endorsement to direct doctoral dissertations.)

Professors
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Assistant Professors
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Academic Advisors
Snehasis Mukhopadhyay* (Bioinformatics), Anna McDaniel* (Health Informatics), Anthony Faiola (Human-Computer Interaction), Mahesh Merchant (Laboratory Informatics), Joe Defazio (Media Arts and Science)

Ph.D. in Informatics

The Indiana University School of Informatics, the first of its kind in the country, was created as a place where innovative multidisciplinary programs could thrive, a program where students can apply the skills of technology to a range of other fields. For current information and specific requirements, go to the website at http://www.informatics.iupui.edu

All Ph.D. candidates must meet with their academic and/or research advisor for course selection and plan of study.

Graduate Office
Union Building 207
Indiana University–Purdue University Indianapolis
Indianapolis, IN 46202
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Contact: gradoff@iupui.edu

This program is administered with the approval of Indiana University, Bloomington.

Program of Study
Students in the doctoral program will explore the connections among technology, theory, social analysis, and application domains in a diverse and multidisciplinary curriculum. This curriculum will include core courses and seminars in informatics, an information subdiscipline [current subdisciplines are bioinformatics, health informatics, and human-computer interaction; courses in methodology and theory; electives in related disciplines inside and outside of the School leading to a Ph.D. minor; and a dissertation. In addition, students will be encouraged to pursue internships as part of the elective courses or independent studies of their program.

Ph.D. in Bioinformatics

The Ph.D. in Bioinformatics is a 90 credit hour program that includes:

15 credit hours of Core A
12 credit hours of Core B
6 credit hours of seminar courses
6 credit hours of electives
6 credit hours of rotation
15 credit hours in minor
30 credit hours of dissertation

Areas of Specialization
Faculty research projects often involve representatives from several different research areas working together to develop innovative and even revolutionary new solutions. While students can expect to concentrate in particular areas, they will also be expected to explore the broader significance of their work as well as ways that their expertise can be leveraged to solve problems outside of their own domains.

Areas of Research
Sequence pattern recognition, comparative genomics, structural genomics, fragment assembly in DNA sequencing, systems biology, models of evolution, molecular modeling, drug design, biological database integration, data mining, and biomedical text mining.

Ph.D. in Health Informatics

The Ph.D. in Health Informatics is a 90 credit hour program that includes:

12 credit hours of Core A
15 credit hours of Core B
6 credit hours of seminar courses
9 credit hours of electives
6 credit hours of rotation
15 credit hours in minor
21-30 credit hours of dissertation

Areas of Specialization
Faculty research projects often involve representatives from several different research areas working together to develop innovative and even revolutionary new solutions. While students can expect to concentrate in particular areas, they will also be expected to explore the broader significance of their work as well as ways that their expertise can be leveraged to solve problems outside of their own domains.

Areas of Research
Electronic medical records, health data exchange, standards and terminology for health data, clinical decision support, consumer health informatics, technology to enhance patient safety, tele-health application development and implementation, cost reimbursement and integrated health information systems. The Health Informatics program has close ties and joint projects with the Veteran Administration Medical Center, Regenstrief Institute, Clarian Health, Methodist Hospital, St. Vincent Hospital, Community Health Network, St. Francis Hospitals, IU School of Medicine, and other local health care systems.

Ph.D. in Human Computer Interaction

The Ph.D. in Human Computer Interaction is a 90 credit hour program that includes:

18 credit hours of Core A courses
15 credit hours of Core B courses
6 credit hours of seminar courses
9 credit hours of electives
6 credit hours of rotation
9-15 credit hours in minor
30 credit hours of dissertation

Areas of Specialization
Faculty research projects often involve representatives from several different research areas working together to develop innovative and even revolutionary new solutions. While students can expect to concentrate in particular areas, they will also be expected to explore the broader significance of their work as well as ways that their expertise can be leveraged to solve problems outside of their own domains.

Areas of Research
Because HCI is a multidisciplinary discipline, students are encourage to expand the scope of their research to cross-traditional disciplinary boundaries into such areas as: user-centered design, cross-cultural theory and application, related areas within new media such as gaming and virtual reality, computer-mediated communication, usability engineering, health informatics, information visualization, biomedical informatics, android science, social robotics, sensorimotor representation, symbol grounding and symbol emergence, and computational neuroscience, etc.

Minor
All students will be required to have an appropriate minor outside or partially inside the school. Minors will be selected with the advisor's recommendation. The selected minor should be appropriate to the student's choice of sub discipline within Informatics. Some appropriate minors would include: biology, chemistry, cognitive psychology, computer science, history and philosophy of science, information science, or sociology. In all cases the number of hours to be included in the minor will be consistent with the requirements of the unit granting the minor. Some of the courses included in the minor may also count toward the student's methodology or other requirements.

Qualifying Examination, Written (Required)
All students will take a written qualifying examination that covers the core courses (CORE A and B). The examination will be set by a group of faculty who are familiar with the content of the core courses. Examinations will be offered in August. Examinations must be completed by the beginning of the student's fourth year in the program but can be completed before that time when the core courses are completed. Students who do not successfully complete the examination can retake the examination a second time.

Qualifying Examination, Oral (Required)
1. The oral examination will take place after the student successfully passes the written exam. Students must pass both the written and the oral exam before passing on to candidacy. Only two attempts to pass the oral examination will be allowed.
2. The oral exam will be based on the student's response to the written exam and any material from the core courses.

Dissertation Proposal (Required)
This is an oral review that covers in-depth knowledge of the student's primary research area and dissertation proposal. The research proposal for dissertation must be approved by the student's research committee. That committee may have the same membership as the program committee or the students may choose different members. The advisor for the dissertation will be a faculty member in the School of Informatics and a member of the Graduate Faculty. At least one of the three members of the committee will be based outside of the school. The student will defend the thesis proposal at a public colloquium in the school. The review should be completed within one-year after passing the Qualifying Examinations.

Dissertation (Required)
A written elaboration of significant original research must be successfully presented to the research committee in a public defense as described in the Graduate School Bulletin.

Ph.D. Minor in Bioinformatics

Bioinformatics gathers knowledge and information from various fields such as informatics, chemistry, computer science, medicine, and biology. Students in relevant Ph.D. programs such as biochemistry and molecular biology, medical and molecular genetics, medicine, chemistry, or biology are the target audience for the Ph.D. minor in bioinformatics.

A minor in bioinformatics requires 12 credit hours. The core curriculum consists of graduate-level courses in informatics. Electives may be chosen based on personal interests from a broad list of courses in biology, chemistry, computer science, information science, and medical and molecular genetics.

Requirements
The graduate bioinformatics courses in the School of Informatics assume a minimal knowledge of cell and molecular biology. That level of understanding could be gained with at least 6 undergraduate credit hours in molecular biology, genetics, or evolution.

Graduate Certificate in Human Computer-Interaction (15 cr.)

The Informatics Graduate Certificate Program in Human-Computer Interaction (HCI) is a 15 credit hour program that focuses on the core theory and best practice of the discipline. Admission requirements and procedures are the same as those established for the Human-Computer Interaction Program master's degree. Specifically, students will be required to submit an application through the graduate school and receive a full review by the Informatics Graduate Admissions Committee, i.e., the review will take place for both master's and certificate seeking applicants. Moreover, certificate seeking applicants will need to submit the same documentation and meet the same criteria as master's seeking students, e.g., undergraduate GPA scores and references letters. GREs are not required for either, unless you are seeking financial assistance from the school. Key differences are that certificate students will NOT be required to complete an additional 15 credit hours of course work nor write a thesis.

HCI Core Courses (6 cr.)
INFO I541 HCI Design 1
INFO I561 HCI Design 2

Specialization Requirements (9 cr.)
INFO I563 Psychology of HCI
INFO I543 Usability and Evaluative Methods in Interactive Design
INFO I564 Prototyping for Interactive Systems

Courses

Informatics (INFO)
The abbreviation "P" refers to the course prerequisite or prerequisites. The number of hours of credit given a course is indicated in parentheses following the course title.

Core Courses
INFO I500 Fundamental Computer Concepts for Informatics (3 cr.) An introduction to fundamental principles of computer concepts for Informatics study, including an overview of computer architecture, computer algorithms, fundamentals of operating systems, data structure, file organization and database concepts. This course is expected to impart the required level of competency in computer science. It may be waived in lieu of six undergraduate credit hours of computer science or informatics coursework, covering areas of programming, discrete structures, and data structures.

INFO I501 Introduction to Informatics (3 cr.) P: Gradaute standing. Basic information representation and processing; searching and organization; evaluation and analysis of information. Internet-based information access tools; ethics and economics of information sharing.

INFO I502 Informatics Management (3 cr.) P: Computer science course 300 level or higher. Survey of data management issues in medical, health, chemical, and biology-related areas; basic techniques of physical database structures and models, data access strategies, management and indexing of massively large files.

INFO I503 Social Impact of Information Technologies (3 cr.) P: Graduate standing. An overview of important social, legal, and ethical issues raised by information technology.

INFO I504 Social Dimensions of Science Informatics (3 cr.) Course will examine ethical, legal, and social issues surrounding contemporary research and practice in science informatics. Topics include the nature of science and technology, the ramifications of recent advances in science informatics, and relevant science policy and research ethics. General knowledge of science informatics is assumed.

INFO I505 Informatics Project Management (3 cr.) This is a professional introduction to informatics project management and organizational implementation of integrated information solutions. The target audience is informatics project team members likely to pursue informatics project manager roles as well as all members not likely to do so. Through reading, lecture, discussion, practice, and targeted projects, students gain historical perspective, current awareness, and proficiency with informatics project management terminology, techniques and technologies.

INFO I506 Globalization and Information (3 cr.) Explores the processes that promote and impede movement of human action and informational activities to the most general levels, e.g., the level of the world as a whole. Surveys diverse theories of globalization to identify the best approaches for professional informatics career planning and making information globally accessible.

INFO I510 Data Acquisition and Laboratory Automation (3 cr.) This course covers the entire process by which signals from a laboratory instrument are converted into useful data. (1) fundamentals of signal conditioning and data sampling; (2) interfacing, communications and data transfer; (3) markup languages and device capability datasets; (4) lab automation; and, (5) robotics.

INFO I511 Laboratory Information Management Systems for Health and Life Sciences (3 cr.) This course involves a comprehensive study of Laboratory Information/Laboratory Information Management Systems in the Healthcare and Life Sciences. It consist of the history, applications, case studies, functional requirements, databases, data flow, workflows, system and network architecture, laboratory roles, establishment of these systems including selection, installation, customization, integration, and validation.

INFO I512 Scientific and Clinical Data Management (3 cr.) Management and mining of data generated in scientific laboratories and clinical trials for data mining and knowledge discovery requires robust solutions that include knowledge discovery techniques and databases, extraction of data/metadata stored in data warehouses that use Storage Area Networks and dealing with security issues of handling this data.

INFO I519 Introduction to Bioinformatics (3 cr.) P: One semester programming course or equivalent. Sequence alignment and assembly; RNA structure, protein and molecular modeling; genomics and proteomics; gene prediction; phylogenetic analysis; information and machine learning; visual and graphical analysis bioinformatics; worldwide biologic databases; experimental design and data collection techniques; scientific and statistical data analysis; database and data mining methods; and network and Internet methods.

INFO I525 Organizational Informatics and Economics Security (3 cr.) Security technologies make explicit organizational choices that allocate power. Security implementations allocate risk, determine authority, reify or alter relationships, and determine trust extended to organizational participants. The course begins with an introduction to relevant definitions (security, privacy, trust) and then moves to a series of timely case studies of security technologies.

INFO I529 Machine Learning for Bioinformatics (3 cr.) P: INFO I519, or equivalent knowledge. The course covers advanced topics in Bioinformatics with a focus on machine learning. The course will review existing techniques such as hidden Markov models, artificial neural network, decision trees, stochastic grammars, and kernel methods. Examine application of these techniques to current bioinformatics problems including: genome annotation and comparision, gene finding, RNA secondary structure prediction, protein structure prediction, gene expression analysis, proteomics, and integrative functional genomics.

INFO I530 Foundations of Health Informatics (3 cr.) This course will introduce the foundation of Health Informatics. It will review how information sciences and computer technology can be applied to enhance research and practice in healthcare. The basic principles of informatics that govern communication systems, clinical decisions, information retrieval, telemedicine, bioinformatics and evidence based medicine will be explored.

INFO I531 Seminar in Health Informatics (1-3 cr.) Variable topic. Emphasis is on advanced topics and research in health informatics. Can be repeated once with a different topic, subject to approval of the program director.

INFO I532 Seminar in Bioinformatics (1-3 cr.) Variable topic. Emphasis is on advanced topics and research in bioinformatics. Can be repeated with different topics, subject to approval of the Dean.

INFO I533 Seminar in Chemical Informatics (1-3 cr.) Variable topic. Emphasis is on advanced topics and research in chemical informatics. Can be repeated once with a different topic, subject to approval of the program director.

INFO I534 Seminar in Human-Computer Interaction (1-3 cr.) P: Graduate standing. Variable topic. Emphasis is on advanced topics and research in human-computer interaction. Can be repeated once with a different topic, subject to approval of the program director.

INFO I535 Clinical Information Systems (3 cr.) Clinical Information Systems includes: human computer interface and systems design; healthcare decision support and clinical guidelines; system selection; organizational issues in system integration; project management for information technology change; system evaluation; regulatory policies; impact of the Internet; economic impacts of e-health; distributed healthcare information technologies and future trends.

INFO I536 Foundational Mathematics of Cybersecurity (3 cr.) P: Knowledge of undergraduate level probability, lined algebra or calculus. Students will learn mathematical tools necessary to understand modern cyber security. The course will cover introductory mathematical material from a number of disparate fields including probability theory, computational theory, complexity theory, group theory, and information theory.

INFO I537 Legal and Social Informatics of Security (3 cr.) This is a case-based course on privacy and security in social contexts. Cases will particularly address the specific designs of technologies (e.g., P3P, PICS) and discuss how different technically feasible design choices would result in distinct regulatory regimes, business strategies, or support different forms of social interaction. This course will focus on specific security and privacy technologies as socio-technical systems.

INFO I538 Introduction to Cryptography (3 cr.) Introduction to the foundational primitives of cryptography and implementations. A primary goal of this course will be to understand the security definitions for each primitive, and how they are used in cryptographic protocols. The ethics of insecure or on-the-fly protocol design will be discussed.

INFO I539 Cryptographic Protocols (3 cr.) Provides a basic understanding of computer security by looking at how things go wrong and how people abuse the system. Once it is understood how computer systems are attacked, it is possible to propose ways to make the system secure.

INFO I540 Data Mining for Security (3 cr.) Introduction to data mining; association rules, clustering and classification. Security basics will be presented, focusing on topics relevant to data mining such as authentication and access control. The course will also explore recent research in data mining and intrusion detection.

INFO I541 Human-Computer Interaction Design I (3 cr.) Human-computer interaction design (HCID) describes the way a person or group accomplishes tasks with a computer—what the individual or group does and how the computer responds; what the computer does and how the individual or group responds. Sometimes known as "interface design," HCID becomes increasingly important as computing intelligence and connectivity spread ubiquitously to home, work, and play environments. This course will be organized around a collection of readings and three design projects concerned with applying human-computer interaction principles to the design, selection, and evaluation of interactive systems.

INFO I543 HCI Design and Evaluation Methods (3 cr.) Students will learn basic concepts and methods for usability studies and evaluation of interactive systems as well as apply those methods to actual system design evaluations. This course is not only for understanding the basics and traditional approaches in this area, but also for exploring new ways of evaluating the usability of state-of-the-art technology-based systems such as systems in ubiquitous computing, CSCW, tangible and social computing areas.

INFO I545 Music Information Representation, Search and Retrieval (3 cr.) P: Major, minor, or outside area standing in music informatics or music information technology. A comprehensive, comparative study of computer-based representation schemes for music, including those oriented toward music notation, music performance, and music analysis. Overview of musical metadata. Techniques and tools for search and retrieval of music information. Credit not given for both INFO I545 and MUS N564.

INFO I546 Music Information Processing: Symbolic (3 cr.) This course deals with both methodology and specific applications that attempt to algorithmically annotate, understand, recognize, and categorize music in symbolic (score-like) form. Particular applications will include key finding, harmonic analysis, note spelling, rhythm recognition, meter induction, piano fingering, and various classification problems such as genre or composer identification. The methodology we will employ will be probabilistic and will include ideas from Machine Learning such as optimal classifiers, hidden Markov models, and Bayesian networks. Students will have computing assignments, present papers, and be expected to implement solutions to some of the problems we address using a high-level language such as R or Matlab.

INFO I547 Music Information Processing: Audio (3 cr.) This course deals with various music analysis and processing problems that use sampled audio as the primary data representation. We discuss digital signal processing including filtering and its relationship to Fourier techniques. Topics include synthesis, effects processing, score following, and blind music recognition, and accompaniment systems.

INFO I548 Introduction to Music Informatics (3 cr.) P: Solid understanding of music fundamentals; music theory background recommended. History, issues, and applications in music information technology. Survey of various types of musical information. Introduction to digital musical media, including data standards and processing; database structure and organization standards and processing; database structure and organization of audio-, score-, and text file objects; and discussion of copyright issues.

INFO I550 Legal and Business Issues in Informatics (3cr.)

INFO I551 Independent Study in Health Informatics (1-3 cr.) Independent study under the direction of a faculty member, culminating in a written report. May be repeated for credit. Total credit for seminars and independent study courses may not exceed nine hours.

INFO I552 Independent Study in Bioinformatics (1-3 cr.) Independent study under the direction of a faculty member, culminating in a written report. May be repeated for credit. Total credit for seminars and independent study courses may not exceed nine hours.

INFO I553 Independent Study in Chemical Informatics (1-3 cr.) Independent study under the direction of a faculty member, culminating in a written report. May be repeated for credit. Total credit for seminars and independent study courses may not exceed nine hours.

INFO I554 Independent Study in Human-Computer Interaction (1-3 cr.) Independent study under the direction of a faculty member, culminating in a written report. May be repeated for credit. Total credit for seminars and independent study courses may not exceed nine hours.

INFO I556 Biological Database Management (3 cr.) Study about database management and its application to bioinformatics. Topics include data modeling, data indexing and query optimization with a bioinformatics perspective, and database issues in complex nature of bioinformatics data. The course also involves study of current challenges related to bioinformatics data management, data integration and semantic Web.

INFO I561 Human Computer Interaction Design II (3 cr.) As a continuation of HCI 1, this course introduces students to advanced HCI theories and practices. Areas of study include: product design research methods and issues underlying design thinking, advanced usability practices, and other human-system interaction models. Thesis research planning, methods, and data analysis will also be covered.

INFO I563 Psychology of Human-Computer Interaction (3 cr.) Covers the pyschological and behavioral science of human-computer interaction related to cognition, memory, mental models, perception, action, and language. Emphasis is placed on understanding the interaction between human and machine systems and how these processes impact the design and testing of interactive technologies.

INFO I564 Prototyping for Interactive Systems (3 cr.) Covers methodologies for designing and prototyping graphic user interfaces, including rapid (paper) and dynamic (interactive) prototypes. Principles of visual communication are discussed in the context of interaction design, cognition, and user behavior, as well as usability testing techniques for concept validation.

INFO I571 Chemical Information Technology (3 cr.) P: Consent of Instructor. Overview of chemical informatics techniques, including: chemical structure coding, chemical data representation, chemical database and search systems, molecular visualization and modeling techniques, and the development of chemical informatics software.

INFO I572 Computational Chemistry and Molecular Modeling (3 cr.) P: INFO-I571. Computer models of molecules and their behavior in gas and condensed phases; implicit and explicit salvation models; quantum and molecular mechanics; search strategies for conformational analysis, geometry optimization methods; information content from Monte Carlo and molecular dynamics simulations; QSAR; CoMFA; docking.

INFO I573 Programming for Chemical and Life Science Informatics (3 cr.) Students will receive a thorough understanding of software development for chem- and bioinformatics, and broaden experience of working in a scientific computing group. Topics include programming for the web, depiction of chemical and biological structures in 2D and 3D, science informatics tool kits, software APIS, AI and machine-learning algorithm development, high performance computing, database management, managing a small software development group, and design and usability of science informatics software.

INFO I575 Informatics Research Design (3 cr.) P: Undergraduate or graduate course in general statistics. Introduction and overview to the spectrum of research in informatics. Qualitative and quantitative research paradigms, deterministic experimental designs to a posteriori discovery. Issues in informatics research; conceptual, design, empirical, analytical, and disseminative phases of research.

INFO I576 Structural Approaches to Systems Biology (3 cr.) Computational approaches to characterizing and predicting tertiary protein configuration, based on known data of atomic, intramolecular and intermolecular interactions.

INFO I578 Data Analysis for Clinical Administrative Decision-Making (3 cr.) Focuses on understanding, manipulating, and analyzing quantitative data in nursing and health care. Includes use of computer-based systems for data management and statistical analysis. Application and interpretation of multivariate statistical models for decision-making.

INFO I581 Health Informatics Standards and Terminologies (3 cr.) Health information standards specify representation of health information for the purpose of communication between information systems. Standards not only standardize data formats, but also the conceptualizations underlying the data structures. The design process of data standards, domain analysis, conceptualization, modeling, and the methods and tools commonly used are explored.

INFO I590 Topics in Informatics (1-3 cr.) Graduate standing. Variable topic. Emphasis is on new developments and research in informatics. Can be repeated with different topics, subject to approval of the Dean.

INFO I600 Professionalism and Pedagogy in Informatics (3 cr.) Course will introduce students to topics and skills necessary for entering careers in industry or the academy. Topics covered will include career planning, curriculum development, effective teaching, research ethics, scholarly and trade publiching, grantsmanship, and intellectual property consideration.

INFO I601 Introduction to Complex Systems (3 cr.) The course will cover fractals, emergent behavior, chaos theory, cooperative phenomena, and complex networks. Students will learn how to think differently about complexities, finding ways to understand their complexity and addressing the problems they pose.

INFO I604 Human Computer Interaction Design Theory (3 cr.) The course will explore, analyze, and criticize underlying assumptions and the rational behind some of the most influential theoretical attempts in HC and related fields. The purpose of the course is to make students aware of how theories can influence practice and to develop critical thinking around the role, purpose, and function for theories.

INFO I605 Social Foundations of Informatics (3 cr.) Topics include the economics of information businesses and information societies, legal and regulatory factors that shape information and information technology use, the relationship between organization cultures and their use of information and information technology, and ownership of intellectual property.

INFO I611 Mathematical and Logical Foundations of Informatics (3 cr.) An introduction to mathematical methods for information modeling, analysis, and manipulation. The topics include proof methods in mathematics, models or computation, counting techniques and discrete probability, optimization, statistical inference and core advanced topics that include but are not limited to Markov chains and random walks, random graphs, and Fourier analysis.

INFO I617 Informatics in Life Science and Chemistry (3 cr.) Introduces the fundamental notions in genome and proteome informatics and chemical informatics focus. P: Advanced graduate standing or consent of instructor. Introduces students to major historical, contemporary, and emerging theories, methods, techniques, technologies and applications in the field of bioinformatics. Students will explore relevant and influential research, results and applications. Students will develop an

understanding of leading research approaches and paradigms, and will design an independent research program in relation to their individual research fields and personal interests. The course will focus on research approaches in bioinformatics, emerging technologies in biology and chemistry, and basic computational techniques, using the design and organizing issues in information systems used in those areas. The course is designed for students with no biology or chemistry background, but some knowledge in informatics, who want to learn basic topics in bioinformatics and chemical informatics.

INFO I619 Structural Bioinformatics (3 cr.) Course covers informatics approaches based on the sequence and 3D structure of biological macromolecules (DNA, RNA, Protein) whose objective is to improve our understanding of the function of these molecules. Topics will include molecular visualization; structure determination, alignment, and databases; and prediction of protein structure, interactions, and function.

INFO I621 Computational Techniques in Comparative Genomics (3 cr.) Course will summarize computational techniques for comparing genomes on the DNA and protein sequence levels. Topics include state of the art computational techniques and their applications: understanding of hereditary diseases and cancer, genetic mobile elements, genome rearrangements, genome evolution, and the identification of potential drug targets in microbial genomes.

INFO I624 Advanced Seminar I – Human Computer Interaction (3 cr.) P: Advanced graduate standing or consent of instructor. Introduces students to major historical, contemporary and emerging theories, methods, techniques, technologies and applications in the field of Human-Computer Interaction. Students will explore relevant and influential research, results and application. Students will design an independent research program in relation to their individual research fields and personal interests.

INFO I627 Advanced Seminar I – Bioinformatics (3 cr.) P: Advanced graduate or consent of instructor. Introduce students to major historical, contemporary, and emerging theories, methods, techniques, technologies and applications in the field of bioinformatics. Student will explore relevant and influential research, results and applications. Students will develop an understanding of leading research approaches and paradigms, and will design an independent research program in relation to their individual research fields and personal interests. The course will focus on research approaches in bioinformatics, and emerging technologies in biology and chemistry, and basic computational techniques.

INFO I628 Advanced Seminar in Complex Systems (3 cr.) P: Advanced graduate standing or consent of instructor. Introduces students to major historical contemporary and emerging theories, methods, and techniques in the filed of complex systems. Students will examine and explore relevant and influential research, results and applications. Students will develop an understanding of leading research approaches and paradigms, and will design an independent research program in relation to their individual research fields and personal interests. The course will focus on the theory of complex systems, systems science and artificial life.

INFO I634 Advanced Seminar II – Human Computer Interaction (3 cr.) P: Advanced graduate standing or consent of instructor. Introduces students to major historical, contemporary and emerging theories, methods, techniques, technologies, and applications in the field of Human-Computer Interaction. Students will explore relevant and influential research, results and applications. Students will develop an understanding of leading research approaches and paradigms, and will design an independent research program in relation to their individual research fields and personal interests.

INFO I637 Advanced Seminar II – Bioinformatics (3 cr.) P: Advanced graduate standing or consent of instructor. Introduces students to major historical contemporary and emerging theories, methods, and techniques in the field of Bioinformatics. Students will examine and explore relevant and influential research, results and applications. Students will develop an understanding of leading research approaches and paradigms, and will design and independent research program in relation to their individual research fields and personal interests. The course will focus on research approaches in bioinformatics, emerging technologies in biology and chemistry, and basic computational techniques.

INFO I638 Advanced Seminar in Complex Systems (3 cr.) P: Advanced graduate standing or consent of instructor. Introduces students to major historical contemporary and emerging theories, methods, and techniques in the filed of complex systems. Students will examine and explore relevant and influential research, results and applications. Students will develop an understanding of leading research approaches and paradigms, and will design an independent research program in relation to their individual research fields and personal interests. The course will be an exposition of “the science at the edge” and the forefront of research in complex systems.

INFO I641 Business of Health Informatics (3 cr.) This class focuses on the economic importance of healthcare information technology adoption for value realization, as a strategic asset, as an investment, and transformation toward integrated decision making. Topics covered include but are not limited to implementation of Decision Support System, barcode tracking, Electronic Health Records, pay-for-performance, incentives for e-prescribing.

INFO I643 Natural Language Processing (NLP) and Text Mining for Biomedical Records and Reports (3 cr.) This course familiarizes students with applications of Natural Language Processing and text mining in health care. While the course provides a short introduction to commonly used algorithms, techniques and software, the focus is on existing health care applications including clinical records and narratives, biomedical literature and claims processing.

INFO I646 Computational Systems Biology (3 cr.) Introduction on how Omics data are generated, managed, analyzed from large-scale computational perspectives, exploring computa-

tional resources, especially biological pathways for integrative mining and computational analysis, representing and modeling multi-scale biological networks, relating static/dynamic properties to the understanding phenotypic functions at the molecular systems level.

INFO I651 The Ethnography of Informatics (3 cr.) Introduces ethnography as a social science methodology and way of knowing with which to study information and its social contexts. Places ethnography in relation to other research methodologies relevant to the production of the Informatics knowledge base. Trains students in the use of a broad range of ethnographic techniques relevant to study of automated information technology in use. Designed to be open to students from other programs with sufficient methodological and substantive background.

INFO I656 Translational Bioinformatics Applications (3 cr.) This course entails a cohesive approach to the theory and practice of bioinformatics applications in translational medicine [TM]. It includes topics related to the complexities of low, medium and high-throughput applications in TM and powerful solutions to TM data management problems by employing various informatics frameworks.

INFO I657 Advanced Seminar II – Chemical Informatics (3 cr.) P: Advanced graduate standing or consent of instructor. Topics vary yearly and include: Representation of chemical compounds: representation of chemical reactions; chemical data, databases and data sources; searching chemical structures; calculation of physical and chemical data (molecular mechanics and quantum mechanics); calculations of structure descriptors; methods for chemical data analysis; integration of chemoinformatics and bioinformatics.

INFO I667 Seminar in Health Informatics II (3 cr.) Advanced graduate seminar in health informatics, designed to complement INFO- I530. Seinartin Health Informatics Applications. This seminar is intended for graduate students enrolled in the Informatics Doctoral Program, taking the Health Informatics Track.

INFO I690 Topics in Informatics (1-3 cr.) P: Graduate Standing. Variable topic. Emphasis is on new developments and research in informatics. Can be repeated with different topics, subject to approval of the Dean. Course in intended for Ph.D. students in the School of Informatics.

INFO I691 Thesis/Project in Health Informatics (1-6 cr.) The student prepares and presents a thesis or project in an area of health informatics. The product is substantial, typically multi-chapter paper or carefully designed and evaluated application, based on well-planned research of scholarly project. Details are worked out between the student and the sponsoring faculty member. May be repeated for credit.

INFO I692 Thesis/Project in Bioinformatics (1-6 cr.) The student prepares and presents thesis or project in an area of bioinformatics. The product is substantial, typically a multi-chapter paper or carefully designed and evaluated application, based on well-planned research or scholarly project. Details are worked out between student and sponsoring faculty member. May be repeated for credit.

INFO I693 Thesis/Project in Chemical Informatics (1-6 cr.) The student prepares and presents a thesis or project in an area of chemical informatics. The product is substantial, typically multi-chapter paper, or a carefully designed and evaluated application, based on well-planned research or scholarly project. Details are worked out between the student and sponsoring faculty member. May be repeated for credit.

INFO I694 Thesis/Project in Human-Computer Interaction (1-6 cr.) The student prepares and presents a thesis or project in an area of Human-computer interaction. The product is substantial, typically multi-chapter paper, or a carefully designed and evaluated application, based on well-planned research or scholarly project. Details are worked out between the student and sponsoring faculty member. May be repeated for credit.

INFO I698 Research in Informatics (1-12 cr.) Research under the direction of a member of the graduate faculty that is not dissertation related. Can be repeated for credit for a total of 30 credit hours.

INFO I699 Independent Study in Informatics (1-3 cr.) Independent readings and research for Ph.D. students under the direction of a faculty member, culminating in a written report. May be repeated for a maximum of 12 credit hours.

INFO I790 Informatics Research Rotation (3 cr.) Work with faculty, investigate research opportunities. Can be repeated for a total of 6 credit hours.

INFO I798 Professional Practice/Internship (non-credit) Provides for participation in graduate level professional training and internship experience.

INFO I890 Thesis Readings and Research (1-12 cr.) Research under the direction of a member of the graduate faculty leading to a Ph.D. dissertation. Can be repeated for credit for a total of 30 credit hours.

Required Graduate Courses
CSCI 548 Introduction to Bioinformatics (3 cr.)

Electives
A student's committee, working in conjunction with an Informatics committee designated to oversee the minor, will decide what elective courses are appropriate for a given student.

Required Graduate Courses

NEWM N500 Principles of Multimedia Technology (3 cr.)
This course examines issues related to digital media communication in the context of e-commerce and the information industry, especially its impact on the cultural, economic, social, and ethical dimensions of local and global communities. Topics

also include: usability, intellectual property, and a diversity of user markets for new media products.

NEWM N501 Foundations of Digital Arts Production (3 cr.) This course examines the production process and management of digital multimedia. Students investigate and produce projects by researching foundations in the use of digital video with special emphasis on production process of storytelling. Skills learned will include: project development and video production. Students will develop presentation skills through reserach papers.

NEWM N502 Digital Media Motion and Simulation Methods (3 cr.) Applications in animation/simulation design and creation using computer desktop tools. Examines the fundamentals of three-dimensional animation through storyboards and planning, modeling, texturing, lighting, rendering, and composite techniques. Topics will include nurbs design development, texture mapping for realism and stylistic output, keyframe and path animation, and cinematography lighting techniques. Skills will be developed through design and modeling of individual or team multidisciplinary projects.

NEWM N503 Digital Media Application Design Processes (3 cr.) Presents the principles and fundamentals of design techniques using authoring tools on PC, Macintosh and emerging computer platforms. Included are storyboarding, planning and organization of scripts, use of current technology, computers, video, and digital arts equipment; computer-assisted design and project planner software tools and management of design team concepts.

NEWM N504 Advanced Interactive Design Applications (3 cr.) Incorporates extensive analysis and use of computer and multimedia authoring tools intended for distributed learning applications. Project management and programming team organization; media management and selection criteria for digital arts development; task analysis and instructional sequencing applied to training and instruction; assessment modeling and feedback for intrinsic motivation.

NEWM N505 Internship in Media Arts (3 cr.) An internship program for students to work with and learn from experts in digital arts technology fields who develop and use new applications in commercial and educational settings. Requirements for interns include the development of a technology project proposal; interview; resume, and project presentation; oral and media presentation of project outcomes.

NEWM N506 Thesis/Project in Media Arts and Science (1-6 cr.) Students prepare a thesis or project that includes supporting documentation, as well as a final public defense. In either case, students are required to prepare a proposal that is approved by their advisor or committee chair before beginning their research.

NEWM N510 Web Database Concepts (3 cr.) P: N503 or consent of instructor. Addresses diverse issues arising when designing World Wide Web interface. Basic database concepts will be presented but the course will focus on discussion of interface issues specific to Web databases, technologies for linking databases to Web servers for delivery, discussion of various Web database applications, case studies, and industry trends.

NEWM N553 Independent Study in New Media (1-3 cr.) This course provides graduate students in the New Media Program an opportunity to work on a project that is beyond any other existing new media courses. The course focuses on developing graduate students' evaluation, synthesis and analysis abilities through a project to obtain an in-depth knowledge of new media within a context of their choice. A graduate student could be engaged in a research project or a production project