Request for a New Graduate Certificate Program
Department of Computer and Information Science
School of Science, IUPUI

Bioinformatics Certificate

To be offered as a Purdue Certificate at IUPUI
May 30, 2005

Purpose of the Program

IUPUI's mission is to serve Indiana by providing the best possible educational experience for the population and the greatest possible growth in knowledge resources in support of the state's business, industrial and governmental activities. In this effort, it is striving to be the exemplary "Urban University."

In support of the university's mission, the department's mission is to build excellent academic programs coupled with strong research programs, industrial collaborations and community relationships. The three pillars supporting this mission are its Graduate, Undergraduate and Service Course Programs. The dynamics of Indiana, particularly in the Indianapolis area, obligate the department to not only continue, but increase this effort. The department has a key role to play in satisfying the information technology needs of the surrounding community and guiding their development.

In order to increase the Graduate Program's ability to support the department's mission, the department proposes to broaden and enrich its curriculum in anticipation of the rapidly growing trends in information technology, particularly as it is manifesting itself in the Indianapolis area. The objective of the proposed Graduate Certificate Program in Bioinformatics is to develop in the student skills and knowledge of the computer science fundamentals and an ability to apply these to practical problems as it relates to Bioinformatics. Another objective of this program is to provide an integrative experience by applying to a complex problem of a practical nature the theory and skills learned in the course work. The graduate of this program is prepared to adapt and respond quickly to the employer's specialized requirements.

The explosive growth of biological genetic information sources, available over the Internet, has given rise to both opportunities and challenges for biological and medical researchers. The opportunities they provide are both scientific (e.g., understanding the information encoded in elementary biological structures) as well as technological (e.g., new drug discovery for specific diseases). The challenges, on the other hand, lie in how to discover, among the vast volume of data, the items that are relevant or interesting to a given researcher, without an undesirable amount of effort and work load.

The complete information system development is based on an agent-society framework where the elementary information services such as resource discovery and information retrieval, representation, classification, and user interaction are carried out autonomously by independent

software units (called agents), and the large-scale information activity is accomplished by means of collaboration between these elementary agents. Such a conceptual agent-based information system is innovative and has the potential to scale up to a broad range of complex information services.

Relation to existing certificate programs
This program has no relation to existing certificate programs. However, the program is a complement to our existing undergraduate and M.S. programs.

The target audience
The location of the IUPUI campus is unique within the state and the need for targeted computer science certificate programs is unique to the population and companies within the metropolitan area. Our current research activities involves local community affiliation and collaboration. The community includes the local industries such as Eli Lilly & Co., Raytheon, and the IU Medical School. All of these entities in the local community have application domains which have the need for high quality fundamental research. This program will allow employees of these local industries to establish collaborations with our research faculty while at the same time providing them with the skills necessary to introduce these initiatives within their companies.

Plan for sustaining steady-state enrollment
In the first year (Fall 2005), five students will likely participate in the program. It is anticipated that this number will rise rapidly to ten per year in the next two to three years, as the awareness of the program increases. The potential exists for much greater growth beyond this subsequently.

New resources
No new resources are needed. All courses are currently taught at IUPUI by existing faculty.

Proposed date of the initiation of the certificate program
Proposed date of implementation is Fall 2005, assuming all necessary approvals have been met.

Persons designated as the certificate program head
Dr. Pamala Crowell, Associate Dean for Research and Graduate Programs, School of Science, will provide the school administrative oversight.
Dr. Mathew Palakal, Professor and Chair, Department of Computer and Information Science will provide the department administrative oversight.
Dr. Snehasis Mukhopadhyay, Associate Professor, Department of Computer and Information Science will advise students.

Faculty initially involved in the program and their credentials

Omran Bukhres **X3801**
Ph.D., North Dakota State University, 1990
Email address: bukhres@cs.iupui.edu 317-274-8674
Personal Web Page: http://www.cs.iupui.edu/~bukhres
Dr. Bukhres is the co-principal investigator of the Large Scale Distributed Computing and Multimedia Laboratory. Research focuses: (1) database management systems for multimedia data, and (2) seamless integration of the distributed multimedia databases. Other research interests include: Transaction and Workflow Management, Multimedia Databases, Interoperability and Recovery in Heterogeneous Distributed Database Systems, Knowledge Base and Expert Systems, Mobile and Client Server Computing.

Yuanshun Dai **X0458**
Ph.D. in Computer Science, National University of Singapore, September 2003
Email address: ydai@cs.iupui.edu 317-274-3473
Personal Web Page: http://www.cs.iupui.edu/~ydai
Computing Systems Reliability, Software/Hardware Reliability, Grid Computing, Parallel/Distributed Computing, Fault Tolerant Computing, System Modeling are Dr. Dai's specialties.

Shiaofen Fang **X0329**
Ph.D., University of Utah, 1992
Email address: sfang@cs.iupui.edu 317-274-9731
Personal Web Page: http://www.cs.iupui.edu/~sfang
Computer graphics, scientific visualization and geometric modeling are Dr. Fang's research specialties. Currently he is collaborating with biomedical researchers to apply computer graphics and visualization techniques, in particular volumetric modeling and visualization, for medical imaging applications.

Jeffrey Huang **X0375**
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Personal Web Page: http://www.cs.iupui.edu/~huang
Jeffrey Huang's specialties and research interests include image processing, pattern recognition, computer vision, machine learning, and Evolutionary Computation (EC) on the applications of face recognition, Human Computer Interaction (HCI) and the interpretations of human activities, multimedia, computer visualization, medical imagery, and Automated Target/Object Recognition (ATR) and detection.

Snehasis Mukhopadhyay **X0313**
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Current research interests are adaption and learning in multi-level and distributed systems; information filtering and retrieval; modeling, simulation analysis and adaptive control of complex nonlinear systems using neural networks; design and analysis of intelligent controllers. Dr. Mukhopadhyay received a National Science Foundation Career Award.

Mathew Palakal **X0199**
Ph.D., Concordia University, 1987
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Personal Web Page: http://www.cs.iupui.edu/~mpalakal 317-274-9735
The development of Artificial Neural Network (ANN) models as learning and decision-making systems for various AI-related problems are of primary interest. He is involved in projects that include modeling Biosonar systems, neural network models to predict damages in materials and structures, and distributed information filtering.

Rajeev Raje **X0328**
Ph.D., Syracus University, 1994
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Personal Web Page: http://www.cs.iupui.edu/~rraje 317-274-5174
Dr. Raje is interested in the system and application aspects of the distributed-object model of computing. His current projects include the development of a seamless environment for net-centric applications, distributed information filtering, collaborative software engineering and visualization environments, and enhancement of different distributed-object models.

Mihran Tuceryan **X0336**
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Dr. Tuceryan's research interests include augmented reality, model-based video coding, 3D computer graphics, 3D computer vision, and pattern recognition. Augmented Reality combines technologies from 3D computer graphics, visualization, advanced user interfaces, and 3D computer vision.

Jiang Yu Zheng **X0384**
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Dr. Zheng's research interests include Computer Vision, 3D Modeling, Dynamic Image Processing Image Processing, Multimedia, Internet, Scene Representation Graphics, Virtual Reality, Digital Museum Sensor Information Processing, Robotics

Xukai Zou **X0422**
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Applied cryptography and network security, Secure group communication: dynamic key, management, key agreement and distribution, Access control in distributed systems, Authentication and digital signature, data integrity and hash functions, Communication networks and wireless/mobile networks, Software engineering and Web/Internet technologies, Design and analysis of computer algorithms, Data/image processing compression.

Admissions requirements and procedures

General Admission Requirements for the Graduate Certificate in Bioinformatics

Academic Standing

The applicant's record should exhibit outstanding achievement as indicated by the grade point average (GPA) for each degree over his or her entire academic record. An applicant is expected to have at least a 3.0 GPA on a scale of 4.

Core Background Requirements

All Graduate Certificate applicants should have a background in the following core areas of computer science:

· Data Structures and Algorithms.
· Theory (discrete math and theory of computation).

In addition, applicants should have a strong background in mathematics, including calculus, linear algebra, and in numerical computations. For students who do not have a degree in Computer Science or related field, CSCI 362 (Data Structures) or an equivalent course is required with a grade of B+ or better.

TOEFL Scores for International Students

All Graduate Certificate applicants whose native language is not English must submit a Test of English as a Foreign Language (TOEFL) score of at least 550 on paper based TOEFL and 250 on computer based TOEFL, or pass an equivalent test administered by IUPUI. These criteria are minimum requirements and the Department of Computer and Information Science may use additional criteria to make admission decisions. Potential applicants who have questions are advised to contact a Graduate advisor in the department.

Students admitted directly to the Computer Science Master of Science graduate program may earn this certificate in conjunction with their M.S. degree provided that all the requirements of the certificate program are satisfied.

Completion requirements and audit and certification procedures
Course Requirements: 12 graduate credit hours are required. These include:

- One core course (3 credits),
- Three specialization courses (9 credits).
- **Specific Requirements**
  1. Core: BIO 322 (Genetics) or BIO 507 (Molecular Biology) or CSCI 580 (Algorithms)
  2. 548 (Introduction to Bioinformatics)
  3. 590 (Intelligent Systems) or 590 (Data Mining)
  4. 541 (Database Systems) or 550 (Computer Graphics)

Minimum overall GPA
Successful completion of the certificate requires at least a B average over all courses counting towards the certificate. Courses with a grade of C- or less must be taken again to count towards the certificate. The minimum grade that will be accepted in any single course is C.

Maximum number of credits that can be transferred from another institution
Applicants who have already earned credit for one or more of the equivalent courses from other institutions and other certificate programs may request to apply up to a maximum of three credits of these courses toward this certificate. Any waivers or substitutions have to be approved by the committee that oversees the program.

Maximum number of undergraduate courses that can be applied
One undergraduate course in Biology can be applied to this certificate program.

Maximum time for completion
All requirements for the certificate must be completed within three years. Most students enrolled in this program will be part-time students, employed full time. Thus two years may be needed for the completion of all courses if students take one course per semester.

Number of credit hours taken prior to admission to the certificate program that may be counted to completion of the degree
Up to 6 equivalent credit hours taken prior to admission to the certificate program, including 3 hours taken from another institution, will be counted towards the certificate. The rest of the courses must be completed at IUPUI within a three-year period from the time of admission.

Course lists for the program including course descriptions

BIOL K322 Genetics and Molecular Biology (3 cr.) P: K103 and CHEM C106. Fall, day. Spring of even-numbered years. The course covers the principles of classical and molecular genetics including Mendelian inheritance, linkage, nucleic acids, gene expression, recombinant DNA, genomics, immunogenetics, and regulation.

BIOL 507 Principles of Molecular Biology (3 cr.) P: K322, CHEM C342, or consent of instructor. Fall, night. Molecular aspects of structure and function of nucleic acids and proteins, including recombinant DNA research. Prokaryotic and eukaryotic molecular biology are given equal weight.

CSCI 548 Introduction to Bioinformatics (3 cr.) P: 340, BIOL K483, CHEM C483, or MATH 511. Analysis of biological data employing various computational methods to obtain useful information in the emerging area of bioinformatics. Topics include: structures, functions and evolution of proteins and nucleic acids, retrieval and interpretation of bioinformation from the Internet, learning principles, algorithms and software for sequence alignment, similarity search of sequence databases, estimation of phylogenetic trees, structural prediction, and functional inference.

CSCI 541 Database Systems (3 cr.) P: 443 or equivalent. Spring. Fundamentals for the logical design of database systems. The entity-relationship model, semantic model, relational model, hierarchical model, network model. Implementations of the models. Design theory for relational databases. Design of query languages and the use of semantics for query optimization. Design and verification of integrity assertions, and security. Introduction to intelligent query processing and database machines.

CSCI 550 Computer Graphics (3 cr.) An introduction to computer graphics. Topics include the concepts, principles, algorithms, and programming techniques in 3D interactive computer graphics. Emphasis is on the development and applications of 3D graphic algorithms and methods.

CSCI 580 Algorithm Design, Analysis, and Implementation (3 cr.) P: 463 and 470. Basic techniques for designing and analyzing algorithms: dynamic programming, divide-and-conquer, balancing, upper and lower bounds on time and space costs, worst case and expected cost measures. A selection of applications such as disjoint set union/find, graph algorithms, search trees, pattern matching. The polynomial complexity classes P, NP, and co-NP; intractable problems.

CSCI 590 Intelligent Systems (3 cr.) This course will discuss problems in the area of intelligent systems. Topics include the formalisms within which these problems are studied, the computational methods that have been proposed for their solution, and the real-world technological systems to which these methods have been applied.

CSCI 590 Datamining (3 cr.) This course introduces the core concepts necessary for the design, implementation, and application of database systems. It stresses the fundamental principles in database modeling and design. The aim is to address the continuing need for engineering databases for complex and ever changing applications requiring security, performance, and reliability. The teaching approach will be both instructional and researching. The course emphasizes fundamentals for the logical design of database systems, the entity-relationship model, semantic model, hierarchical model, network model implementations of the models, design theory for relational database, design of query languages and the use of semantics for query optimization, design and verification of integrity assertions and security, and introduction to intelligent query processing and database machines.

Procedures for governing the program including construction of committees that will provide oversight

A committee comprised of Dr. Mathew Palakal, Dr. Snehasis Mukhapadhyay and Dr. Jeffrey Huang will jointly oversee the program. All advising will be done by these faculty members. The Department of Computer and Information Science and Ms. Myla Langford, the graduate coordinator, will take responsibility for all record keeping and tracking of students.

Procedures for program evaluation including the criteria for success

Upon completion of the program, exit interviews will be conducted for all students to determine the effectiveness of the program in meeting their needs and to identify how they are using the skills and tools learned in the program in their professions. Follow-up interviews will be conducted after three and five years. Given the projected enrollment of this program, and the fact many of the graduates will remain employed locally, it is anticipated that most students will be tracked this way.

Success of the program will be defined in terms of demand (enrollment) and the responses of the students surveyed upon completion of their degree and in the follow-up interviews.