Doctor of Philosophy in Informatics
2014 Handbook

Indiana University established the School of Informatics and Computing as a place where innovative multidisciplinary programs could thrive, a program where students can integrate technological skills and computer science methods with diverse disciplines. The School announced a new Doctor of Philosophy (Ph.D.) degree program in Informatics beginning in the fall of 2005 and offered on the Bloomington (IUB) and Indianapolis (IUPUI) campuses.

The Doctor of Philosophy in Informatics follows the policies described in this document and the University Graduate School Bulletin 2013-2014 (pages 9-14, in particular).

Areas of Research

Faculty research projects often involve collaborations 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. The following lists the approved research tracks in the Informatics Program:

- **Bioinformatics** (IUB and IUPUI)
  Sequence pattern recognition, comparative genomics, structural genomics, fragment assembly in DNA sequencing, systems biology, models of evolution, molecular modeling and drug design.

- **Chemical Informatics** (IUB and IUPUI)
  Molecular modeling, computational chemistry, computer-aided drug design, 2D and 3D chemical structure coding and searching systems, analysis of data from high throughput screening and combinatorial chemistry.

- **Complex Networks and Systems** (IUB)
  Analysis and modeling of complex techno-social, information, and biological networks. Modeling and simulations of complex systems, epidemics of disease and ideas, self-organization, multi-agent systems, computational biology, nonlinear dynamics for chemical and biological systems, adaptive systems, computational intelligence, and artificial life. Bio-inspired systems such as evolutionary computation, neural networks, social computation, and distributed intelligent systems.

- **Health Informatics** (IUPUI and IUB)
  Electronic health records, health data exchange, standards and terminology for health data, clinical decision support, consumer health informatics, technology to enhance patient safety,

health application development and implementation, ontologies, mining clinical data, and natural language processing.

- **Human-Computer Interaction Design** (IUB and IUPUI)
  Design theory, design methods, experience design, design thinking, humanist approaches to HCI, critical design, socio-cultural computing, feminist HCI, intimacy, interaction culture, interaction criticism, CSCW, sustainable interaction design/HCI, digital imagery, studio-based learning, strategic design planning, slow change interaction design, interaction design practice, digital learning environments, and design pedagogy.

- **Logical and Mathematical Foundations of Informatics** (IUB)
  Computational complexity theory, mathematical foundations of computation, analysis of algorithms, models of computation, substructural logics such as linear and relevance logic, category theory, proof theory, information based logics, algebraic logic, and relations between computation and logic.

- **Music Informatics** (IUB)
  Digital music libraries, music recognition (audio, optical, time-sequence), modeling musical expression, musical accompaniment systems, computational music analysis, and music information retrieval.

- **Robotics** (IUB)
  Autonomous robots, motion planning and control, human-robot interaction, culturally-situated robot design, social robotics, computer vision, large-scale 3D mapping, and evolutionary robotics.

- **Security Informatics** (IUB)
  Economics of security, user-centered design of security, cryptographic primitive design, security modeling, foundational cryptography, threat assessment and analysis, protocol design, provable security, security heuristics, light-weight cryptography, network security, privacy, security auditing, security and computer forensics.

- **Social and Organizational Informatics** (IUB)
  Gender and technology; gender and informatics; cultural variation and informatics; free/libre and open source software; social dimensions of information and communications technology; methodologies for developing an informatics knowledge base; the ethics of information and informatics; privacy; file sharing, blogging and other mechanisms of collaborative ad-hoc filtering.

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 informatics track (listed above); courses in methodology and theory; electives in related disciplines inside and outside of the School leading to a Ph.D. Minor; and a dissertation. Students will be encouraged to pursue internships as part of the elective courses or independent studies of their program.

Employment Opportunities

Graduates of this program are expected to enter academic positions in research and teaching universities or to conduct research for industries that use informatics. They should be able to shape the direction of information technology in the scholarly work they do on the social, organizational, and design environment of technologies as well as in designing solutions for the issues confronting the biological, chemical and health-based scientific communities.

Values

Ours is the first Ph.D. program (in the U.S.) to carry the label "Informatics." We expect students to abide by the spirit as well as the requirements of the *Code of Student Rights, Responsibilities, and Conduct* (see: http://www.indiana.edu/~code/). This applies to scholarship, any role you may have as an Associate Instructor, relations with colleagues, relations with students, and compliance with academic standards with respect to academic ethics. In particular, if you are not familiar with the concept and best practices to avoid any hint of plagiarism in American universities, please become familiar with these standards before you arrive at the University. The University has provided a series of documents describing the behaviors, ideals, and goals for Indiana University.

Advising

Students admitted to the Ph.D. Program are assigned an **advisor** who may be consulted for advice. The Associate Dean for Graduate Studies and the Director of Graduate Studies, Informatics (DGS) also are available for general consultation. The student may change advisor upon the consent of the new advisor and by filing documentation with the Informatics Graduate Studies Office. The student must inform the existing advisor of the change. This advisor is the chair of the student's **advisory committee**.

No later than one year after admission to the Ph.D. program, each student will consult with appropriate faculty members and designate, with their consent, members of a suitable advisory committee. The advisory committee will guide the student's doctoral program as well as oversee and conduct the qualifying exam in the student's research area. The advisory committee must by University Graduate School rules include at least two members from the student's major area, and at least one from another area (track); at least two must be members of the graduate faculty. The names of the committee members presented by the student will be forwarded to the University Graduate School upon approval by the DGS for the Informatics program.

The advisory committee oversees the student's progress until the passing of the qualifying examination, whereupon the student consults with the committee concerning a **dissertation advisor**. When the student has a dissertation advisor, the student and dissertation advisor identifies members of a suitable **research committee** (and the advisory committee is abolished). After the members have agreed to serve on the research committee, the appropriate form is filed with the Graduate Studies Office.

The members of the research committee must meet the requirements of the University Graduate School: the committee includes the advisor, normally the professor directing the dissertation, two or more additional faculty members from the School, and must include a representative of any

minor. With certain exceptions, the members must belong to the graduate faculty. This committee supervises the dissertation research, conducts the thesis proposal examination, and conducts the Ph.D. thesis defense final examination.

Research Group Rotations

Each student will engage in research rotations during the first two to three semesters of the program. The student is required to engage in two research rotations (three credits each for a total of six credits) and may engage in a third rotation although no course credit will be given. The student chooses an Informatics faculty person with whom to study for one semester. The faculty integrates the student into his/her research group and the student and faculty create a formal agreement of goals consistent with the research area for the student to achieve during the rotation. Minimally, the student will engage in readings and apprenticeship work with the faculty and other students in that group. The goal is twofold. First the goal is to engage in research with the faculty (typically at a beginning level) and to decide if this person is a potential advisor for the student's dissertation work. The second is to ensure the student has a view of the research area from at least two faculty perspectives.

Curriculum

Credit Hours:

I501 and I502: The Informatics Core (6 credits)

It is required that each student begin 501 upon entering the program. These two courses should be taken the first year. Exceptions must be granted by the DGS.

Courses in area of study (6 credits)

Each student is required to take a set of two courses from within his/her chosen area of study. For example, Bioinformatics specialists take I609 Seminar in Bioinformatics I and I709 Seminar in Bioinformatics II. Security students may take Cryptographic Foundations and Malware.

Research Group Rotations (6 credits)

Each student is required to complete two one semester research rotations. Each rotation is for three credits.

Theory and Methodology (12 credits)

The primary source for guidance for the appropriate courses is the advisor. The advisor may select from the entire range of courses offered at the University; however, these should contain theoretical or methodological components. Students may select qualitative methods, quantitative data analysis or advanced statistics, algorithms, computing theory, research development, ethnographic methods, psychology, economics, design, or evaluation courses. Research lab experience may be substituted for classroom courses upon approval of the advisor and, if extant, the director of the area of study.

Electives (12 to 21 credits)

Research lab experience may be substituted for classroom courses upon approval of the advisor and the advisory committee.

Minor (6 to 12 credits)

This requirement may be met by a minor approved by the University, or specific courses approved by the School as a minor (see below). Alternatively the student may select a set of three courses recommended by the advisor and approved by the DGS.

Dissertation (from 21 to 30 credits)
Dissertation credits as approved by the Advisor.

Minors

All students must have either an approved minor outside of Informatics or pursue a minor inside the School. Internal and external minors should be appropriate to the student's research as determined by the student's advisory committee. Some appropriate minors would include biology, chemistry, physics, cognitive science, computer science, history and philosophy of science, anthropology, statistics, information science, law, sociology, or learning sciences. *In all cases the number of hours to be included in the minor is consistent with the requirements of the unit granting the minor.*

In the case of an **internal minor**, students may choose from one of eight internal school minors. Minors in Computer Science, Bioinformatics, HCI, and Social Informatics are currently advertised in the *University Graduate School Academic Bulletin*. Please refer to the bulletin regarding the requirements for each.

Four additional internal minors exist in Complex Systems, Music Informatics, Security Informatics, and an Individualized minor. Ph.D. students inside the School may obtain a minor in one of the four distinct areas by completing nine credit hours of course work from courses listed 500 and above. The course prescription for the minor must be approved by the student's advisor and the DGS. The average grade point for the minor must be at least a B (3.0) or above, and no course grade below a B- (2.7) is counted toward the minor.

To be used for graduate credit, 300 and 400 level courses must receive prior approval by the University Graduate School. See the *University Graduate School Academic Bulletin* for more details.

Classes for the internal minors:

Complex Systems
Both I609 and I709 are required. The student may choose among the remaining courses to obtain the degree. In consultation with both the Area Director and advisor, additional classes can be counted toward the degree.
· I609 Advanced Ph.D. Seminar in Complex Systems I (3 cr.)
· I709 Advanced Ph.D. Seminar in Complex Systems II (3 cr.)
· I585 Biologically-inspired Computing (3 cr.)
· I586 Artificial Life as an Approach to Artificial Intelligence (3 cr.)
· I601 Introduction to Complex Systems (3 cr.)
· I690 Mathematical Methods for Complex Systems (3 cr.)

Music Informatics
· I545 Music Information, Search, and Retrieval (3 cr.)
· I546 Music Information Processing: Symbolic (3 cr.)
· I547 Music Information Processing: Audio (3 cr.)
· I548 Music Information Processing: Audio (3 cr.)

Security
In consultation with both the Area Director and advisor, CS649 (Networking Security) and CS649 (Trusted Computing) may be substituted for any two of the courses. The minor is obtained from the following list of classes:
· I533 Protocol Analysis and Design (3 cr.)
· I537 Social Information Security (3 cr.)
· I599 Malware (3 cr.)
· I536 Cryptography (3 cr.)
· I525 Economics of Security (3 cr.)

Individualized Informatics
Upon consultation with the Director of Graduate Studies and with recommendation by the student's advisor, a suite of classes 500 and above can be obtained for an Informatics minor. The courses taken: twelve (12) credits for an external degree, including I501; and nine (9) for an internal degree. For internal degrees, the three courses must be outside the student's area/track.

To summarize:
There are eight minors for those inside the School, with 9 credits required and fully controlled by the School. Also, there is an existing School Bioinformatics minor already existing requiring 9 credit hours for Informatics students and 12 credit hours for those outside School. There is an existing campus HCI Minor currently headed by School faculty requiring 12 credit hours for School students. There is also an existing campus Social Informatics minor requiring 12 credit hours for School students. Finally, there is the Computer Science minor. There are many minors approved by the University with requirements ranging from 6 to 12 hours.

Program Description

Description of program and its objectives:
The Ph.D. in informatics encompasses a range of informatics-based options for the student. Informatics is an integrated multidisciplinary field. The doctoral program provides a balance between technological, scientific, and social dimensions involved in the development and application of information technology.

Whatever the specific focus of their informatics doctoral study, students draw on course work taken from several disciplines. In the science informatics areas, the degree is built on a base of advanced computer programming skills, mathematics, and statistics; and scientific disciplines like molecular biology for bioinformatics and organic chemistry for chemical informatics. Knowledge acquired from the integrated study of these areas is applied to research topics related to the storing, retrieving and analyzing of data in the fields of bioinformatics and chemical informatics.

For the student interested in health informatics, the program offers the resources of one of the largest academic health centers in the country. The School of Informatics and Computing works closely with the School of Medicine (collaboration in and support of bioinformatics, primarily in the Center for Computational Biology and Bioinformatics), School of Nursing (faculty appointments in Health Informatics track), and School of Health and Rehabilitation Sciences (Health Education for the 21st Century Project). The School also collaborates with the Regenstrief Institute, one of the premier research centers for medical informatics, located on the IUPUI campus.

For the student interested in human-computer interaction design, the multidisciplinary program brings together user studies, behavioral science theory, new media theory, criticism, and design principles to allow the student to address research topics related to the design, evaluation and implementation of interactive computing systems in social settings. For the student interested in social informatics, the program offers a combination of knowledge of computing with the interdisciplinary study of the uses and consequences of information technologies that takes into account their interaction with institutional and cultural contexts.

Qualifying examinations - written (required):
All students will take a written qualifying examination that consists of a *depth exam*. The qualifying examinations are prescribed by track faculty. Examinations will be offered at the end of August and at the beginning of the second semester in January. Examinations may also be individually scheduled with the permission of all members of the student's advisory committee. 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 student completes all courses. Students who do not successfully complete the examination can retake the exam a second time. The *breadth* component of the student's examination is addressed by completion of the core courses (501 and 502) and by the completion of a minor.

Qualifying examinations - oral (required):
The oral qualifying examination covers in-depth knowledge of the student's primary research area. This examination is administered by the student's advisory committee.

The qualifying examinations will normally be completed at the end of course work, before the student embarks on the dissertation. The student must pass this examination before passing on to candidacy.

Dissertation proposal:
The research proposal for the dissertation must be approved by the student's research committee. That committee may include the same membership as the advisory committee or the student may choose different members. The advisor for the dissertation will be a faculty member in the School of Informatics and Computing and a member of the Graduate Faculty. Consult the University Graduate School bulletin for the committee member requirements. The student will defend the proposal at a public colloquium in the school.