Computer & Information Science

2014 Self Study
ACKNOWLEDGEMENTS

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Shiaofen Fang, Ph.D.
Professor and Chair
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Chapter 1  Introduction

The Department of Computer and Information Science at the IUPUI (henceforth referred to as “the Department”) seeks to receive, as an outcome of the review, suggestions and recommendations from the Review Committee to improve its educational, research, and service missions so as to maintain its ongoing upward trajectory. The last review of the Department was in the Fall of 2006 and was an internal review. Just before that review, then Chair of the Department (Prof. Mathew Palakal) had left to join the IUPUI School of Informatics and a new Interim Chair (Prof. Shiaofen Fang) and Interim Associate Chair (Prof. Rajeev Raje) were appointed by then Dean (Prof. William Bosron) of the School of Science. Subsequently in the Fall of 2007, Profs. Fang and Raje took over the responsibilities of these two roles in a permanent capacity. Since the past review, the Department has achieved significant progress on all the fronts of its academic mission. For example, the faculty strength in the Fall of 2006 was 10, while it is 16 in the Fall of 2014 with one additional faculty member joining in the Spring of 2015. Similarly, the number of undergraduate, M.S., and Ph.D. students in the Fall of 2006 were 161, 65, and 4, while the strengths for Fall 2013 are 219, 138, and 31 respectively. The total research expenditure of the Department increased nearly 6 times over these eight years, to over $1.2 million – and three of the faculty members (Profs. Hasan, Dundar, and Tsechpenakis) hired since 2006 have received the prestigious NSF CAREER Awards. All these are clear signs of a thriving department and its successful programs.

The recent upward growth of the Department has been significant, especially considering the current decline of state and federal support for higher education. Sustaining this growth, in the short- and long-term future, will require the Department to continue its efforts on all three fronts of its academic mission. Hence, this review provides an opportunity to critically assess the strengths and weaknesses of the Department, its programs, and devise a concrete plan to build upon the past achievements and address limitations. In this context, the Department has identified following topics and specific questions for the assessment.

Review Topics

1. The current and future size of the faculty and research areas
2. CS Education-related efforts
3. Recruitment of research students
4. Curriculum
5. Mission differentiation
6. Assessment of Learning

Specific Review Questions

The Department has, after an extensive discussion, identified the following six questions for the Review Committee.

1. What is the appropriate size of the faculty in the Department to have the needed critical mass to be competitive nationally in research and education? More specifically, (i) Are
the focal areas of strength in the Department appropriate? Which areas need further reinforcement? (ii) Should the Department establish new areas of strength outside the existing ones? If so, which areas?

Existing areas of research focus are discussed in depth in Chapter 8 with detailed descriptions of projects and grants, faculty involvement, collaborations, etc. to give a sense of the current state of Department research and our research focus. This question is also related to concerns regarding physical space allocation and fiscal resources, which are discussed in Chapter 5.

2. Computer science education research has been a new area of emphasis nationally. How can the Department develop a funded CS education research program that can help inform the Department’s academic programs? Should the focus be on hiring new faculty trained in CS education research, or develop the expertise internally?

As can be seen in Chapter 8, the Department has already begun formal efforts in Education Research with current faculty, but this is an area we have actively sought to grow through external hiring without much success. As much of this research is related to course assessment and improvement efforts in undergraduate courses, some of the current effort is also discussed in Chapter 6 in the sections on undergraduate assessment, and this presents an area where we could potentially expand on existing efforts in a more formal manner.

3. The lack of quality Ph.D. students and research-oriented Masters’ students has been a bottleneck to the Department’s research programs. How can the Department more effectively recruit research-oriented graduate students to support active research projects?

Our graduate programs and population are discussed in detail in Chapter 7; while the creation of the course-only M.S. program option described therein (as well as in Chapter 2 under response #1) has certainly served to increase Department enrollment generally, it has also served in some ways to compound the problem of attracting M.S. students to research-oriented programs, due in part to the increased time to graduation that is typically involved with research programs compounded by the desire to enter the job market as soon as possible. In terms of Ph.D., the informal program for application transfer from PUWL described in Chapter 7 has so far seen success in increasing applications to and enrollment in our program from high-quality candidates, but we are still looking for other ways to reach out and recruit such candidates.

4. The Department’s academic curriculum has been recently revised to better represent several new academic programs. Are the current graduate and undergraduate curricula adequate in meeting Computer Science educational goals and industry needs? What changes, if any, are recommended to improve the curriculum?
Again, the undergraduate and graduate curricula, including new programs, are described in detail in Chapters 6 and 7, respectively. Curriculum improvements and developments are also discussed in detail in Chapter 2 within some of the responses to 2006 review questions.

5. While IUPUI has a number of units related to computing and information technology, computer science remains the “central” computing discipline that provides the foundation for education and training in the broad computing field. As a computer science department, how does the Department position and properly differentiate itself in this complex and sometimes competing environment to better serve our students and the community?

6. The Principles of Undergraduate Learning (PULs) undergird IUPUI’s approach to general education for undergraduate students. Do you find evidence that the department’s courses for undergraduates have (a) statements of expected learning outcomes for students that incorporate the PULs, (b) means of assessing student learning related to the stated outcomes, and (c) systematic processes for collectively examining the assessment information and taking warranted actions designed to improve instruction, the curriculum, and/or student support services?

Current efforts and initiatives in undergraduate assessment are discussed in some of the Chapter 2 responses, as well as toward the end of Chapter 6. We are also actively seeking to begin this type of assessment within the graduate programs as well, but have not begun this effort; graduate assessment is discussed at the end of Chapter 7.

It is hoped that these questions will aid the Review Committee in providing concrete feedback to the Department. This feedback will help the Department maintain its ongoing growth and assist in creating a blue-print for achieving its near- and long-term goals.

The remainder of the self-study document is organized as follows. Chapter 2 addresses the 5 recommendations made as a result of the 2006 self-study and presents detailed responses as to how the Department has addressed these recommendations since that time. Chapter 3 provides “institutional context” including a history of the Department, a brief overview of the Department’s academic programs and a brief description of the faculty body and faculty governance. Chapter 4 provides a detailed listing of all departmental personnel including tenured and tenure-track faculty, Lecturers, jointly appointed faculty, Emeritus faculty and full-time staff. Information regarding teaching loads, faculty recruitment and development, and brief descriptions of faculty achievements since 2006 is also included in Chapter 4. Chapter 5 discusses departmental resources in detail, in particular an overview of the Department’s finances, computing resources and space allocation. Chapter 6 presents a detailed description of the Department’s various undergraduate academic programs, enrollment statistics and trends, and information about assessment and outreach activities. Chapter 7 provides a
similar overview of the Department’s graduate academic programs, along with enrollment and assessment information. The Department’s research profile, including research groups and information about projects, grants and publications are found in Chapter 8 (accompanied by more detailed information in the Appendix). Chapter 9 highlights faculty service activities since 2006, while Chapter 10 presents the conclusion addressing current challenges and future directions. Supplemental information is found in the Appendix.
Chapter 2  Recommendations from 2006 Review and Departmental Responses

The Department underwent an internal review in the Fall of 2006. The Review Team made five recommendations. These, along with the departmental responses to them, are indicated below.

1. The Department identified several important areas of research focus, developed new graduate programs, and took steps to deliver more courses online in order to increase future credit hours. Continue to evaluate ways to increase credit hours.

**Response:** The Department has undertaken several new initiatives to increase the credit hours at all levels. Some of these efforts are briefly described below.

i) Since the 2006 self-study, the following new faculty hires have been made:
   - Dr. Murat Dundar (2008): Machine Learning, Pattern Recognition
   - Dr. Mohammad Hasan (2010): Data Mining, Graph Mining
   - Dr. Gavriil Tsechpenakis (2010): Computer Vision, Image Processing
   - Dr. Fengguang Song (2013): High-performance Computing
   - Dr. Xia Ning (Fall 2014): Big Data Analytics, Data Mining
   - Dr. Erman Ayday (Spring 2015): Big Data, Privacy Enhancing Technologies

These new hires have developed and offered innovative graduate and undergraduate major courses in their areas of expertise. Such offerings have attracted new students to the Department.

ii) In Fall 2008, the Department received approval to offer 12-credit hour Graduate Certificates in five specialized areas. The popularity of the course-only Applied M.S. option has also facilitated increased graduate enrollment.

iii) In 2012, the Department enhanced its curriculum offerings with a Bachelor of Arts degree in Computer Science (CS). This B.A. degree, similar to the traditional Bachelor of Arts programs, includes a foreign language requirement (which helps prepare CS students for participation on diverse work teams and employment with global organizations). Additionally, in contrast to the B.S., the B.A. has a much stronger applied focus, requiring significant application proficiencies and concluding with an industry internship. The required upper-level application classes replace the upper level math and CS theory classes required in the B.S. program. The B.A. extends the Department target market beyond traditional Computer Science
students and was designed for students who are seeking technical leadership positions in industry.

iv) Additionally, the Department has developed an additional certificate program called a “Data Analytics Certificate”. This 15-credit hour certificate targets students with majors outside of Computer Science and returning professionals whose career paths will require fundamental competencies in data analysis. Required coursework includes theoretical concepts, as well as applied skills in spreadsheets, databases, and data-focused programming languages such as R, MATLAB, and SPSS. In addition to increasing enrollment beyond computing majors, this certificate will additionally serve the Department’s mission of broadening participation in the computing curriculum and extend computational thinking into additional disciplines. Moreover, it allows the Department to build faculty and programmatic relationships with other campus units. The Data Analytics Certificate has been unanimously approved by the School of Science, and is scheduled for university review in September 2014.

v) The General Education Core 30 went into effect for all incoming freshmen in the Fall 2013 semester. The General Education Core 30 consists of six competency areas that all IUPUI students, regardless of major, are required to complete. The six competency areas are Core Communication, Analytical Reasoning, Cultural Understanding, Life and Physical Sciences, Arts and Humanities, and Social Sciences. As of Fall 2014, five CSCI courses have been approved to meet the Analytical Reasoning requirement:

- CSCI 23000 Computing I
- CSCI-N200 Principles of Computer Science
- CSCI-N201 Programming Concepts
- CSCI-N207 Data Analysis Using Spreadsheets
- CSCI-N211 Introduction to Databases

The Department has also increased credit hours by adding new service courses. For example, CSCI N200: Principles of Computer Science is a course developed within a curriculum framework established by the NSF as part of a national initiative to broaden participation in computing. This course identifies seven “Big Ideas” of computing -- identification purposed to “myth-bust” some of common misconceptions by introducing non-traditional computing students to the breadth, creativity and problem-based nature of Computing. The Department was selected to host an early pilot for the AP College Board Principles program targeted to launch in 2016. The delivery of the CS Principles curriculum, via the CSCI N200 course, emphasizes collaborative and peer-led learning techniques to better leverage student success. The CSCI N200 was launched in the Fall 2013, and enrollment in it has been high enough to maintain a steady course offering in every
subsequent semester. In Spring 2015, an additional section of the CSCI N200 will be added as part of a themed Learning Community. In addition, the CSCI N317 (Computation for Scientific Applications) will be offered as a new course in the Fall 2014. The course will teach computational approaches and software tools used in data processing, data analytics, data visualization and data mining. The course will be a core course in the new data analytics certificate that is proposed by the Department.

2. Work closely with the Center for Teaching and Learning to gain expertise in application and assessment of the Principles of Undergraduate Learning (PULs).

Response: The Department has implemented 6 stage SLOs (Student Learning Outcomes) as they pertain to the undergraduate curriculum. These are:

Stage 1: Identify the program’s student learning outcomes (SLOs).
Stage 2: Link these SLOs to specific components of the program’s curriculum.
Stage 3: Identify or create methods to measure these SLOs.
Stage 4: Collect data to determine if the SLOs are being accomplished successfully.
Stage 5: Use the data collected in Stage 4 to make curricular changes.
Stage 6: Repeat Stage 4 to determine if the curricular changes were effective.

The Department has, in recent past, focused on Stages 4, 5, and 6 in particular, since stages 1-3 had essentially already been in place for some time and were easy to re-define. Stage 6 for the Department is to test basic understanding of students on the computer architecture, the interrelations among structure and functionality of hardware and software components, and understanding of the utmost necessity for exploiting the capabilities offered by modern computer systems. The Department has decided to use the ETS Major Field Test (MFT) to examine student learning outcomes. The MFT is a standardized exam that covers topics in programming concepts, discrete structures and algorithms, and computer systems, norm-referenced to a large set of college seniors. After implementing the MFT in the capstone course for two consecutive years, the Department started data analysis and discussion of future improvement of the undergraduate curriculum based on the outcomes of the MFT. The Department determined that an additional course, CSCI 48400 (Computational Theory), should be added to the core requirements. This course, since the Spring 2010 semester, has been taught once yearly by Dr. Judith Gersting who is a Professor Emeritus in the Department. This course includes topics in computational theory, complexity, and algorithms. Proficiency in these areas has been shown to be lacking in the senior-level students for the past two MFT cycles. This deficit persists when viewing the results of the MFT as compared with the overall group, as well as a selected peer group of universities. Since the introduction of this course, the results on the MFTs have been better when compared with both the peer and the national group for the past two years.
To support enrollment growth, the Department began offering an additional, online version of CSCI 23000 (the gateway course for majors) in Fall of 2011. An end of semester review by the Undergraduate Committee observed an unacceptable DWF rate of 66.7% in the online section. A review of CS educational research suggested that a lab/recitation model called Cyber Peer Led Team Learning (cPLTL) might offer a significant opportunity for providing improved student impact in the online section. With the faculty approval, cPLTL was adopted in CSCI 23000 in the next online offering (Fall 2012). Its impact on student outcomes was significant, with improved student success each subsequent semester. By Spring 2014, the DWF rates for the online section are comparable to those in the face to face section (as illustrated in the following chart).

The cPLTL model was expanded to the online section of CSCI 24000 (the next course in the curriculum), with positive results (i.e., again, comparable DWF rates between live and online sections). The Department is currently considering the PLTL approach for the live sections of the gateway courses, as well.

3. Address areas of overlap in course content among CIS, the School of Informatics, and the School of Engineering and Technology.

Response: The C4 (Computing Curriculum Coordination Council) was formed in 2011 at IUPUI as a result of the Indiana University Academic Directions Initiative, with the objective of discussing and resolving potential new curriculum proposals among the Schools of Engineering & Technology, Informatics, and Science, before these proposals are forwarded to the campus level for possible approval. One of the first tasks accomplished by this Council, after much discussion, was to agree on a Computing Discipline Differentiation document, outlining the descriptions of each relevant unit’s mission and objectives, to be shared with students and advisors. This document is included in the appendix. There have
also been numerous courses (including two from the Department — CSCI N200: Principles of Computer Science and CSCI N317: Computation for Scientific Applications) and new programs that have been discussed and approved by the C4, in order to address potential overlap before the campus-level approval process. The Department representatives recently proposed a cap on the number of new course/program proposals from any unit in a given time period to prevent course proliferation and duplication. This proposal was objected to by the representatives from other units and was tabled for possible further future discussions.

The Department has also developed an agreement with the Department of Electrical & Computer Engineering whereby several courses, on a regular basis, are cross-listed with both departments (e.g., CSCI 40300: Introduction to Operating Systems, CSCI 43600: Principles of Computer Networking, and CSCI 50400: Concepts in Computer Organization), rather than being offered as discrete sections offered within each department. Faculty from each department alternate in teaching these courses. The Department is currently in discussion on a similar arrangement with the Department of Computer and Information Technology (CIT) in the School of Engineering and Technology.

4. The School of Science should support the Department as they grow their efforts to collaborate with faculty in other units and establish the master's and doctoral degree programs.

*Response*: The School of Science has provided significant support to the Department in recent years, most notably with a large increase in Research Investment Fund fellowship (RIF) funding allocations (through matching funds given by the Dean's Office, which were not available in previous years). This funding has enabled the Department to increase its support of a greater number of Ph.D. (and some M.S. students) on Teaching Assistantships at a time when departmental graduate enrollment has grown significantly. In addition, the School of Science has supported departmental efforts to recruit high-quality, research-oriented international M.S. students with the “Dean’s Scholarship” program; this program provides selected students with a fee remission award to reduce their tuition to the in-state rate for the duration of their 30 credit hour program. These students must maintain sufficient academic progress (3.5 GPA) and complete the M.S. thesis option. The funding for this scholarship is provided by the Dean's Office. Other school-wide initiatives have provided increasing support to the Department, including the formalized ICR (Indirect Cost Return) agreement and the School's tuition policy.

Additionally, the School of Science has been very supportive in recognizing the need for hiring more faculty and staff; 9 new faculty lines have been approved and filled since 2007 and 1 new staff position has been created and filled in 2013-14.
5. Continued discussion should take place to consider the options that might lead to combining portions of the School of Engineering and Technology, the School of Informatics, CS, or those entire units into one School.

*Response:* This recommendation can only be addressed by the campus higher administration and the Department is not aware of any recent attempts in this regard. In November of 2010, the Department made a formal position statement, unanimously approved by the faculty, to express its strong preference of staying within the School of Science as a Purdue department.
Chapter 3  
Institutional Context

History of IUPUI and the School of Science

Indiana University established its first extension center at Indianapolis in 1916, although the first IU course was taught in Indianapolis in 1890. The Indianapolis campus of Purdue University grew out of World War II training programs sponsored by the Purdue University and began its major operations in 1946. Indiana University established the Indianapolis regional campus in the mid-1960s. In 1968, Indiana University at Indianapolis was created by the Trustees of Indiana University, and less than a year later, in 1969, the trustees of Indiana and Purdue universities merged their Indianapolis operations to form Indiana University–Purdue University at Indianapolis. Indiana University was selected to administer the campus. Purdue University brought to the merger a growing complex of degree programs and Purdue’s traditional strengths in the physical sciences, engineering, and technology. The name of the campus was changed to Indiana University–Purdue University Indianapolis (IUPUI) in 1992. IUPUI and IU Bloomington are the largest of Indiana University’s eight campuses.

A restructuring of undergraduate programs at IUPUI in the fall of 1972 created three new schools: the School of Liberal Arts (humanities and the social sciences), the School of Science (physical, behavioral, and life sciences), and the School of Engineering and Technology. After being housed for almost 22 years on the 38th Street Campus, the School of Science made a historic move in two phases into two buildings on the main campus during 1991-1993.

IUPUI’s Mission

IUPUI's mission is to advance the state of Indiana and the intellectual growth of its citizens through research and creative activity, teaching and learning, and civic engagement. By offering a distinctive range of bachelor's, master's, professional and doctoral degrees, IUPUI promotes the educational, cultural and economic development of central Indiana and beyond through innovative collaborations, external partnerships and a strong commitment to diversity.

Mission of the School of Science

“The mission of the School of Science is to serve society by educating our students as discerning citizens and leaders in productive careers, and by advancing knowledge and understanding through basic and applied research.”

History of the Department of Computer and Information Science

The program of Computer Science began as an option in the Department of Mathematical Sciences in 1967, shortly after the formation of IUPUI. In 1970, the M. S. in Computer Science was proposed, and in 1974 the B. S. was proposed. Initially, these programs were closely coordinated with the programs in the Computer Science Department at Purdue University. At
that time, the M. S. Program at the IUPUI was qualified as "Applied" with the focus on numerical computation. Subsequently, undergraduate program became independent and began to differ considerably from that at Purdue University. The nature of the M. S. curriculum followed the historical trend in the Computer Science field from primary emphasis on scientific computing to computer systems issues, such as operating systems, languages, networks, and databases. Also following a national trend, the Computer Science program was separated from the Mathematical Sciences Department in 1981 to form the present Department of Computer and Information Science. Prof. Judith Gersting was the Chair of the Department when it was founded in 1981 and Prof. John Gersting was also a faculty member at that time. Professors Judith Gersting and John Gersting are currently Professors Emeritus in the Department.

The Department revised the B.S. degree requirements in 2010, resulting in a curriculum that is current and adaptable to student interests. This was accomplished by reducing the number of required core courses to provide students more flexibility in pursuing advanced electives and skill courses. Changes were also made in the introductory programming courses to focus more on programing principles while deemphasizing language specific features.

The Bachelor of Arts in Applied Computer Science was added as the second undergraduate degree program in the Fall of 2012. The B.A. offers a balance of theoretical and applied computing coursework to prepare students for multiple pathways into the information technology workforce. Additional coursework in the liberal arts and social sciences further enhances communication skills and understanding of issues in other sectors of the economy.

A five year dual-degree B.S./M.S. program was introduced in the Fall of 2013. This program allows students who are highly motivated to earn both a Bachelor of Science and Master of Science degree in just five academic years. B.S./M.S. students complete three 500-level courses that satisfy general/free elective requirements in the B.S., thus shortening the time to complete their M.S. degree by one academic term. Students then complete the remaining twenty-one credit hours of the M.S. program after admission and earn their M.S. degree in just one year's time.

In recognition of the need to provide non-majors with a strong ability to apply computers in their own disciplines and future professional lives, the Department broadened and continues to expand its curricular offerings to these students and emphasizes the use of computers in problem solving. The Certificate of Applied Computer Science is a popular option for many students, and tends to attract students from the Schools of Business, Continuing Studies, Informatics, Liberal Arts, and Science. Non-major classes comprise a significant portion of the undergraduate credit hours, and serve the needs of multiple constituencies well.

In the Fall of 2008 the Department was granted permission to offer five graduate certificates to attract potential students from local industries. These certificates are offered in: a) Biocomputing, b) Biometrics, c) Computer Security, d) Databases and Data Mining, and e) Software Engineering. In addition to attracting students from local industries, these certificates also allow students to get admitted into the M.S. program after the successful completion of the
certificate with a formal application process. The number of current students in the certificate programs is only 1 – mainly, as many incoming certificate students prefer to switch to the MS program after an initial advising session. The M.S. program has experienced significant growth since 2006, particularly with the adoption of the course-only applied option.

The Department submitted a proposal to the CS Department at Purdue University and was granted permission to offer the Ph.D. degree at the Indianapolis campus in 2003. The program has grown significantly since 2006, with 31 current students and 5 graduates; in addition 10 new students have joined the program in the Fall of 2014. The Ph.D. program is offered in close cooperation with the CS Department at Purdue University West Lafayette, and students must pass qualifying exams and follow the Purdue University policies regarding the Ph.D. study.

Departmental Mission

“Our mission is to build excellent academic programs at all levels of computer science education and support this academic mission through strong research programs, industrial collaborations and community relations.”

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.

Department Overview

Academic Programs

The Department currently offers a comprehensive set of degree programs, including:

- Undergraduate Certificate in Applied Computer Science
- Bachelor of Science in Computer Science
- Bachelor of Arts in Computer Science
- B.S./M.S. Combined Degree in Computer Science
- Master of Science in Computer Science
- Graduate Certificates
- Doctor of Philosophy in Computer Science
- Ph.D. Minor in Computer Science
Generally, the student enrollment has increased since the last review of 2006, with significant increases in the graduate program enrollment. The popularity of new programs, such as the B.A. and combined B.S./M.S., has also helped to not only boost the enrollment, but also to address various key issues the Department has continued to face – e.g., attracting new students to the Department (outside of the traditional B.S. program) and transitioning current students from the undergraduate programs into the graduate programs. A snapshot of Departmental enrollment showing this growth trend is shown in Table 3.1; more detailed information about these programs is found in Chapters 6 and 7.

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
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<th>2011</th>
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<th>2013</th>
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<td>1,491</td>
<td>1,547</td>
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<tr>
<td>TOTAL</td>
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<td>9,757</td>
<td>10,041</td>
<td>9,256</td>
<td>10,300</td>
<td>11,953</td>
</tr>
</tbody>
</table>

Table 3.1: Computer Science Enrollment (by credit hours) 2007-2013 (Fall semesters)

**Faculty Profile**
As enrollment in the Department has grown, it has become necessary to increase the faculty size accordingly. Since 2006, the Department has hired 9 new tenure-track faculty members (with one joining in the Spring of 2015) and one Lecturer. The faculty members are all actively engaged in the teaching, research and service missions of the Department. The success in obtaining research grants has continued to increase since 2006. Chapter 4 contains information about the faculty research, including external and internal grants awarded for the years 2007-present, and information on faculty accomplishments and recognitions. Shortened CVs of the faculty members are included in the Appendix for further reference.

**Faculty Governance**
The Department is governed by a Chair, who serves as the chief administrative officer and is responsible for the proper functioning of the educational, research and service programs of the Department. The Chair is supported in these duties by an Associate Chair. As per the bylaws, the Department has a number of standing committees to which faculty are either appointed or elected to serve—the Faculty Advisory Council, the Primary Committee, the Undergraduate Program Committee, the Service Course Committee, the Graduate Program Committee and the Infrastructure Committee. In addition, the Department’s faculty annually elects a representative to the School of Science Steering Committee. A copy of the Department’s bylaws is included in the Appendix for further reference.

**Infrastructure and Resources**
Enrollment growth has driven the need for significant expansion in the Department’s physical footprint and computing infrastructure. The details of these two critical aspects are provided in Chapter 5.
Chapter 4 Personnel

Current Tenured and Tenure-Track Faculty

The Department has grown significantly since 2006, with several successful searches resulting in the hiring of 9 new tenure-track faculty members (2 who will be starting later this year). Following is the list of current tenured and tenure-track faculty; more detailed CVs of the faculty members are included in the Appendix.

- Ayday, Erman, Assistant Professor of Computer and Information Science (Expected Start: January 2015); B.S., 2005, Middle East Technical University; M.S., 2007, Georgia Institute of Technology; Ph.D., 2011, Georgia Institute of Technology. Specialties: Big Data, Privacy Enhancing Technologies, Cryptography and Wireless Network Security.

- Al Hasan, Mohammad, Assistant Professor in Computer and Information Science (2010); B.Sc., 1998, Bangladesh University of Engineering and Technology; M.S., 2002, University of Minnesota; Ph.D., 2009, Rensselaer Polytechnic Institute. Specialty: Data Mining.

- Dundar, Murat, Associate Professor of Computer and Information Science (2008); B.Sc., 1997, Bogazici University, Turkey; M.S., 1999, Ph.D., 2003, Purdue University. Specialties: Machine Learning, Pattern Recognition.


Ning, Xia, Assistant Professor of Computer and Information Science (August 2014); B.S., 2005, Zhejiang University; M.S., 2009, University of Minnesota, Ph.D., 2012, University of Minnesota. Specialties: Big-Data Analytics, Data Mining, Machine Learning, Chemical Informatics.


Xia, Yuni, Associate Professor of Computer and Information Science (2005); B.S., 1996, Huazhong University of Science and Technology; M.S. 2002, Ph.D., 2005 Purdue University. Specialties: Databases, Data Mining.


Zou, Xukai, Associate Professor of Computer and Information Science (2003); B.S., 1983, Zhengzhou University; M.S., 1986, Huazhong University of Science and Technology; Ph.D., 2000, University of Nebraska-Lincoln. Specialties: Cryptography, Network Security, Secure Electronic Voting, Health and Genomic Data Security and Privacy.
Joint Appointments

- Chen, Yue (Jake) (5% Appointment), Associate Professor of Computer and Information Science and Informatics (2004); B.S., 1995, Peking University, China; M.S., 1997, Ph.D., 2001, University of Minnesota-Twin Cities. Specialties: Bioinformatics, Data Warehousing, Data Mining.

- Palakal, Mathew J. (5% Appointment), Executive Associate Dean, IU School of Informatics (IUPUI) and Professor of Computer and Information Science (1988); B. Comp. Sci., 1979, M. Comp. Sci., 1983, Ph.D., 1987, Concordia University, Canada. Specialties: Artificial Intelligence, Bioinformatics, Pattern Recognition, Artificial Neural Networks.

Non-Tenure Track Researchers

- Liu, Jing-Yuan, Research Assistant Professor (2011); B.Sc., 1995, Shandong University, China; M.Sc., 1998, Chinese Academy of Sciences, China; Ph.D., 2004, Indiana University. Specialties: Computational Biology and Bioinformatics.

Non-Tenure Track Full Time Lecturers


- Harris, Andrew J., Senior Lecturer in Computer and Information Science (1995); B.S., 1990, M.S., 2003, Indiana University-Purdue University Indianapolis. Specialties: General Computing, Multimedia and Game Programming.


Active Emeriti and Honorary


Gersting, Judith L., Professor Emeritus and Chair of Computer Science (2011); B.S., 1962, Stetson University; M.S., 1964, Ph.D., 1969, Arizona State University. Specialties: Computer Education.


Faculty departures

Several faculty members have left the Department since the last review, as listed below.

- Dr. Yuanshun Dai, Assistant Professor, resigned June 2007
- Dr. Jeffrey Huang, Assistant Professor, did not receive tenure, August 2007
- Mr. Jeffrey Allen, Lecturer, resigned August 2008
- Mr. Robert Molnar, Lecturer, resigned August 2007
- Mr. Dale Roberts, Lecturer, not reappointed effective August 2010

Faculty Teaching Load

The regular teaching load for the tenure-track/tenured faculty is three courses per academic year. The new faculty members are allowed a course bye for the first two years so that they can establish their research programs as quickly as possible. There is a possibility of buying out of the course commitment, within the framework provided by the School of Science, with a mutual agreement between the faculty member and the Chair as indicated in the next section. The typical teaching load for lecturers is four courses per semester and two courses in summer (10 per year). Starting Fall 2014, the teaching load of the Lecturers is reduced to 8 courses per year -- some of these courses are taught in an online format.

In addition, the Department does employ the services of adjunct and part-time instructors especially for non-major courses. These instructors are chosen after a careful process. This process is typically coordinated by the Chair of the Service Course Committee.

Faculty Development and Recruitment

Faculty Development

Faculty are provided annual development opportunities including start-up funds for new faculty, release time for research, teaching and research awards, and support for travel to conferences, seminars, and workshops. Start-up funds are provided as part of the initial hiring package and
are valid for a period of three years after initial hire; faculty may use these funds to pay summer salary (up to two months), support students and to support equipment purchases or travel. The Department allocates an amount to each faculty on a yearly basis to support travel; the amount varies annually according to the available budget but is generally $1,000 to $1,500 per year per faculty.

The Department adopted a set of Course Buyout Guidelines in September 2009 that sets policy for research release. As per this policy, with the approval of the Department Chair a tenured or tenure-track faculty has the option of buying out one course per academic year, at a cost of 16.7% of his/her regular 10-month salary charged to either an external research grant or internal grant that was specifically budgeted for course buyout. A faculty member subject to this policy is required to teach a minimum of one course per academic year.

Faculty Recruitment

The Department has completed several successful faculty searches since the last review — in 2007 (Drs. Durresi and Liang), 2008 (Dr. Dundar), 2010 (Drs. Hasan and Tsechpenakis) and 2013 (Dr. Song). Two new faculty members have also been hired at the completion of a faculty search this year (2014); one has started in August 2014 (Dr. Ning) and the other will be starting in January 2015 (Dr. Ayday). Additionally, Dr. James Hill was successfully recruited from the Vanderbilt University as an Assistant Professor in 2009. Faculty searches follow the Search and Screen procedures set forth by the Office of Equal Opportunity and are coordinated by the Search Committee that the Chair appoints before each search.

Faculty Accomplishments and Recognitions

Ms. Lingma Acheson, Lecturer
Since 2007, Ms. Acheson has worked extensively in international program development, establishing a 2+2 joint degree program with Sun Yat-sen University and a 3+2 student transfer program with Changzhou Institute of Technology, as well as a joint research program between the IUPUI Computer Science, the IUPUI Department of Tourism and Convention Management and Ball State University. In 2009, Lingma was the recipient of the IUPUI Glenn W. Irwin, Jr., M.D. Experience Excellence Award, given to faculty members whose service goes “above and beyond the call of duty.” She has also worked significantly on course development, revising many of the department’s N-series courses and receiving a 2013 Curriculum Enhancement Grant from the IUPUI Center for Teaching and Learning for revising N431.

Dr. Erman Ayday, Assistant Professor (Expected to join in January 2015)
Dr. Ayday’s research interests include privacy-enhancing technologies (including big data and genomic privacy), wireless network security, game theory for wireless networks, trust and reputation management, and recommender systems. He is the recipient of 2010 Outstanding Research Award from the Center of Signal and Image Processing (CSIP) at Georgia Tech and 2011 ECE Graduate Research Assistant (GRA) Excellence Award from Georgia Tech. He is a member of the IEEE and the ACM.
Dr. Jake Chen, Associate Professor
Since 2007, Dr. Chen has co-authored numerous peer-reviewed publications and received several awards including many from NIH, NSF, IU MURI and IUCRG; he has also been awarded several patents. He is the Founding Director (2007) of the Indiana Center for Systems Biology and Personalized Medicine and since 2012 has served as a Visiting Professor at the Zhejiang Institute of Biopharmaceutical Informatics and Technology.

Dr. Murat Dundar, Associate Professor
Since 2007 Dr. Dundar has co-authored 23 peer-reviewed publications and has received five awards including the prestigious NSF CAREER award. He has served as a PC member for ACM SIGKDD, IEEE ICDM, SIAM SDM conferences and as a panelist for NIH and NSF review panels. He is the main author of the paper that received the best scientific paper award in the Bioinformatics and Biomedical Applications track at the 20th International Conference on Pattern Recognition (ICPR’10).

Dr. Arjan Durresi, Professor
Dr. Durresi’s research focuses on networking, security and trust. He is particularly interested in new network architectures as response to the changing challenges and needs of users in various environments and applications. Since 2007, he has co-authored 144 peer-reviewed publications, two of which have received Best Paper Award (at IEEE International Conference on Digital Ecosystems and Technologies - DEST 2010, and the 6th International Conference on Advances in Mobile Computing & Multimedia MoMM2008). He has been keynote speaker in conferences such as IEEE AINA 2007 and NBiS 2008. Since 2007, he has been the PI of four NSF funded research projects and chair of several international conferences, including 13th International Conference on Network Based Information Systems – NBiS 2010, 23rd IEEE Advanced Information and Networking Applications Conference – AINA 2009, International Conference on Availability, Reliability and Security ARES 2009 and founder of four ongoing workshops.

Dr. Shiaofen Fang, Professor and Chair
Since 2007, Prof. Fang has published 34 peer reviewed research papers and has received 4 external research grants from NIH and DoD as PI or co-PI totaling nearly $3.4 million. He was also the funding director of the IUPUI Signature Center for Biocomputing which was established in 2007 through a campus Signature Center internal grant. Prof. Fang’s research since 2007 has been focused on two major areas: (1) 3D image analysis for medical applications; and (2) Information visualization for Health and social network applications. He has collaborated with many health and biomedical researchers on projects such as 3D facial image analysis for fetal alcohol syndrome diagnosis; shape analysis for neuroimaging; and large scale healthcare data visualization.

Mr. Andrew Harris, Senior Lecturer
Mr. Harris has taught the CSCI 23000 and 24000 courses for several years and has been involved in extensive innovation in these integral majors’ courses, including ongoing work in distributed education and live versions of the courses, and incorporation of a peer-led team
learning model to improve DWF rates and student retention. Mr. Harris is a well-known author of computing books, including a number of books in the famous “Dummies” series and game development books featuring Flash, HTML5, and Python. He is also the author of a number of well-known open-source tools, including the Miracle language, two game engines, and a database integration tool. He has taught internationally in Macedonia and China, and is currently leading a project teaching children how to cope with Type I Diabetes through iPad games. This grant is in conjunction with Riley Children’s Hospital.

Dr. Mohammad Hasan, Assistant Professor
Since 2007 Dr. Hasan has co-authored 25 peer-reviewed publications and has received four awards including the prestigious NSF CAREER award in 2012. He has served as a PC Chair of BIOKDD’10 Workshop, and PC member for ACM SIGKDD, IEEE ICDM, SIAM SDM, PKDD, ACM CIKM, IEEE BIBM, IEEE BigData conferences in different years. He also served as a panelist for NSF review panels, and reviewed grant applications submitted to Louisiana Board of Regents and Netherland organization of Scientific Research. He is the first author of the paper that received the best scientific paper award in the Thirteenth Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD’09). In 2010, he won the SIGKDD doctoral dissertation award. In 2013 he won IUPUI School of Science Pre-tenure research award. He has given technical tutorials on graph sampling methodologies in top-tier data mining conferences, such as, SIGKDD, and ICDM.

Dr. James Hill, Assistant Professor
Since joining IUPUI in 2009 as an Assistant Professor, Dr. Hill has raised more than 1 million dollars in competitive research funds. He has also published more than 40 peer-reviewed publications (i.e., journals, conference, workshop, book chapters, and abstracts). Dr. Hill has graduate 3 M.S. students, and will be graduating 1 Ph.D. student. In 2010, Dr. Hill was invested to participate in the Air Force Research Lab (AFRL) Summer Faculty Program. Due to the applied nature of the research, Dr. Hill has transitioned several research artifacts into industrial practice. Most notably, his research on system execution modeling and early performance testing, realized a tool called CUTS, is to be used in the research labs of the Australian Defense Science and Technology Organization (DSTO). Dr. Hill has severed as a invited reviewed for many professional journals, and has assisted in organized several top conferences in Computer Science, such as OOPSLA (now called SPLASH) and MODELS, and has served on the Program Committee of several international conferences, such as MODELS and SOSE.

Dr. Yao Liang, Professor
Since 2007, Dr. Liang has co-authored/authored 38 journal and conference papers (full paper peer reviewed), received 7 federal grant awards (about $1.4M external funding brought into the university), and received 1 U.S. patent. He was a co-author of the paper received Outstanding Student Paper Award from American Geophysical Union, 2009.

Dr. Jingyuan Liu, Research Assistant Professor
Dr. Liu was trained both as a molecular/structural biologist during her graduate studies and computational biologist during her postdoctoral training. Before she joined CS in 2011, she
performed *in-silico* drug screening and successfully identified inhibitors/enhancers targeting various proteins. Her research interest is in protein-protein interaction and drug development and repurposing. She was awarded a pilot grant which allowed for the identification of the dimerization core entity in protein-protein interactions and study the dimerization mechanism of protein in 2012. She was awarded another pilot grant to develop a novel approach targeting “undruggable” oncogenic protein dimers for drug discovery in 2013. The outcome of these internal grants enabled the awarding of a DOD grant to develop inhibitors targeting survivin to overcome acquired taxol resistance in Prostate Cancer Chemotherapy.

**Dr. Snehasis Mukhopadhyay, Professor**

Since 2008, Dr. Mukhopadhyay has co-authored 26 peer-reviewed publications and has received four awards including an NSF and an NOAA research grants. He has served as a PC member for 5 international conferences and been on the editorial board of 2 journals. He has been on 2 NSF review panels. In 2014, he received an Indiana University Trustees Teaching Award.

**Dr. Xia Ning, Assistant Professor (Joined in August 2014)**

Dr. Ning has published 21 peer-reviewed papers in top-tier conferences (e.g., KDD, ICDM, SDM, WWW, Recsys and AISTATS) and high-impact journals and 4 technical reports, for most of which Dr. Ning performed as the first author. Dr. Ning also has 2 pending patent applications and another 5 under filing. She has served as a panelist for multiple NSF review panels, a PC member for IEEE BigData workshop, BESC, ECML/PKDD, SDM workshop, SDM, ICDM, RecSys, BioKDD, and a reviewer for high-impact journals such as Bioinformatics, Journal of Chemical Informatics and Modeling, Transaction of Knowledge Discovery and Engineering and Knowledge and Information Systems. She received the Roberto Patine Scholarship from Qualcomm CR&D in 2009, and was nominated for the University of Minnesota Grad School Doctoral Dissertation Fellowship in 2011.

**Dr. Mathew Palakal, Professor**

Dr. Palakal has been actively engaged in research and he has published numerous manuscripts in peer-reviewed venues in the areas of natural language processing (text mining) and machine learning. As a PI or Co-PI, Dr. Palakal received over several million in grants, in support of his research. He has presented his work at local, national and international conferences including presenting as a keynote speaker. Dr. Palakal has been an active organizer of ACM SIGAPP SAC, where he has served as the Program Chair for two years and Poster Chair for several years. For his dedicated services, he received the Outstanding Service Award from ACM SIGAPP in 2012. Dr. Palakal served as an external reviewer for Journals, numerous conferences, the National Science Foundation, and the National Institute of Health. He is also on the Editorial Board for the International Journal of Data Mining and Bioinformatics.

**Dr. Rajeev Raje, Professor**

Since 2007, Dr. Raje has co-authored thirty four publications as book chapters, book, journal and conference articles in the fields of distributed computing, software engineering and component-based systems. He has been involved as PI or Co-PI, since 2007, in external and
internal grants worth around four hundred and ninety thousand dollars. His research was also presented, in the form of posters, on more than twenty five occasions since 2007. Dr. Raje has also acted as an invited speaker on many occasions including a recent keynote talk in 2013 in an international conference. Dr. Raje has served on program committees of prominent conferences such as the EDOC, SEKE, HPCC, and SAC -- in total, more than thirty times since 2007. He has also acted as an external reviewer for journals, conferences, the NSF, and national and international universities. Since 2007, Dr. Raje has been a recipient of several honors, including the IUPUI Trustees Teaching Award (2010), Favorite Faculty Award, Computer Science Club, IUPUI (2007-08) and was elected as a Senior Member of both ACM and IEEE in 2014.

Ms. Michele Roberts, Senior Lecturer
From 2007, the scope of Ms. Roberts's responsibilities grew from regular class-room teaching to heading up the Service Committee, being responsible for the N-Series Curriculum, the department’s DE program, and managing the part-time teaching faculty. In addition, Michele pursued her research interest in Computer Science education, being awarded several internal and external grants, including participation in the CS 10K Project as a pilot instructor for the new CS Principles course and a poster presentation at the 2014 SIGSCE convention. Most recently, Michele was promoted to Senior Lecturer and won the School of Science Outstanding Faculty Service award.

Dr. Fengguang Song, Assistant Professor
Since 2007, Dr. Song has co-authored twelve peer-reviewed research papers in premier international conferences such as HPDC’07, SC’09, SC’10, ICS’12, UCC’13, ICS’14. He was awarded one IUPUI grant and one PRF travel grant in the year of 2013. He has served as a TPC member for the prestigious SC conferences, IPDPS conferences, EuroMicro conferences and been a regular reviewer for TPDS, JPDC, and ParCo journals. One of his papers was the Best Paper Award runner up in the ACM/IEEE UCC’13 conference. Furthermore, he is one of the four main contributors to Samsung’s KVCache project, which won the Gold Medal at the Samsung Best Paper Award 2013, one of 9 Gold Medals from 1,700 submissions around the world.

Dr. Gavriil Tsechpenakis, Associate Professor
Since 2007 Dr. Tsechpenakis has co-authored 14 journal papers, 19 peer-review conference papers, and 3 book chapters, while most of his cross-disciplinary work has been presented in abstracts or short papers in 8 conferences, either as oral or poster format. He has completed 6 funded projects, as a co-investigator, and 1 NSF project as principal investigator. He is the recipient of the NSF CAREER Award (2013-2018) and the IU Collaborative Research Grant (IUCRG, 2013; funding rate ~5%). The total budget from his grants, as PI or co-(P)I while in IUPUI (2010--present) sums up to approximately $1.2M (amount for CIS-IUPUI, not total grant budget).
Dr. Mihran Tuceryan, Professor
Since 2007, Dr. Tuceryan has authored a total of 2 abstracts, 20 peer-reviewed papers (journal or conference proceedings), and 9 presentations, and has a total of 1,371 citations since 2009 (Google Scholar). He has received 2 grants from National Institute of Justice (1 subcontract from Institute for Forensic Imaging) totaling $96,000 and $253,000. He has taught 5 courses for a total enrollment of 549 since 2007, along with graduating 1 Ph.D. student and 3 M.S. thesis students since 2007. He has served as Program Committee Member of the following conferences: International Symposium on Mixed and Augmented Reality (ISMAR), ACM Symposium on Applied Computing (SAC), ACM Multimedia (MM). In addition, he has been a Member of the Scientific Working Group on Imaging Technology (SWGIT) since 2008 and has served as Reviewer for the Research Grants Council of Hong Kong.

Dr. Yuni Xia, Associate Professor
Since 2007 Dr. Xia has co-authored 28 peer-reviewed publications and has received 7 grants/awards including the IBM real time innovation award in 2008 and IBM scalable analytics award in 2010. She has served as a PC member for over 10 conferences and as a panelist for NSF review panels. She is the main author of the paper that received the best demo award in International Conference on Database Systems for Advanced Applications (DASFAA) 2011.

Dr. Jiang Yu Zheng, Professor
Dr. Zheng works in the areas of image, video, multimedia, computer vision, virtual reality, pervasive computing, and intelligent transportation systems. His current research interests include 3D measuring and modeling, dynamic image processing and tracking, scene representation for various environments, intelligent vehicle, and sensor network. His research was supported by NIJ, NICT and TOYOTA. Dr. Zheng has published 150 papers in journals and conferences as main author and he is a senior member of IEEE.

Dr. Xukai Zou, Associate Professor
Since 2007, Dr. Zou has published 45 peer-reviewed papers including five book chapters and one monographic book. He was awarded three external grants: one from the National Science Foundation, one from Cisco and one from Northrup Grumman; he also has received four internal grants. He has served as associate editor for three international journals and as program co-chair and committee member and reviewer for several international conferences and journals. He has also served as a NSF panelist and panel reviewer for NIH.

In addition to the regular faculty members, the Department has routinely hosted many visiting faculty and visiting researchers since 2006. These visitors typically collaborate with one of the research groups in The Department and also serve as a bridge for inter-university collaborations.
Current Staff
Ms. Katherine “Kat” Biggers, Senior Administrative Secretary
Ms. Biggers joined the Department in January 2014, in a newly created position. She is responsible for assisting with graduate admissions, purchasing and travel arrangements, reimbursements, department marketing assistance and other administrative duties.

Ms. Emily Good, Academic Advisor & Program Coordinator
Ms. Good has just recently joined the Department, in August 2014. She is responsible for undergraduate advising and program coordination duties such as scheduling, program proposals, marketing, recruitment and retention and industrial partnership development.

Ms. Nancy Reddington, Secretary and Receptionist
Ms. Reddington joined the Department in 2011 and is the first point-of-contact for handling visitors and general inquiries at the front desk and over the phone. She is also responsible for coordinating travel arrangements, department scheduling, book orders and setting up course evaluations.

Ms. Nicole Wittlief, Assistant to the Chair
Ms. Wittlief rejoined the Department in 2006 and is responsible for graduate program administration/coordination and oversees the graduate admissions process. She also serves as the Department’s fiscal officer and is responsible for all fiscal management, including HR matters; this also includes serving as the Department’s grant coordinator, which involves assisting faculty with proposal creation/development and post-award management.

Staff Departures
The Department has had to cope with several staff departures since 2006, completing several successful searches for new staff.

- Ms. Myla Langford, Secretary and Receptionist, resigned September 2008.
- Mr. Joshua Morrison, Research, Administrative and Program Coordinator, resigned May 2012.
- Ms. Beth Tidball, Academic Advisor and Program Coordinator, resigned July 2014.
- Ms. DeeDee Whittaker, Secretary and Receptionist, resigned February 2011.

In 2010, the School of Science centralized IT services and now includes 4 full-time staff members who support the Department, as well as the rest of the school. The following 2 staff members (out of 4) were formally full-time with the Department before they transitioned to the School.

- Mr. David Debon, Computer Support Specialist
- Mr. Scott Orr, Network Systems Engineer
Chapter 5  Resources

Fiscal Resources

The Department takes seriously its role as a financial steward and has enjoyed financial stability in the period from 2007-present. Table 5.1 illustrates the academic year expenditures for various departmental responsibilities.

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</tr>
</thead>
<tbody>
<tr>
<td>Graduate stipend (includes RIF/CTE)</td>
<td>$115,000</td>
<td>$113,850</td>
<td>$170,600</td>
<td>$250,126</td>
<td>$219,406</td>
<td>$274,364</td>
<td>$321,471</td>
</tr>
<tr>
<td>Supplies &amp; Expense (S&amp;E)</td>
<td>$79,618</td>
<td>$53,352</td>
<td>$69,785</td>
<td>$52,835</td>
<td>$21,731</td>
<td>$44,719</td>
<td>$58,666</td>
</tr>
<tr>
<td>Hourly and PT instructor</td>
<td>$15,816</td>
<td>$112,881</td>
<td>$95,657</td>
<td>$79,161</td>
<td>$64,402</td>
<td>$66,862</td>
<td>$90,549</td>
</tr>
<tr>
<td>Travel</td>
<td>$19,661</td>
<td>$16,841</td>
<td>$9,237</td>
<td>$15,687</td>
<td>$13,779</td>
<td>$23,334</td>
<td>$30,373</td>
</tr>
<tr>
<td>Fee Remission</td>
<td>$113,775</td>
<td>$138,723</td>
<td>$90,679</td>
<td>$20,788</td>
<td>$26,515</td>
<td>$24,223</td>
<td>$52,063</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$343,870</td>
<td>$435,647</td>
<td>$435,958</td>
<td>$418,597</td>
<td>$345,833</td>
<td>$433,502</td>
<td>$553,122</td>
</tr>
</tbody>
</table>

Table 5.1  Budget Appropriations by Fiscal Year, 2007/08 to 2013/14

General fund appropriations have increased slightly or generally held steady in the study period and the Department has closed each fiscal year either even or with an unspent balance that was carried over into the following year to support office renovation and supplement the departmental lab fee escrow account, which is used to renovate teaching labs and make other large departmental equipment purchases. The reason for the large increase in Supplies & Expense (S&E) expenditures and travel expenses in the 2013-14 fiscal year is due to a concerted effort to spend the entire amount of carryover from previous years; to this end, several large renovations were undertaken (SL 280 conference room kitchen, SL 280 reception area) and faculty were given a greater allocation of departmental travel funds to support conference travel.

Research Investment Fund fellowship (RIF) and Commitment to Excellence (CTE) allocations have increased significantly, with the advent of the Dean’s Office match, allowing the Department to support the growing Ph.D. population with Teaching Assistant appointments and thus, the increased trend in graduate stipend expenses. The Department has been more careful in monitoring S&E expenses and these have fluctuated through the study period due to variables such as faculty hires (which incur significant costs for moving expenses) and various changes in how telephone and network services were charged by the UITS (University Information Technology Services).

Hourly and Part-time instructor costs have fluctuated as well, but the ratio of part-time instructor costs to the general fund account have decreased due both to an increase in DE funds (which are used separately to pay for part-time instructors to teach DE courses) and a decline in the
need to hire part-time instructors as enrollment in N-series courses has declined. Hourly worker (e.g., tutors, graders, etc.) costs have remained steady but have increased in the last few years with the implementation of the Peer-Led Team Learning model in CSCI 23000 and CSCI 24000 courses, as well as the opening of the CS Study Center in 2010 where tutoring was offered to students enrolled in CS courses. The Study Center services have been discontinued effective Fall 2014, as an internal review of the services showed that it was being significantly underutilized and that the PLTL model was more successful in providing assistance to students.

In the past, fee remission costs for graduate students were charged directly to the Department and were included in the Department’s general fund allocation; as the Department’s graduate student population is largely international, these costs were at the out-of-state rate. With the implementation of the School of Science tuition remission policy, though the number of credit hours supported by the Department has significantly increased across the years, the amount charged to the Department has been reduced since the Department is now assessed only $80 per credit hour. Along with the increase in RIF/CTE funding, this change in fee remission accounting has allowed the Department to increase Ph.D. support across the years.

Departmental Revenue (by fiscal year) is listed in Table 5.2 below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Undergrad. Fee</th>
<th>Grad. Fee</th>
<th>Lab Fee</th>
<th>ICR</th>
<th>Distance Ed.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-08</td>
<td>$1,706,341</td>
<td>$528,161</td>
<td>$150,232</td>
<td>$21,195</td>
<td>$46,955</td>
<td>$2,452,884</td>
</tr>
<tr>
<td>2008-09</td>
<td>$1,893,964</td>
<td>$608,046</td>
<td>$171,522</td>
<td>$54,915</td>
<td>$87,342</td>
<td>$2,815,789</td>
</tr>
<tr>
<td>2009-10</td>
<td>$2,083,728</td>
<td>$916,603</td>
<td>$171,897</td>
<td>$76,621</td>
<td>$96,011</td>
<td>$3,344,860</td>
</tr>
<tr>
<td>2010-11</td>
<td>$2,265,032</td>
<td>$1,186,397</td>
<td>$159,980</td>
<td>$211,260</td>
<td>$84,835</td>
<td>$3,907,504</td>
</tr>
<tr>
<td>2011-12</td>
<td>$2,300,146</td>
<td>$1,217,029</td>
<td>$140,416</td>
<td>$234,289</td>
<td>$81,720</td>
<td>$3,973,600</td>
</tr>
<tr>
<td>2012-13</td>
<td>$2,645,785</td>
<td>$2,073,690</td>
<td>$81,979</td>
<td>$263,437</td>
<td>$84,992</td>
<td>$5,149,883</td>
</tr>
<tr>
<td>2013-14</td>
<td>$2,851,532</td>
<td>$2,261,731</td>
<td>$69,241</td>
<td>$312,118</td>
<td>$73,651</td>
<td>$5,568,273</td>
</tr>
</tbody>
</table>

Table 5.2 Department Revenue by Fiscal Year, 2007/08 to 2013/14

As seen from Table 5.2, the undergraduate revenue has continued to grow steadily since the 2007-08 fiscal year, with over a $1 million increase in the study period. More remarkably, the graduate revenue has increased by around 4 times since 2007-08; this is due to the significant growth in enrollment in both the M.S. and Ph.D. programs and the fact that this growth is largely composed of international students who pay tuition at nearly 3 times the rates of residents. Lab fees are currently charged at $73.00 per course; the Department conducted a reassessment of lab fees in 2011 that resulted in some changes in which courses were charged lab fees and the lab fee amount; this, combined with decreased enrollment in lab fee courses, has resulted in the decreases in revenue seen above. Similarly, DE fees (currently charged at $59.30 per course) have generally held steady but have declined in the last year due to decreased enrollment. As faculty research awards have increased, so has the amount of ICR generated, with a significant increase across the study period.
The Department also incurs significant expenses, mainly in the form of faculty and staff salaries. Table 5.3 shows the total revenue and general fund expenses by fiscal year from 2007/08 to 2013/14.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen. Exp.</td>
<td>$1,921,776</td>
<td>$2,027,063</td>
<td>$2,121,742</td>
<td>$2,336,469</td>
<td>$2,491,589</td>
<td>$2,385,789</td>
<td>$3,024,585</td>
</tr>
<tr>
<td>Revenue</td>
<td>$2,452,884</td>
<td>$2,815,789</td>
<td>$3,344,860</td>
<td>$3,907,504</td>
<td>$3,973,600</td>
<td>$5,149,883</td>
<td>$5,568,273</td>
</tr>
</tbody>
</table>

Table 5.3 Department revenue and expenses by fiscal year

The bulk of general expenditures are faculty and staff salaries and fringe benefits (approximately 80%), while the remainder is composed of expenses listed above. As the Department has grown in size, particularly with the hiring of 9 new tenure-track faculty since 2007, the salary costs have steadily increased each year. The total revenue of the Department shows significant increases in the last several years, driven primarily by the large increase in graduate fee revenue as described above.

Computing Resources

The Department maintains a robust computing infrastructure capable of supporting all the department's administrative, academic, and research needs. Currently, there are over 20 servers, 5 clusters and 130 workstations deployed to meet these needs and are maintained by the School of Science IT staff.

Core Servers

There are a number of servers which provide the key services needed to support all the department missions. Several Dell PowerEdge Linux and Microsoft based systems provide for much of the infrastructure, including e-mail, web, DNS, DHCP, and database services. All users, including all students taking a Computer Science course, have remotely accessible storage available to meet various course needs. General computing needs are provided by a Linux based server and include compilers, a full Oracle Database installation, and scientific applications such as Matlab and Maple. Virtual academic and research servers are deployed as needed on the CIS VMware server. All CIS servers are also backed up via a duel-tape library system which combined have a storage capacity of over 80 terabytes.

Academic Resources

Several Linux and Microsoft-based advanced Web programming servers enable students to utilize commercial grade e-Commerce applications. Each platform provides a full set of development tools, a major database system, and space on specialized web servers. Originally developed to support specific courses, these servers are now also used by undergraduate and graduate students for capstone projects and research.
The Department maintains two primary teaching labs with 36 computers running Microsoft Windows 7. Each system has a wide array of tools and applications to support all course needs. While labs are used primarily at scheduled course times, one lab is open for student use at any time. A third lab will be deployed in the spring of 2015 that will feature advanced software and networking technologies to support a number of computational and wireless projects including a HADOOP cluster and sensor-net equipments and will be intended to support mostly graduate courses.

The Department has also made a strong commitment to distributed education, providing support for multiple courses which have lecture content delivered completely online. Equipment can be brought into classrooms for live lecture recording that may also be edited later for more modular organization.

Research Centers and Resources

The Department has several research labs and centers, each with their own computing resources. Supporting these labs are specialized servers or clusters. Jamuna is a dual-16 core Linux server with 128GB of RAM for large shared memory computation. Pyrite is a 40-node, 640 core, and 8 GPU cluster used for massively parallel computation. This cluster also provides over 40 TB of data storage and is modeled after the University’s Big Red II cluster. The Department also has a 10 node HADOOP cluster featuring map reduction software. For distributed software and network performance analysis, the Department recently deployed an Emulab cluster with both physical and virtual nodes which can be reconfigured into any network topology needed for a given experiment. Smaller projects needing server support are deployed as needed on the CIS VMware server.

Institute for Mathematical Modeling and Computational Science (iMMCS)

The School of Science Institute for Mathematical Modeling and Computational Science (iM2CS) is a cross-departmental school-level unit which promotes interdisciplinary research and educational activities, integrating mathematical and computational approaches to address problems arising in various areas of science, engineering and medicine. The specific goals of the iM2CS Institute are:

- to foster excellence and innovation in research and education
- to promote multidisciplinary research endeavors across departments, schools and units at IUPUI
- to create greater opportunities and increase competitiveness in seeking and procuring extramural funding to support research, educational and outreach activities
- to engage undergraduate and graduate students in interdisciplinary research and training activities to improve the quality of their IUPUI experience and add value and marketability to their degrees

The Institute has received financial support from many sources, including the School of Science at IUPUI, IUPUI’s Office of the Vice Chancellor for Research, the National Science Foundation and the National Institute of Health.

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Staffing and IT Management

The Department’s infrastructure is currently managed by two teams as part of the School of Science IT unit. This unit includes 4 full time staff members and 8 student interns. To keep track of the many projects and requests, this team uses a Web-based request tracking system. Priorities are given to each request and assigned to a staff member. The team manager monitors this system to ensure all projects are completed quickly and satisfactorily. To aid in managing all the servers and research systems, the IT staff have also deployed monitoring systems which track system and service status as well as resource utilization. When performance thresholds are reached, the IT staff members are notified digitally before problems impact faculty, staff, and students.

Research and Teaching Laboratory Space

The Department maintains two teaching labs (as indicated above) in SL 247 and 251; since the last review, SL 116 has been converted from a teaching lab into a research lab that currently houses the Software Engineering and Distributed Systems research group. The Networking and Security research group occupies SL 112 and the Imaging and Visualization research group utilizes SL 239. 3 additional lab spaces were granted to the Department on the 4th floor of the HITS building as a result of the creation of the Center for Biocomputing in 2008; since that time one lab has been reassigned to the Math department. The Department retains use of labs 4044 and 4048, which house the Computer Aided Diagnosis and Knowledge Discovery Lab and the Intelligent Database and Information Systems Lab, respectively. In 2012, the Department was granted half of the suite located in Room 300 of the Walker Plaza building, which was formerly occupied by the Center for Earth and Environmental Science. This space has been converted into graduate student research space for the growing Intelligent Database and Information Systems group.

Office Space

The main Department office in SL 280 consists of several faculty and staff offices of approximately 125 square feet each, a reception area, a conference room/kitchen and the Chair’s office. Additional faculty offices are located in SL 275, SL 277 and SL 239. SL 236 was converted into an office space for the Department’s Lecturers and contains 4 cubicle-style workspaces; three of these are occupied by the Lecturers, the fourth is used for DE recording. Recent flood damage to this area has forced a temporary relocation of the Department’s Lecturers and possible renovation of this space is currently pending. SL 265 and SL 263 were recently vacated when the School of Science Technology group relocated to the new Science Engineering and Lab Building in October 2013. These offices will be assigned to the two new faculty who will begin in mid-2014 and early 2015.

Six additional offices were assigned to the Department on the 4th floor of the HITS Building as part of the Center for Biocomputing (see above), however two of these have since been reassigned to the Math department. The Department retains the use of offices numbered 4039,
4041, 4043 and 4045. These offices are assigned to the Emeritus faculty, visiting postdocs as needed and are also available for use by full-time faculty whose research labs are located in the building. There is one cubicle for faculty/office use located in the recently obtained Walker Plaza space (see above); this has been used to house visiting postdocs.

In 2012, the Department was able to obtain a small office space in SL 228 which was used to house free tutoring service. With this service being discontinued starting in Fall 2014, the space will be made available to Departmental Teaching Assistants for use as needed.

In summary, as the Department and its programs have grown so has been the need for more personnel, computing and physical resources. Currently, all the resources are used at its capacity and any further increase in the student population will necessitate the additional allocation of personnel, computing infrastructure and space. The Department has indicated this need to the School of Science Administration on a regular basis and the Administration has been generally supportive of such requests.
Chapter 6 Undergraduate Programs

Undergraduate programs are overseen by the Department’s Undergraduate Committee. The Undergraduate Committee consists of members of the regular faculty and others named by the Department Chair with the advice of the Faculty Advisory Council. It is responsible for advising the faculty on matters relating to the undergraduate educational and research programs. These include admission and retention standards, establishment and maintenance of specific curriculum structure and academic requirements for the undergraduate major and service course programs, the creation and cancellation of courses, and content and prerequisites of new and existing courses.

Description of Programs

The Department offers following undergraduate degree programs:

- Bachelor of Science in Computer Science,
- Bachelor of Arts in Applied Computer Science,
- Bachelor of Science: Biocomputing Pre-Med Concentration
- B.S./M.S. Dual degree,
- Certificate in Applied Computer Science,
- Minors in Computer Science
- Sun Yat-Sen University 2+2 Program

These programs are described briefly below. More details about these programs are available at: http://cs.iupui.edu/undergraduate/degrees.

Bachelor of Science in Computer Science: The B.S. program in Computer Science requires a minimum of 124 credit hours. This program follows state-of-the-art curriculum, keeping current with the ACM Curriculum Guidelines. It is a calculus-based Bachelor’s degree program. Students completing the undergraduate degree in Computer and Information Science will have acquired a fundamental understanding of computing, information processing, and information communication.

Bachelor of Arts in Applied Computer Science: The B.A. in Applied Computer Science offers a balance of theoretical and applied computing coursework to prepare a student for multiple pathways into the information technology workforce. The student’s complementary coursework in the liberal arts and social sciences further enhances communication skills and understanding of issues in other sectors of the economy. The program requires 120 credit hours including five core courses in Computer Science that are supplemented by applied electives and rounded out with courses in Algebra and Statistics, foreign language, communications, liberal arts and social sciences. This program allows students flexibility in pursuing a minor or undergraduate certificate program of their choice.

Bachelor of Science: Biocomputing Pre-Med Concentration: The B.S. degree program in Computer Science with pre-med concentration, in addition to satisfying the requirements of a
B.S. degree in Computer Science, is designed to also satisfy the pre-requisite course requirements to be considered for admission into U.S. medical schools. This program, similar to the B.S. degree in Computer Science, follows state-of-the-art curriculum, keeping current with the ACM Curriculum Guidelines. Students completing the undergraduate degree with the pre-med concentration will have acquired a fundamental understanding of computing, information processing, and information communication and will also be ready to enter the medical schools. This program requires a minimum of 124 credit hours.

**B.S./M.S. Dual degree:** This B.S./M.S. program in Computer Science allows students who are highly motivated to earn both a Bachelor of Science and Master of Science degrees in five academic years. This is accomplished by allowing students to complete three 500-level courses that satisfy general/free elective requirements in the B.S., thus shortening the time to complete their M.S. degree by one academic term. Students then complete the remaining twenty-one credit hours of the M.S. program after admission and earn their M.S. degree in just one year's time.

**Certificate in Applied Computer Science:** The certificate program requires completion of 18 credit hours (six courses) with a GPA of at least 2.0. No individual grade below a C– is acceptable for this certificate program. At least 9 credit hours in the certificate program must be taken in the Department. The certificate program prepares students for entry-level positions in jobs such as database management, web development, multimedia, system administration, or user support. The certificate program introduces Computer Science principles, develops practical skills in market-driven software applications and prepares students to be successful with emerging technologies. Students will have the ability to solve complex problems, design and implement algorithms, apply computer science theory to practical problems, adapt to technological change and to program in at least two high-level languages.

**Minor in Computer Science:** The minor in Computer Science is aimed at undergraduate students pursuing other majors at IUPUI and who would like to develop their problem solving, computational thinking, and abstract reasoning skills that can be used in their chosen field of study. There are two types of minor options offered by the Department: a) Minor in Applied Computer Science aimed at students pursuing degrees in the social and behavioral sciences, business, liberal arts, and health-related professions, and b) Minor in Computer and Information Science aimed at students from math, science, and engineering disciplines.

**Sun Yat-Sen University 2+2 Program:** The School of Software at Sun Yat-Sen University (SYSU) and the Department have established a collaborative program, allowing qualified students to complete the first two years of the program at SYSU and the remaining two years at IUPUI. Students who meet all the requirements from IUPUI will be awarded a Purdue University Bachelor’s degree. Students who meet all the requirements from Sun Yat-Sen University will be awarded the undergraduate graduation certificate and the Bachelor’s degree granted by Sun Yat-Sen University. Both SYSU and IUPUI have exchanged descriptions of curricula, academic standards, and evaluation techniques; have established equivalencies between credits earned at SYSU and credits earned at IUPUI; and have determined that the degree programs offered by both universities can be completed by fully qualified students within four years. The actual
length of study will be determined by the student's credit-hour load per semester, and the student’s enrollment in optional summer sessions.

Student Enrollment Data

The Undergraduate enrollment in the Department has been on the rise since 2007. Recent undergraduate admissions data and the enrollment data are given in the following figures:

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Applicants</td>
<td>27</td>
<td>45</td>
<td>51</td>
<td>55</td>
<td>51</td>
<td>71</td>
<td>77</td>
</tr>
<tr>
<td>Total Admits</td>
<td>24</td>
<td>40</td>
<td>48</td>
<td>51</td>
<td>46</td>
<td>69</td>
<td>71</td>
</tr>
<tr>
<td>Total Enrolled</td>
<td>14</td>
<td>27</td>
<td>26</td>
<td>24</td>
<td>27</td>
<td>39</td>
<td>36</td>
</tr>
<tr>
<td>% of Applicants Admitted</td>
<td>89%</td>
<td>89%</td>
<td>94%</td>
<td>93%</td>
<td>90%</td>
<td>97%</td>
<td>92%</td>
</tr>
<tr>
<td>% of Admits Enrolled</td>
<td>58%</td>
<td>68%</td>
<td>54%</td>
<td>47%</td>
<td>59%</td>
<td>57%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Table 6.1: Direct School of Science Undergraduate Admission Applications—B.S., B.A., B.S./M.S.

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Applicants</td>
<td>104</td>
<td>111</td>
<td>112</td>
<td>131</td>
<td>136</td>
<td>87</td>
<td>61</td>
</tr>
<tr>
<td>Total Admits</td>
<td>71</td>
<td>72</td>
<td>48</td>
<td>66</td>
<td>75</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>Total Enrolled</td>
<td>48</td>
<td>46</td>
<td>31</td>
<td>38</td>
<td>42</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>% of Applicants Admitted</td>
<td>68%</td>
<td>65%</td>
<td>43%</td>
<td>50%</td>
<td>55%</td>
<td>51%</td>
<td>49%</td>
</tr>
<tr>
<td>% of Admits Enrolled</td>
<td>68%</td>
<td>64%</td>
<td>65%</td>
<td>58%</td>
<td>56%</td>
<td>43%</td>
<td>47%</td>
</tr>
</tbody>
</table>

Table 6.2: University College CSCI Undergraduate Admission Applications

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Certificate</td>
<td>8</td>
<td>8</td>
<td>11</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>B.S. in Computer Science</td>
<td>77</td>
<td>93</td>
<td>102</td>
<td>114</td>
<td>138</td>
<td>182</td>
<td>201</td>
</tr>
<tr>
<td>B.A. in Applied Computer Science*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Dual Degree B.S./M.S.**</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>UNDERGRADUATE TOTAL</td>
<td>85</td>
<td>101</td>
<td>113</td>
<td>126</td>
<td>151</td>
<td>195</td>
<td>219</td>
</tr>
</tbody>
</table>

Table 6.3: Total students enrolled in undergraduate CS certificates and degree programs

*Program added Fall 2012  **Program added Fall 2013
The numbers in Tables 6.1-6.5 indicate the following trends: The total number of direct admits into School of Science CSCI program since 2007 has steadily increased. The total number of applicants into the Department from the University College (UC) has peaked in 2010 and 2011 and seems to be on the decline. The rate of admission from the UC has remained relatively constant and of those admitted, either directly or indirectly, the enrollment rate has also remained relatively constant. The total enrollment in the undergraduate programs (B.S., B.A., and certificate) has steadily increased since 2007. The total number of degrees conferred in that time period has remained more or less constant. The significant increase in the total enrollment has occurred since 2012, therefore it has not yet had an effect on the total number of degrees conferred. The expectation is that in the next 2 years, this number (i.e., the degrees conferred) will also increase.

Compared to competing computing units on campus, the Department has maintained a steady trend of growth in enrollment and, as of Fall 2014, has surpassed Computer & Information Technology as the computing unit with the highest enrollment. These trends in comparative enrollment can be seen in the chart below.
Since 2005 and 2006, the percent of full-time enrolled students has steadily increased, with them making up about 76% of the undergraduate population in 2013. The large majority of the students (89% or more) have been Indiana residents. The percent of women undergraduate population is very disappointing; undergraduate female enrollment has trended steadily low, dipping beneath ten percent in 2012. From a commitment to reverse this trend, in 2012 the department began participating in national efforts at broadening participation in Computer Science, implementing some of the best practices shared by other universities with more successfully diverse student bodies. In K-12 outreach activities, for example, presentation content was modified to include materials shown to be more gender friendly to females, such as
the global impact of computing. Female enrollment moved positively in 2013, and the Department hopes to continue this improvement in subsequent years. Best practice adoption in our outreach efforts and collaborative programs (such as the 2+2 program with Sun Yat-Sen University in China) appears to have positively impacted minority enrollment, as well, with an increase jump to over 20% in 2013. A more detailed breakdown of ethnic minority enrollment can be found in the Appendix; it shows some success in attracting African American, Hispanic and Asian students into our undergraduate program. The Department will continue efforts in broadening participation, hopeful that the single data point gains can be sustained over time as positive trending.

**Advising**

Undergraduate Computer Science majors directly admitted to the School of Science are assigned to the Department’s Program Coordinator/Academic Advisor. The first meeting with the Academic Advisor occurs during the new student orientation. The Academic Advisor ensures incoming students have a thorough understanding of the general education and major requirements and the dependencies involved in the Computer Science coursework.

After the initial orientation advising session, students are encouraged to meet with the Academic Advisor at least once a semester. To help remind students of the importance of these meetings, a registration hold is placed on first year student accounts in the middle of the first semester. In order to register for second semester classes, students are required to meet with the Academic Advisor to get the hold lifted. After the second semester, no advising holds are placed although students are still encouraged to meet with the Academic Advisor prior to registering for classes.

Students admitted as pre-Computer Science majors in the University College are assigned to a University College Academic Advisor and meet with that Advisor during new student orientation. However, the Computer Science advisor routinely meets with these students to answer questions, approve course selections, and assist students in the process of applying to the School of Science.

The Computer Science Advisor also presents a few introductory topics to students enrolled in SCI12000 Windows on Computer Science in the fall semester. This required first year experience course is typically taught by the Department Chair, Dr. Fang, and the students are both Computer Science and pre-Computer Science majors. This is a wonderful opportunity for pre-Computer Science students to interact with the Computer Science Advisor and learn more about the program. Beginning in the Fall 2014 semester, all students enrolled in this course are required to complete a CITI (Collaborative Institutional Training Initiative) “Responsible Conduct of Research” course, offered through IUPUI’s Office of Research Administration.

All incoming students are added to an undergraduate email list at the beginning of the semester. This email list is used to share announcements about new classes, changes to the curriculum, departmental events, internships, and job postings.

The Computer Science Advisor hosts a departmental open house for all undergraduate students in the early fall. The open house is an opportunity for new students to get to know one another,
interact with upperclassmen, and become familiar with the faculty and staff. Food is provided by the Department and students can enter drawings for prizes.

The Department also supports a Computer Science Club (described under the Outreach Section). The club also plays an active role in developing student interactions and informal discussions, including student-to-student advising.

Faculty in the Department are also involved in mentoring and advising activities in a number of other contexts such as undergraduate research and honors classes for undergraduate students. Furthermore, if undergraduate students show interest in specific topics, they may be mentored under the guidance of an individual faculty member in a capstone project

**Peer-Led Team Learning**

Peer Led Team Learning ("PLTL") is a recitation/laboratory model developed in the 1990’s at City College, New York, as an experiment to address the low success rate of undergraduate Chemistry students in gateway courses. In the PLTL model, trained student peers lead small discussion groups in collaborative learning and problem solving that supplement lecture materials. Using the PLTL approach, impact on student learning gains, as measured by course assessment outcomes and DWF (Drop, Withdraw and Failure) rates have proved significant, and the PLTL model is now utilized in numerous STEM curricula, including Computer Science.

At IUPUI, the PLTL model has been successfully extended to online courses, using an approach called cyber Peer Led Team Learning ("cPLTL"). In cPLTL, the peer led small discussion groups occur online, using a campus wide technology platform that allows students to meet synchronously in a video chat to discuss lecture content and solve problems. Interestingly, the cPLTL appears to be particularly “gender friendly”, which is of particular interest to the department mission of supporting broadening participation in the computing field.

The Department utilizes a combination of live and online PLTL groups to offer students scheduling flexibility. Students in gateway courses register for the PLTL small group of their choice, and then meet weekly with trained student leaders in their small groups to discuss lecture content and complete laboratory work. Using this model, the Department has seen significant impact on student gains and DWF rates, especially in the online sections of the gateway courses.

**Assessment**

- Assessment based on Principles of Undergraduate Learning (PULs): The PULs provide a campus wide academic framework for all IUPUI students. Detailed Information about the PULs is located at: [http://www.iupui.edu/~bulletin/iupui/2012-2014/undergraduate/principles.shtml](http://www.iupui.edu/~bulletin/iupui/2012-2014/undergraduate/principles.shtml). To support this campus wide initiative, all departments identify the top two PUL’s addressed in each course. At semester end, each student receives not only a course grade, but also an achievement assessment against both identified PUL’s. As part of continuous improvement, instructors and the various undergraduate committees review aggregated PUL assessment data and fine tune course curriculum. As an example, in 2013 a review of PUL data for non-major courses indicated that PUL scoring was lowest for the entry level N100 course. The
N100 syllabus and course materials were modified to make explicit connections between computing course content and the targeted PUL’s (Resource skills and Critical Thinking), lab work was modified (such as the addition of an algorithm development lab that demonstrates critical thinking skills), etc. 2014 PUL data will be examined for scoring impact when available, and if results are positive, curriculum fine-tuning will be implemented upward across the non-major course offerings.

The Department and the faculty have participated in the PUL assessments as part of the campus-wide framework since Spring 2010. The detailed data collected in the Spring 2010 – Fall 2013 semester is included in the Appendix. A summary of the results of this data is shown in Tables 6.7 and 6.8. The two tables separate the major course results from the non-major course results, and they summarize the total effectiveness scores at the 100, 200, 300, and 400 levels for the Major Emphasis and Moderate Emphasis principles for each level. The effectiveness score ranges between 1 and 4 (1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”).

<table>
<thead>
<tr>
<th>Major Courses</th>
<th>Major emphasis effectiveness</th>
<th>Moderate Emphasis effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 level</td>
<td>2.74</td>
<td>2.74</td>
</tr>
<tr>
<td>200 level</td>
<td>3.35</td>
<td>3.30</td>
</tr>
<tr>
<td>300 level</td>
<td>2.41</td>
<td>2.51</td>
</tr>
<tr>
<td>400 level</td>
<td>2.69</td>
<td>2.62</td>
</tr>
</tbody>
</table>

Table 6.7: The mean effectiveness score for each level of major courses. Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”

<table>
<thead>
<tr>
<th>Non-Major Courses</th>
<th>Major emphasis effectiveness</th>
<th>Moderate Emphasis effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 level</td>
<td>3.01</td>
<td>2.94</td>
</tr>
<tr>
<td>200 level</td>
<td>3.32</td>
<td>3.29</td>
</tr>
<tr>
<td>300 level</td>
<td>3.26</td>
<td>3.25</td>
</tr>
<tr>
<td>400 level</td>
<td>3.42</td>
<td>3.38</td>
</tr>
</tbody>
</table>

Table 6.8: The mean effectiveness score for each level of non-major courses. Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”

- Assessment based on Student Learning Outcomes: In the Spring of 2011, the Department drafted a set of Undergraduate Student Learning Outcomes; the full list of these outcomes can be found in the Appendix. The Student Learning Outcomes interpret the institutional PUL’s within the CS domain, articulating specific exiting competencies a successful major in our program should acquire. In addition to ongoing assessment of the Student Learning Outcomes through a traditional battery of assessment tools such as exams, quizzes, homeworks, programming projects, research papers, etc., each student is additionally assessed on the Student Learning Outcomes by a Major Field Test (described below) administered in the senior Capstone course.
The Department would request input and suggestions from the review committee as to what other assessments methods could be used.

- Assessment based on Major Field Tests: Computer Science Students take the major field test as a required component of their senior capstone class. The mean institution score given below is based on the IUPUI peer institutions.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Inst. Score (National Level)</th>
<th>IUPUI Score</th>
<th>Programming Sub-score</th>
<th>Discrete Struct. &amp; Algo. Sub-score</th>
<th>Systems (Arch., OS, Networks, DB) Sub-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>148.4</td>
<td>158</td>
<td>70% correct 85th percentile</td>
<td>40% correct 75th percentile</td>
<td>54% correct 80th percentile</td>
</tr>
<tr>
<td>2009</td>
<td>148.5</td>
<td>154</td>
<td>62% correct 70th percentile</td>
<td>39% correct 90th percentile</td>
<td>45% correct 40th percentile</td>
</tr>
<tr>
<td>2010</td>
<td>149.3</td>
<td>160</td>
<td>65% correct</td>
<td>49% correct</td>
<td>50% correct</td>
</tr>
<tr>
<td>2011</td>
<td>149.3</td>
<td>155</td>
<td>50% 63rd percentile</td>
<td>40% 70th percentile</td>
<td>57% 90th percentile</td>
</tr>
<tr>
<td>2012</td>
<td>147.6</td>
<td>157</td>
<td>58% correct 52nd percentile</td>
<td>46% correct 89th percentile</td>
<td>49% correct 75th percentile</td>
</tr>
<tr>
<td>2013</td>
<td>149.6</td>
<td>152</td>
<td>53% correct 57th percentile</td>
<td>44% correct 68th percentile</td>
<td>42% correct 59th percentile</td>
</tr>
</tbody>
</table>

Table 6.9: Comparison of Major Field Test Scores

This data indicates that majors in the Department are doing better than the national average and are placed typically above the 60-70 percentile in most subjects compared to their national peers. They seem to be better prepared in systems oriented subjects than either theoretical or programming sub scores. As a result of the relatively low test scores in the theoretical component, during the first two years, a new theory course was created (CSCI 48400 – Theory of Computation) in Spring 2010. This course was made a core required course that has been offered since. The performance of the students, after taking this core course, has somewhat improved in the theory component of the test.

Outreach Activities

The Department is fully committed to building engagement and broadening participation in computing and STEM activities with K-12 audiences. Ongoing outreach activities include the following:

(1) Computer Science Day – The Department holds an annual Computer Science Day that allows high-school students, teachers and parents to explore Computer Science through guest speakers, student and industry panels, and contests. The main contest is a programming contest managed in accordance with the ACM contest guidelines; contests in gaming and Web design have been recently added to broaden appeal to less
traditional students. The popularity of Computer Science Day has driven yearly expansion of the participants; the number of entries has risen from 41 students in 2007 to 125 in 2014, including increases in the number of female and minority participants, as well as entrants from outside of Indiana. One of the goals of this program is to attract high quality, local high school students to ultimately enroll at IUPUI for their bachelor’s programs. While exit surveys submitted by student participants indicate significant levels of interest in applying to IUPUI, particularly from schools such as Pike High School and Westfield High School, there have only been a handful of student participants who have ultimately enrolled IUPUI after high school graduation. This is an area where we are seeking improvement and would invite the Review Committee’s suggestions on how to achieve a better enrollment “yield” from the Computer Science Day event.

(2) Computer Science Club – The Department sponsors a Computer Science Club that is part of campus student organizations. The club is open to any student interested in Computer Science, and is an officially registered ACM organization. Among other activities, the club explores industry opportunities, supports community outreach and provides a sense of community for current and prospective students.

(3) Science Olympiad – The Department provides support and content to the annual Science Olympiad as part of STEM outreach.

(4) STARS Computing Corps – The Department is an official STARS sponsor, with an active students participating in STEM outreach within the student STARS organizational model.

(5) InWiC (Indiana Women in Computing) – The Department founded a local InWiC chapter to support women in computing, and now participates in a campus wide InWiT chapter.

(6) K-12 outreach – The Department supports an active K-12 outreach program targeted at the public, private and home school organizations through sponsored clubs, visits, programs and mentoring.

(7) Summer Camps – As part of outreach, the Department has supported various Summer Camps for local youth, including computing camps for young women, a web programming camp, and a bioinformatics camp.

(8) STEM outreach – In addition to outreach for Computing, the Department also supports efforts to build computational thinking within the STEM disciplines. Coordinated with other departments within the School of Science, the Department participates in K-12 outreach programs that encourage computing within the overall context of Science, Technology, Engineering and Math initiatives.

(9) SPAN Support – IUPUI supports an early bridge to college program for rising K-12 talent. The SPAN (Special Programs for Academic Nurturing) program allows qualifying students to be admitted as college students (as early as 9th grade) and earn college credit for successfully completed academic work. Over the years, the SPAN program has been a successful recruiting tool for undergraduate enrollment. The Department engages in a variety of course arrangements with SPAN students including participation in live courses, online courses, and offering courses on site to sufficient enrollment numbers. By working closely with SPAN, the Department is able to reach many Indiana
students whose local schools offer little or no computing coursework; quite a few of these students have continued to complete degrees within the Department.

Future Issues and Questions

The Department has many ongoing efforts to expand interdisciplinary programs in collaboration with other departments in the School of Science. As a concrete initiative, the Department has proposed to create a set of six “Computational” tracks in the B.S. in Interdisciplinary Studies option. These tracks will have quite standardized course plans, while still allowing for some individualized customization, to be approved by an advisor as well as the SOS Undergraduate Educational Policies Committee. There is currently a proposal with a number of predefined interdisciplinary programs:

1. Computational Biology,
2. Computational Chemistry,
3. Computational Earth Sciences,
4. Computational Forensic Sciences,
5. Computational Neuroscience,

These tracks are designed with a combination of existing courses from various departments involved in the program.

Broadening Participation

The Department is strongly committed to broadening participation in its computing programs. After careful consideration, the faculty identified three programmatic threads that hold particular value for achieving a more balanced student profile. First, with the support of the Dean's office, the Department has integrated its outreach efforts into the broader STEM outreach efforts led at the School level. In addition to specific computing programs, the Department has begun to include a computational thread into the various STEM activities supported by the School. In summer of 2014, for example, computational threads were added to the outreach programs hosted by Earth Science and School of Education. Second, a proposed new Data track (which is currently moving through the system for approval) will target a more balanced student population, and the Department will be working with the School marketing organization to advertise the new program to broadened target audiences. Third, the Department has invested heavily in the national broadening participation efforts identified in the NSF 10K challenge (i.e., to help create a community of computational thinkers) with the launch of a Principles of Computing pilot course. The CS Principles course, now in its third semester, has achieved appreciable demographics, with approximately sixty percent women enrolled in the course.

In summary, the overall trends in undergraduate enrollment seem to be in a positive direction, with some specific issues to be addressed. The direct admissions into the programs and the total enrollments have increased over time. Since 2007, minority enrollment has increased from 8 to 42, and efforts are needed to make sure that this trend stays. The Department needs to
address the small percentage of women students enrolled in the program and make targeted outreach efforts to overcome this limitation.
Chapter 7  Graduate Programs

The Department offers the following graduate programs, which are described briefly in this chapter:

- Master of Science
- Doctor of Philosophy
- Graduate Certificates
- Graduate Minor for students pursuing other degree programs with the Indiana University or Purdue University

The oversight of these graduate programs is entrusted to the Graduate Committee of the Department. This Committee, typically, consists of four faculty members selected by the Chair of the Department. One faculty member is selected as the Chair of this Committee – Prof. Raje has served as the Chair of this Committee since 2006. This Committee routinely interacts with the Graduate Admissions Committee and the Graduate Affairs Committee of the Computer Science Department at the Purdue University, West Lafayette (CS-PUWL) and also with the Graduate Office at the IUPUI campus. The detailed descriptions of these programs are available at: http://cs.iupui.edu/graduate/degrees.

Graduate student Ethics requirement

Beginning in the Fall 2014 semester, all graduate students are required to complete a CITI (Collaborative Institutional Training Initiative) “Responsible Conduct of Research” course, offered through IUPUI’s Office of Research Administration.

Master of Science (M.S.) Program

In addition to teaching Computer Science fundamentals, the M.S. degree program emphasizes research in network security, databases, bioinformatics, biometrics, intelligent systems, visualization, Software engineering, and distributed computing.

Admission Requirements

Applicants to the graduate program must have a four-year bachelor's degree or equivalent. M.S. applicants should have a background in the following core areas of Computer Science:

- Software development experience in a high level language
- Data structures and algorithms
- Systems (principles of operating systems, compilers, and programming languages)
- Theory (discrete math and theory of computation)
- Hardware (computer architecture)
**GPA and GRE Requirement:** The applicant's record should exhibit outstanding achievement as indicated by the grade point average for each degree over his or her entire academic record. Applicants are expected to have a GPA of at least a 3.0 on a scale of 4.0. The record should also demonstrate strong individual accomplishments and recommendations from independent references. Scores on the Graduate Record Exam are not required for admissions. Applicants seeking financial aid, however, must submit general GRE exam scores.

**English Proficiency Requirements:** All applicants whose native language is not English are required to submit scores for TOEFL or IELTS. An overall TOEFL IBT score of 79 or an IELTS band score of 6.5 is required.

**Program Requirements**

To receive the M.S. Degree, the applicant must be admitted as a graduate student without provisions and complete 30 semester-credit hours of study in CSCI courses numbered 500 or above. In addition, there is a “core”/required course component which must be satisfied as part of the 30 credit hour program; these requirements are listed below, and differ according to semester of initial admission.

**“Core” Course Requirement (for those admitted before the Fall 2013 semester)**

At least 6 of the 30 required hours must be from the following Core Courses: CSCI 503, Operating Systems; CSCI 504, Concepts in Computer Organization; CSCI 565, Programming Languages; CSCI 580, Algorithm Design, Analysis and Implementation.

**New Required Course Guidelines (effective beginning with those admitted for the Fall 2013 semester)**

Of the 30 required hours, students must select 1 course each from 4 different "foundational" categories for a total of 12 credit hours. There are 6 categories from which to select the 4, as listed below:

- Networking and Security -- CSCI 53600, CSCI 55500
- Databases and Intelligent Systems -- CSCI 54100, CSCI 54900, CSCI 57300
- Visualization and Graphics -- CSCI 55000, CSCI 55200, CSCI 59000 (Image Processing)
- Software Engineering -- CSCI 50600, CSCI 50700, CSCI 59000 (Software Quality Assurance)
- Theory -- CSCI 52000, CSCI 56500, CSCI 58000
- Systems -- CSCI 50300, CSCI 50400, CSCI 53700
M.S. Program Options

The Department offers two options, as described below, for study in the M.S. Program. Both options are administered according to the policies established by the Department and Purdue University.

- **M.S. Research Option**
  The objective of the research option is to develop a general knowledge of Computer Science, deep in a specific area, and an ability to perform independent research. The student, enrolled in this option, learns research techniques by working in close cooperation with a faculty member while doing the thesis research. This program requires 6-9 credit hours of thesis work and at least 21 hours of graduate level course work. The Department offers a wide selection of courses from which the student chooses, in consultation with the graduate advisor, in order to acquire the background necessary for doing the thesis research. The student chooses a sufficient number of courses to complete the remainder of his or her 30-credit program beyond the two core courses and the six to nine credit hours of thesis. These are identified on the formal Plan of Study, which the Graduate Committee must approve. A formal defense and associated thesis report are necessary to certify the quality of the thesis work.

- **M.S. Applied Option**
  The objective of the applied option is to develop in the student skills and knowledge of the Computer Science fundamentals and an ability to apply these to practical problems. The student has two tracks in the applied program, the project track and the course-only track.

  - For project students, a project is completed, usually from her or his work environment or internship, or a faculty member's work. Its objective 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 objective of the course work is to provide breadth of knowledge to the student as well as specialized knowledge in the areas that the project will require. The graduate of this program is prepared to adapt and respond quickly to the employer's specialized requirements. The Applied Program, project track, requires three to six credits of work in a Project Course and at least 24 hours of additional graduate course credits. The Project normally involves at least two semesters of intensive work. The student carries out the project under the supervision of a faculty member. It is highly recommended that there also be a mentor from the sponsoring organization in cases that the project has a non-academic sponsor. A formal presentation and associated report are necessary to assess the quality of the project.
The course-only track requires no thesis or project, and is comprised of thirty
credit hours of course work successfully completed, including at least two core
courses or four “foundational” courses as indicated above.

Graduate Certificate Programs

In addition to the M.S. program, the Department also offers Graduate Certificates in five
specialized areas. A graduate certificate will be issued when a student has completed 12
graduate credit hours in one of the specialization areas. These areas are: i) Biocomputing, ii)
After finishing the requirements for the graduate certificate, the student may opt to finish the
remaining requirements towards a M.S. degree.

Doctor of Philosophy (Ph.D.) Program

Unlike the M.S. program, the Ph.D. program is conducted in close cooperation with the
Computer Science Department at the Purdue University, West Lafayette (CS-PUWL). The
admission to the Ph.D. program is recommended by the Graduate Committee of the
Department and the final decision is made by the Graduate Admissions Committee of the CS-
PUWL. Hence, the Ph.D. program follows all the guidelines created by the CS-PUWL.

An informal program was started in the Fall 2014 semester, whereby students who were not
accepted, or were accepted without funding, by the program at West Lafayette were given the
option to pass their applications on to IUPUI; this has thus far been fairly successful, with Ph.D.
applications increasing significantly for the Fall 2014 semester, including high quality candidates
who may not have otherwise considered IUPUI. As a result, we have had our largest entering
class of Ph.D. students (10).

The Ph.D. program is of 90 credits beyond bachelors, of which at least 54 credits are reserved
for research. It also includes 1 Research Orientation Course, 2 Research Courses (CS 69900,
Research Ph.D. Thesis), Ethics Requirement, and 9 Courses (which must include Operating
Systems and Algorithms). The Advisory Committee for each Ph.D. student is comprised of three
faculty members from CS-PUWL (including a Co-Advisor) and two faculty members (including
an Advisor) from the Department. In addition, the qualifying examinations, the prelims and the
final defenses are carried out with a significant involvement of the faculty members from the CS-
PUWL. It is expected that the quality of the research of the Ph.D. students is worthy of original
publications in esteemed peer-reviewed venues.

Some of the milestones of the Ph.D. program are briefly described (in a near-verbatim manner)
below. All the relevant details are available at:

Qualifying Process
To qualify for the doctoral program, students must pass the qualifying examination, which consists of two parts taken in sequence. Part 1 tests a student for breadth of knowledge in computer science and the ability to use that knowledge. Part 2 tests a student for the knowledge and ability to conduct research.

**Qualifying Examination, Part 1**

The Qualifying Examination, Part 1 consists of passing a written or oral Qualifying Course Examination (QCE) corresponding to one course from each of four different areas in the list below:

- Artificial Intelligence
- Data Mining and Information Retrieval
- Bioinformatics
- Cryptography and Information Security
- Databases
- High Performance Computing and Numerical Computing
- Programming Languages and Compilers
- Scientific Visualization, Geometric Modeling and Graphics
- Simulation and Modeling
- Software Engineering
- Systems and Networking
- Theory

The QCE need not be taken in the same semester as the course is taken. Students may take more than four QCEs, however QCEs may be repeated only with the permission of the graduate committee. Students must pass part 1 by the end of their fourth semester.

QCEs are given at the end of the course. Students who wish to take a QCE must register by the end of the 12th week of the semester. The examining committee for each QCE is appointed by the chair of the graduate committee. The instructor of the course is normally a member.

**Qualifying Examination, Part 2**

Students must pass an oral examination by the end of the fourth semester. Part 2 can be taken only after the student has completed the two research courses and passed at least three of the four QCEs.

Students are nominated for Part 2 by their research advisor, who indicates the area of research. The examining committee consists of three faculty members, none of whom is the student's advisor, appointed by the graduate committee in consultation with the student's advisor. The student must arrange with the examining committee members the date, time, and place of the examination and secure the approval of the assistant to the head (acting for the head) to schedule the examination.
Preliminary Examination

The preliminary examination tests the student's competence in a research area and readiness for research on some specific problem. The content of the examination is at the discretion of the examining committee. The examination may consist, for example, of a presentation by the student of papers relevant to a research topic agreed upon by the student and the committee; or it may consist of a proposal for thesis research; or it may involve an oral examination over the material in appropriate courses beyond the qualifying level.

The examining committee normally consists of the student's advisory committee and an additional member chosen by the graduate committee. The preliminary examination is to be taken by the end of the third semester following the one in which the student completes the qualifying process and at least two semesters before the examination on the thesis.

Thesis

The thesis must present new results worthy of publication. The student must defend the thesis publicly and to the satisfaction of the examining committee, which normally consists of the student's advisory committee and one additional faculty member representing an area outside that of the thesis. The thesis should be completed by the end of the fourth semester following the one in which the student passes the preliminary examination. The graduate committee may grant extensions.

Graduate Minor
Overview

The objective of the graduate minor in Computer Science is to provide an opportunity for current Indiana University or Purdue University doctoral students in other disciplines at IUPUI to learn and use Computer Science techniques and tools to solve problems in their academic fields.

Requirements

The minor will require coursework totaling 12 graduate credit hours at the 500 level or above. These must include one three-credit hour core course selected from the following list, and three elective computer science courses. Additional CSCI courses at the 500 level or above, such as independent studies, may be substituted for elective courses with the permission of a student's faculty advisor and the Minor Program Coordinator in the Department.

Core Courses for Minor

- CSCI 50300, Operating Systems
- CSCI 56500, Programming Languages
- CSCI 58000, Algorithm Design, Analysis, and Implementation

Approved Elective Courses for Minor
CSCI 50600, Management of the Software Development Process
CSCI 54100, Databases
CSCI 54900, Intelligent Systems
CSCI 55000, Computer Graphics
CSCI 55200, Advanced Graphics and Visualization
CSCI 55500, Cryptography
CSCI 57300, Data Mining
CSCI 59000 (Distributed Databases, Pattern Recognition/Data Mining, and Wireless Sensor Networks)

Student Enrollment Data

As of Fall 2014, the Department's graduate program has grown to nearly 200 students; the Department's graduate program accounts for 33% of the graduate headcount within the School of Science. For the MS program only, the Department's program accounts for 54% of the School's Master's headcount. Graduate program enrollment is shown in Tables 7.1 and 7.2 below.

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.</td>
<td>64</td>
<td>57</td>
<td>75</td>
<td>100</td>
<td>84</td>
<td>112</td>
<td>138</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>5</td>
<td>10</td>
<td>14</td>
<td>20</td>
<td>22</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Grad Certificate</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>69</td>
<td>68</td>
<td>90</td>
<td>123</td>
<td>107</td>
<td>147</td>
<td>169</td>
</tr>
</tbody>
</table>

Table 7.1: Graduate Enrollment

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.</td>
<td>69%</td>
<td>78%</td>
<td>80%</td>
<td>72%</td>
<td>65%</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td>Ph.D.</td>
<td>80%</td>
<td>70%</td>
<td>72%</td>
<td>79%</td>
<td>66.6%</td>
<td>58%</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.3: Graduate Acceptance Rates (fall semester)

As interest in the M.S. program has grown, applications have increased from 75 in the Fall semester of 2009 to over 200 in Fall 2014. As Table 7.3 shows, this has resulted in a more strict set of admission criteria being applied to applications by the Graduate Admissions Committee.
A comparison of enrollment across computing units on campus, as seen in the chart below, also confirms the Department’s trend of increasing enrollment and shows that the Department’s graduate program is now one of the largest, rivaling the School of Informatics.

Profile of Graduate Students

As of Fall 2013, 62% of the Department’s graduate population was above the age of 25; this has remained fairly steady since 2007, with percentages ranging from 57 to 63. As seen from the above enrollment Table 7.1, since 2007, the number of graduate students (M.S. and Ph.D.) has significantly increased. The increase is mainly due to the large enrollment of international students. In addition to the local full and part-time students, currently, The Department houses international students with representatives from India, China, Sri Lanka, Bangladesh, Colombia, Iran, Greece, Thailand, Vietnam, and Palestine. These students increase the diversity (one of the prime objectives of the IUPUI’s Strategic Plan) of the CS graduate programs. In addition, there are currently around 60 female graduate students – a traditionally underrepresented group in Computer Science; these numbers are slightly higher than the last national average reported by the CRA of 22.6% in 2012. These numbers are generally the byproduct of the large international composition of the graduate population, where female students generally comprise a significant portion of those in U.S. graduate programs. Table 7.4 provides additional statistics on the Department’s graduate student population. A more detailed breakdown of ethnic minority enrollment can be found in the Appendix; this data, not surprisingly, indicates that the vast majority of graduate students identify as Asian. It also indicates that the Department has not been successful in attracting African American or Hispanic students into graduate programs.
The Department is currently working on efforts to attract and retain more local and minority (non-international) graduate students, in particular women, and would seek the Review Committee’s suggestions in this area.

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>36%</td>
<td>34%</td>
<td>38%</td>
<td>29%</td>
<td>24%</td>
<td>29%</td>
<td>34%</td>
</tr>
<tr>
<td>Ethnic Minority</td>
<td>9%</td>
<td>6%</td>
<td>8%</td>
<td>11%</td>
<td>10%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>Age 25 and Over</td>
<td>58%</td>
<td>63%</td>
<td>64%</td>
<td>68%</td>
<td>70%</td>
<td>54%</td>
<td>53%</td>
</tr>
<tr>
<td>Enrolled Full-Time</td>
<td>29%</td>
<td>25%</td>
<td>40%</td>
<td>34%</td>
<td>39%</td>
<td>54%</td>
<td>57%</td>
</tr>
<tr>
<td>Indiana Resident</td>
<td>41%</td>
<td>50%</td>
<td>42%</td>
<td>41%</td>
<td>36%</td>
<td>27%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Table 7.4 Graduate Student Profile

A typical incoming M.S. and Certificate student has a GPA of 3.0 or better (or its equivalent in the case of international students) and a TOEFL score (again for international students) of 79 or better. Many of the incoming students are in the top 10% of their graduating class. Some of these students also have a few years of industrial experience after their bachelor’s degree. The graduating requirement for the MS students is to achieve a GPA (as indicated in their plan of study) of 3.0 or better – a large number of students do successfully meet that requirement. Around 5% of these students participate in the M.S. thesis or the project option and publish their research in peer-reviewed venues.

A typical incoming Ph.D. student has a GPA of 3.5 or better (or its equivalent in the case of international students), a TOEFL score of (again, for international students) of 79 or better and prior research experience. Any student requesting financial assistance is required to submit their GRE scores. A typical graduation time for a Ph.D. degree is between 5 and 6 years (after starting the Ph.D. program). So far, six students have graduated with the Ph.D. degree and all are employed in industry.

A typical incoming Graduate Minor student is enrolled in a Ph.D. program at the IUPUI campus in a related discipline such as Informatics. So far, 5 students have applied for this option as part of their academic requirements.

**Advising**

Each student, admitted to the M.S./Ph.D. program, is assigned an initial Advisor and thereafter, the student may decide to keep that Advisor or change the Advisor based on his/her specific plan and preferences.

The student populations in different graduate programs require different kinds of advising. For example, a M.S. student enrolled in the course-only typically meets with the assigned Advisor on an infrequent basis – mainly, to discuss the courses to be taken and the associated plan of study. In contrast, a M.S. student enrolled in the thesis or project option will be advised continuously throughout his/her program duration. These advising efforts will be related, both, to
course selections and feedbacks on the research efforts. Irrespective of their program options, each M.S. student is associated with an Advisory Committee made up of three faculty members. This Committee approves the plan of study for that student and in the case of thesis/project students it acts as the Examination Committee for assessing the quality of the thesis/project effort and decides the final outcome (i.e., pass or fail).

Each Ph.D. student has an Advisor in the Department and a Co-Advisor at the CS-PUWL. In addition, each student is associated with an Advisory Committee and an Examination Committee as described earlier in the Section related to the Ph.D. programs. Each Ph.D. student is continuously advised by these Committees and works in close cooperation with the Advisor and the Co-Advisor.

Each Graduate Minor student is associated with the Minor Advisor and the Graduate Committee of the Department and is advised as needed.

Assessment
The vast majority of students who have completed the M.S. program transition into jobs in industry; these graduates have successfully found positions in a variety of companies around the U.S. and even overseas. Currently, as a sample, graduates are working in the following companies: Deloitte (San Diego, CA), Knowledge Advisors (Chicago, IL), Dell (Round Rock, TX), Intel (Portland, OR), Microsoft (Redmond, WA), JDS Uniphase (Germantown, MD), Manhattan Associates (Atlanta, GA), Epic Systems (Madison, WI), USAA, Echostar (Denver, CO), ProTrans International (Indianapolis, IN), Interactive Intelligence (Indianapolis, IN), Gyansys (Indianapolis, IN), Sears (Chicago, IL), ChaCha (Indianapolis, IN), Angie’s List (Indianapolis, IN), Northwestern University School of Medicine (Chicago, IL), Ratuken (Tokyo, Japan), Nimbula (Santa Clara, CA), and Barclays (Pune, India).

A large population of the Department’s M.S. students is international. This trend, although adds significant diversity to the M.S. program, needs to be balanced by admitting many domestic students. The Graduate Committee has proposed “an introduction to Graduate Study” event targeted at the current undergraduate students especially the ones that are in the Junior-level.

Generally, a few M.S. graduates have transitioned to Doctoral programs at other institutes, though in recent years several M.S. students have been accepted into the Ph.D. program of the Department. Last year, one M.S. student was admitted into the Ph.D. program at the University of Utah. In addition, several M.S. graduates have successfully completed the IU MBA program, and one student transitioned to the IU Law School after completion of his M.S degree.

In the Spring of 2011, the Department drafted a set of Student Learning Outcomes for Graduate Programs. These outcomes include outcomes for both the Graduate Certificate and M.S. programs, with additional outcomes for M.S. Project/Thesis and Ph.D. students. The full list of Graduate Student Learning Outcomes can be found in the Appendix. There has not been significant assessment conducted thus far at the graduate level based on the SLOs. The Department’s Graduate Committee is currently working on devising strategies for program
evaluation based on these SLOs and would like to solicit the Review Committee’s suggestions in this area. There are no PULs currently for graduate programs, though the Department has very recently begun an effort to create a set of PULs for graduate programs based loosely on the undergraduate PULs; in this effort also, the Department would like to solicit the Review Committee’s suggestions.

Work done by those in the M.S. project, M.S. thesis and Ph.D. tracks has in many cases resulted in co-authored publications in peer-reviewed venues, which can be considered as a form of "external assessment." Publications which have been co-authored by graduate students are marked with the * notation in the appendix.

In summary, the overall trend in the M.S. program enrollment is moving in a positive direction, with some specific issues (e.g., a lack of more domestic and minority students) to be addressed. The direct admissions (i.e., without any conditions) into the M.S. program and the total enrollments have also increased over time. The percentage of accepted students (from the total number of applications) into the M.S. program has decreased in past few years (from 78% in Fall 2010 to 54% in Fall 2014), indicating the more selective nature of the admission and the increased quality of the M.S. program. The size of the Ph.D. program has also increased from 2007 with better quality of students applying to the program. These positive trends need to be preserved over next few years as the size of all the graduate programs is expected to increase.
Chapter 8 Research

The Department, in addition to quality teaching, places a significant emphasis on research and innovation. The faculty has been constantly active and successful in the research mission of the Department. In this chapter, a brief synopsis of the research activities is provided.

Research Overview

<table>
<thead>
<tr>
<th></th>
<th>Abstracts</th>
<th>Papers (Journal and Conference)</th>
<th>Book Chapters</th>
<th>Presentations</th>
<th>Colloquia</th>
<th>Total Active Awards (internal and external, PI and Co-PI)</th>
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<td>20</td>
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<tr>
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<td>63</td>
<td>15</td>
<td>32</td>
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</table>

Table 8.1: Research Productivity of the Faculty

External Funding

<table>
<thead>
<tr>
<th></th>
<th># Grants Proposed*</th>
<th>$ Grants Proposed*</th>
<th># Grants Received*</th>
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Table 8.2: External Research Funding

*Table not all-inclusive; only includes grants where departmental faculty are PIs. External grants only. Multi-year grants (such as CAREER awards) are included in the calculations as reported in the university financial/grant system, where large awards are broken down by individual award years, rather than have the total award amount listed in the award’s 1st year. Thus for large awards that extend past 2013, the full amount of the award will not yet be reflected in this table.
As seen from the above tables, the research productivity (publications and grants) of the faculty has also been on an upward swing. This is certainly a significant achievement considering the relatively young age of the Ph.D. program and the current economic climate.

**Faculty Research Groups**

Since early 2000, The Department made a strategic decision of focusing its research efforts in a few critical areas. These areas are: a) Database, Data Mining, and Machine Learning, b) Software Engineering, Distributed and Parallel Computing, c) Imaging and Visualization, d) Networking and Security, and e) Educational Research. Hence, there are five active research groups, one each corresponding to the abovementioned areas, in the Department. A brief description of the ongoing projects pursued in these groups is provided below. An inclusive grant and publication list is included in the Appendices.

**Database, Data Mining and Machine Learning (DDMML) Group**

**Faculty:** Murat Dundar, Mohammad Al Hasan, Snehasis Mukhopadhyay, Yuni Xia

**Collaborative Units:** eBay Research Labs (Nish Parikh, Neel Sundaresan), Joe Bidwell (IU School of Medicine), Oregon State University (Meghana Babbar-Sebens), Mathew Palakal (IUPUI School of Informatics), Keith Dunker (IU School of Medicine), John Lee (IUPUI School of Engineering), Bartek Rajwa and Paul Robinson (Bindley Bioscience Center, Purdue University), Sunil Badve (IU School of Medicine), Metin Gurcan (The Ohio State University School of Medicine)

Understanding how human brain or other intelligent biological systems function has always been one of the holy grails of human knowledge endeavor. Recent advances in learning and adaptive systems make this goal less remote and unattainable than before. New computing paradigms such as artificial neural networks, machine learning, and multi-agent systems incorporate the ability to solve complex problems and make decisions in a dynamic environment in an adaptive fashion. At the same time, the enormous growth of computational power, cheap storage, superior communication networks, and sophisticated sensor devices has granted scientists, government organizations, and enterprises an unprecedented ability to collect, and store massive amount of data. Besides, the proliferation of handheld devices, and widespread penetration of various online social networks, along with the availability of many cloud storages have transformed numerous individuals from a data consumer to a data generator. These phenomena have created a data-rich society where analyzing and mining data has become a routine task. However, the availability of massive data has brought unique challenges both to the data management task and also to the data analysis, mining, and learning task. The DDMML group is dedicating its research to address these challenges. It develops theory, systems, and applications for storing and managing of big data, mining data for knowledge discovery, and building predictive models from dynamic and heterogeneous data. A brief description of ongoing projects by DDMML is provided below.
Interactive Pattern Mining from Massive Data (Mohammad Al Hasan and Snehasis Mukhopadhyay)

One of the key bottlenecks of knowledge discovery through frequent pattern mining based methods is the large size of the output which is caused by the combinatorial nature of the pattern space. Due to this, it is difficult for the end users to select a succinct set of patterns for utilizing them in subsequent tasks, such as classification, or clustering. In recent years, a large number of works are attempted to address this limitation by mining patterns that are interesting based on some additional metrics other than the frequency, however no universal metric exists that works for all different application domains. So it is better to involve the end-user in an interactive setup (aka, human-in-the-loop), where the user guides the pattern selection process.

The research objective of this project is to invent an interactive pattern mining method which uses sampling based approach. In this paradigm, the sampler returns a pattern to the user who provides feedback on that pattern, and based on the feedback the sampler updates the sampling distribution so that subsequent patterns align well with user's interest. To assist the user, the interactive system also equips the user with a visual interface, which further helps the user to run visual analytics over the mined patterns. This project is funded by National Science Foundation.

Scalable Methods for graph mining using MCMC Sampling (Mohammad Al Hasan)

The phenomenal growth of social, communication, and information networks over the last decade has motivated the scientists to work on various interesting problems relating to graphs, including, mine interesting subgraphs, model the temporal growth of social networks, model the diffusion of nodal attributes over the networks, predict the status of a node or a link, and discover the community structure in a network. However, given the gigantic size of today's networks, one of the foremost challenges for each of the above tasks is the lack of scalability of the existing algorithms for mining and learning on graphs. The high computation cost of typical graph algorithms are to blame for this limitation; subgraph isomorphism is NP-Complete; graph isomorphism is costly with an unknown complexity status; even polynomial tasks, such as finding eigenvalues of a graph Laplacian, has roughly cubic complexity, and they are deemed infeasible for networks with millions of vertices, and edges.

The research task of this project is to discover sampling based strategies for obtaining scalable solutions for mining, modeling, and analyzing large graphs. The core idea of this direction is to perform a random walk over the candidate pattern space and sample patterns using Markov chain Monte Carlo (MCMC) method that maximizes some objective criteria. This project is funded by the National Science Foundation.

Mining big-data using MapReduce based distributed system (Mohammad Al Hasan)

Since its inception almost a decade ago by Google engineers, the MapReduce has gained enormous popularity because of its economic efficiency, and automated fault-tolerant capability.
Now it has become a de-facto standard for running peta-scale analytics in the industry. The goal of this project is to design distributed graph mining algorithms that run on MapReduce platform. A parallel goal is to teach MapReduce based computation paradigm to new generation of students. To carry out this project, the PI has already built a 10-node Hadoop cluster using National Science Foundation funding. A new MapReduce based graph mining software is also released recently.

**Understanding the intent of e-Commerce Queries for better relevance matching** (Mohammad Al Hasan, in collaboration with eBay Research Labs)

The aim of this project is to understand the user’s search intent by understanding e-Commerce queries. The project covers several tasks, which include computing query similarities for substitution, query segmentation and understanding, query suggestion, and search result ranking. The researchers at eBay research Labs are key partners in this project.

**Development of Key Technologies for Big Data Analysis and Management Software Based on Next Generation Memory** (Yuni Xia, in collaboration with John Lee)

This collaborative project seeks to develop big-data main memory database management system and distributed streaming processing system using hardware acceleration techniques including FPGA (programmable / reconfigurable chips) and GPGPU (general purpose graphics processing unit).

**Uncertain Data Management and Mining** (Yuni Xia)

Due to limited bandwidth and battery power, it is infeasible for a system to keep track of the actual values continuously produced by sensors. Database queries, in this case, may produce incorrect answers. This project models the uncertainty inherent to dynamic sensor data with a range of possible values together with the probability distribution of the values within that range. Probabilistic queries, which evaluate uncertain data and produce answers with probabilistic guarantees, are proposed and their efficiency issues are evaluated. In particular, the project proposes efficient algorithms to enhance the performance of nearest-neighbor queries, range queries, and joins. It has also developed uncertain data classification, clustering and association mining algorithms.

**DisProt Database: A Central Repository of Information on Intrinsically Disordered Proteins** (Yuni Xia, in collaboration with Keith Dunker)

The goal of this project is to fully develop DisProt, a database that provides an essential depository of information about intrinsically disordered proteins (IDPs). DisProt will be not only a collection of data on intrinsically disordered proteins and their functions, but also a unique research tool to conduct various computational studies on these proteins and to help design better research strategies for studying individual IDPs in laboratory. It's expected that DisProt
will support a very wide-spread use, both for the purpose of carrying out bioinformatics experiments and for the entire community involved in understanding cell and molecular biology.

**Large Scale Sensor Stream Analysis and Mining for Geriatric Care (Yuni Xia, in collaboration with IBM Watson Research Center)**

This project aims to design and develop a real-time distributed sensor stream monitoring and analysis system for geriatric care. This enables effective home-based continuous geriatrics care, which is not only cost-savings, but also improves the quality of life of the elderly and their families.

**TrafficAnalyzer: A Real-time Traffic Stream Processing and Analyzing System (Yuni Xia, in collaboration with IBM Watson Research Center)**

Modern traffic monitoring systems are required to perform real-time processing and analysis of peta-bit continuous data streams. This project proposes to design and develop a real-time traffic stream processing and analyzing system. The most important feature of TrafficAnalyzer is the real-time performance. The results of processing need to be produced with virtually zero latency, because in traffic monitoring system, real-time response is crucial for reducing accident rate and smoothing traffic flow. TrafficAnalyzer must support sophisticated time-windowed processing operations since streaming data continually changes, often at high rates. These operations should be executed in a way that produces results incrementally as new data arrives, since the entire data set is never available in its entirety. TrafficAnalyzer also provides careful management of the historical data, as it need compare and combine present data with the past to study the traffic flow change over the time. TrafficAnalyzer is also resilient to inaccuracy and uncertainties in the data streams, because inherent variations, losses, or reordering of the data streams cause data to arrive in the wrong order, or with variable delays.

**Development of SYMBIOTE; A Reconfigurable Logic Assisted Data Stream Management System for Multimedia Sensor Networks (Yuni Xia, in collaboration with John Lee)**

Numerous emerging applications require real-time processing of high bandwidth multimedia data streams. This project proposes a novel class of data stream management systems called Reconfigurable Logic Assisted DSMS (RLADSMS) that will provide one of the first comprehensive and demonstrative approaches to using Reconfigurable Logic coprocessors as data stream accelerators in the prototype RLADSMS called SYMBIOTE. This project will investigate key issues such as data models, query languages, hardware DSMS operators, corresponding cost models of query execution, considering hardware complexity of database operators, run-time complexity of hardware and software operators, interconnect latencies, bandwidth, resource allocation as well as optimization techniques for this new class of data stream management system.
WRESTORE: Watershed REstoration using Spatio-Temporal Optimization of REsources (Snehasis Mukhopadhyay, in collaboration with Meghna Babbar-Sebens, Oregon State University)

WRESTORE (wrestore.iupui.edu) is a web-based, user-friendly, interactive, transparent, and participatory decision support system for helping land owners, government agencies, policy makers, planners, and other stakeholders design a distributed system of conservation practices in their watersheds. In WRESTORE, web-based tools allow users to test multiple solutions (or, alternatives) for locating and designing conservation practices in a simulated environment of their watershed landscape. Based on the overall performance of the practices in the simulated environment, users can then identify alternatives most suitable to their needs. The interactive framework takes feedbacks from the users and then uses an iterative search-and-learning method to search for better potential solutions that incorporate the users’ feedbacks. In this manner, not only does the tool learn from the users about their needs while searching for better alternatives, the users also learn about how their watershed can respond to various actions or changes on the landscape and how to manage their landscape within the constraints of their physical and socio-economic environment. For example, a farmer concerned with the problem of erosion on her/his land can explore multiple types of best management practices and locations where the practices can be implemented on her/his landscape.

Fast Reinforcement Learning using Multiple Models and State Decomposition (Snehasis Mukhopadhyay, in collaboration with K. S. Narendra, Yale University)

Originally based on mathematical psychology models of animal and child learning, reinforcement learning algorithms aim to find the optimal decisions (or, decision rules) in feedback with an unknown and uncertain teacher or environment, on the basis of a qualitative and noisy on-line performance feedback provided by the teacher in the form of a reinforcement signal. One of the well-known and major limitations of current reinforcement learning methods proposed in the literature is the slow speed of convergence. This slowness, in turn, may be attributed to the underlying assumption that the identification model of the environment needs to be learned from complete ignorance using a single model, and also to the well-known “curse of dimensionality” associated with a high dimensional state space.

The principal objective of this project is to address this important problem using the following novel methods:

i. the use of multiple identification models.
ii. decomposition of high dimensional state and action spaces.

Self-adjusting Models as a New Direction in Machine Learning (Murat Dundar)

Traditional supervised learning algorithms assume that the list of classes defined by a training data set is exhaustive and that new data samples originate from one of the existing classes represented in the training data set. This assumption is not very realistic in many real-world
domains as the data-generating mechanisms constantly evolve and new classes of interest emerge on a continual basis. Under such circumstances it is impractical if not impossible to define a training data set with a complete set of classes. When the training data set is not exhaustively defined, a future sample of a class not represented in the training data set will be misclassified with certainty, leading to an ill-defined classification problem. This study offers a new direction for supervised learning that relaxes the fixed-model assumption defined by the existing data in order to have a self-adjusting model that can evolve by dynamically adding new classes to better accommodate prospective data in offline as well as online settings. Specifically, the aims of the project include (1) studying non-parametric prior models to dynamically model the number of classes (2) developing new online and offline inference techniques in partially-observed settings (3) modeling the rapidly accumulating nature of samples evident with emerging classes (4) automatically associating a newly discovered class with higher-level groups of classes in an attempt to identify potentially interesting class formations, and (5) developing partially-observed tree models containing observed and unobserved nodes, where observed nodes represent existing classes and unobserved nodes are introduced online to fill the gaps in the existing data hierarchy that become evident only with the arrival of new data.

Automated Spectral Data Transformations and Analysis Pipeline for High Throughput Flow Cytometry (Murat Dundar, in collaboration with Bartek Rajwa and Alex Pothen, Purdue University)

High-throughput flow cytometry is an emerging cell-analysis and screening technique employed in various fields of life-sciences, including drug discovery and clinical research. One of the major limitations of HT-FC is the lack of robust, rapid, and reproducible tools for data analysis and data mining. The current paradigm of FC analysis does not fit suit the HT format well. Traditionally, FC data are analyzed employing interactive exploratory visualization, which requires preparing a number of 2-D scatter plots that are used by an FC operator or researcher for visual evaluation of sample characteristics. Although the recent interest of computer science and bioinformatics communities in FC has spurred development of automated compensation and gating techniques, the proposed algorithms still follow the traditional analysis pathway (compensation plus gating), and typically attempt to mimic trained human operators in delineating various cell populations defined by the presence of fluorescent markers of varying intensities. Unfortunately, this model is not sustainable when hundreds or thousands of data sets must be processed in real time. This proposed research attempts to radically re-invent the FC data analysis pipeline for high-throughput FC by employing spectral classification approaches to FC data. In the proposed framework the FC data will be modeled as a mixture of signals that can be quantitatively recovered if certain physical and biological constraints describing the experimental system are rigorously followed. This project proposes a set of algorithms that will allow first to define and encode the domain knowledge describing the analyzed specimens, subsequently to approximate the concentrations of labels, and from there recover information about the presence or absence of specific phenotypes of interest. The techniques employed will functionally replace two steps in FC data analysis that have traditionally been viewed as separate: compensation and gating. Instead, a new iterative
spectral classification process will recover the quantitative characteristic of samples. This will allow for fast and automated extraction of sample features, as well as for mining the collected specimens for similar datasets. The proposed algorithm will be prototyped using R language for statistical computing, and relevant procedures will be made available to other researchers in the field of FC via the Bioconductor project. Upon successful testing and validation using various datasets contributed by collaborators, the classification algorithms will be implemented in PlateAnalyzer, an HT-FC data analysis package developed at Purdue University.

**Machine-learning Approach to Label-free Detection of New Bacterial Pathogens (Murat Dundar, in collaboration with Bartek Rajwa, Purdue University)**

Technologies for rapid detection and classification of bacterial pathogens are crucial for securing the food supply. A light-scattering sensor recently developed for real-time detection and identification of colonies of multiple pathogens has shown great promise for distinguishing bacteria cultures at the genus and species level for *Listeria, Staphylococcus, Salmonella, Vibrio*, and *Escherichia Coli*. Unlike traditional testing methods, this new technology does not require a labeling reagent or biochemical processing. The classification approach currently used with this technology relies on supervised learning. For an accurate detection and classification of bacterial pathogens, the training library used to train the classifier should consist of samples of all possible forms of the pathogens. Construction of such a training library is impractical if not impossible due to the high mutation rate that characterizes some of the infectious agents. This project proposes to advance this sensor technology to allow for the detection of new classes/subclasses of bacteria, which do not exist in the training library. Learning with a non-exhaustive training library is an ill-defined problem. A two stage classification scheme to alleviate this problem is designed. The first stage, i.e. detection, identifies whether the bacteria sample belongs to one of the subclasses in the training library or a yet unseen and thus unrepresented subclass. If the former is true, the sample is fed to the second stage, i.e. classification, where it is classified to one of the existing subclasses. If the latter is true, an alert is raised and the sample is saved for follow-up analysis.

**Software Engineering, Distributed and Parallel Computing (SEDPC) Group**

**Faculty:** Ray Chin (Emeritus), James Hill, Andrew Olson (Emeritus), Rajeev Raje, Fengguang Song, Mihran Tuceryan

**Collaborative Units:** University of Alabama at Birmingham and University of North Texas (Barrett Bryant), Naval Postgraduate School (Mikhail Auguston), Oregon State University (Meghana Babbar-Sebens), Vanderbilt University (Anirudha Gokhale, Douglas Schmidt), University of Maryland (Adam Porter), University of Adelaide (Katrina Falkner), University of Tennessee (Jack Dongarra)

The SEDPC group is investigating various fundamental and applied research issues that arise in creating high-performance, distributed, pervasive, and quality-aware software systems. Such systems are omni-present in today’s world and span a large spectrum of application domains from scientific and engineering to defense. As appealing the applicability of these systems is,
their software realization is hardly a trivial task due to challenges such as the complexities and scale associated with the domain, the performance and quality of service (QoS) issues, the trust metrics and effective validation techniques. The projects pursued by the SEDPC group aim to address some of these challenges. A brief description of these projects is provided below.

**System Execution Modeling Environment Research and Development: Phase 1 – 5**

(James H. Hill)

This project is a multi-phased project. The significance of the first 2 phases was to showcase that it is possible to generalize several system execution modeling capabilities, such as modeling, system integration, and performance analysis, to many different middleware technologies and execution environments. The last 3 phases of the project focused on building an international collaboration effort between the Australian DSTO and the University of Adelaide. Dr. Hill’s role in the collaboration is the focus on unclassified open research problems. The University of Adelaide then focuses on adapting the solutions created to the needs to the Australian DSTO. This project has been supported by the Australia Defense Science and Technology Organization (DSTO)

**Testing-as-a-Service: Static Code Analysis (SCA) Tool Study – Phases 1, 2, and 3**

(James Hill and Rajeev Raje)

This project is focused on assessing the effectiveness of various Static Code Analysis (SCA) tools. The techniques used in the assessment involve the use of Joliet test suite from the NIST and principles of machine learning. The underlying hypothesis behind this study is that such an analysis will allow the prediction of which static code analysis tool will perform best on a given piece of source code (i.e., find the most number of flaws in source code while having a low false positive rate). The initial results from this project have been integrated into the SoftWare Assurance Marketplace (SWAMP). This will allow SWAMP’s end-users to evaluate the quality of static code analysis tools. This work has also provided preliminary data for a white paper that has been approved for a full proposal currently under review for the DHS Long Range BAA (DHSST-LRBAA14-02). The proposed project is research collaboration between IUPUI and University of Maryland, College Park. This project has been supported by the Lockheed-Martin, Northrup Grumman, and the Department of Homeland Security via the Security and Software Engineering Research Center.

**Automatic Identification of Software Performance Anti-patterns in Cloud Computing Applications**

(James Hill)

In this project, an approach for identifying software performance anti-patterns in cloud computing applications was suggested and tested on the Amazon Cloud. This project has been supported by Amazon Inc.

**Continued Support for Research and Development on System Integration Testing as a Service**

(James Hill)

This project was an extension awarded to Dr. Hill after completing the AFRL Summer Faculty Program in Summer 2010. The project performed a feasibility study of using abstract models to
define and generate performance and system integration tests for large-scale component-based distributed systems. This end result of such an approach would alleviate distributed system developers from having to re-write large amounts of code to execute performance and integration test across different systems under development.

Cyber-physical multi-core Optimization for Resource & cachE effects [C2ORES] (James Hill)

The project developed a methodology for emulating CPU workloads that can easily adapt to many core architectures (e.g., 2-core, 4-core, 16-core, 64-core) without requiring integrated knowledge of the underlying architecture or manufacturer. This project was supported by the US Office of Naval Research with the Vanderbilt University as the Primary organization.

EISA/OASIS Transition Project – Transition Planning, Phases 3 and 4

The aim of this project was to investigate integrating event-based middleware into real-time instrumentation of software systems. This project was supported by the Science Applications International Corporation with the Vanderbilt University as the Primary organization.

CoSMIC Extensions for the Scalable Node Architecture (James Hill)

The aim of this project was to extend the CoSMIC tool suite, which is maintained by Dr. Hill, to support new functionalities of the DAnCE research artifact developed and maintained by the Vanderbilt University. The project provided with real-life case studies that are used to train students who are interested in model-driven engineering for component-based distributed system development. This project was supported by the Northrup Grumman Corporation with the Vanderbilt University as the Primary organization.

Reducing Accidental Complexities Associated with CoSMIC Tool Suite – Phases 1 and 2 (James Hill)

The aim of this project was to extend the CoSMIC modeling tool to support the new Interface Definition Language (IDL) 3+ specification from the Object Management Group (OMG). The methodology created as a result of these explorations for modeling connectors in IDL3+ was adopted by Zeligsoft CX and Artisan Studio, which are commercial available tools for designing component-based systems that use IDL3+. This project was supported by the Northrup Grumman Corporation with the Vanderbilt University as the Primary organization.

Modeling, Specifying, Discovering, and Integrating Trust into Distributed Real-time and Embedded (DRE) Systems – Phases 1 and 2 (Rajeev Raje and James Hill)

The aim of this project is to research and develop a methodology for integrating trust into each phases of the software lifecycle. The concept of trust in the context of individual software components and their aggregated system was defined as the conformance of these entities to their specifications. This definition was quantified as a tuple of belief, disbelief and uncertainty using the theory of belief functions. This quantification was applied to both the inside (i.e., a developer's) and outside (i.e., the user's) views of that entity. Various different operators for
selecting, composing and predicting trust values of combinations of components were suggested and applied using the topology of communication the association between different entities and machine learning principles. The outcomes of these efforts have been applied to publicly available resources such as the Google’s Play Store, Microsoft’s Store and the QWS dataset. This project has been supported in part by the Air Force Research Labs via the Security and Software Engineering Research Center.

**A Narrative-based Approach to Requirement Analysis** (Rajeev Raje and James Hill)

Software requirements, which typically are written as free flowing text, for complex, and often distributed, projects present myriad of challenges to stakeholders such as the domain experts, designers, developers, testers, and user. The process of analyzing these requirements is laborious and requires a large amount of manual intervention. This project suggests a different alternative to the analysis of requirements based on the notion of a narrative-based analysis – a technique that uses principles of NLP and AI – and has been successfully used in analyzing folklore tales by MIT researchers. The outcome of this research will address these critical questions: a) what abstractions are necessary to identify and extract underlying knowledge from a sample set of requirements?, b) can such an analysis also highlight inconsistencies, if any, in the requirements?, and c) can guidelines be created/inferred using this analysis to better formulate requirements? Answers to these questions will help in achieving better insights into the requirement analysis process. A proposal based on this is currently pending at the Security and Software Engineering Research Center.

**UniFrame – A Framework for Seamless Integration of Heterogeneous Distributed Components** (Rajeev Raje and Andrew Olson)

Software intensive distributed systems are omni-present in today's world. The realization of such systems, mainly due to the reasons of economy and scalability, should be achieved as loose coalitions of independently created components that offer services. This is an incarnation of McIlroy's vision of a component bazaar in the context of distributed systems. At the same time, the proliferation of these systems into a variety of domains, including critical applications, is necessitating a high confidence about these individual services and an ensemble created out of them. The creation of dependable software systems is so critical that it is listed as one of the grand challenges in computing research. If future distributed systems, requiring a desired level of high confidence, have to be composed out of independently created and deployed services, then care must be taken in creating, specifying, deploying, discovering and evaluating appropriate services for a specific instance of a distributed system, as the confidence of the ensemble depends upon the confidence about individual services and their inter-dependencies. This research is carried out under the umbrella of UniFrame project. A part of this project was a collaborative venture between multiple universities and was supported by the US Office of Naval Research and the Indigo Foundation between 2001 and 2006. Recent efforts have focused on distributed discovery of resources and some of the results have been applied at searching software services for the domain of Earth Sciences.
A Framework for Development of Adaptive Software Services and Systems (Rajeev Raje)

Many applications demand for the development of software services and systems composed of them to be adaptive in response to certain stimuli. However, the adaptive ability of a software component is often considered as an after-thought instead of following the notion of “adaptive by construction”. This project aims at formalizing the types of adaptations, creating their taxonomy, providing programmatic representations of adaptations and a tool suite to develop adaptive components from the start. The principles developed are being applied to publically available software repositories such as the Google Play Store.

eDOTS - An Opportunistic Indoor Tracking Solution (Rajeev Raje, Mihran Tuceryan, and Fengguang Song)

The eDOTS is an indoor tracking solution being currently developed at IUPUI. The goal of this project is to make use of existing sensor networks and the proliferation of inexpensive and available mobile sensor devices - opportunistic indoor tracking. Through this work a solution for indoor tracking that prevents the need for installing a costly/invasive tracking infrastructure all the while provide a high degree of accuracy in real-time is provided. The project uses the principles of opportunistic discovery, sensor subset selection, data fusion, and trust and reliability issues of sensors. This project would benefit many application domains including that of health care and emergency rescue. Collaboration with the colleagues with the IU School of Nursing is being investigated. This project is supported in part by the Purdue Research Foundation and a proposal based on this effort is pending with the Samsung Corporation.

Mazu: A High Performance Computing Framework for Simulating Large-Scale Computational Fluid-Structure-Interaction Dynamics (Fengguang Song)

The objective of this project is to design and develop a task-based domain-specific computing framework to exploit parallelism, scalability, I/O optimization, and performance potential of extreme-scale high performance computing systems to enable highly efficient Computational Fluid Dynamics (CFD) computing. With a number of new and emerging disruptive technologies, the conventional programming models used to develop CFD applications, such as MPI, Pthreads, hybrid MPI/OpenMP, hybrid MPI/CUDA, are not well suited to scale on the new heterogeneous extreme-scale HPC systems with billions of cores. In this project, a domain-specific approach is taken to develop a fundamentally new task-based computing framework for the CFD domain, called Mazu, to address the parallelism and scalability challenges presented by extreme-scale HPC systems. This project involves creating and designing new scientific libraries, programming models, runtime systems, computational fluid dynamics methods, and optimization methodologies.

Building an Open-Workflow Scheduling Middleware for Water-Related Communities on Cluster/Grids/Cloud (Fengguang Song)

The goal of this project is to build up an open and sustainable modeling infrastructure for scientific water-science communities. A lightweight middleware is designed and implemented to enable easy access and efficient large-scale computations on distributed computing resources.
The project will provide as simple a user interface as possible and hide all the details of various types of resources provided in the backend such as clusters, Grids, and Clouds. From an end user's perspective, his or her only task is to draw a workflow that couples different computational models without knowing anything about parallel programming. The middleware automatically finds and allocates high performance computing resources, schedules and executes the user's workflow dynamically. This project will have profound impacts in almost every discipline in water science and beyond, where scientists can use this project to greatly simplify their data access, model studies, coupling and HPC facility access, and thus boost their research explorations.

**A High Performance Synergistic Software System for both Compute-Intensive and Data-Intensive Computing** (Fengguang Song)

The goal of this project is to integrate and couple extreme-scale computing with IO-intensive big data analysis to simplify, enhance, and speedup the scientific discovery process. In this project, new computing technologies to manage/schedule large-volumes of data and large computation simultaneously, to maximize data locality, minimize synchronous operations, design out-of-memory algorithms, and to create simplified and flexible programming models to improve the productivity of various domain scientists are being developed. A scalable and general computing framework is being developed to co-schedule advanced computations, data analyses, and I/O activities. This project is expected to fundamentally advance both scientific computing and extreme-scale big data analytics.

**Imaging and Visualization**

*Faculty*: Shiaofen Fang, Mihran Tuceryan, Jiang yu Zheng, Gavriil Tsechpenakis, Li Shen (adjunct)

*Collaborative Units*: Indiana University School of Medicine; Indiana University School of Dentistry; Regenstrief Institute; Indiana Forensic Institute; Indiana University Advanced Visualization Lab (AVL); Indiana University Center for Neuroimaging.

The Imaging and Visualization group’s research focus is on the processing, analysis, fusion, and presentation of multi-modal, multi-dimensional and multi-scale sensory information using visual computing techniques. The goal is to develop fundamental theory and strategies, and efficient and effective algorithms and techniques for practical applications of important social and scientific significance.

As part of the Imaging and Visualization group, the **Center for Visual Information Sensing and Computing** (VISC) is a cross-disciplinary research center, dedicated to fundamental and applied research in the emerging field of multi-sensory information processing. As the primary means in which digital world interacts with the physical world, sensory technology (e.g. electronic surveillance, 3D range data scanning, biometric sensory, medical imaging, forensic and law enforcement imaging, remote sensing, senor networks) is rapidly becoming an integrated part of everyday life. The science of understanding and reasoning with sensory information constitutes the “brain” of a digital system, and is destined to become a grand challenge of the new century.
Sensor systems provide digitized information of real world, thus allowing computers to interact with the physical world in its digital forms. The most direct use of sensory information is visualization in which virtual objects and digitized real objects are rendered together within the same virtual environment. The landscape of sensory technology has, however, drastically changed recently. On one hand, sensory systems have become much more sophisticated, less expensive, more convenient, and faster. In particular, mobile platforms have become ubiquitous, cheap, and portable with great computational power and a plethora of sensors that are built in. This allows for new applications of imaging and visualization techniques to practical real-world problems. Similar progress has also been made in remote sensing, satellite imagery, panoramic imaging, video surveillance, and medical imaging. Ubiquitous and high quality and multi-dimensional sensory data from multiple sensors of various scales allow the applications not only to visualize but also to analyze and understand the physical world. Understanding sensory information involves extracting or verifying meaningful information from raw sensory data. Examples include shape features, identities, patterns, emotions, expressions, movements, behaviors and relationships. Such sensory intelligence has the potential to revolutionize a wide range of applications such as medical diagnosis, security screening, electronic surveillance, scientific discovery, law enforcement, forensics, intelligent virtual environment, etc.

The specific research projects (current and past since 2007) of Imaging and Visualization group are:

**3D Facial Image Analysis for FAS Diagnosis** *(Shiaofen Fang, Li Shen)*

This is a collaboration with Tatiana Foroud from IU School of Medicine and Rick Ward from Anthropology. The project seeks to collect a longitudinal, multi-ethnic sample of individuals prenatally exposed to alcohol. This sample will allow for a reliable separation of the effects of ethnic variation and developmental age from those due to alcohol exposure. The focus is on enhancing the understanding of FASD dysmorphology through 3D image analysis. Fetal Alcohol Syndrome Disorder (FASD) is a neurological abnormality caused by exposure to alcohol during pregnancy. Children with FAS disorder often exhibit characteristic facial features that can be used in FAS diagnosis. As the Imaging Core of the NIH funded International Consortium for FASD (CIFASD), novel 3D surface analysis techniques were developed, using laser scanned facial images, for effective early FAS diagnosis and the discovery of new FAS features and their biological relationships. Geometric and visual feature detection methods were used to identify potential facial features which were then analyzed by pattern recognition and machine learning techniques. This research has led to significant success in FAS diagnosis. *(Funding: NIH-NIAAA)*.

**Mouse Model Neuro-Facial Dysmorphology** *(Shiaofen Fang)*:

This is a collaboration with Feng Zhou and Yun Liang from IU School of Medicine. This project aims to define a mouse model for facial and brain phenotypes as a function of the dose and stage of embryonic development of the alcohol exposure. New applications of 3D Micro-video-imaging and Micro-computed tomography (Micro-CT) imaging of facial and underlying bone/cartilage allow, for the first time, high resolution analysis of surface-to-bone/cartilage craniofacial dysmorphology from fetal ages to young adulthood. 3D surface reconstruction
techniques from volumetric images were developed to generate surface features for pattern recognition and analysis. (Funding: NIH-NIAAA).

**Health Care Data Visualization (Shiaofen Fang):**

This is a collaboration with Shuan Grannis (Regenstrief Institute), Mathew Palakal (Informatics) and Yuni Xia (CS). The objective of this project is to investigate better visualization approaches to improve the usability of emerging large scale clinical data sets by developing a prototype open-source visualization framework that are adaptive to any application use cases and datasets. The approach includes (1) constructing an information-rich concept space as a uniform visualization platform by developing a set of data and text mining toolkits to extract concept terms and their relationships; (2) developing a suite of visualization tools that are automatically applied based on the user selected visualization objectives in the concept space; and (3) building a configurable visualization interface for the different use case needs. The visualization framework will be tested on a large scale healthcare database that is currently available at Regenstrief Institute. (Funding: DoD - US Army).

**Modeling the structure and dynamics of neuronal circuits in the Drosophila larvae using image analytics (Gavriil Tsechpenakis)**

The ability to adjust dynamically to attain stability in the face of widely ranging internal changes and external insults is a feature observed commonly in natural systems. The human brain, for example, has an amazing capacity to functionally recover from strokes that caused damages to local neuronal circuitries. Despite their scientific and social values, little is known about the principles of such highly adaptive systems. However, recent advances in imaging and computational technologies are practically ripe for visualizing and processing the small insect brain in its entirety, down to the level of individual synaptic connectivity.

The objective of this project is the image-based computational modeling of how synaptic connectivity is established in vivo during brain development, a major question in neuroscience today. This project estimates and patterns the complete morphology, connectivity properties and structure dynamics of single neurons and neuronal circuits in the Drosophila larvae. It is anticipated that this work will set the principle for large-scale study of more complex brains at single-cell resolution, and for modeling adaptive responses of neuronal circuits to changes such as aging, disease and injury. This work is sponsored by NSF CAREER and ABI Innovation grants.

**A Novel Retinal Imaging Approach to Diagnose Glaucoma (Gavriil Tsechpenakis)**

Glaucoma, a leading cause of blindness worldwide, can be detected using retinal thicknesses from spectral-domain optical coherence tomography (SD-OCT) scans of the macula. This research calculates the desired thickness maps as the distance between the inner-limiting membrane (ILM) and retinal pigmented epithelium (RPE) of the retina. Then, thickness map and symmetry are calculated, using image-based criteria, rectangular grid (average thickness within
each bin), and arcuate grid, considering the anatomy and orientation patterns of the nerve fibers.

This work is sponsored by the Indiana University Collaborative Research Grant initiative.

**Prediction and simulation of angiogenesis using growth factor delivering scaffolds**  
(Gavriil Tsechpenakis)

The development of organized vascular networks necessitates a tightly regulated interplay between variable cells, growth factors and soluble mediators. The long-term goal of this project is to develop therapeutic angiogenic strategies based on the rational design of cytokine releasing constructs that promote vascular patterning and vessel stability. The objective of this work is to (i) develop electrospun, three-dimensional constructs with patterned architecture, (ii) demonstrate that the spatial and temporal delivery of two model angiogenic growth factors promotes the formation of an organized capillary network and (iii) develop a computational model that can predict the biological effect of a growth factor releasing construct as a function of specified fabrication parameters. It is hypothesized that guided therapeutic angiogenesis (i.e. patterned vascular networks) can be obtained by controlling the spatial and temporal presentation of soluble mediators at the site of ischemia.

This work was sponsored by a NIH R21 grant subcontract from the University of Miami.

**In situ Protein-protein interaction networks**  
(Gavriil Tsechpenakis)

This is a collaborative project that redefines the proteomics as a context-rich molecular bioinformatics. Proteomics has been hailed as ‘the next big thing’ after genomics. It has progressed from cataloging the whole complement of proteins, or proteome, to charting their interactions, or interactome. Yet the major predicament in proteomics today is its paucity of in situ contexts. The cross-disciplinary team (University of Miami and IUPUI) launched an imaging-based survey of protein-protein interaction networks within neurons. Its ultimate goal is reconstruction of genome-wide protein-protein interaction networks within each and every subcellular compartment of neurons at progressive steps of their development. This project is the first systematic inspection of when and where each protein-protein interaction takes place in vivo. The investigators bring their expertise in neuronal imaging, Drosophila genetics, and computational analysis.

Over one million 3D images of model neurons were analyzed to construct proteomic maps specific for different neuronal types, developmental stages and subcellular compartments. This image library underwent cross-correlation analysis to arrive at a model of the dynamics of the molecular networks of wild type neurons. At its completion, the project not only delivered the first context-rich proteomics resource, but also offered a new intellectual infrastructure for determining the molecular circuitries affected by neurological disorders, aging or drug addiction and designing strategies to repair and/or protect neurons.

This work was sponsored by a NIH RC2 grant subcontract from the University of Miami.
**Forensic Identification using Bitemarks** (Mihran Tuceryan in collaboration with Herbert Blitzer of the Indiana Forensic Institute in Indianapolis)

Forensic odontology generally addresses the problem of identifying individuals based on the properties of teeth or identifying individuals based on bite mark impressions left behind in crime scenes. This project explores methods of matching 2D bite mark images to 3D models (made from dental casts) of suspects. The specific goal of the project is to develop a population model of the *probability of match* using a collection of such dental casts.

This project was funded by the National Institute of Justice (NIJ).

**Advanced In-car Video System** (Mihran Tuceryan, Jiang Yu Zheng, in collaboration with Herbert Blitzer of the Indiana Forensic Institute in Indianapolis)

This work aims at real-time in-car video analysis to detect several critical events during a routine traffic stop in order to alarm and assist police action. Particularly, detecting a tracked or stopped vehicle is a crucial task for further examination of suspects, protecting police safety, and remote monitoring from police station. Some examples of critical events are person running out of the stopped car, package thrown out of the car during pursuit, door of stopped car opens, and officer down.

This work employs a comprehensive approach to localize target vehicles in the video under various environments and illumination conditions. The extracted geometry features on the moving objects and background are dynamically projected onto a 1D profile and are constantly tracked. Temporal information of features was relied upon for vehicle identification, which compensates for the complexity of vehicle shapes, colors and types. The project investigated videos of day and night, and different types of roads, proving that the employed approach is robust and effective.

This project was funded by the National Institute of Justice (NIJ).

**A Device to Digitize and Produce 3D Images of Impression Evidence** (Mihran Tuceryan, Jiang Yu Zheng)

In crime scene investigations it is necessary to capture images of impression evidence such as tire track or shoe impressions. Currently, such evidence is captured by taking two-dimensional (2D) color photographs or making a physical cast of the impression in order to capture the three-dimensional (3D) structure of the information. In the case of tire track impressions that have long spans, the current practice is to take multiple overlapping photographs and stitch them together. The 2D photographs, under the right illumination conditions, may highlight feature details in the evidence, but do not provide metric depth measurement information for such features. Obtaining a 3D physical cast of the impression may destroy the evidence in the process. Therefore, the use of a 3D imaging device which can capture the fine details of such impression evidence without destroying the evidence can be a useful addition to the toolkit of the crime scene investigators (CSI).
This project designed such an impression imaging device and built a prototype hardware and software which included a calibration method for obtaining the 3D image with the proper metric information. The device can provide a depth resolution of around 0.5mm at the shortest zoom setting and even higher resolution at longer zoom settings as well as a high resolution color image properly registered with the depth image. It can digitize impression evidence which have long spatial spans such as long tire track impressions which would be difficult to fit into a single photographic shot. The device is portable, light-weight, and can be used outdoors. Even though the main goal for the device is for use in forensic evidence collection, it can be used in other application domains as well such as archeology, etc.

This project was funded by the National Institute of Justice (NIJ).

**Sensor Network over 2D Communication LAN Sheet** (Jiang Yu Zheng)

This is a cooperative project with National Institute of Information and Communication Technologies in Japan. This project has designed and developed a media infrastructure that can distribute multimedia signals and power via a two dimensional communication sheet. Small and low power devices placed on top of the sheet will be able to receive audio and video signals transmitted from a computer. The 2D sheet is printed in three layers and the electromagnetic waves are distributed in the middle layer. Through a grid of slits printed on the top layer, the electromagnetic waves leak and are thus picked up by small multimedia devices with antennas. Compared to the wired and wireless communication, this 2D sheet has its unique properties such as free to put and move devices on it, power efficient, wide transmission bandwidth, secure communication, etc.

This project was funded by National Institute of Information and Communication Technologies (NICT) in Japan.

**Scenario Generation for Vehicle Testing** (Jiang Yu Zheng)

This is a cooperative project with Yaobin Chen, Stanley Chien, and Lauren Christopher in the Transportation Active Safety Institute in IUPUI. Extensive research interest from both vehicle manufacturers and road safety practitioners has been focused on protecting vulnerable road users such as pedestrians, bicyclists, and wheelchairs. Pre-collision systems (PCS), with vulnerable road user detection capability are becoming a standard feature of active safety systems in the market. Understanding the road user (pedestrians, bicyclists) behavior is important to the pre-collision system design and testing. Large scale naturalistic driving data analysis can provide valuable and objective information on how road users behave in real life. Analyzing road user behavior within large scale naturalistic driving data requires efficient detection methods. In this work, monocular based bicyclist detection in naturalistic driving video is a very challenging problem due to the high variance of the bicyclist appearance and complex background of naturalistic driving environment. In this paper, a two-stage multi-modal bicyclist detection scheme was proposed to efficiently detect bicyclists with varied poses for further behavior analysis. A new motion based region of interest (ROI) detection is first applied to the entire video to refine the region for sliding-window detection. Then an efficient integral feature based detector is applied to quickly filter out the negative windows. Finally, the remaining
candidate windows are encoded and tested by three pre-learned pose-specific detectors. The experimental results on the TASI 110 car naturalistic driving dataset show the effectiveness and efficiency of the proposed method.

This project was funded by Toyota.

**Video Profiling and Indexing in Large Video Websites** (Jiang Yu Zheng)

Massive amounts of videos are uploaded onto video websites; with these videos smooth and efficient video browsing, editing, retrieval, and summarization are needed. Most of the videos employ several types of camera operations for expanding field of view, emphasizing events, and expressing cinematic effects. To digest heterogeneous videos in video websites and databases, video clips are profiled to 2D image scrolls containing both spatial and temporal information for video preview. The video profile is visually continuous, compact, scalable, and indexed to each frame.

This work analyzes the camera kinematics including zoom, translation, and rotation, and it categorizes camera actions as their combinations. An automatic video summarization framework is proposed and developed. After conventional video clip segmentation and video segmentation for smooth camera operations, the global flow field under all camera actions has been investigated for profiling various types of video. A new algorithm has been designed to extract the major flow direction and convergence factor using condensed images. Then this work proposes a uniform scheme to segment video clips and sections, sample video volume across the major flow, compute flow convergence factor, in order to obtain an intrinsic scene space less influenced by the camera ego-motion. The motion blur technique has also been used to render dynamic targets in the profile. The resulting profile of video can be displayed in a video track to guide the access to video frames, help video editing, and facilitate the applications such as surveillance, visual archiving of environment, video retrieval, and online video preview.

**SPHARM Shape Modeling and Analysis Toolkit for Brain Imaging** (Li Shen, Shiaofen Fang)

Shape analysis is becoming of increasing interest to the neuroimaging community because of its potential to provide important information beyond simple volume measurements and to understand morphometric changes in neuroanatomical structures related to specific brain disorders. The purpose of this project is to develop and release SPHARM-MAT, a 3D shape modeling and analysis toolkit for neuroanatomical studies. SPHARM-MAT is a synergistic effort in relation to existing tools, and is a powerful toolkit with several new features that add value, including ease of use, broad applicability, good interoperability, and wide dissemination. SPHARM-MAT is now available at http://www.nitrc.org/projects/spharm-mat, and has been applied to several biomedical imaging applications.

This project was funded by National Institute of Health (NIH-NIBIB)
Data Mining Framework for Genome-Wide Mapping of Multi-Modal Phenotypic Biomarkers and Outcome Prediction (Li Shen, Shiaofen Fang)

Today's massive generation of digital data is greatly outpacing the development of computational methods and tools and presents critical challenges for achieving the full transformative potential of these data. This project employs the new capabilities of large-scale data mining techniques in multi-view learning, multi-task learning, and robust classification to address critical challenges in systematically analyzing massive multi-modal genetic, imaging, and other biomarker data. Several sparse regression and classification methods have been developed, and applied to the integrative analysis of imaging, biomarker and genetics data in the study of Alzheimer's disease.

This project was funded by the National Science Foundation (NSF-IIS).

Networking and Security Group

Faculty: Arjan Durresi, Yao Liang, Xukai Zou, Erman Ayday (to join in January 2015)

Collaborative Units: Purdue University (Elisa Bertino), Washington University in St. Louis (Raj Jain), Fukuoka Institute of Technology Japan (Leonard Barolli), University of Central Arkansas (Vamsi Paruchuri), QualComm (Eliza. Y. Du), School of Engineering and Technology, IUPUI (Feng Li), School of Informatics, IUPUI (Jake Chen), Medical School, IU (Zeynep Salih), National Weather Service (NWS), NOAA (Thomas E. Adams, Pedro Restrepo), USGS (Jerad Bales), CUAHSI, (Richard Hooper), NASA (Steve Kempler, William Teng), Univ. of Pittsburgh (Xu Liang).

Networking and security is a central fundamental part in today’s cyber technology. This research includes Internet architecture, cyber infrastructure for sciences and engineering, wireless sensor networks (WSNs) and Internet of Things, ad hoc mobile networks, Software Defined Networking, networking and communication security, and various security and privacy issues in real applications such as health care and personal genomics and electronic voting. Research work and projects range from sensor network and data management, QoS over Software Defined Networking, Internet mobility, sensor data compression, energy efficient WSN protocols and deployments, WSN tomography, in-network processing, to trusted collaborative computing, trusted social networking, biometrics and user authentication, secure online electronic voting, genomic data security and privacy, and secure moving cloud and mobile computing security.

Economically Viable Support for Network Mobility (Arjan Durresi)

Mobility is one of the top requirements for the future Internet. Recent studies predict that mobile data traffic will continue to increase. Such technological changes are accompanied by new types of interactions, including various forms of social networking applications, such as Facebook and Twitter, which indicate the trend of more direct interactions among users. On the other hand service delivery is being consolidated and empowered by various cloud computing platforms and many such new applications need mobility support. This project proposes to develop a Mobility Support Service (MSS) that will manage the mobility for its customers. MSS will be offered by service providers dedicated to mobility, called Mobility Service Provider...
(MSP). MSP role could be played by existing network or content service providers too. MSS will be offered as a value-added service to users who are willing to pay for it. Therefore, mobility support will generate its own revenue and will justify the business and investments of MSPs. MSS does not require any change on access networks, existing network infrastructure, legacy applications, and operating systems. MSS is a distributed service over the Internet, in various implementation architectures, such as on premise, on cloud or hybrid at various degrees between on premise and cloud.

Trust Management Framework for Social Networks (Arjan Durresi)

Social networking is one of the major developments of recent times. Very successful examples of social networking include Facebook, Twitter, etc. Many other systems have components of social networks, for example eBay, Amazon, and Epinions are based on user reviews. Humans have built tools during history to enhance their capabilities. Computers are the signature tools of the current time, and social networks enhance an individual's social capabilities. All social interactions are based on trust. Therefore, social networking will rely heavily on trust. Conceptually, trust is also attributable to relationships within and between social groups (families, friends, communities, organizations, companies, nations, etc.) It is then necessary to develop tools that project trust capability to social networks. Furthermore, similar to real life, such trust enhancement tools can enable security and trustworthy decisions in social networks. In addition, this trust framework can be integrated in various social network analysis tools, by increasing their trustworthiness. Finally, real life social networks are extremely large, therefore it is necessary to use scalable graph based techniques in order to make trust solutions applicable to real world social networks.

The approach in this project is based on the similarities between human trust operations and physical measurements. They both are evaluations of some values, enhanced by repetition of the evaluation. Furthermore, the uncertainty in measurement is similar to human confidence when people make trust judgments. In addition, trusts are aggregated it becomes necessary to take into account the corresponding confidence, similar to the theory of error propagation, in which single step errors in a chain of measurements are aggregated. Therefore, this project is working toward a general trust management framework including trust metrics and management methods to aggregate trust, which are based on measurement theory and guided by psychology and common sense. Furthermore, it explores the development of security mechanisms, based on the proposed trust framework, against Denial of Service and cliques in social networks.

Video Over Software Defined Networking (Arjan Durresi)

Software-Defined Networking (SDN) is a new approach in designing and developing computer networks. SDN, using similar concepts as seen in server virtualization, allows computer networks to support the rapid changing business needs. The key concepts in SDN are abstraction (i.e., network as a graph), network virtualization, automation and orchestration of network services. These key concepts allow network services to be rapidly developed and deployed. The control and data planes in SDN architecture are separated; the network
intelligence and state is relocated in a centralized SDN controller. The network applications (e.g., traffic engineering, network virtualization and path resiliency) are abstracted from the network and relocated in the centralized controller. The SDN controller views the network infrastructure (i.e., switches, routers, links and middle-boxes) as a graph; this is the core of SDN architecture. The SDN architecture exposes the network infrastructure switch’s flow-tables with an open programmable interface (e.g., OpenFlow or ForCES) which is used to program the network. Video over Software Defined Networking (VSDN) architecture was developed to address rigidity of the path selection process of today’s network architectures. VSDN provides end-to-end QoS guarantees for video applications or other real-time applications. VSDN uses the network global view to select the optimum path for video applications in terms of bandwidth, delay and jitter. VSDN utilizes SDN architecture and OpenFlow protocol to separate the control and data planes. The VSDN controller contains the routing logic and path selection application. The core component of VSDN architecture is the routing module (RM) which performs the path computation.

**Open Application Delivery Networking Architecture (Arjan Durresi)**

Social networking, personalized searches, recommendation based online shopping, online banking, and other similar personalized services form the bulk of the traffic over the Internet today. Cloud computing provides unique opportunities for these Application Service Providers (ASPs) to manage and optimize their distributed computing resources. For this trend to be successful, similar facilities need to be developed for on-demand optimization of connectivity resources to enhance user experience. The usual solution of content distribution networks (e.g., Akamai) is not always feasible due to the sensitivity of the personalized data and also because such data is mostly dynamic and hence static caching is not feasible. Many big ASPs, such as Google and Microsoft, have solved this problem by having their own WAN optimized and customized for delivery of their applications. This project works to develop an open application delivery network architecture (OpenADN) which allows any ASP to be able to optimize their user experience using a shared public WAN infrastructure in a multi-cloud environment, that is, multiple cloud computing facilities belonging to multiple cloud providers and private data centers. Application delivery is different from content delivery in that it allows ASPs to deploy customized dynamic virtual network topologies and achieve replication, load balancing, server mobility, fault tolerance, and end-to-end security. OpenADN extends software defined networking (SDN) which provides new opportunities for designing control architectures for networks by providing cleaner abstractions between the network control and data planes. These extensions include several innovative techniques including control plane programmability using rule-based delegation, cross-layer communication, context routing, control/data plane separation, id/locator split, and application level flow-based routing to provide these services to ASPs. Control plane programming using a Rule-based delegation allows an ASP to customize and optimize network handling of their application traffic. These delegation rules may include rules for how to select the instances among multiple replicas of the server, how to load-balance among different instances, what to do under network and instance failure (due to security attack or hardware malfunction), forward application traffic over off-path middleboxes, etc. The internet service providers (ISPs) or cloud service providers (CSPs) can then translate these rules into
forwarding rules for the data plane, using data-plane programmability as an extension of OpenFlow.

Secure Communications among Cell Phones and Sensors for Medical Applications (Arjan Durresi)

Various healthcare areas such as diagnosis, surgery, intensive care and treatment, and patient monitoring in general, would greatly benefit from light, autonomous devices which can be unobtrusively mounted on the patient’s body in order to monitor and report health relevant variables to an interconnection device in the vicinity. This interconnection device should be able to connect to access points at different locations within the healthcare institution. Examples of health sensors include: ECG (Electrocardiogram) for monitoring heart activities, EMG (Electromyogram) for monitoring muscle activity, EEG (Electroencephalogram) for monitoring brain electrical activity, SO2 sensors for measuring of oxygen level in the bloodstream, Blood pressure monitoring sensor, Tilt sensor for monitoring trunk position, Breathing sensor for monitoring respiration, Motion sensors for recording user’s status and level of activity. This project uses sensor and other wireless devices in health care, teaching, evaluation and research areas in resuscitation of the newborn in the neonatal intensive care unit and also is investigating a new, secure and hybrid communication architecture among cell phones and sensor networks to be used in medical applications. It is believed that cell phones could be used to communicate aggregated sensed data to users in real time. The ubiquity of cell phones makes them the ideal candidate to be used as user interface to sensor data. The features and available resources of cell phones have been increasing at a staggering pace. Sensor limitations make symmetric cryptography based schemes, such as key predistribution suitable for sensor networks. However, in general, such schemes provide weak authentication and non-repudiation. Stronger authentication with key predistribution can be achieved by using pairwise keys. The use of cell phones as communicating devices with sensor networks has two major advances from the secure view: (1) cell phones have the necessary resources to perform asymmetric key cryptography, and (2) the cellular infrastructure can be used to obtain the required pairwise keys to perform secure authentication.

Using Lessons from the Disaster in Japan to Develop Communications for Emergency Situations (Arjan Durresi)

The goal of this project is twofold: First, it studied cell phone based communications in the last disaster in Japan and extract meaningful patterns. Second, such patterns and inputs from the field were used to further develop and better tune a broadcast protocol that self-adapts to satisfy the communication needs in highly dynamic and unpredictable disaster situations. When disasters occur, the telecommunication infrastructures are usually disrupted. Consequently, the lack of communications among authorities, first responders and population causes tragic results, including massive loss of human lives in US, in Japan and all over the world. The key characteristic of disaster situations is their unpredictability. Therefore, the premise of this work is that the technologies for communications should always be ready. Consequently, following another recommendation to “take advantage of opportunities for adoption of existing
technology,” the project studied the use of ad hoc wireless communications among cell phones in disaster situations.

**Data Compression in Wireless Sensor Networks (Yao Liang)**

Wireless sensor networks (WSNs) are being increasingly deployed for enabling continuous monitoring and sensing of physical variables of the world. Energy efficiency is of paramount importance in the design and deployment of wireless sensor networks, as WSN nodes are typically battery-powered, and in many real physical environments the replacement of batteries for nodes is either difficult or virtually impossible. In general, radio transmissions and receptions are most power consuming compared to the energy consumption of node microcontroller and memory in WSNs. Data compression is a useful technique in the deployments of resource-constrained WSNs for energy conservation. This project has worked on developing both compression algorithm and compression framework for WSNs and has resulted in the development of a new lossless data compression algorithm in WSNs, called Sequential Lossless Entropy Compression (S-LEC). Compared to existing WSN data compression algorithms, the proposed algorithm is not only efficient but also highly robust for diverse WSN data sets with very different characteristics. This project has developed a sophisticated framework of temporal compression, called Two-Modal Transmission (TMT), and its extension as a unified algorithmic framework for both lossless and lossy data compression. This research has also resulted in the development of a novel approach for exploiting spatial correlation in WSNs based Markov Random Field (MRF) to infer missing observations, which simultaneously facilitates energy-efficient and robust data collections.

**Topology Tomography in Sensor Networks (Yao Liang)**

Sensor network topology tomography is essential for routing improvement, topology control, anomaly detection and load balance. Previous studies on WSN topology tomography are restricted to either static routing tree estimation or heuristic approaches, which is inadequate in real-world WSNs due to dramatic wireless channel dynamics. This project studied general WSN routing topology tomography from indirect measurements observed at the sink, where routing structure is highly dynamic. The problem was formulated as a novel compressed sensing (CS) problem, and then a suite of efficient decoding algorithms to effectively recover WSN routing topology was devised using the indirect measurement at the sink for both reliable and lossy WSNs. The project analyzed the complexity of the devised algorithms and validated the approach and algorithms with a real-world outdoor WSN system using CTP for environmental data collection as well as extensive simulations. One of unique strengths of this work is that the approach and algorithms are able to reconstruct loops in per-packet paths, which would be very helpful for WSN diagnosis and performance analysis of routing protocols.

**Studies on WSN Deployment, Operations, and Network/Data Management (Yao Liang)**

In collaboration with the University of Pittsburgh, this project deployed and experimented on a real-world environmental WSN testbed for years to thoroughly study important practical issues in WSN operations, including sensors’ energy characteristics in depth, and WSN network data and management. Through this research, a novel integrated network and data management
system for heterogeneous WSNs was developed. Network management of WSNs is one of the key practical challenges that arise from the increasing number of applications and technologies deployed. WSN management becomes increasingly important to monitor and ensure that deployed motes operate correctly and healthily along time. The severe resource constraints of WSNs have introduced and involved different hardware and software technologies of sensor networking, being designed for very specific purposes. As a result, users with complex applications are directly facing the complexity of interacting with diverse technologies from different manufacturers and specific requirements. This work presents a web-based integrated network and data management system that is aimed at: (1) systematically supporting heterogeneous WSNs with a unified management system; (2) presenting a clear separation between WSN management and application functions; and (3) offering management functionalities with a clear user interface. This work has developed and deployed a heterogeneous WSN management system in a real-world WSN testbed for environmental monitoring.

**Open Data Open Modeling Cyberinfrastructure for Geosciences Communities (Yao Liang)**

To improve understanding of the complex behaviors of the various processes (e.g., physical, hydrological) and their interactions involved in the Earth System, as well as the accuracy and reliability of model predictions of weather, floods, droughts, and climate variability, researchers need to be able to make good use of the available data across disciplines to improve their theories, algorithms, models, and validations. However, a large amount of such valuable data often goes unused, due to the significant overhead of time and effort needed to discover, access, understand, and prepare the data. Similarly, there are many models available (e.g., hydrological/land surface models, routing models), but the complexity of these models necessitates a long lead time, even for a domain scientist, to learn how to use the models. Complexities related to individual models, different data requirements of models, and the myriad data formats, coordinate systems, and resolutions cause huge difficulties for both research and user communities. This combination of the variety and complexity of models and the usability of existing diverse data presents one of the most critical challenges in Earth Science. Hence, the development of an open data and open modeling framework, which can integrate data and models easily and incrementally for knowledge discovery and management, is fundamentally important and urgent, not only to the research community and operational professionals, but also to policy makers and other users. The ultimate goal of this collaborated project is to build an open data open modeling cyberinfrastructure, which should significantly reduce the time and effort on the part of users in the preparatory work for data and model comparisons, model testing and validations, and fundamental knowledge discoveries. In such a framework, components/modules interact via user-configured open interfaces, so that various scientific models and data sources can be easily added and composed to interoperate on an open architecture of cyberinfrastructure, through scientific workflows. The developed prototype, called as OHMF (Open Hydrospheric Modeling Framework), has now integrated four data agents into the framework prototype, which already covers a broad range of data sources and data access protocols: NASA (OPeNDAP-GDS), USGS (REST Web services), CUAHSI HIS (SOAP Web services), and CUAHSI WaterOneFlow (SOAP Web services). Data are brought in via both gridded (netCDF) and point time series (WaterML) services, using two major cataloging services
(NASA GES DISC and CUAHSI). With the help of this OHMF framework, new data agents can be efficiently developed. This project also developed two model agents for VIC model and a simple routing model. Any scientific models integrated into the framework can then directly access those data sources online in an automatic manner, and easily couple with each other in the OHMF via workflow. The crux of this framework is that it allows scientists to write their own model agents. Benefits of getting their models into the framework significantly outweigh the costs of writing their own model agents.

**Improving Hydrologic Disaster Forecasting and Response for Transportation by Assimilating and Fusing NASA and Other Data Sets (Yao Liang)**

In this project, the work involves collaboration with researchers in environmental engineering at the University of Pittsburgh and NASA Data Center on improving PennDOT’s hydrologic disaster forecasting and response, by using an innovative spatial data fusion and assimilation framework, and NASA’s satellite data on soil moisture and snow, as well as other data from WSNs. The main project goal is to develop a hydrologic disaster forecast and response (HDFR) system, which will forecast severe weather conditions at the road level and thus improve PennDOT’s decision making capability from its current reactive nature to a more proactive nature. The approach is through innovative assimilation and fusing of NASA data, radar data, RWIS road weather data, and other available data to form adequate and coherent multiscale information for having useful and reliable hydrologic forecasts at the multiple spatial scales. The development of HDFR system is on-going.

**Enhancing NOAA Advanced Weather Interactive Processing System (AWIPS) DSS by Infusing NASA Research Results for Drought and Other Disaster Management (Yao Liang)**

In this project, the IUPUI PI collaborated with hydrologists at the University of Pittsburgh and NOAA National Weather Service, as well as researchers at NASA Goddard Earth Sciences Data Center, to innovatively infuses NASA’s newly available remote sensing data and models into National Weather Service’s core operation to enhance its decision making and weather forecasting performance for flooding and drought disaster management. The developed system has been successfully deployed and tested offline at the Ohio River Forecast Center (ORFC). In this project, a labeled-tree data integration mode, referred to as DataNode tree, was developed and based on which a data integration framework HIDE was developed. This systematic investigation of the statistical behaviors of the spatial similarities and dissimilarities between NEXRAD (Next Generation Radar) and NLDAS (North American Land Data Assimilation Systems) precipitation data is the first of its kind, which provides significant insights into these two widely used data products in various hydrological and climatic studies.

**The Internet based Electronic Voting enabling open and fair election (Xukai Zou)**

Voting is the pillar of modern democracies. However, examination of current voting systems (including E-voting techniques) shows a gap between casting secret ballots and tallying and verifying individual votes. This gap is caused by either disconnection between the vote-casting process and the vote-tallying process, or opaque transition (e.g. due to encryption) from vote-
casting to vote-tallying and thus, damages voter assurance, i.e. failing to answer the question: “Will your vote count?”. This work proposed a groundbreaking E-voting protocol that fills this gap and provides a fully transparent election. In this new voting system, this transition is seamless, viewable, and verifiable. As a result, the above question can be answered assuredly: “Yes, my vote counts!” The new technique is the first fully transparent E-voting protocol which fills the aforementioned gap. The trust is split equally among all tallying authorities who are of conflict-of-interest and will technologically restrain from each other. As a result, the new technique enables open and fair elections, even for minor or weak political parties. It is able to mitigate errors and risk and detect fraud and attacks including collusion, with convincingly high probability \(1 - 2^{-\left(m-\log(m)\right)n}\) (n: voters and m \(\geq 2\): candidates). It removes many existing requirements such as trusted central tallying authorities, tailored hardware or software, and complex cryptographic primitives. In summary, the new voting technique delivers voter assurance and can transform the present voting booth based voting and election practice. Besides voting and elections, the new technique can also be adapted to other applications such as student class evaluation, rating and reputation systems. The project will continue to investigate related issues such as vote-selling and voter-coercion and develop a practical online e-voting system and also adapt it to various university applications such as tenure and promotion voting and class evaluation.

**Revocable, Interoperable and User-Centric (Active) Authentication Across Cyberspace (Xukai Zou)**

User authentication is the first guard of any trustworthy computing system. This work addresses fundamental and challenging user authentication and universal identity issues and solves the problems of system usability, authentication data security, user privacy, irrevocability, interoperability, cross-matching attacks, and post-login authentication breaches associated with existing authentication systems. It developed a solid user-centric biometrics-based authentication model, called Bio-Capsule (BC), and implemented an (active) authentication system. BC is the template derived from the (secure) fusion of a user’s biometrics and that of a Reference Subject (RS). RS is simply a physical object such as a doll or an artificial one, such as an image. It is users’ BCs, rather than original biometric templates, that are utilized for user authentication and identification. The implemented (active) authentication system will facilitate and safely protect individuals’ diffused cyber activities, which is particularly important nowadays, when people are immersed in cyberspace. Biometrics is becoming a promising authentication/identification method because it binds an individual with his identity, is resistant to losses, and does not need to memorize/carry. However, biometrics introduces its own challenges. One serious problem with biometrics is that biometric templates are hard to be replaced once compromised. In addition, biometrics may disclose user’s sensitive information (such as race, gender, even health condition), thus creating user privacy concerns. The proposed approach is the first elegant solution to effectively address irreplaceability, privacy-preserving, and interoperability of both login and after-login authentication. The proposed methodology preserves biometrics’ robustness and accuracy, without sacrificing system acceptability for the same user, and distinguishability between different users. Biometric features cannot be recovered from the user’s Biometric Capsule or Reference Subject, even when both are stolen. The proposed model can be applied at the signal, feature, or template
levels, and facilitates integration with new biometric identification methods to further enhance authentication performance. The project will continue to develop BC based active authentication and privacy-preserving BC computation using secure two party computation.

**NSF REU Site: Enhancing Undergraduate Experience in Mobile Computing Security (Shiaofen Fang, Mohammad Al Hasan (Hasan), and Xukai Zou)**

This REU Site project enrolls 10 undergraduate students each year in an intensive 10-week summer research program, to be hosted at Indiana University-Purdue University Indianapolis (IUPUI), on mobile computing security. The students will work closely with faculty mentors from the Mobile Computing Security Research laboratory (MCSR) and the Trusted Electronics and Cloud Obfuscation research and education center (TECO) at IUPUI. The goal of this program is to inspire underrepresented minorities and students from institutes with limited research opportunities to pursue advanced education and professional careers in Computer and Information Science and Engineering (CISE). To reach that goal, the program is designed to: (1) Familiarize the students with the latest developments in mobile and cloud computing technologies through hands-on projects; (2) Increase the students awareness of recent advancements in academic research in these areas by extensive literature review, presentation, and discussion; (3) Help the students make informed decisions on, and prepare for, advanced graduate studies and professional careers in CISE by working on research projects under one-on-one mentoring.

**MovingCloud: Create Moving-target Defense in Cloud by Learning from Botnets (Xukai Zou)**

The research objective of this project is to investigate recent botnets and design a moving-target defense framework to improve resiliency and harden existing static infrastructure in CLOUD systems. Two facts set the stage for the proposed research: 1) making the physically static cloud a Moving Target, by designing secure logic operation schemes, to increase the robustness and survivability of the networks; 2) Botnets, which are networks of computers that are compromised and controlled by an attacker, show some sophisticated developments in the recent years, greatly increased the agility and polymorphism of the botnets, and reduced the defenders ability to disrupt the operations in botnets. The project plans to learn from the attackers schemes, and create diverse, continually shifting, and changing over time CLOUD environment, to reduce the attackers understanding of the systems and their ability to launch attacks, while maintaining satisfactory CLOUD service performance. The resulting MovingCLOUD scheme will increase the complexity and costs for the attackers, limit the exposure of vulnerabilities and opportunities for attack, and increase CLOUD systems survivability.

**Building A Secure Video Streaming Framework for Dynamic and Anonymous Subscriber Groups (Xukai Zou)**

Secure video content distribution is a key aspect in the deployment of Telepresence Services and Video on Demand, two critical applications for the ecosystem targeted by Cisco products.
Efficient mechanisms and systems need to be developed to guarantee confidentiality and controlled access to a broad range of broadcast video streams. At the same time, an effective framework for secure video content distribution should also guarantee subscribers' privileges to access video streams matching their respective subscription and on-demand requirements. In this project a Secure Video Stream Framework for dynamic and anonymous subscriber groups will be built, by employing an innovative approach called Access Control Polynomial (ACP). The framework will effectively address the underlying challenges of secure video stream broadcasting and guaranteed access, anonymity, dynamicity, granularity, and scalability.

**Evaluation of Clinical and Genomic Information Privacy Risks from Inference Attacks (Xukai Zou)**

This project examines the quantitative relationships between clinical and genomic information disclosure and associated privacy risks due to inference attacks. For inference attacks, the inference of private personal identity and other personal information is referred to without the information owners’ explicit consent or knowledge. In translational medical studies, identifiable personal information is usually anonymized and protected using a set of high-level guidelines. However, there is no explicit guarantee that such anonymization is performed to the best interests of research participants, especially with the increasing demand for open access of biobanks by researchers worldwide and, in some cases, patients themselves who are allowed to gain access to their own research results. Nor does there exist a method that can help researchers and biobank stakeholders gauge the risks for inference attacks, if the anonymized clinical database is compromised due to security leaks.

**Education Research**

**Members:** Andy Harris, Michele Roberts, Lingma Acheson, Snehasis Mukhopadhyay, Judy Gersting, Xukai Zou, Shiaofen Fang, Mohammad Hasan  
**Collaborative Units:** Faculty members of the CS department and Kathy Marrs from the School of Science Dean’s office, Feng Li (CIT), Chris Lapish (Psychology), Giovanna Guidoboni (Math)

Along with full teaching loads, the service committee has supported the department mission with research pursuits in two main categories: Computer Science education and Serious Gaming. In CS Education, grants have allowed the department to significantly lower DWF rates in gateway courses, integrate new IEEE guidelines into existing curriculum, seed applied coursework with project-based learning, and utilize peer-based, team learning to bolster knowledge gains for undergraduates in live and online course sections. An ongoing partnership with Riley Hospital explores the impact of serious gaming to teach key skills for better managing childhood diabetes. These grants have both improved the quality of pedagogy the department offers its students, as well as extended the range of available research opportunities for undergraduate talent.

**AP CS Principles course (Michele Roberts)**

The AP Pilot grant was awarded based on a syllabus submission for the AP CS Principles course pilot. The submitted syllabus proposed balanced treatment of the so-called “Big Ideas” in
computer science and included innovative project work to support and document student inquiry. In addition, the described course infrastructure outlined the use of peer led team learning, included Honors credit opportunities and developed service learning opportunities through community outreach programs.

**Curriculum Development for CS Principles course** (Kathy Marrs, Snehasis Mukhopadhyay, Michele Roberts)

This internal grant was a Curriculum Grant awarded by the Center of Teaching and Learning. The grant provides support for detailed curriculum development to support the CS Principles course, including the assembly of resource materials, exploration of robots for use in the programming unit, and descriptions and assessment materials for course project work.

**Redesign and Curriculum Enhancement of CSCI N341** (Lingma Acheson)

The grant was awarded by the IUPUI Center of Teaching and Learning for the redesign of the course CSCI N431 “E-commerce with ASP.NET” to incorporate real-world, client-specified projects originating from corporate, not-for-profit, educational and service-oriented entities. The project involved a design stage from August 2013 till December 2013, and an implementation stage from January 2014 till May 2014. During the design stage, new course materials, documentations were developed; candidate projects were identified, and the teaching assistant was selected. At the implementation stage, projects were carried out smoothly and feedback was collected timely. At the end of the semester, a total of 6 real-world projects were completed, some of which will have significant positive impact to the community. This new approach also significant improved students business communication skills, team working ability, time management skills and presentation skills, which are vital in a working environment yet were missing in the old lecture-based learning style.

**REU Site: Enhancing Undergraduate Experience in Mobile Computing Security** (Xukai Zou, Shiaofen Fang, Mohammad Hasan, Feng Li—CIT)

This REU site project enrolls 10 undergraduate students each year in an intensive 10-week summer research program, hosted on the IUPUI campus, on mobile computing security. The students work closely with faculty mentors from the Mobile Computing Security Research laboratory (MCSR), the Trusted Electronics and Cloud Obfuscation research and education center (TECO), and Center for Visual Information Sensing and Computing (VISCI) at IUPUI. The goal of this program is to inspire underrepresented minorities and students from institutes with limited research opportunities to pursue advanced education and professional careers in Computer and Information Science and Engineering. Up until now, the Department has hosted this intensive summer camp for two years and the participating students have shown a very positive and encouraging response after attendance. Particularly, three papers from these students have been accepted as conference papers to be presented and published.

**Undergraduate Curriculum in Interdisciplinary Computational Science** (Snehasis Mukhopadhyay, /Chris Lapish, Giovanna Guidoboni)
Computers constitute one of the technological innovations that have had the most impact in all spheres of human activity and endeavor in the entire history. It is a common knowledge now, both in academia and popular media, that computation forms an integral part of all scientific disciplines (http://www.nytimes.com/2001/03/25/weekinreview/25JOHN.html). In this spirit, this project proposes to create a set of Interdisciplinary Computational Tracks for the B.S. degree.

Among other disciplines, science and engineering are probably the ones that went through the most major transformations with the advent of computers. The President’s Information Technology Advisory Committee (PITAC) in a 2005 report to the President of the United States, noted that “Together with theory and experimentation, computational science now constitutes the ‘third pillar’ of scientific inquiry” and goes on to say, “In industry, computational science provides a competitive edge by transforming business and engineering practices”. Computational biology, computational chemistry, computational physics, computational environmental science, computational neuroscience, etc., are being recognized as very promising inter-disciplinary research areas capable of leading to fundamental discoveries in science, medicine, and technology. Yet, while recognizing that computational science will be one of the major drivers of the global economy in the twenty first century, the President’s Information Technology Advisory Committee (PITAC) also noted in 2005 the need for new academic programs and institutional support to train the next generation of computational scientists (http://www.nitrd.gov/pitac). These scientists will not be mere users of computational tools, but will be leaders in employing computational and mathematical thinking to solve complex scientific and engineering problems that defy traditional non-computational solutions. On behalf of the iMMCS (Institute for Mathematical Modeling and Computational Science) institute, Dr. Mukhopadhyay made a formal proposal to the SOS Undergraduate Education Committee (UEC) to create a set of six so-called “Computational” tracks (Computational Biology, Computational Chemistry, Computational Earth Sciences, Computational Forensic Sciences, Computational Neuroscience, and Computational Physics) in the B.S. program. These tracks will have standardized course plans, while still allowing for some individualized customization. During the Fall 2013 semester, the School of Science Undergraduate Education Committee approved the creation of 6 such computational tracks in concept. The Computational Biology track has been approved by the Biology Department's undergraduate committee. The Physics Department is also supportive of a Computational Physics option.

Three salient features of these course plans are:

(i) **No new courses are included or proposed (except for 2-3 in the Computational Neuroscience track); these are almost all existing courses.**

(ii) **All plans have a substantial number of credit hours for free/advanced electives. By utilizing 9 of them for graduate/undergraduate dual-level coursework, it is possible for the students to complete an integrated B.S. and M.S. degree in Computer Science, in some cases Mathematics, or the other relevant Science Department(s) roughly in 5 years**, as is currently available to Computer Science students in the school.
It is believed that these programs will provide a quality education to students in modern sciences, which will make them **attractive to potential employers and prepare them well for advanced research careers in science.**

A presentation was made by Profs. Snehasis Mukhopadhyay (Computer Science), Chris Lapish (Psychology), and Giovanna Guidoboni (Mathematics) to the School of Science Chairs’ Council in Summer 2014, providing the rationale as well as a tentative structure and outline for 4 such tracks (Computational Biology, Computational Physics, Computational Chemistry, and Computational Neuroscience). The goal is to make interdisciplinary computational sciences a signature of the School of Science.

**Student Learning Objectives Across Applied CS Curriculum** (Michele Roberts)

The purpose of this internal grant was to update student learning objectives across the applied curriculum. As a result, twelve courses were updated to explicitly link to the university Principles of Undergraduate Learning and the 2008 release of the joint ACM/IEEE curricula committee standards.

**Improvement of DWF rates for CSCI N241** (Michele Roberts)

The purpose of this internal grant was to analyze and improve DWF and progression rates for N241: Fundamentals of Web Development, which functions as the gateway course for the applied computing curriculum. As a result of this effort, N241 DWF rates dropped by eight percent and retention (as measured by student movement to the next course in the series, N341: Client Side Programming), improved by six percent.

**Development and Implementation of Web-based Modules for a Diabetes education Program in the Pediatric Outpatient Setting** (Stancombe, K, Andrew Harris)

This grant investigates use of web and mobile games to motivate patient education among young people with type I Diabetes. This project is a joint effort with the Diabetes team at Riley Hospital for Children. The team created a number of iPad games designed to teach specific patient education skills including understanding glucose monitor readings (with a game similar to Angry Birds) to nutrition and ketone management, and an adventure game which explores difficult areas including depression, eating disorders, and bullying. The project has also created a tracking program to manage patient knowledge and to determine the efficacy of the project. Currently the project is halfway through completion, and the first three games are currently undergoing beta testing in the clinical setting.

In summary, the faculty members in the Department are actively pursuing various research directions and many of these are funded via external and competitive sources. This positive trend is expected to continue with the hiring of new and high-caliber faculty members.
Chapter 9  Service

The Department’s faculty members have continued to maintain a high level of service—at the School, University, professional and community levels. Some highlights of each faculty member’s service record are listed below; more details may be found in the faculty CVs in the Appendix.

Ms. Acheson’s service to IUPUI is focused on international collaboration, recruitment and advising, and support to various campus events. Upon joining the Department in 2007, Ms. Acheson immediately started her exploration and development in international collaborative programs with universities and high schools in China for the purpose of international student recruitment and joint research. Working with the Department, the School of Science Dean’s Office and the IUPUI Office of International Affairs, she visited many universities and high schools in China and established a 2+2 joint degree program with the Sun Yat-sen University, a 3+2 student transfer program with the Changzhou Institute of Technology, and a joint research program between the Department, the IUPUI Department of Tourism and Convention Management and Ball State University. She also coordinated multiple delegation visits from China and recruited many students to IUPUI. Ms. Acheson serves as the International Student Advisor in the Department and is also involved in domestic student recruitment and advising. She has been active in department, school and university events, such as CS Day, the Science Day, the Campus Day, and the International Festival. Ms. Acheson was the recipient of the 2009 IUPUI Irwin Experience Excellence Award.

Dr. Dundar has been privileged to serve on the Graduate Committee of the Department (2008-2012), the Technology (2008-2009), Academic Affairs (2009-2012), and Appeals Committees (2012-2013) of the School of Science. He served as a member of the Organization Committee for the ACM SIGKDD conference in 2009. He also served as a Program Committee member for the ACM SIGKDD in 2012, IEEE ICDM in 2012 and 2014, SIAM SDM in 2013 and 2014, and SPIE Medical Imaging/Digital Pathology in 2013. He served as a mail reviewer in 2009 and as a panelist in 2012 for the NIH. He also served as a panelist for the NSF IIS division in 2012 and 2013. As a passionate promoter of math and science education at the K-12 level, he has served since 2008 as a board member of the Indiana Math and Science Academy (IMSA) charter school, which has two locations in the Indianapolis area.

Dr. Durresi has been very active in organizing international conferences and workshops. He was the Chair of the 13th International Conference on Network Based Information Systems (NBIS 2010), 23rd IEEE Advanced Information and Networking Applications Conference (AINA 2009), and the International Conference on Availability, Reliability and Security (ARES 2009). He was the Program Chair of the 12th International Conference on Network Based Information Systems (NBIS 2009), held at IUPUI campus in Indianapolis and the program vice chair for Security and Trustworthy Computing of the 17th IEEE International Conference on Parallel and Distributed Systems (ICPADS 2011). He has founded and co-chaired in continuation the following workshops: International Workshop on Trustworthy Computing (TwC 2012-14),

Dr. Fang has served as a panelist for the National Science Foundation (NSF) many times, and has been a regular proposal reviewer for the National Institutes of Health (NIH) and other federal and foreign funding agencies. He regularly serves as a program committee member for international conferences such as VRST, CGI, and VRCAI. He was a regular co-chair of the Workshop on Bio-Computing, and a Keynote Speaker for the 2011 International Conference on Remote Sensing, Environment and Transportation Engineering. Prof. Fang has also served on numerous campus, university and school level committees such as the IU Strategic Initiatives (informatics Working Group), Department of Physics Review Team, Purdue System Distance Education Working Group, Search Committee for School of Science Associate Dean (Chair), and Search Committee for the School of Informatics Chair.

Dr. Hasan’s services include program committee member of multiple tier-one data mining and information systems conferences, such as the ACM SIGKDD, IEEE ICDM, ACM CIKM, SIAM SDM, and IEEE BigData, and reviewer of various data mining and knowledge discovery journals including the IEEE Trans TKDE, Springer DMKD, ACM Trans KDD, VLDB journal, and IEEE Trans TNNLS. He also frequently serves on the NSF grant review panel in divisions of the IIS, BigData, and SBIR/STTR programs. He is currently serving as the Publicity Chair of SIAM SDM 2015 Conference, the program chair of BigGraph Data 2015 Workshop, and an Award Committee member for the ACM SIGKDD dissertation award. He also serves as a member of the Graduate Committee of the Department, and the Library Committee of the School of Science. He is a member of IEEE, ACM, and ACM SIGKDD.

Dr. Hill has served on the department’s Technology Committee (2009~2011) and Undergraduate Committee (2013~present), as seminar co-coordinator (2009~2010), co-planner for CS Day @ IUPUI (2011~2013), and faculty advisor for Computer Science Club (2012~2014). Dr. Hill was appointed to the 2013~2014 Advisory Board for IUPUI’s Department of Continuing Education. Dr. Hill was invited to give keynote talks at CS Day @ IUPUI in 2011; Softec 2011 in Kuala Lumpur, Malaysia; and IU’s HBCU STEM Summer Scholars Institute Closing Luncheon. He has been invited to speak about his research with trustees, graduate students, undergraduate students, and the general public at Science on Tap. Dr. Hill has been very involved in professional organizations and related groups. He has co-organized workshops and student research competitions, been invited to be committee member and session chair for
conferences and workshops, chaired panel discussions, served on panel discussions, and reviewed for panel, journals, conferences, book chapters, and books.

Dr. Liang has been on the Editorial Board for International Journal of Distributed Sensor Networks, and The Open Cybernetics and Systems Journal. He has served on the program committees for major international conferences in networking and communications, including ICC, WCNC, LCN, HPCC, and PIMRC. He has served as a reviewer for many primary international journals (e.g., IEEE Journal on Selected Areas in Communications, IEEE Transactions on Vehicular Technology, IEEE Communications Letters, Ad Hoc & Sensor Wireless Networks, IEEE Transactions on Systems, Man, and Cybernetics (Part B), IET Communications, IET Signal Processing). He served as an NSF review panelist in 2010. At IUPUI, he has served on the Steering Committee (2010-2014), Appeals Committee (2007-2010), and Research Committee (2010-2011) of the School of Science; he has served on the Department's Graduate Committee (2008-2014), Undergraduate Committee (2007-2008), Faculty Search Committee, Primary Committee, and P&T Committee.

Dr. Mukhopadhyay served as the School of Science Faculty President-Elect, President, and then Past President for the academic years 2011-2012, 2012-2013, and 2013-2014, respectively. From 2011 to 2014, he was an appointed member of the IUPUI Undergraduate Curriculum Advisory Committee (UCAC). He was a member of the School of Science Promotion and Tenure (Unit) Committee in 2011-2012. He has been the Chair of the Computer and Information Science Department Promotion and Tenure (Primary Committee) since 2011. He has served on the Department's faculty recruitment committee in 2014. He has been a member of the School of Science Nominations and Awards Committee since 2011. He is a member of and was a past chair of the Computer and Information Science Department's undergraduate committee. He has been serving on the IUPUI Computing Curriculum Coordination Council (C4) since its inception in 2011. He has also been serving as an IUPUI Honors College Scholarship Interviewer since 2010. Dr. Mukhopadhyay has served as the Director of the IUPUI Signature Center on Biocomputing and is currently serving as a Co-Director of the School of Science Institute for Mathematical Modeling and Computational Science (iMMCS). Additionally, Dr. Mukhopadhyay served as an NSF panel member during the years 2009 and 2011. He has been a reviewer for NIH. He is an editorial board member of the ISSN Artificial Intelligence Journal and the Journal of Biomedical Science. He has reviewed papers for numerous journals and conferences including IEEE Transactions on Neural Networks, IEEE Transactions on Systems, Man, and Cybernetics, Artificial Intelligence in Medicine Journal, etc., and served on the program committees of several international conferences including IEEE Systems, Man, and Cybernetics Conference. He has been recruited to serve as a General Chair of the ACM International Conference on Information and Knowledge Management (ACM CIKM) in 2016. He has been a member of the IEEE Technical Committee on Intelligent Control (TCIC) since 1998, and has been recently recruited to serve in the IEEE Technical Committee on Soft Computing (TCSC).

Dr. Raje, in addition to serving as the Associate Chair of the Department, has been serving as the Graduate Program Director (and hence, the chair of the Graduate Committee of the
Department) since 2006. He has also served as a member and the chair of the Faculty Search Committee on multiple occasions since 2006. He was a member (2006-08 and 2010-2014) and the chair of the Primary Committee (2010-11) of the Department. Dr. Raje has also been a member of multiple search committees of the Department for different staff positions. Dr. Raje has been also a member (2010-14) and the Chair (2012-14) of the Unit Committee of the School of Science. The other School of Science Committees on which he has served are: Graduate Education Committee (2013-14), Ad-Hoc Committee for P & T Document (2012-13), Dean Search Committee (2007-08, 2010-11), Graduate Affairs Committee (2003-08), Associate Dean Search Committee (2008), Graduate Training Strategic Working Group (2007) and Faculty Grant Workshop (2006). Dr. Raje has also rendered his services at the campus (IUPUI) level by acting as a Top 100 Judge (2012-14) and a member of the campus Tenure and Promotion Committee (2010-11). Dr. Raje has been a regular panelist at the NSF and has acted as an external reviewer (in some cases as a Tenure and Promotions Reviewer) for many universities such as the University of Colorado at Denver, the University of Washington at Tacoma, the Cleveland State University and the University of UAE. In addition, he has served as an external PhD examiner for the following universities: the Deakin University, Australia (multiple times) and the Tezapur University, India. Dr. Raje also acts a reviewer for many esteemed journals (e.g., Journal of Parallel and Distributed Computing, Concurrency and Computation, and the ETRI journal) and conferences (e.g., IEEE EDOC, SEKE, and IEEE HPCC) on a routine basis. He has also served on numerous conference program committees since 2006 and acted as the Local Arrangements Chair (ACM SPLASH Conference, 2014), the Program Vice-Chair (IEEE HPCC 2008 and 2010), the Program Vice-Chair (IEEE ICPADS 2008) and a Track Chair (NBiS, 2009). He is currently a member of the Editorial Board for the following journals: CSI Transactions on ICT, Software Engineering: An International Journal, International Journal of Information Technology, Communications and Convergence and the International Journal of E-adoption.

Dr. Song has served on technical program committees for numerous premier international parallel computing conferences such as SC, IPDPS, CCGrid, and Euromicro conferences. He has also been a regular reviewer for top journals of JPDC, TPDS, ParCO, and Journal of Supercomputing. He organized the first International BigGraph workshop in conjunction with the IEEE Big Data 2014 conference. At IUPUI, Dr. Song has been a member of the School of Science Technology Committee since 2013.

Dr. Tuceryan has served on various Departmental committees (Primary Committee member and chair, faculty search committee chair, Undergraduate Committee chair, Advisory Council member), School of Science committees (Steering Committee member, secretary, president, and past president of the school’s faculty, unit committee member, and school’s Undergraduate Educational Policies committee member), and university level committee (Promotion and Tenure committee). He has also served on various professional and community service panels and committees (associate member of the Scientific Working Group on Imaging Technology, member of program committees as well as reviewer on a number of professional conferences of the ACM and IEEE, reviewer of grant proposals to
National Institute of Justice, the Research Grants Council of Hong Kong, and the Innovation and Technology Support Programme of Hong Kong).

Dr. Tsechpenakis has frequently served as a reviewer for the primary international journals and conferences of the Computer Vision, Machine Learning, and Biomedical Imaging/Engineering societies (e.g., IEEE Trans PAMI, IEEE TMI., IEEE TBME., Elsevier CVIU, IJCV, ICCV, CVPR, ECCV, MICCAI, ISBI). In 2010, he served as a reviewer on an NSF panel. Since 2011, his lab has been hosting internships for K-12 students (2-4 students every summer). He has served on the Undergraduate (2010--2011) and Graduate (2013-2014) committees of the Department, and on the Research (2011--2012), Diversity (2011--2012), and Library (2012--2013) Committees of the School of Science.

Dr. Xia has served on the program committee on many international conferences such as the International Conference on Collaborative Computing (CollaborateCom), the IEEE International Conference on Computer and Information Technology (CIT) and the IEEE International Conference on Computational Science and Engineering (CSE). She has also served as a reviewer for high impact journals in databases and data mining such as IEEE Transaction on Knowledge and Data Engineering (TKDE), IEEE Transactions on Parallel and Distributed Systems, ACM Transactions on Database System (TODS), ACM Transaction on Knowledge Discovery from Data, Journal of Knowledge and Information Systems, Journal of Data and Knowledge Engineering, etc. She served on NSF panels in 2007, 2009 and 2011. She has also served on the Graduate Committees of the Computer and Information Science Department, and on the Research Committee, Award Committee and Library Committee of the IUPUI School of Science.

Dr. Zheng has served as a reviewer for ACM TOMCCAP, IEEE MM, IEEE VCG, IJCV, VCIP, CVIU, IPSJ Trans. PVA, MVA, IEEE Trans. ITS, Sensor, IEICE, JMPE, IJHC, CAVW, Digital Content Technology and Application, and the International Journal on Wireless and Mobile Computing. He has served on the program committee for ICPR, ICME, ACM MM, CYBERWORLD, IROS, IEEE ICRA, ACCV, ACPR, VSMM, OMNIVISION and Digital Heritage. In addition, he has served on grant review panels for NSF, NPRP and the US-Israel Binational Science Foundation, and he has hosted several international researchers. He has served on the Department’s Undergraduate and Advisory committees and the IUPUI School of Science Library and Undergraduate Education Committees.

Dr. Zou has frequently served as a reviewer for the primary international journals and conferences related to cryptography and information and network security (e.g., IEEE Trans. TDSC, IEEE Trans. TIFS, IEEE Trans. TPDS, ACM Trans. TISSEC, and INFOCOM) and as an invited reviewer for Computing Review. He serves as an associate editor for several international journals (e.g., International Journal of Security and Networks, International Journal of Computer Applications). He also served as an NSF panelist in 2009 and 2011 and an NIH grant external reviewer in 2009. He has been in charge of the weekly Department research seminars (2008-2014), and has also served on the Teaching and Assessment (2007-2010) and Appeal (2013-2014) committees of the IUPUI School of Science.
As can be seen from the above descriptions, the Department's faculty members have been and continue to be extremely active in all areas of service, both within IUPUI and the broader academic field, including at the international level. Faculty members have served in various leadership capacities, including reviewer, panel member, organizer, mentor, conference host and chair, etc. These efforts will certainly continue and, in fact, strengthen as newer approaches will be identified to increase faculty service opportunities in the future.
Chapter 10  Challenges and Future Directions

Although the Department has made tremendous progress in all aspects of teaching, research and service since the last review in 2007, major challenges are still ahead that require timely and determined actions.

a) **Research Sustainability.** The success in recruiting high quality faculty members and the emphasis on grant proposal activities have led to a remarkable upward trend in faculty research productivity during the past a few years. Sustaining this level of research output, however, is a major challenge as grant funding becomes increasingly difficult and the need for recruiting and supporting more high quality Ph.D. students is growing. New and innovative research initiatives and greater and more balanced faculty research efforts will be needed to sustain long term research success and to improve per faculty research output.

b) **Teaching Scalability.** Increased enrollments in both undergraduate and graduate courses in recent years have led to a new challenge in the ability of the Department to deliver quality education to an increasingly larger student population, and to improve retention rates at all levels. Since Computer Science enrollments often depend on national trends and market forces, flexibility and scalability in course offering and delivery is a critical factor in maintaining the long term financial health of the Department. The faculty needs to be innovative in developing better teaching methods, improving curriculum structures, and providing a flexible and scalable mechanism in course offering and delivery.

c) **Outreach and Recruitment.** As a field with close industrial relevance, the Department has not made and sustained sufficient progress in building industrial connections, both in terms of research collaborations and student co-op and internship partnerships. There is also a need to make a greater effort in working with local high schools to create a Computer Science education community, which can also help in the recruitment of local high-caliber high school students.

A 5-year strategic planning exercise was conducted in 2007. In 2012, when the Department evaluated its performance against the goals of the first strategic plan, it was clear that the Department has exceeded all the goals set in 2007. In 2012, a new 5-year strategic plan with much higher goals and aspirations was created. While the Department has already made some progress in many of these goals, there is much work to be done. The following are the priority future directions that will be of focus in the next few years.

1. **Growth of Faculty Size.** While the Department has gained strength in data mining and visualization/imaging, it still lacks the critical mass in other areas, in particular, high performance computing and network security. The faculty has also expressed a strong need to recruit an active researcher specializing in the domain of Computer Science educational research. With these critical research needs and an increasingly larger student population, it is the aspiration of the Department to reach a size of about 25 full time faculty members (including lecturers) in the next few years. The faculty believes that the Department is on its way to becoming nationally competitive in innovations in both research and education.
Timely investment is critical in establishing the Department as a flagship unit of the IUPUI campus.

2. **Computer Science Education Research.** Computer Science education in U.S. high schools and at beginning college levels has not kept pace with national needs for computing professionals. Despite this perceived national urgency, there is very little investment in the Department on CS education research. As a strategic initiative, the Department would like to establish a research program in the area of Computer Science Education Research. In addition to recruiting a tenure-track faculty member in this field, existing education research activities within the Department as well as various STEM education initiatives on the campus will be leveraged. Such an approach will enable the Department to become one of the national leaders in this field.

3. **Improving Retention.** In the past few years, the Department has made major revisions and additions to its academic programs and curricula. The new degree programs and curricula are more comprehensive and diverse so that they can serve a wider spectrum of students. In the next few years, the Department would like to focus more on how to better deliver its programs and courses to various student populations. One major goal is to improve the retention rates at all levels. This will involve innovations in teaching methods and the enhancement of student learning assistance programs. The Department would like to introduce recitations and peer-led team learning to more courses, and experiment with different learning assistance techniques for different types of courses. The Department would also consider developing a new quality control and assessment mechanism for online courses, so that it can make better decisions on whether and how to expand the current online course and program offerings.
Appendices
Disciplinary Differences of Undergraduate Computing Programs at IUPUI

PURDUE UNIVERSITY - SCHOOL OF SCIENCE

Computer and Information Science (CSCI)
CSCI at IUPUI teaches the foundations of computing and information processing along with the necessary scientific and practical skills to prepare students for the demands of the current and future computing-driven society. Graduates are able to devise, analyze, improve upon, and experiment with algorithms, system design principles, and software solutions for a wide variety of problems and to apply these skills to specific real-world application areas such as biology, medicine, engineering, environmental systems, business and industry, cyber security, and forensics. Undergraduate research is encouraged so that students may contribute to, as well as benefit from, the frontiers of computing.

INDIANA UNIVERSITY - SCHOOL OF INFORMATICS AND COMPUTING

Informatics
The undergraduate program in Informatics, combining principles from information systems, computer science, psychology, and sociology, prepares students to tackle current-day problems in business, healthcare, science, law, art, and entertainment. In the core set of classes, students study information management, application development human-computer interaction, and the legal and social aspects of information and technology. Students also complete a concentration, which involves the application of informatics to a field of study of their choice. Popular choices include business, human-computer interaction, media arts, biological and health-related sciences, and legal informatics.

Media Arts and Science
In the Media Arts and Science program, students study and practice the use of digital media to communicate, educate, engage, or entertain. The program explores the fundamentals of communication and digital storytelling. Many courses in the program are project-based, allowing students to become fluent in the use of contemporary tools for producing Web sites, games, 3D motion graphics, and videos. Students also learn to develop software applications for the desktop, the Web, and mobile devices. The program is flexible, allowing to students to choose the path that best matches their career goals. The program also fosters the skills and qualities prized by employers in the 21st century workplace – skills for communication, teamwork, and productivity.

PURDUE UNIVERSITY - SCHOOL OF ENGINEERING & TECHNOLOGY

Computer Engineering
Computer Engineering is the integration of the fields of electrical engineering and computer science to develop computer-based systems. Students get training in electrical engineering,
software design, and hardware-software integration. Computer engineering students study many hardware and software aspects of computing. Computer engineers are usually involved in writing software and firmware for embedded microcontrollers, designing VLSI chips, designing analog sensors, and designing mixed signal circuit boards. Computer engineers can work on computer controlled mechanical devices, such as robots, which involved the control and communication of motors and sensors. Computer engineering students are allowed to choose areas of in-depth study in different percentage mixture of hardware and software in their junior and senior year.

**Computer and Information Technology (CIT)**

CIT students learn to identify, design, implement, and manage applied software and hardware solutions to business problems using current and emerging technology. The CIT program creates IT professionals who can employ and manage technology to best meet the information management needs of an organization. Students receive instruction in both front-end and back-end technologies. The CIT program is centered on hands-on experience and real-world problem-solving with experiential learning incorporated throughout the curriculum. After a thorough grounding in fundamentals, CIT students select one or more of 4 concentration areas: networking systems, information security, Web and application development, and data management. CIT - we make IT work.

**Computer Graphics Technology (CGT)**

CGT prepares students to become the finest practitioners, managers, and leaders in the field of applied computer graphics technology and digital communication. Graduates are creative and technological problem solvers. Graduates gain proficiency in two-dimensional, three-dimensional, interactive, and time-based principles of computer graphics as they relate to practical applications demanded by business and industry in Indiana, the nation, and the world. An innovative leader in its field, CGT provides practical experience through learning, discovery, and engagement on a domestic and international basis.
THE DEPARTMENT OF COMPUTER & INFORMATION SCIENCE

1 MEMBERSHIP

1.1 ADMINISTRATIVE UNITS

“University” shall mean Indiana University, Purdue University, or IUPUI as appropriate for the context. “School” shall mean the School of Science at IUPUI and “Department” shall mean the Department of Computer & Information Science in the School.

1.2 THE FACULTY

1.2.1 Composition of the Faculty of the Department

1.2.1.1 The regular faculty shall consist of all persons who hold appointments in the Department and are faculty according to the Indiana University Handbooks [1, 2].

1.2.1.2 The graduate faculty consists of the regular faculty who have graduate standing in the University [5].

1.2.1.3 The honorary faculty shall consist of all other persons who hold academic appointments in the Department or whom the regular faculty determine according to the Bylaws of the School [3] that pertain to honorary faculty.

1.2.1.4 The emeritus faculty shall consist of all persons appointed in the Department according to the regulations of the University that pertain to emeritus faculty members [1].

1.2.2 The Voting Faculty

1.2.2.1 The voting faculty in the election of Department representatives to School and University academic governance bodies shall be the regular faculty.

1.2.2.2 The voting members in Department Meetings, committee meetings, and in the election of representatives to Department academic governance bodies shall be the members who are regular faculty or are other members to whom the regular faculty of the Department have voted to extend voting privileges; the statement of a voting privilege of another member shall specify the meeting(s) or election(s) to which the privilege pertains.
1.2.2.3 A tenure-track or tenured faculty member may be elected to an academic governance body of the Department or School only if that individual is qualified to vote in the election of representatives to that body.

1.3 THE SPECIALISTS

A Specialist shall be any person who holds a full-time, nonacademic appointment in the Department.

1.4 THE ADMINISTRATION

The Administration of the Department shall consist of the Chair of the Department, the Acting Chair, the Specialists, the Chair of the Graduate Program Committee and the Chair of the Undergraduate Program Committee.

2 MEETINGS

2.1 PROCEDURES

2.1.1 The conduct of all meetings of standing committees and of all meetings of the Department shall be governed by Robert's Rules of Order, as revised, except as these Bylaws specify.

2.1.2 Individuals other than members of the Department may attend meetings of the Department and of its committees with the permission of the members. The person presiding at the meeting may grant such individuals the right to participate in the discussion.

2.2. MEETINGS OF THE DEPARTMENT

2.2.1 It is through these meetings that the regular faculty shall exercise its responsibilities and that the Chair of the Department shall inform the faculty about the formal recommendations of the Faculty Advisory Council and about the major administrative events and policies, such as activities of the Dean's Chairs' Council.

2.2.2 The persons eligible to vote shall be the voting members of the Department (defined in Section 1.2.2.2).

2.2.3 The Department Chair shall convene a meeting of the Department at least once each academic session, except for summer sessions, and shall preside at the meetings of the Department.

2.2.4 A majority of the voting members of the Department shall constitute a quorum.

2.2.5 Consideration of matters of official business shall require that a quorum be present. Approval of such business shall require a favorable vote by a majority of those voting. Business of the Department requiring a vote shall be listed on the Agenda, which shall be distributed to the members of the Department at least two days before the date of the meeting.
2.2.6 The voting faculty shall select a Secretary to record minutes of all meetings, distribute them to the members of the Department and maintain them in a permanent archive.

3. ORGANIZATION OF THE DEPARTMENT

3.1. ADMINISTRATION

3.1.1 CHAIR OF THE DEPARTMENT

3.1.1.1 The Chair of the Department shall participate in the academic governance and administration of the Department and University, as established in these Bylaws, the Bylaws of the School and the Indiana University Handbooks [1,2]. Specifically, the Chair and the faculty of the Department share responsibility in the areas II.3d-II.3p listed in the Bylaws of the School (1997) [3].

3.1.1.2 The Chair of the Department shall be a tenured member of the regular faculty.

3.1.1.3 Nomination of Candidates for the Chair of the Department

The regular faculty shall share responsibility with the Dean of the School for determining the procedures for selecting the nominee for the Chair.

3.1.1.4 Specific Responsibilities

3.1.1.4.1 The Chair is the chief administrative officer of the Department.

3.1.1.4.2 The Chair is responsible for the proper functioning of the educational, research and service programs of the Department. This responsibility shall take into account the process of academic governance of the Department. It includes, but is not limited to, scheduling, budgetary matters, physical facilities and the personnel matters not under the jurisdiction of the Primary Committee.

3.1.1.4.3 Near the end of each fiscal year, the Chair shall consult the Faculty Advisory Council and then select the Acting Chair for the following year.

3.1.1.4.4 The Chair shall meet with the Faculty Advisory Council at least once each Fall and Spring sessions concerning matters of shared responsibility. The Chair shall actively solicit the advice of the Faculty Advisory Council on matters listed in Item 3.2.1.2.2 of these Bylaws and shall carefully consider its recommendations.

3.1.1.4.5 The Chair shall participate, along with the Primary Committee, in the process of reappointment, promotion, tenure and dismissal of faculty members according to the procedures established in [4].

3.1.1.4.6 The Chair shall review each member of the Department annually according to the rules and regulations of the School and the University and shall inform the Department members of the date and nature of the review at the beginning of each academic year.
3.1.1.4.7 In consultation with the Faculty Advisory Council, the Chair shall establish, and review annually, the criteria and procedures to be used in merit salary decisions. The Chair shall communicate them to the faculty members prior to making committee assignments and reviews and at any other times there are changes to them.

3.1.1.4.8 The Chair of the Department shall seek the advice of the Graduate Program Committee on matters pertaining to the graduate program and shall present the formal recommendations of that Committee to the graduate faculty for its recommendations.

3.1.1.4.9 The Chair shall seek the advice of the Undergraduate Program Committee on matters of shared responsibility pertaining to the undergraduate program in accordance with [3].

3.1.1.4.10 The Chair shall seek the advice of the Infrastructure Committee on matters relating to infrastructure and computing in the Department.

3.1.2. ACTING CHAIR OF THE DEPARTMENT

3.1.2.1 Near the end of each fiscal year, and at other times as necessary, the Department Chair shall select, by mutual agreement between the Chair and the nominee, a member of the regular faculty who is not a member of the Faculty Advisory Council, to serve as Acting Chair. Prior to selection, the Chair shall consult the Advisory Council to determine the opinion of the faculty on the matter.

3.1.2.2 The role of the Acting Chair is to act in place of the Chair in the Chair's absence from the Department, except as the Chair may prescribe at any time. It is the joint responsibility of the Chair and Acting Chair to assure the smooth transition between each other's administrations.

Other than this, the Acting Chair has no responsibilities when the Chair is in the Department. It is expected that any recompense allocated to the position will be commensurate with the effort expended, as mutually agreed upon by the Chair and the Acting Chair.

3.1.3 CHAIR OF THE GRADUATE PROGRAM COMMITTEE

3.1.3.1 The role of the Graduate Program Committee Chair shall be to supervise the academic and administrative affairs of the Graduate Program as determined by the Chair of the Department and the graduate faculty.

3.1.3.2 Early in the fall semester, and at other times as necessary, the Department Chair shall consult the Faculty Advisory Council to determine the graduate faculty's preferences concerning candidates for the position of Graduate Program Committee Chair. After this, the Department Chair shall select a member of the graduate faculty to fill this position.

3.1.3.3 Specific responsibilities of the Graduate Program Committee Chair are:

3.1.3.3.1 to serve as a member and Chair of the Graduate Program Committee;
3.1.3.3.2 to supervise the advising of all graduate students in accordance with the regulations that the graduate faculty establishes with the approval of the Department Chair and with the University's guidelines [8];

3.1.3.3.3 to coordinate the activities of the Graduate Advisors in accordance with the Purdue University procedures established in [5];

3.1.3.3.4 to monitor all graduate applications, assuring that they are submitted in good order to the Graduate Program Committee for admission recommendations;

3.1.3.3.5 to supervise the maintenance of contact with prospective graduate students regarding the Graduate Program, application status, financial support and research opportunities;

3.1.3.3.6 to coordinate faculty efforts and to work with the Department Chair in the recruitment of graduate students, including the development of materials and recruitment strategies;

3.1.3.3.7 to coordinate the activities of the Graduate Program Committee with those of the other departmental committees;

3.1.3.3.8 to perform other activities as directed by the Department Chair.

3.1.4. CHAIR OF THE UNDERGRADUATE PROGRAM COMMITTEE

3.1.4.1 The role of the Undergraduate Program Committee Chair shall be to supervise the academic and administrative affairs of the Undergraduate Program as determined by the Chair of the Department and the voting faculty.

3.1.4.2 Early in the fall semester, and at other times as necessary, the Department Chair shall consult the Faculty Advisory Council to determine the voting faculty's preferences concerning candidates for the position of Undergraduate Program Committee Chair. After this, the Department Chair shall select a member of the regular faculty to fill this position.

3.1.4.3 Specific responsibilities of the Undergraduate Program Committee Chair are:

3.1.4.3.1 to serve as a member and Chair of the Undergraduate Program Committee and to present the formal recommendations of that Committee to the faculty;

3.1.4.3.2 to supervise the advising of all undergraduate students in accordance with the regulations that the voting faculty establishes and with the University's guidelines [8];

3.1.4.3.3 to supervise or delegate the monitoring of all undergraduate applications, assuring that they are submitted in good order to the Undergraduate Program Committee for admission decisions;

3.1.4.3.4 to supervise or delegate the maintenance of contact with prospective undergraduate students regarding the Undergraduate Program, application status, financial support and research opportunities;
3.1.4.3.5 to coordinate faculty efforts and to work with the Department Chair in the recruitment of undergraduate students, including the development of materials and recruitment strategies;

3.1.4.3.6 to coordinate the activities of the Undergraduate Program Committee with those of the other departmental committees;

3.1.4.3.7 to perform other activities as directed by the Department Chair and the voting faculty.

3.2 THE STANDING COMMITTEES

3.2.1 FACULTY ADVISORY COUNCIL

3.2.1.1. Membership and Election

3.2.1.1.1 The Faculty Advisory Council shall consist of three members of the regular faculty, excluding the Chair and the Acting Chair.

3.2.1.1.2 The term of office of the members shall be two years except that, initially, one member shall serve for one year.

3.2.1.1.3 New members shall be elected during the Spring session and shall take office at the beginning of the Fall session.

3.2.1.1.4 A member with an unexpired term may not stand for election to an overlapping term.

3.2.1.1.5 The members of the Faculty Advisory Council are elected in a secret ballot by the voting faculty. If more than one seat on the Council is vacant, the candidates with the most votes in the ballot shall fill the vacancies. Repeated balloting shall be used for any ties that need to be resolved. Vacancies occurring for less than a full term, other than for summer sessions, shall be filled for the remainder of the term by election in this way, too.

3.2.1.1.6 At the first meeting at which a new member elected to a full term takes office, the Council shall elect a President by majority vote of the Council members. The role of the President of the Council is to preside at the Council meetings and act as Council spokesperson.

3.2.1.1.7 The Advisory Council shall select a Secretary to record minutes of all meetings and distribute them to the faculty of the Department.

3.2.1.2 Function

3.2.1.2.1 The role of the Faculty Advisory Council is to serve as a vehicle of communication among the faculty, specialists, students, and the Chair of the Department.

3.2.1.2.2 The Advisory Council shall advise the Chair of the Department on matters of shared responsibility according to the Bylaws of the School [3]. These shall include, but not be limited to, the following specific matters:

   a) General policy recommendations pertaining to the educational and research programs of the Department;
b) Assignments to all committees;

c) Policies pertaining to faculty loads;

d) Policies relating to faculty compensation;

e) Policies on recommending faculty for re-appointment, tenure, and promotion;

f) Selection of individuals for the chairs of the standing committees and the Acting Chair.

3.2.1.2.3 The Advisory Council shall act as the Departmental Grievance Committee in accordance with the grievance procedures of the University, including those of students [6]. It shall also act as an informal grievance sounding board for members of the Department and students.

3.2.1.3 Meetings

3.2.1.3.1 The Faculty Advisory Council shall meet with the Department Chair at least once each Fall and Spring sessions.

3.2.1.3.2 The Advisory Council shall meet without the Department Chair at the call of any member. In this case, the President need not notify the Department Chair about the meeting. Additional meetings shall be held at the call of the Department Chair, any member of the Advisory Council, or by petition of at least 20% of the voting faculty.

3.2.2 PRIMARY COMMITTEE

3.2.2.1 This committee participates, with the Chair of the Department, in the process of recommending reappointment, promotion and tenure of the regular faculty according to the University's procedures [1-3] and [4] of Purdue University.

3.2.2.2 It shall also serve as the responsible committee in faculty disciplinary and dismissal cases and other matters as the Chair of the Department or the voting faculty delegate.

3.2.2.3 The departmental Promotion and Tenure guidelines and changes thereof shall be voted on by all voting members of the faculty.

3.2.2.4 The departmental representative to the Unit Committee, unless decided by the Dean of the School, shall be elected by the voting faculty for each academic year.

3.2.3 GRADUATE PROGRAM COMMITTEE

3.2.3.1 The Graduate Program Committee shall consist of members of the graduate faculty named by the Department Chair with the advice of the Faculty Advisory Council.

3.2.3.2 The Chair shall constitute the Committee at the time of naming the Graduate Program Chair, who shall be a voting member.
3.2.3.3. Function

3.2.3.3.1 The Committee shall advise, and recommend to, the Department Chair concerning matters relating to the Graduate Program in the Department that are shared responsibility according to the Bylaws of the School [3], the program authorization of the Dean of the Graduate School of Purdue University [7], as revised, and the Purdue University Policies Manual [5]. This shall include specifically, but not be limited to, the following:

a) establishing academic standards, course content and degree requirements for all graduate programs;

b) scheduling graduate course offerings, including the courses, the number of sections, and the frequency of course offerings;

c) admission and retention standards for all graduate programs;

d) policies on financial support of teaching assistantships and fellowships;

e) evaluation and selection of nominees to be recommended for admission to the Graduate Program;

f) examination of candidates to the graduate degree in compliance with [5].

3.2.3.3.2. The Committee shall exercise the authority in all matters relating to the department's graduate educational and research programs that the Department Chair and the graduate faculty delegate to it.

3.2.3.3.3 The Chair of the Department shall inform the graduate faculty of the formal recommendations of the Committee on matters of graduate faculty responsibility pertaining to the Graduate Program pursuant to 3.2.3.3.1.

3.2.3.4 The Chair of the Committee shall call meetings at least once each session, excluding summer sessions, and as necessary to conduct its business.

3.2.4 UNDERGRADUATE PROGRAM COMMITTEE

3.2.4.1. Membership

3.2.4.1.1 The Undergraduate Program Committee shall consist of members of the regular faculty and others named by the Department Chair with the advice of the Faculty Advisory Council.

3.2.4.1.2 The Department Chair shall constitute the Committee at the time of naming the Undergraduate Program Chair, who shall be a voting member.

3.2.4.2 Function
3.2.4.2.1 The Committee shall advise the faculty on matters relating to the undergraduate educational and research programs that are the responsibility of the faculty according to the Bylaws of the School [3].

These shall include, but not be limited to:

a) admission and retention standards;

b) establishment and maintenance of the specific curriculum structure and academic requirements for the undergraduate major and service course programs;

c) creation and dropping of courses; and

d) content and prerequisites of new and existing courses.

3.2.4.2.2 The Committee shall advise the Department Chair on matters relating to the undergraduate educational and research programs that are the shared responsibility of the faculty and Department Chair according to the Bylaws of the School [3]. These shall include, but not be limited to

a) scheduling of courses and class size;

b) policies concerning part-time instructors and undergraduate student assistants.

3.2.4.2.3 The Committee shall exercise the authority in matters relating to the undergraduate programs in the Department that the faculty and the Department Chair delegate to it.

3.2.4.2.4 The Chair of the Committee shall present to the faculty the formal recommendations of the Undergraduate Program Committee on matters of faculty responsibility, shared or not, pertaining to the undergraduate programs in accordance with [3].

3.2.4.3 The Chair of the Committee shall call meetings at least once each session, excluding summer sessions, and as necessary to conduct its business.

3.2.5 INFRASTRUCTURE COMMITTEE

3.2.5.1 Membership and Appointment

3.2.5.1.1 Early in the Fall session, the Department Chair shall select all of the members of the Infrastructure Committee from among the members of the regular faculty and specialists of the department with the advice of the Faculty Advisory Council.

3.2.5.1.2 The Department Chair shall select the Chair of the Infrastructure Committee from among the regular faculty members of the Committee.

3.2.5.2 Function
3.2.5.2.1 The Committee shall advise the department members and the Department Chair on matters concerning research, educational and administrative computing in the Department, including hardware, software, and space issues.

3.2.5.2.2 The Committee shall advise the Department Chair on the specific matters:

a) Policies for the procurement, use, and maintenance of hardware and software for the instructional programs of the Department;

b) Purchase of specific hardware and software for the instructional programs of the Department and for the use of the full, part-time and student faculty and the specialists;

c) Expenditure of the Department's budget for infrastructure items;

d) Coordination of the common equipment for the research programs of the Department.

3.2.5.2.3 The committee shall perform other activities as directed by the Department Chair or the faculty.

3.2.5.2.4 The Chair of the Committee shall report the formal recommendations of the committee to the members of the Department at the Department's meetings.

3.2.5.2.5 The Chair of the Committee shall call meetings of the committee at least once every academic session, except summer sessions, and as necessary to conduct its business.

4 REPRESENTATIVE TO THE STEERING COMMITTEE OF THE SCHOOL'S FACULTY ASSEMBLY

4.1 The Faculty Representative to the Steering Committee shall be a tenured member of the regular faculty.

4.2 Election of Representative

The regular faculty of the Department shall elect annually the Representative, in conformity with the Bylaws of the School [3], by a favorable majority in a secret ballot of the regular faculty of the Department. The regular faculty shall determine the balloting procedures. In case there is no candidate for the position, the Department Chair shall appoint a representative from the faculty members eligible according to 4.1.

5 STUDENT ADVISING

The Department adopts the recommendations concerning goals and responsibilities in administering and carrying out the process of academic advising described in [8].

6 ADJUDICATION OF RIGHTS AND RESPONSIBILITIES

FACULTY AND STUDENTS
Grievance procedures are in accordance with those defined by the University [1], [2], including [1], [6] specifically for students.

7 BYLAWS PRESERVATION/DISSEMINATION PROCEDURES

7.1 These bylaws shall be made available upon request.

8 BYLAWS AMENDMENT PROCEDURES

8.1 Approval of amendments to these Bylaws shall be a shared responsibility of the voting faculty and Chair of the Department. A favorable vote by greater than or equal to two thirds majority of the voting faculty is required for approval, with the Chair of the Department possessing line-item veto for items or clauses that pertain to the administrative responsibilities having budgetary consequences in areas that are shared responsibility according to the Bylaws of the School [3].

8.2 The Department Chair, the Faculty Advisory Council or any two members of the regular faculty may propose amendments to these Bylaws by presenting them at a meeting of the department.

8.3 These Bylaws shall be amended in a secret ballot, and the amendments shall take effect immediately after approval.

8.4 With any change of the Bylaws, The Department Chair shall prepare, archive and transmit updated copies of the Bylaws to the department members and to the Dean of the School. A department member may request a copy of the Bylaws at any time.

8.5 The voting faculty shall review the Bylaws for possible amendment at regular intervals not to exceed five years.

REFERENCE DOCUMENTS

[3] Bylaws of the Faculty Assembly. Purdue University School of Science, IUPUI, Indianapolis, Indiana.
[7] Recommendation Letter Concerning Administration of the Master's Program in Computer & Information Science at IUPUI to Dr. Luis Proenza, Dean of the Graduate
School from Dr. Ahmed Sameh, Head of the Computer Science Graduate Program. Purdue University. April 28, 1997.

## Ethnic Minority Enrollment Data Tables

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Fall 2011</th>
<th>Spring 2012</th>
<th>Fall 2012</th>
<th>Spring 2013</th>
<th>Fall 2013</th>
<th>Spring 2014</th>
<th>Fall 2014</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>10</td>
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<td>156</td>
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<td><strong>213</strong></td>
<td><strong>205</strong></td>
<td><strong>218</strong></td>
<td><strong>239</strong></td>
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### Undergraduate enrollment by Race/Ethnicity

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<th>Race/Ethnicity</th>
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<th>Fall 2012</th>
<th>Spring 2013</th>
<th>Fall 2013</th>
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<th>Fall 2014</th>
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<td>25</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>106</strong></td>
<td><strong>98</strong></td>
<td><strong>147</strong></td>
<td><strong>145</strong></td>
<td><strong>170</strong></td>
<td><strong>161</strong></td>
<td><strong>160</strong></td>
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</tbody>
</table>

### Graduate enrollment by Race/Ethnicity
Undergraduate Student Learning Outcomes

The Department’s Undergraduate Committee states the following Student Learning Outcomes. After graduation, a student should be able to:

1) Write software programs in multiple programming languages
2) Understand the theoretical foundations of computer science, including the study of discrete computational structures
3) Understand and use different programming language paradigms such as procedural, object-oriented, etc.
4) Use different data structures such as linked lists, arrays, stacks, trees, graphs, hash tables, etc. to improve efficiency of software, and mathematically or experimentally analyze them and operations on them.
5) Know a diverse array of computational algorithms and their analysis techniques, as related to searching, sorting, optimization, and graph problems.
6) Know fundamental limitations of designing efficient algorithms and the theoretical meaning of the P?=NP problem
7) Know the basic concepts in formal language theory and their application to compiler design
8) Understand the basic design of computer architecture and their relationship to software design
9) Understand and design the basic functionalities of different computer operating systems
10) Acquire knowledge in multiple advanced areas of computer science, such as databases, data mining, multimedia, graphics, computing security, networking, software engineering, bio-computing, etc.
11) Design, develop, and test small scale software projects
12) Write scientific project reports and software documentation
Graduate Student Learning Outcomes

Graduate Certificates (5)

1. Demonstrate a sound understanding of computing principles in the chosen area of study (Biocomputing, Biometrics, Computer Security, Databases and Data Mining, Software Engineering)
   a. As evident from appropriate grades earned to satisfy the core course requirement for a specific certificate program
2. Demonstrate an ability to work in a group
   a. As evident from successfully developing moderately intense collaborative projects (e.g., semester projects in courses)
3. Demonstrate an ability to solve moderately complex problems in the chosen area of study
   a. As evident from successful completion of elective courses in Computer Science or related fields, as required by the Certificate program(s)

MS Students

1. Demonstrate a sound understanding of general fundamental computing concepts (e.g., algorithms, programming languages, operating systems, etc.)
   a. As evident from appropriate grades earned to satisfy the core course requirements
2. Demonstrate a relatively in-depth understanding of a subarea
   a. As evident from successfully completing a series of courses in a sub-area (e.g., databases)
3. Demonstrate an ability to successfully work in a group and/or demonstrate an ability to successfully carry out moderately complex software projects
   a. As evident from successfully developing moderately intense collaborative projects (e.g., semester projects in courses) and/or
   b. As evident from software development assignments/projects in courses (e.g., projects in networking course)

Additional Expectation from MS Students choosing Thesis or Project Option

1. Demonstrate an ability to systematically carry out scientific research (empirical and/or theoretical) on a moderately complex problem

Additional Expectation from PhD Students

1. Demonstrate an ability to develop original solutions and their validation that extend the state-of-art in a chosen specialization to significant research problem(s) as evident from publications in highly-ranked conferences/journals
## Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Major Emphasis (100 Level & Lower)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1C. Information Resource Skills</td>
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<td>54.3</td>
<td>100.0</td>
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<tr>
<td>Total</td>
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<td>4</td>
<td>12</td>
<td>0</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>2.97</td>
<td>11.4</td>
<td>34.3</td>
<td>0.0</td>
<td>54.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1 Combined number of student ratings in all 100-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 100 level course.

2 Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”

## Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Moderate Emphasis (100 Level & Lower)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Understanding Society and Culture</td>
<td>35</td>
<td>11</td>
<td>3</td>
<td>5</td>
<td>16</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>2.74</td>
<td>31.4</td>
<td>8.6</td>
<td>14.3</td>
<td>45.7</td>
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</tr>
<tr>
<td>Total 1</td>
<td>35</td>
<td>11</td>
<td>3</td>
<td>5</td>
<td>16</td>
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<tr>
<td></td>
<td>2.74</td>
<td>31.4</td>
<td>8.6</td>
<td>14.3</td>
<td>45.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1 Combined number of student ratings in all 100-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 100 level course.

2 Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”
Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Major Emphasis (200 Level)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean ²</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Critical Thinking</td>
<td>105</td>
<td>16</td>
<td>3</td>
<td>14</td>
<td>72</td>
<td>105</td>
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<tr>
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<td>3.35</td>
<td>15.2</td>
<td>2.9</td>
<td>13.3</td>
<td>68.6</td>
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</tr>
<tr>
<td>Total ¹</td>
<td>105</td>
<td>16</td>
<td>3</td>
<td>14</td>
<td>72</td>
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<td>15.2</td>
<td>2.9</td>
<td>13.3</td>
<td>68.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>

¹ Combined number of student ratings in all 200-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 200 level course.


Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Moderate Emphasis (200 Level)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean ²</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B. Quantitative Skills</td>
<td>105</td>
<td>16</td>
<td>6</td>
<td>13</td>
<td>70</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>3.30</td>
<td>15.2</td>
<td>5.7</td>
<td>12.4</td>
<td>66.7</td>
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<td>15.2</td>
<td>5.7</td>
<td>12.4</td>
<td>66.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

¹ Combined number of student ratings in all 200-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 200 level course.

## Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Major Emphasis (300 Level)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean</th>
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<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
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<tr>
<td></td>
<td>2</td>
<td>2.36</td>
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<td>2. Critical Thinking</td>
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<td>72</td>
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<td>18</td>
<td>13</td>
<td>18</td>
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<tr>
<td>3. Integration and Application of Knowledge</td>
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</table>

1 Combined number of student ratings in all 300-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 300 level course.

2 Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”

## Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Moderate Emphasis (300 Level)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
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<td>72</td>
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<td>18</td>
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<td>14</td>
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</table>

1 Combined number of student ratings in all 300-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 300 level course.

2 Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”
## Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Major Emphasis (400 Level)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
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<th>Effective</th>
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<th>Total</th>
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<tbody>
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<td>11</td>
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<td>4. Intellectual Depth, Breadth, and Adaptiveness</td>
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1 Combined number of student ratings in all 400-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 400 level course.

2 Scale: 1 = "Not Effective", 2 = "Somewhat Effective", 3 = "Effective", 4 = "Very Effective"
### Faculty Ratings of Department of Computer Science: Major Courses Student Performance on PULs with Moderate Emphasis (400 Level)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean ²</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>3. Integration and Application of Knowledge</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>4.00</td>
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<td>0.0</td>
<td>0.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>6. Values and Ethics</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>3.13</td>
<td>12.5</td>
<td>12.5</td>
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<td>50.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total ¹</td>
<td>209</td>
<td>24</td>
<td>65</td>
<td>87</td>
<td>33</td>
<td>209</td>
</tr>
<tr>
<td></td>
<td>2.62</td>
<td>11.5</td>
<td>31.1</td>
<td>41.6</td>
<td>15.8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

¹Combined number of student ratings in all 400-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 400 level course.


### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Major Emphasis (100 Level & Lower)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean ²</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1C. Information Resource Skills</td>
<td>108</td>
<td>11</td>
<td>13</td>
<td>48</td>
<td>36</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>3.01</td>
<td>10.2</td>
<td>12.0</td>
<td>44.4</td>
<td>33.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total ¹</td>
<td>108</td>
<td>11</td>
<td>13</td>
<td>48</td>
<td>36</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>3.01</td>
<td>10.2</td>
<td>12.0</td>
<td>44.4</td>
<td>33.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

¹Combined number of student ratings in all 100-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 100 level course.

### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Moderate Emphasis (100 Level & Lower)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Critical Thinking</td>
<td>2.94</td>
<td>11.1</td>
<td>12.0</td>
<td>49.1</td>
<td>27.8</td>
<td>108</td>
</tr>
<tr>
<td>Total ¹</td>
<td>2.94</td>
<td>11.1</td>
<td>12.0</td>
<td>49.1</td>
<td>27.8</td>
<td>108</td>
</tr>
</tbody>
</table>

¹ Combined number of student ratings in all 100-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 100 level course.


### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Major Emphasis (200 Level)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B. Quantitative Skills</td>
<td>3.44</td>
<td>9.1</td>
<td>3.0</td>
<td>22.7</td>
<td>65.2</td>
<td>66</td>
</tr>
<tr>
<td>2. Critical Thinking</td>
<td>3.30</td>
<td>14.4</td>
<td>8.7</td>
<td>9.8</td>
<td>67.2</td>
<td>439</td>
</tr>
<tr>
<td>Total ¹</td>
<td>3.32</td>
<td>13.7</td>
<td>7.9</td>
<td>11.5</td>
<td>66.9</td>
<td>505</td>
</tr>
</tbody>
</table>

¹ Combined number of student ratings in all 200-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 200 level course.

### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Moderate Emphasis (200 Level)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Written, Oral, &amp; Visual Communication Skills</td>
<td>23</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>3.87</td>
<td>4.3</td>
<td>0.00</td>
<td>0.00</td>
<td>95.7</td>
<td>100.0</td>
</tr>
<tr>
<td>1C. Information Resource Skills</td>
<td>385</td>
<td>52</td>
<td>38</td>
<td>48</td>
<td>247</td>
<td>385</td>
</tr>
<tr>
<td></td>
<td>3.27</td>
<td>13.5</td>
<td>9.9</td>
<td>12.5</td>
<td>64.2</td>
<td>100.0</td>
</tr>
<tr>
<td>3. Integration and Application of Knowledge</td>
<td>97</td>
<td>13</td>
<td>11</td>
<td>14</td>
<td>59</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>3.23</td>
<td>13.4</td>
<td>11.3</td>
<td>14.4</td>
<td>60.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total 1</td>
<td>505</td>
<td>66</td>
<td>49</td>
<td>62</td>
<td>328</td>
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<td>3.29</td>
<td>13.1</td>
<td>9.7</td>
<td>12.3</td>
<td>65.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1 Combined number of student ratings in all 200-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 200 level course.

2 Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”

### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Major Emphasis (300 Level)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Written, Oral, &amp; Visual Communication Skills</td>
<td>61</td>
<td>4</td>
<td>5</td>
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<td>3.33</td>
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<td>8.2</td>
<td>31.1</td>
<td>54.1</td>
<td>100.0</td>
</tr>
<tr>
<td>1B. Quantitative Skills</td>
<td>27</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>3.85</td>
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<td>0.0</td>
<td>3.7</td>
<td>92.6</td>
<td>100.0</td>
</tr>
<tr>
<td>2. Critical Thinking</td>
<td>617</td>
<td>62</td>
<td>92</td>
<td>105</td>
<td>358</td>
<td>617</td>
</tr>
<tr>
<td></td>
<td>3.23</td>
<td>10.1</td>
<td>14.9</td>
<td>17.0</td>
<td>58.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total 1</td>
<td>705</td>
<td>67</td>
<td>97</td>
<td>125</td>
<td>416</td>
<td>705</td>
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<td>3.26</td>
<td>9.5</td>
<td>13.8</td>
<td>17.7</td>
<td>59.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1 Combined number of student ratings in all 300-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 300 level course.

2 Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”
**Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Moderate Emphasis (300 Level)**

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean (^2)</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Written, Oral, &amp; Visual Communication Skills</td>
<td>3.26</td>
<td>6.1</td>
<td>16.7</td>
<td>22.7</td>
<td>54.6</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>66</td>
<td>4</td>
<td>11</td>
<td>15</td>
<td>36</td>
<td>66</td>
</tr>
<tr>
<td>1B. Quantitative Skills</td>
<td>3.15</td>
<td>6.5</td>
<td>21.2</td>
<td>22.7</td>
<td>49.6</td>
<td>278</td>
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<td>59</td>
<td>63</td>
<td>138</td>
<td>278</td>
</tr>
<tr>
<td>1C. Information Resource Skills</td>
<td>3.30</td>
<td>13.1</td>
<td>10.2</td>
<td>28</td>
<td>66.5</td>
<td>275</td>
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<td>275</td>
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<td>28</td>
<td>28</td>
<td>183</td>
<td>275</td>
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<tr>
<td>3. Integration and Application of Knowledge</td>
<td>3.43</td>
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<td>4.9</td>
<td>32.8</td>
<td>57.4</td>
<td>61</td>
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</tr>
<tr>
<td>6. Values and Ethics</td>
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<td>25</td>
</tr>
<tr>
<td>Total (^1)</td>
<td>3.25</td>
<td>8.9</td>
<td>15.0</td>
<td>17.9</td>
<td>58.2</td>
<td>100.0</td>
</tr>
<tr>
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<td>705</td>
<td>63</td>
<td>106</td>
<td>126</td>
<td>410</td>
<td>705</td>
</tr>
</tbody>
</table>

\(^{1}\) Combined number of student ratings in all 300-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 300 level course.

\(^2\) Scale: 1 = “Not Effective”, 2 = “Somewhat Effective”, 3 = “Effective”, 4 = “Very Effective”
### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Major Emphasis (400 Level)

<table>
<thead>
<tr>
<th>PUL – Major Emphasis</th>
<th>Mean ²</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. Written, Oral, &amp; Visual Communication Skills</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>3.56</td>
<td>6.3</td>
<td>6.3</td>
<td>12.5</td>
<td>75.0</td>
<td>100.0</td>
</tr>
<tr>
<td>1B. Quantitative Skills</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>6. Values and Ethics</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3.80</td>
<td>0.0</td>
<td>0.0</td>
<td>20.0</td>
<td>80.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total ¹</td>
<td>24</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>16</td>
<td>24</td>
</tr>
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<td></td>
<td>3.42</td>
<td>4.2</td>
<td>16.7</td>
<td>12.5</td>
<td>66.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

¹ Combined number of student ratings in all 400-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 400 level course.


### Faculty Ratings of Department of Computer Science: Non-Major Courses Student Performance on PULs with Moderate Emphasis (400 Level)

<table>
<thead>
<tr>
<th>PUL – Moderate Emphasis</th>
<th>Mean ²</th>
<th>Not Effective</th>
<th>Somewhat Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Total ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Integration and Application of Knowledge</td>
<td>19</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>3.26</td>
<td>5.3</td>
<td>26.3</td>
<td>5.3</td>
<td>63.2</td>
<td>100.0</td>
</tr>
<tr>
<td>4. Intellectual Depth, Breadth, and Adaptiveness</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3.80</td>
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<td>0.0</td>
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<td>80.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total ¹</td>
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<td>5</td>
<td>2</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>3.38</td>
<td>4.2</td>
<td>20.8</td>
<td>8.3</td>
<td>66.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

¹ Combined number of student ratings in all 400-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013 and Fall 2013. A student may be evaluated more than once if he or she is taking more than one 400 level course.

Listing of Publications and Grants

This list contains publications and awards by research group; as the Department faculty work in close collaboration with each other and with other groups, some publications may be repeated in the listing in more than one group if they are co-authored, for example. IUPUI CS Graduate student co-authors are indicated with *.

Database, Data Mining and Machine Learning (DDMML) Group

Referred Publications


17. *Chandima Hewa Nadungodage, Yuni Xia, Jaehwan John Lee, Yi-cheng Tu, Hyper-Structure Mining of Frequent Patterns in Uncertain Data Streams, Journal of Knowledge and Information Systems (KAIS), 2013.


35. *Jiaqi Ge, Yuni Xia, A Discretization Algorithm for Uncertain Data, the 21st International Conference on Database and Expert Systems Applications (DEXA), 2010.


38. Murat Dundar, Sunil Badve, Vikas Raykar, Rohit Jain, Olcay Sertel, Metin Gurcan, “A Multiple Instance Learning Approach toward Optimal Classification of Pathology Slides”, In Proceedings of 20th International Conference on Pattern Recognition, Istanbul, Turkey, August 23-26, 2010 (pp. 2732-2735). (Best scientific paper in Biomedical and Bioinformatics applications


41. *Jiaqi Ge, Yuni Xia, *Chandima Hewa Nadungodage. Classify Uncertain Data with Neural Network, the 14th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD), 2010.

42. Biao Qin, Yuni Xia, Fang Li. A Bayesian Classifier for Uncertain Data. the 25th ACM Symposium on Applied Computing (SAC), 2010.
43. Biao Qin, Yuni Xia, Rakesh Sathyesh, Sunil Prabhakar, Yicheng Tu, uRule: A Rule Based Classifier for Data with Uncertainty, the IEEE International Conference on Data Mining (ICDM), Demo, 2009.
44. Biao Qin, Yuni Xia, Fang Li. DTU: A Decision Tree for Uncertain Data. Proc. of the 13th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD), 2009.
46. *Andrew Campen, Yuni Xia, Dan Rigsby, Ying Guo, Xingdong Feng, Eric W. Su, Mathew Palakal and Shuyu Li. Mining Gene Expression Database for Primary Human Disease Tissues. Proc. of the IEEE 24th International Conference on Data Engineering (ICDE), Demo, 1604-1608, 2008.


The proceedings of the 2009 IEEE International Conference on Bioinformatics & Biomedicine (BIBM), Washington D.C, 2009 (acceptance rate: 35%).


**Funded Projects:**

3. US Department of the Army, "Health-Terrain: Visualizing Large Scale Health Data", (PI: Shiaofen Fang, Co-PI: Mathew Palakal, Shaun Grannis, Yuni Xia), $565,430, 2013-2014,
4. Electronics and Telecommunications Research( ETRI), South Korea, "Development of Key Technologies for Big Data Analysis and Management Software Based on Next Generation Memory", (Institute PI: John Lee, Co-PI: Yuni Xia), $117,000, 2012-2014.
6. IBM Research Award, "Large Scale Sensor Stream Analysis and Mining for Geriatric Care", $19,000, 2011


Software Engineering, Distributed and Parallel Computing (SEDP) Group

Referred Journal Publications, Books, & Book Chapters


Refereed Conference and Workshop Publications


**Editorials**

Refereed Tool Demonstrations


Abstracts and Posters


Internal and External Funding

Title: System Execution Modeling Environment Research and Development: Phase 1 – 5 (James H. Hill)
Sponsor: Australia Defense Science and Technology Organization (DSTO)
Period of Performance: 8/1/2009 - 12/31/2016
Funding: $464,211 USD

Title: A Pervasive Computing Infrastructure for Supporting CS Graduate Courses (Raje, Tuceryan, Song, Liang)
Sponsor: IUPUI School of Science teaching support
**Period of Performance:** 2014-2015  
**Funding:** $27,657 USD  

**Title:** Testing-as-a-Service: Static Code Analysis (SCA) Tool Study – Phase 3 (Hill and Raje)  
**Sponsor:** Northrup Grumman via S2ERC  
**Period of Performance:** 2/1/2014 - 1/31/2015  
**Funding:** $10,000 USD  

**Title:** Testing-as-a-Service: Static Code Analysis (SCA) Tool Study – Phase 2 (Hill and Raje)  
**Sponsor:** Department of Homeland Security via S2ERC  
**Period of Performance:** 8/1/2013 – 12/31/2014  
**Funding:** $30,000 USD  

**Title:** Testing-as-a-Service: Static Code Analysis (SCA) Tool Study – Phase 1 (Hill and Raje)  
**Sponsor:** Lockheed Martin & Northrup Grumman via S2ERC  
**Period of Performance:** 1/1/2013 – 12/31/2013  
**Funding:** $49,060 USD  

**Title:** An Integrated Architecture-Aware Framework Supporting Highly Scalable Scientific Computing for Many Cores (Song)  
**Sponsor:** IUPUI  
**Period of Performance:** 1/1/2013 – 12/31/2013  
**Funding:** $8,000 USD  

**Title:** Automatic Identification of Software Performance Anti-patterns in Cloud Computing Applications (Hill)  
**Sponsor:** Amazon Inc.  
**Period of Performance:** 1/1/2012 – 12/31/2013  
**Funding:** $5,000 (no indirect cost allowed)  

**Title:** Modeling, Specifying, Discovering, and Integrating Trust into Distributed Real-time and Embedded (DRE) Systems – Phases 1 and 2 (Rajeev Raje and James Hill)  
**Sponsor:** Air Force Research Lab vs S2ERC  
**Period of Performance:** 7/1/2011 – 1/31/2013  
**Funding:** $79,000 USD  

**Title:** Continued Support for Research and Development on System Integration Testing as a Service (Hill)  
**Sponsor:** Air Force Research Lab (AFRL)  
**Period of Performance:** 9/1/2010 – 12/31/2010  
**Funding:** $10,000 USD  

**Title:** Cyber-physical multi-core Optimization for Resource & cachE effectS (C2ORES) (Hill)  
**Sponsor:** Office of Naval Research  
**Primary Organization:** Vanderbilt University  
**Period of Performance:** 7/3/2012 – 7/2/2013  
**Portion of Funding:** $300,000 (IUPUI Portion $85,478 USD)  

**Title:** EISA/OASIS Transition Project – Transition Planning, Phase 3 & Phase 4 (Hill)  
**Sponsor:** Science Applications International Corporation  
**Primary Organization:** Vanderbilt University
**Period of Performance:** 11/1/10 - 5/15/2011  
**Portion of Funding:** $348,350 (IUPUI Portion $88,269 USD)

**Title:** CoSMIC Extensions for the Scalable Node Architecture (Hill)  
**Sponsor:** Northrop Grumman  
**Primary Organization:** Vanderbilt University  
**Period of Performance:** 5/1/10 – 8/31/10  
**Portion of Funding:** IUPUI Portion $47,599 USD

**Title:** Reducing Accidental Complexities Associated with CoSMIC Tool Suite – Phase 1 & 2 (Hill)  
**Sponsor:** Northrop Grumman  
**Primary Organization:** Vanderbilt University  
**Period of Performance:** 8/1/2009 – 8/31/2010  
**Portion of Funding:** (IUPUI Portion $145,230 USD)

**Title:** A Distributed Framework for Indoor Location Tracking (Raje, Tuceryan)  
**Sponsor:** Purdue Research Foundation  
**Period of Performance:** 7/1/2013 – 6/30/2014  
**Funding:** $17,608 USD

**Title:** Developing a Fast and Accurate Parallel Solver for Multi-scale Biochemical Reacting Systems (Chin, Raje)  
**Sponsor:** IUPUI MURI  
**Period of Performance:** 2009-2010  
**Funding:** $2,000 USD

**Title:** Developing Fast and Accurate Parallel Solver for Multi-Scale Chemically Reacting Systems (Chin, Raje)  
**Sponsor:** IUPUI MURI  
**Period of Performance:** 2008-2009  
**Funding:** $1,500

**Imaging and Visualization Group**

**Journal papers and book chapters**


4. Andrew Hoblitzell, Omkar Tilak, Snehasis Mukhopadhyay, *Qian You, Shaoften Fang, Yuni Xia, Joseph Bidwell, Multi-Level text Mining for Bone Biology, Concurrency and Computation: Practice and Experience. 23(17), 2011, 2355-2364.


Publications in blind peer-reviewed conference proceedings


22. X. Chang, M.D. Kim, R. Stephens, T. Qu, A. Chiba, and G. Tsechpenakis, “Neuron Recognition with Hidden Neural Network Random Fields,” Int'l Symposium on Biomedical Imaging: from Nano to Macro (ISBI), Beijing, China, 2014. (Tsechpenakis and his mentees Xiao, Stephens, and Qu are the main contributors, >90% of the work.)

23. *P. Mukherjee, M.D. Kim, A. Chiba, and G. Tsechpenakis, “Active Geometric Model: Application to Neuron Morphology Estimation in the Drosophila Ventral Nerve Cord,” Int'l Conference on Image Processing, Melbourne, Australia, 2013. (Tsechpenakis and his student, Mukherjee, are the main contributors, >90% of the work.)

Francisco, USA, 2013. (Tsechpenakis and his student, Farhand, are the main contributors, >90% of the work.)

25. X. Chang, M.D. Kim, A. Chiba, and G. Tsechpenakis, "Motor Neuron Recognition in the Drosophila Ventral Nerve Cord," Int'l Symposium on Biomedical Imaging: from Nano to Macro (ISBI), San Francisco, USA, 2013. (Tsechpenakis and his postdoc, Chang, are the main contributors, >90% of the work.)

26. *S. Farhand, R.B. Montero, X. Vial, D.T. Nguyen, M. Reardon, S.M. Pham, F.M. Andreopoulos, and G. Tsechpenakis, "Probabilistic Multi-compartment Geometric Model: Application to Cell Segmentation," Int'l Symposium on Biomedical Imaging: from Nano to Macro (ISBI), Barcelona, Spain, 2012. (Tsechpenakis and his student, Farhand, are the main contributors, >90% of the work.)

27. X. Chang, M.D. Kim, A. Chiba, and G. Tsechpenakis, "Patterning Motor Neurons in the Drosophila Ventral Nerve Cord using Latent State Conditional Random Fields," Int'l Symposium on Biomedical Imaging: from Nano to Macro (ISBI), Barcelona, Spain, 2012. (Tsechpenakis and his postdoc, Chang, are the main contributors, >90% of the work.)


29. A.W. Irvine†, S. Chatzis, and G. Tsechpenakis, “Which Brainstem Cells Generate the Respiration Cycles?,” 7th Int'l Symposium on Biomedical Imaging: from Nano to Macro (ISBI), Rotterdam, Netherlands, April 2010. (All authors contributed equally.)


**ABSTRACTS**


Internal and External Funding


3. 3D Facial Imaging on FASD, co-PI (PI: Tatiana Foroud), National Institutes of Health (NIH), 9U01AA014809-04, $1,500,000, 06/01/08 – 05/31/13.

4. Mouse Model Neuro-Facial Dysmorphology: Translational and Treatment Studies, co-PI (PI: Feng Zhou), National Institutes of Health (NIH), 1U01AA017123-01, $1,200,000, 06/01/08 – 05/31/13.

5. NSF/DBI [#1252597]: CAREER: Modeling the Structure and Dynamics of Neuronal Circuits in the Drosophila larvae using Image Analytics [2013–2018]


7. This work is sponsored by Indiana University Collaborative Research Grant initiative [2013-3014]

8. This work was sponsored by NIH [#R21EB012136-01]: ‘Construction and profiling of biodegradable cardiac patches for the co-delivery of bFGF and G-CSF growth factors’, awarded to F.M. Andreopoulos (University of Miami). Subcontract to IUPUI.

9. This work was sponsored by NIH RC2[36632]: 'In situ Protein-Protein Interaction Networks (isPIN) of Neurons [2009-2011]', awarded to A. Chiba (University of Miami). Subcontract to IUPUI.

10. (with Dr. Jiang Yu Zheng as co-PI), National Institute of Justice (NIJ): Digitizing Device to Capture Track Impressions, $253,120, September 2010–August 2012.


13. TOYOTA: Co-PI, 2014-2016 Vehicle testing scenario generation $1,500,000

Networking and Security Group

Referred Publications


5) Harold Owens, Arjan Durresi, *Reliable Video over Software-Defined Networking*, *Globecom 2014*, December 8-12, Austin, TX (accepted)


7) Lina Alfantoukh, Arjan Durresi, *Techniques for Collecting data in Social Networks*, NBiS 2014, September 10-12, Salerno, Italy, (accepted)


20) Shpetim Latifi, Arjan Durreisi, Betim Cico; “Separating network control from routers with Software Defined Networking”. BCI, 2013: 59
22) *Ping Zhang, Arjan Durreisi, Raj Jain: “Cloud aided Internet mobility”. ICC 2013: 3688-3693


120) S. Magliveras, W. Wei, and X. Zou, “Notes on the CRTDH Group Key Agreement Protocol,” Proceedings of The 28th International Conference on Distributed Computing Systems Workshops (ICDCS’08), Beijing, China, June 17–20, 2008, pp. 406-411. (Note: the authors are listed in the alphabetic order of their last names.)


X. Zou, Y.S. Dai, B. Doebbeling,* M. Qi, “Dependability and Security in Medical Information
163 Y. Wang, B. Ramamurthy, and X. Zou, “KeyRev: An Efficient Key Revocation Scheme for Wireless
164 Arjan Durresi, Mukundan Sridharan, Raj Jain, “Adaptive Multi-level Explicit Congestion
Notification,” International Journal of High performance Computing and Networking
(IJHPCN), Vol. 5, No. 1/2, October 2007, pp. 3–11.
165 Arjan Durresi, Mimoza Durresi, Leonard Barolli, “Secure Broadcast for Inter Vehicle
Communications,” International Journal of High performance Computing and Networking
166 Arjan Durresi, Vamsi Paruchuri, “Broadcast Protocol for Energy-Constrained Networks,”
2.248)
167 Fatos Xhafa, Leonard Barolli, Arjan Durresi, “Requirements for an Event-Based
168 Tao Yang, Leonard Barolli, Makoto Ikeda, Arjan Durresi, Fatos Xhafa, “Performance
Evaluation Of Reactive And Proactive Protocols For Ad-Hoc Sensor Networks Using
Different Radio Models,” Journal of Interconnection Networks (JOIN), Vol. 8, No. 4,
169 Fatos Xhafa, Leonard Barolli, Arjan Durresi, “An Experimental Study On Genetic
170 Akio Koyama, Junpei Arai, Leonard Barolli, Arjan Durresi, “EZRP: An Enhanced Zone-
Based Routing Protocol for Ad-Hoc Networks and Its Performance Evaluation,”
Concurrency and Computation: Practice and Experience, Wiley InterScience, Vol. 19,
171 Tao Yang, Makoto Ikeda, Leonard Barolli, Arjan Durresi and Fatos Xhafa, “Network
Energy Consumption in Ad-hoc Networks Under Different Radio Models,” in Proceedings
of The 13th International Conference on Parallel and Distributed Systems (ICPADS
2007), Hsinchu, Taiwan, December 5-7, 2007.
172 Leonard Barolli, Fatos Xhafa, Arjan Durresi, Akio Koyama, Makoto Takizawa,
“Performance Evaluation of a Fuzzy-based Handover System for Wireless Cellular
Networks,” in Proceedings of The 9th International Conference on Information
Integration and Web-based Application & Services (iiWAS 2007), Jakarta, Indonesia,
December 3-5, 2007.
Marking for IP Traceback under DDoS Attacks,” in Proceedings of the 50th IEEE Global
Telecommunications Conference GLOBECOM 2007, Washington, D.C., on November
174 Vamsi Paruchuri, Arjan Durresi, Leonard Barolli, Makoto Takizawa, “Three Dimensional
Broadcast Protocol for Wireless Networks,” in Proceedings of the International


216) Mangesh Chitnis*, Yao Liang, Jiang Yu Zheng, Paolo Pagano, Giuseppe


228) Mei Han* and Yao Liang, Virtual Queue Based RED-VBR, System and
Editorials

1) Arjan Durresi, Guest Editor for the IEEE Communication Magazine, Special Issue on Networking Issues for Cloud Computing published in September 2012

2) Arjan Durresi, Guest Editor for the IEEE Communication Magazine, Special Issue on Future Internet Architectures: Design and Deployment Perspectives, published in July 2011.

Conference Presentations


2 Villalba, G., X. Liang, D. Salas, and Y. Liang, Using graphical models to infer missing streamflow data with its application to the Ohio river basin, American Geophysical Union Fall meeting, San Francisco, CA, December 9-13, 2013.


5 X. Liang, T. Davis, T. Hare, *M. Navarro, and Y. Liang, An Experimental Study of a WSN System for Environmental Monitoring, American Geophysical Union Fall meeting, San Francisco, CA, December 5-9, 2011.


9 T. Davis, C. Kuo, Yao Liang, and X. Liang, Application of wireless sensor networks for environmental monitoring, American Geophysical Union 2009 Joint Assembly – The Meeting of the Americas, Toronto, Canada, May 24-27, 2009, poster presentation. (Outstanding Student Paper Award)


Abstracts and Posters


Grants

External

2) National Science Foundation (NSF# 1019120): "Large-Scale Distributed Scientific Experiments on Shared Substrates", (PI: Arjan Durresi), ($ 100,000): NSF, 2010-2015. Research Experiences for Undergraduates ($16,000).
5) NSF #1262984, REU Site: Enhancing Undergraduate Experience in Mobile Computing Security, 6/1/2013–5/31/2016, $360,000, Shiaofen Fang, Mohammad Al Hasan, X. Zou (with Feng Li from CIT as PI).
6) Northrop Grumman, MovingCloud: Create Moving-target Defense in Cloud by Learning from Botnets, 10/1/2012–9/31/2013, $107,000, X. Zou (with Feng Li from CIT as PI)
8) NSF, Secure Group Communications over Wired/Wireless Networks, (CCR-0311577), 08/01/03 - 07/31/07, $349,990, X. Zou (PI at IUPUI) (with B. Ramamurthy from UNL as leading PI and V. Vardam from UNL as Co-PI).
9) Department of Veterans Affairs, Secure and Reliable Medical Information Systems, 01/01/06 - 12/31/07, $156,000 (initially awarded), X. Zou (with Y. Dai. as Co-PI)
11) Department of Transportation (DOT), Improving Hydrologic Disaster Forecasting and Response for Transportation by Assimilating and Fusing NASA and Other Data Sets, (IUPUI PI: Yao Liang), $131,463, 2/1/2014-1/31/2016.
14) National Aeronautics and Space Administration (NASA), Improving Pennsylvania Department of Transportation Hydrologic Disaster Forecasting and Response by Assimilating and Fusing NASA and Other Data Sets, (IUPUI PI: Yao Liang), $61,467; 9/1/2012-12/31/2013.

Internal

1) Purdue University Summer Research Grant, Research and Evaluation of Privacy-Preserving and Replaceable Biometrics-based Authentication, 2011, $8,000, X. Zou.
2) Indiana University’s Center for Applied Cybersecurity Research (CACR) Grant, Evaluation of Clinical and Genomic Information Privacy Risks from Inference Attacks, 06/01/10-07/31/11, $49,952, X. Zou (and with J. Chen from Sol as PI)
3) Indiana University’s Center for Applied Cybersecurity Research (CACR) Grant, A novel approach to resilient, secure, and cancellable biometrics, 07/01/09-07/31/10, $33,736,, X. Zou with S. Orr (and E. Y. Du originally from ECE as PI).
5) Purdue University, “Secure & Economically Viable Support for Internet Mobility”, (PI: Arjan Durresi), ($ 17,000): 2010-2012.
7) Purdue University Summer Research Grant, Implementation and Evaluation of Secure, Composable, and Scalable Framework for Trusted Collaborative Computing, 2008, $8,000, X. Zou

**Educational Research Group**

**Referred Journal Publications, Books, & Book Chapters**

- **HTML / XHTML / CSS All in One for Dummies** Wiley Press 2008 (A Harris, C McCullough)
- **PHP6 / MySQL Programming for the Absolute Beginner** Course Technology 2009 (A Harris)
- **JavaScript and AJAX for Dummies** Wiley Press 2010 (A Harris)
- **HTML / XHTML / CSS All in One for Dummies 2nd Ed** Wiley Press 2011 (A Harris)
- **HTML5 Quick Reference for Dummies** Wiley Press 2012 (A Harris)
- **HTML5 Game Programming for Dummies** (2013)

**Refereed Conference and Workshop Publications**

- **Scratch@MIT – Massachusetts Institute of Technology 2012 – Adding a Game Programming Component to National Science Olympics using Scratch** A Harris

**Grants**

Computer Science Pilot Grant, 2013-2014, awarded by the AP College Board, July 2013 (Michele Roberts)

Development and Implementation of Web-based Modules for a Diabetes education Program in the Pediatric Outpatient Setting, 2014 (Stancombe, K, Andrew Harris IU Health Values Fund for Education $100,000 2014-2015)

Curriculum Enhancement Grant, May 2013 (Kathy Marrs, Senehasis Mukhopadhyay, Michele Roberts)

Curriculum Enhancement Grant, IUPUI Center of Teaching and Learning, $7,600, May 2013 (Lingma Acheson)

Integrative Department Grant, awarded by the IUPUI Center of Teaching and Learning, 2009 (Michele Roberts)

Curriculum Enhancement Grant, awarded by the IUPUI Center of Teaching and Learning, 2008 (Michele Roberts)

ICHE Teacher Training Partnership Grant, 2003 (Nguyen, K., Kastberg, S., Michele Roberts)
Curriculum Vitae

Lingma L. Acheson
Department of Computer and Information Science, IUPUI
Email: linglu@iupui.edu | Phone: (317)2749733

Education

- MS in Computer Science, IUPUI 2004
- BS in English Education, Suzhou University, China, 1989

Teaching Experience

- 2007 Fall - Present: Lecturer, Computer Science Department, IUPUI
- 2007 spring: Part-time Instructor, Computer Science Department, IUPUI
- 2004 – 2007: Adjunct Faculty in Chinese Language, Butler University, Indianapolis, IN
- 1999 – 2000: Adjunct Faculty in English, San Jiang University, Jiangsu, China
- 1989 – 1999: English Teacher, Changzhou Tourism School, Jiangsu, China

Non-Academic Experience

- 2004 – 2007: Database Administrator and Webmaster, School of Engineering and Technology, IUPUI
- 1995 – 1997: Associate Director of Curriculum Department, Changzhou Tourism School, Jiangsu, China
- 1994 – 1995: Associate Director of Principal’s Office, Changzhou Tourism School, Jiangsu, China
- 1989 – 1994: Director of Student Organizations and Activities, Changzhou Tourism School, Jiangsu, China

Honors and Awards

- Recipient of the IUPUI 2009 Glenn W. Irwin, Jr. M.D. Experience Excellence Recognition Award
- First Prize in Changzhou Teacher’s Qualification Contest, 1997
- First Prize in Changzhou English Speech-Making Contest, 1997
- Second Prize Instructor’s Award in National Makeup Art Contest of Tourism Schools, 1997
• Third Prize Instructor’s Award in National Makeup Art Contest of Tourism Schools, 1997
• First Prize Instructor’s Award in Makeup Art Contest of Jiangsu Tourism Schools, 1995
• First Prize Instructor’s Award in Spoken English Contest of Jiangsu Province, 1995
• Best Essay Award in Fifth Annual National Beauty Art Seminar of China, 1994
• First Prize in Changzhou Teaching Essays Contest, 1993
• First Prize in Changzhou Teaching Skills Contest, 1992
• First Prize in Changzhou Teaching Planning Contest, 1992
• Third Prize in Changzhou Teaching Skills Contest, 1989
• University Academic Excellence Award (top 5%), 1986, 1987, 1988

Publications

• Acheson, D., Acheson, L.: Implementing a Database Drive Solution for Nominations and Elections of Faculty Governance. ASEE 2007


• Lu, L.: On Training Students to Be Professional Beauty Artists. Fifth National Conference of Association for Beauty Art, Beijing, China, January 1994


• Lu, L.: Avoiding Interference of Mother Tongue in Foreign Language Teaching. 1989 Seminar on English Teaching, Changzhou, Jiangsu, China, December 1989
NAME
Jake Y. Chen, Ph.D.

EDUCATION

2001 Ph.D. The University of Minnesota, Twin Cities, MN
Department of Computer Science and Engineering
Thesis: *A Bioinformatics Discovery-oriented Computing Framework*

1997 M.S. The University of Minnesota, Twin Cities, MN
Department of Computer Science and Engineering
Minor in *Biochemistry, Biophysics, and Molecular Biology*

1995 B.S. *Peking University*, Beijing, China
Department of Biochemistry & Molecular Biology, College of Life Sciences
GRE Biochemistry Subject Test (1995): 99%

ACADEMIC APPOINTMENTS

2012—present *Visiting Professor*, Zhejiang Institute of Biopharmaceutical Informatics and Technology, Wenzhou Medical College, China

2010—present *Associate Professor of Informatics* (with tenure), Indiana University School of Informatics, Indianapolis, IN

2010—present *Associate Professor of Computer Science* (joint appointment), Department of Computer and Information Science, Purdue University, Indianapolis, IN

2007—present *Founding Director*, Indiana Center for Systems Biology and Personalized Medicine, Indiana University – Purdue University, Indianapolis, IN

2004—2010 *Assistant Professor of Informatics*, Indiana University School of Informatics, Indianapolis, IN

2004—2010 *Assistant Professor of Computer Science* (joint appointment), Department of Computer and Information Science, Purdue University, Indianapolis, IN

INDUSTRIAL & ENTREPRENEURIAL EXPERIENCE

2011—present *Founding Board Director*, Health and Science Innovations, Inc., Indianapolis, IN

2006—present *Founder and Chairman*, Medeolinx, LLC., Indianapolis, IN

PROFESSIONAL AFFILIATIONS

*Senior Member*, Association for Computing Machinery (ACM) 2009—present

*Chair*, IEEE Engineering in Medicine & Biology Society (EMBS), Central Indiana Chapter 2005—present

*Proteomics Chair*, the Life Science Society (LSS) 2005—2008 *Senior*

*Member*, Institute of Electrical and Electronic Engineers (IEEE) 2004—present *Co-founder/Steering Committee Member*, IN Biomedical Entrepreneur Network (IBEN) 2004—2009

*Board Member*, Association of Chinese Bioinformaticians (ACBIX) 2001—2007

*Member*, International Society of Computational Biology (ISCB) 1996—present

HONORS

2012 *Innocentive Grand Challenge Award Winner*

2011 Inaugural IUPUI School of Informatics Research Award

2011 “17 Informatics Experts Worth Listening To”, HealthTechTopia

2009 IUPUI Translational Research into Practice (TRIP) Scholar Recognition Award 2008

IUPUI Chancellor’s Prestigious External Awards Recognition (PEAR)

2008 & 2007 Indiana Small Business Grant Preparation Award (for MedeoLinx, LLC, $12K)
RESEARCH GRANT AWARDS
Note: Current pending proposals are not listed.


[3] IU Subcontract PI: “R01: Initiation and Regulation of Chronic Autoimmune Prostate Inflammation”. ~$1M (my direct cost is ~$100K total), 4/1/2012 –03/31/2017, National Institute of Health (PI: Timothy Ratliff, Purdue University).

RESEARCH PUBLICATIONS
* Indicates serving as a corresponding/co-corresponding author.


SOFTWARE AND PATENTS


PROFESSIONAL SERVICE

External Grant Review Panels
Special Emphasis Panel, AREA, Pennsylvania Department of Health, Genome Canada, National Institute of Health, Emerging Technologies and Training in Neurosciences (Neurotechnology Study Section), American Institute of Biological Sciences / Department of Defense, Department of Energy, National Science Foundation

Journal Editorial Board
Personalized Medicine, Network Biology, International Journal of Functional Informatics and Personalized Medicine, BMC Systems Biology (as Associate Editor), Proteomics Insights

UNIVERSITY SERVICE

Campus Committees
IUPUI Graduate Fellowship Committee, IUPUI Research Support Fund Grant (RSFG) Review Committee, IUPUI Program Review and Assessment (PRAC) Committee

School Committees
IUPUI School of Informatics Budgetary Affairs Committee Chair, IUPUI School of Informatics Faculty Search Committee, IUPUI School of Informatics Colloquium Committee, IUPUI School of Informatics Nomination Committee

Department Committees
Bioinformatics MS/PhD Program Curriculum Committee, Bioinformatics MS/PhD Program Graduate Admissions Committee, IUPUI School of Informatics Bioinformatics Faculty Search Committee
Raymond C. Y. Chin  
Department of Mathematical Science  Indiana University Purdue University  
Indianapolis  
402 N. Blackford Street  Indianapolis, IN 46202-3216  
(317) 274-6998 (O)

Education
1970  Ph.D.  Case Western Reserve University, Cleveland, OH 1964
       M.A.E.  Rensselaer Polytechnic Institute, Troy, NY
1962  B.A.E.  Rensselaer Polytechnic Institute, Troy, NY

Professional Experience
1/05 -  Professor  Department of Mathematical Sciences,  
                  Indiana University Purdue University Indianapolis
7/97 - 12/05  Professor  Department of Computer & Information Science,  
                  Indiana University Purdue University Indianapolis
7/90 - 6/97  Professor & Chair  Department of Computer & Information Science,  
                  Indiana University Purdue University Indianapolis

Professional service
6/95 - 6/02  Ad-hoc Member  NIH study section, SSS-9
6/02 - 6/07  Ad-hoc member  NIH Bio Computing and Bio-informatics Study Section
9/89 - 9/00  Reviewer  NSF proposals and Panels
3/95 - present  Reviewer  Louisiana’s Board of Regents

Editorship
•  1976-1990 Editor, Journal of Computational Physics

Teaching Grants
1. NSF Instrument and Laboratory Improvement Grant, 1993; Chin, R. C. Y., Ng, B. S., Cox, R. W., and Palakal, M. J., “Computing Science and Mathematics: A Laboratory-Based Curriculum”
3. NSF Course and Curriculum Grant, DUE #9729433, 1997; Chin, R. C. Y. and Springer, G., “Miracle: An Environment for Teaching Programming”
4. IUPUI Honors Program Research Fellow 2000/2001
5. IUPUI Honors Program Research Fellow 2001/2002
6. IUPUI Multidisciplinary Undergraduate Research Institute grant, 2007
7. IUPUI Multidisciplinary Undergraduate Research Institute grant, 2008
8. IUPUI Multidisciplinary Undergraduate Research Institute grant, 2009

Selected Publications

174


Selected Presentations


Courses Taught

- CSCI 207 Data Analysis Using a Spreadsheets
- CSCI 340 Discrete Computational Structures
- CSCI 414 Numerical Methods
- CSCI 475 Scientific Computing I
- CSCI 476 Scientific Computing II
- CSCI 512 Numerical Methods for Engineers and Scientists
- CSCI 514 Numerical Analysis
- CSCI 515 Numerical Analysis of Linear Systems
- CSCI 520 Computational Methods in Analysis
- CSCI 590 Modeling and Computation in Neuroscience
- CSCI 590 Mathematical and Computational Physiology
- CSCI 614 Numerical Solution of Ordinary Differential Equations
- Math 163 Integrated Calculus and Analytic Geometry I
- Math 261 Multivariate Calculus
- Math 426 Introduction to Applied Mathematics and Modeling
- Math 559 Applied Computational Methods I
- Math 552 Applied Computational Methods II
- Math 511 Linear Algebra with Applications
- Math 578 Mathematical Modeling of Physical Systems, I
- Math 692 Topics in Applied Mathematics
- Math 692 Topics in Applied Mathematics: Mathematical Physiology
M. Murat Dundar, Ph.D.
Assistant Professor
Department of Computer & Information Science
IUPUI, Indianapolis, IN 46202
Email: Dundar@cs.iupui.edu
Phone: (317)278-6488

a. Professional Preparation

Bogazici University, Istanbul  Electrical & Electronics Engineering  BSc 1997
Purdue University, West Lafayette  Electrical & Computer Engineering  MS 1999
Purdue University, West Lafayette  Electrical & Computer Engineering  PhD 2003

b. Appointments

2008-Present  Assistant Professor, Department of Computer & Information Science, Indiana University – Purdue University, Indianapolis
2003-2008  Research Scientist, Computer-aided Diagnosis & Knowledge Solutions, Siemens Healthcare, USA.

c. General Summary

My area of expertise is in machine learning and data mining with a more recent focus on non-parametric Bayesian models and inference, learning with partially-observed data, online and offline class discovery and modeling. My research is mainly driven by real-world problems in computer aided diagnosis/detection, hyper-spectral data analysis and remote sensing, bio-detection, flow cytometry data analysis, information retrieval, and topic modeling. I am a co-author on over 30 peer-reviewed publications and a co-inventor in 5 patents and 2 FDA-approved computer-aided diagnosis products. I have served as a PC member for ACM SIGKDD, IEEE ICDM, SIAM SDM conferences and as a panelist for NIH and NSF review panels. I and my colleagues at Siemens Health received the Data Mining Practice Prize Award for our work on medical image mining by ACM SIGKDD in 2009. I am the main author of the paper that received the best scientific paper award in the Bioinformatics and Biomedical Applications track at the 20th International Conference on Pattern Recognition (ICPR’10). I have most recently received the 2013 NSF Early Faculty Career Development (CAREER) Award.

d. Publications  (* indicates students advised by the PI)

1. Murat Dundar, Halid Ziya Yerebakan, Bartek Rajwa, "Batch Discovery of Recurring Rare Classes toward Identifying Anomalous Samples," To appear at SIGKDD 2014. (acceptance rate: 15%)


e. Synergistic Activities

- Co-inventor on 10 patent applications and key machine learning scientist in two FDA-approved computer-aided diagnostic systems currently deployed in hundreds of hospitals around the globe.
- Organizing committee member KDD’10, PC member KDD’12, ICDM’12, SDM’13, SDM’14, ICDM’14.
- Founding board member of the Truebright Science Academy, Web:http://www.truebright.org (Grades 6-12, over 90% African-American) (2006)
- Governing board member for the Indiana Math and Science Academy (IMSA) Web:http://www.imsaindy.org (K-12). Two locations in Indianapolis with over 900 students (over 80% African American) (2008-present)

f. Collaborators and Other Affiliations:

**Collaborators and Co-Editors:** Sunil Badve (IUPUI, Associate Editor, Clinical Breast Cancer), Arun K. Bhunia (Purdue University), Jinbo Bi (University of Connecticut), Glenn Fung (Siemens Healthcare), Metin N. Gurcan (The Ohio State University, Associate Editor, IEEE TMI), E. Daniel Hirleman (UC Merced), Balaji Krishnapuram (Siemens Healthcare), Yuan Qi (Purdue University), Bartek Rajwa (Purdue University, Associate Editor Cytometry Part A), R. Bharat Rao (Siemens Healthcare, General Chair KDD’10), Vikas Raykar (Siemens Healthcare), J. Paul Robinson (Purdue University)

**Graduate Advisors and Postdoctoral Sponsors** David Landgrebe (Purdue University)

**Thesis Advisor and Postgraduate Scholar Sponsor** Ferit Akova, Gokhan Bilgin, Allison Irvine, Halidziya Yerebakan

g. Recent Grants:

2. Automated Spectral Data Transformations and Analysis Pipeline for High Throughput Flow Cytometry (funded by NIH/NIBIB) Duration: 7/12-6/14 Role: co-investigator

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Arjan Durresi  
Professor  
Department of Computer and Information Science  
Indiana University-Purdue University Indianapolis (IUPUI)  
Phone: (317) 274-8942  
Web: http://www.cs.iupui.edu/~durresi  
E-mail: durresi@cs.iupui.edu

a. Professional Preparation

Polytechnic University of Tirana, Electronic Engineering  
B. E.  
1986

Polytechnic University of Tirana, Electronic-Telecommunication Engineering  
M. S.  
1990

Italian Telecommunication Institute, Superior Specialization in Telecommunication  
1991

Polytechnic University of Tirana, Telecommunication Engineering  
Ph.D.  
1993

Tokyo Denki University, Tokyo, Japan, Computer Science  
Ph.D.  
2006

b. Appointments

Professor, Department of Computer and Information Science, IUPUI  
2013 – Present

Associate Professor, Department of Computer and Information Science, IUPUI  
2007-2013

Assistant Professor, Department of Computer Science, Louisiana State University  
2003 – 2007

Research Scientist, Department of Computer and Information Science, The Ohio State University  
1996 – 2003

Associate Professor, Chairman of the Telecommunication Dep., Polytechnic University of Tirana  
1994 – 1996

Senior Software Analyst and Designer, R&D Department at Telesoft Inc., Rome, Italy  
1991 – 1994

c. General Summary

My research focuses on networking, security and trust. I am particularly interested in new network architectures as response to the changing challenges and needs of users in various environments and applications, such as Internet, wireless, optical, multimedia, and so on. Important design goals for such systems include scalability, security, robustness, reliability, economic viability, manageability. My research explores the design space among various goals and constrains and tries to find desirable tradeoffs, which would enable the practical use of new solutions. Furthermore, I work to develop trust management systems, by using measurement theory to evaluate trust. I am the co-author of over seventy five papers in journals and over 170 papers in conference proceedings, seven book chapters, and over thirty contributions to standardization organizations such as IETF, ATM Forum, ITU, ANSI and TIA. Several of my papers has received conference awards. I have been keynote speaker in conferences including IEEE AINA and NBiS. I am the PI of four NSF funded research projects. My research has also been funded by the States of Ohio and Louisiana, as well as university and industry sources.

d. Recent Publications


e. Synergistic Activities

f. Collaborators & Other Affiliates
Collaborators and Co-Editors: Dr. Raj Jain (WUSTL), Dr. Makoto Takizawa (Seikei University, Japan), Dr. Leonard Barolli (Fukuoka Institute of Technology, Japan), Dr. Akio Koyama (Yamagata University, Japan), Dr. M. Uehara (Toyo University, Japan), Dr. Tomoya Enokido (Rissho University, Japan), Dr. Fatos Xhafa (Universitat Politècnica de Catalunya Barcelona, Spain).

Thesis Advisor and Postgraduate-Scholar Sponsor: Ph. D.: Ping Zheng (IUPUI), Yefeng Ruan (IUPUI), Harold Owens (IUPUI), Lina Alfantoukh (IUPUI), Vamsi Paruchuri (UCA).

h. Recent Grants
- PI, Secure Communications among Cell Phones and Sensors for Medical Applications, Center for Applied Cybersecurity Research - CACR, 2010-2011.
EDUCATION:
- Ph.D., Computer Science, University of Utah, 1992.
- B.S. Mathematics, Zhejiang University, China, 1983.

APPOINTMENTS:
- July 2007 – Present: Chair, Department of Computer and Information Science, Indiana University Purdue University Indianapolis (IUPUI)
- September 2006 -- June 2007: Interim Chair, Department of Computer and Information Science, IUPUI
- July 2009 – Present: Professor, Department of Computer and Information Science, IUPUI
- July 2009 – June 2011, School of Science Director of Information Technology, Indiana University Purdue University Indianapolis (IUPUI)
- August 2002 – June 2009: Associate Professor, Department of Computer and Information Science, IUPUI
- August 1996 – June 2002: Assistant Professor, Department of Computer and Information Science, IUPUI
- December 1993 – August 1996: Research Staff, Center for Information Enhanced Medicine (CiMed), National University of Singapore and The Johns Hopkins University.
- September 1992 – December 1993: Assistant Professor, CAD program, School of Architecture, The Ohio State University.
- July 1988 -- June 1992: Graduate Research and Teaching Assistant, Department of Computer Science, University of Utah
- July 1986 -- June 1988: Research Staff, CAD/CAM Center, Zhejiang University, China

PROFESSIONAL SERVICES AND RECOGNITIONS:
- Panelists, National Science Foundation (NSF), Review Panels on Career Award Panel (Media and Informatics), HCI, ITR, IIS, etc.
- Panelist, Chinese National Science Foundation (CNSF), Special Oversea Invitation.
- International Proposal Reviewer for: Hong Kong Research Grants Council; Singapore National Research Foundation; Singapore Science and Engineering Research Council; Qatar National Research Fund, etc.
- Program Committee Members / Program Chair: ACM VRST, CGI, ACM/SIGGRAPH VRCAI, CAD/Graphics International Conference, ACM SAC, Workshop on Bio-Computing (Program Co-Chair), etc.
- 1999 & 2004: Trustee’s Teaching Awards, School of Science, IUPUI.

PATENTS

MAJOR EXTERNAL RESEARCH GRANTS
- 3D Facial Imaging on FASD, co-PI (15% and 1 graduate student support; PI: Tatiana Foroud), National Institutes of Health (NIH), $1,500,000, 06/01/08 – 05/31/13.
- Mouse Model Neuro-Facial Dysmorphology: Translational and Treatment Studies, co-PI (10%, and 1 graduate student support; PI: Feng Zhou), National Institutes of Health (NIH), $1,200,000, 06/01/08 – 05/31/13.
- A Cross-Cultural Longitudinal Assessment of FASD, Co-PI (15%, and 1 graduate student support; PI: Tatiana Foroud), National Institutes of Health (NIH), $662,733, 9/29/03 – 9/28/07.
- Deformable Volume Modeling, National Science Foundation (NSF), $120,171, 7/15/98 – 12/31/01, role: PI.

SELECTED RECENT PEER REVIEWED PUBLICATIONS (From a total of 75)


a. Professional Preparation
   Ph.D. Engineering Science, Arizona State University, 1970
   M.S. Engineering Science, Arizona State University, 1964
   B.S. Engineering Science, Purdue University, 1962

b. Appointments
   2009 – present  Professor Emeritus, Department of Computer and Information Science, IUPUI
   2009 – present  Professor Emeritus, Department of Mechanical Engineering, IUPUI

c. General Summary
   1991-2009 Professor of Computer Science and Engineering
   University of Hawaii at Hilo
   Hilo, HI
   1981-1991 Professor of Computer and Information Science
   Indiana University-Purdue University at Indianapolis
   1981-1984 Staff Scientist
   Indianapolis Center for Advanced Research
   1980-1981 Associate Professor of Computer Science
   University of Central Florida
   Orlando, FL
   1970-1979 Assistant, Associate, Professor of Computer Science and Engineering Science
   Indiana University-Purdue University at Indianapolis
   2013 Outstanding Associate Faculty Award
   Purdue School of Engineering and Technology
   Indiana University-Purdue University at Indianapolis

   Research areas: database and numerical methods
   Developed numerous textbook manuals for service courses at the University of Hawaii at Hilo

d. Recent Publications

   Rothe, C.F., and Gersting, J. M., "Cardiovascular Interactions: An Interactive Tutorial and Mathematical

e. Synergistic Activities
   1975-2013 Software developer for Department of Medical and Molecular Genetics, Indiana University School of Medicine
   2009 Board Member, IndyPASS (Indianapolis Professional Association for SQL Server)
   2005-2007 Instructor, NSF Chautauqua short course on "Using Access, SQL Server, SQL, and XML in Your Database Course", University of Dayton
   1972-present Member of ACM (Association for Computing Machinery)

g. Collaborators & Other Affiliates

h. Recent Grants
Judith Gersting
Indiana University-Purdue University Indianapolis (IUPUI)
Phone: (317) 274-9727
E-mail: gersting@iupui.edu

a. Professional Preparation
   Ph.D. Mathematics, Arizona State University, 1969
   M.S. Mathematics, Arizona State University, 1964
   B.S. Mathematics, Stetson University, 1962

b. Appointments
   2009 – present Professor Emeritus, Department of Computer and Information Science, IUPUI

c. General Summary
   1990-2009 Professor of Computer Science
   University of Hawaii at Hilo
   Hilo, HI (UHH)
   Department Chair 1994-2009

   1981-1990 Professor of Computer and Information Science
   Indiana University-Purdue University at Indianapolis
   Acting Department Chair 1981-1982

   1982-1984 Staff Scientist
   Indianapolis Center for Advanced Research

   1980-1981 Associate Professor of Computer Science
   University of Central Florida
   Orlando, FL

   1970-1979 Assistant, Associate, Professor of Computer and Information Science
   Indiana University-Purdue University at Indianapolis

   Research areas: Computer science education, fault-tolerant computing

d. Recent Publications
   and Company, 2014 (969 pages)


   Learning, 2013 (855 pages)

   Technology, 2010 (718 pages)

   Edwards, H. K., Gersting, J. L., and Tangaro, T., “Teaching Alice in Hawai‘i: Cultural
   Perspectives”, Proc. of the Frontiers in Education Conference, Milwaukee, WI, October 10-13,

   Gersting, J. L., Mathematical Structures for Computer Science, Sixth Edition, W. H. Freeman and


e. Synergistic Activities
2011, Reviewer for Discrete Structures knowledge area for the ACM/IEEE CS2013 curriculum guidelines

2000-present, Referee for IEEE Transactions in Education


2008, 2009 NSF Reviewer for CCLI grant program, Washington DC


2007, Poster Session on Alice Programming, 38th SIGCSE Technical Symposium on Computer Science Education, Covington, KY

2007, Instructor, NSF-sponsored short course "Programming with Alice: A New Strategy for Introductory Computer Science Courses", University of Dayton, Dayton, OH

2007, Attended Google Faculty Summit for Computer Science, Mountain View CA

2007, NSF Reviewer for Foundation Pathways to Revitalized Undergraduate Computing Education (CPATH) program, Washington D.C.

2006, Attended NSF-sponsored Stanford by-invitation workshop on “Integrative Computing Education and Research: Preparing IT Graduates for 2010 and Beyond”, Stanford University,

1987-2009, Member of Editorial Board, Computer Science Education

1981-present Member of ACM (Association for Computing Machinery) and SIGCSE

g. Collaborators & Other Affiliates
G. Michael Schneider, Macalester College

h. Recent Grants
2005-2008, National Science Foundation Grant ($59,262), "Alice in Paradise: Adapting 3-D graphics interactive animation for teaching an introductory computer science (CS-0) course in Hawaii"
Andrew Harris  
Sr. Lecturer, Department of Computer and Information Science  
Indiana University / Purdue University – Indianapolis  
aharris@cs.iupui.edu

1. Curriculum Vitae

a. Education
- MS Informatics - New Media IUPUI 2003
- BS Special Education, IUPUI 1990

b. Academic Appointments
- 2006 – Present: Sr. Lecturer, Department of Computer and Information Science Indiana University / Purdue University – Indianapolis
- 2010 – Present: Instructor – In-Grace Homeschool cooperative High School Computer Science and Algebra (Volunteer)
- 1998 – 2006: Lecturer, Department of Computer and Information Science Indiana University / Purdue University – Indianapolis
- 1995 – 1998: Visiting Lecturer, Department of Computer and Information Science Indiana University / Purdue University - Indianapolis

c. Non-Academic Experience
- 2011 – Present: Columnist The Old Schoolhouse Magazine “The Tech Homeschooler”
- 2000 – Present: Editor (series editor Absolute Beginner Series) and technical editor - Wiley Press, Premiere Press
- 2003 – Present: Consultant, Indiana Vocational Rehabilitation Services

d. Honors and Awards
- Teaching Excellence Recognition Award (TERA), IUPUI School of Science, 1997
- Outstanding Associate Faculty, IUPUI School of Science, 1998
- Teaching Excellence Recognition Award, IUPUI School of Science, 1999
- Who’s Who Among American Teachers, Student Nomination, 2003
- School of Science Trustee’s Teaching Award, 2004

2. Grants
- Curriculum Improvement Grant, School of Science, IUPUI. Worked on use of streaming media, television, virtual reality and traditional media resources to offer high-quality course offerings
- Cultural Literacy Indexing Our Heritage, Assisted with streaming media production and inclusion.
- Using Mobile Games to Teach Children to manage Juvenile Diabetes (ongoing with Riley Children's Hospital.)

3. Publications
a. Books
- JavaScript Programming for the Absolute Beginner (Prima Tech, 2001)
- Palm Programming for the Absolute Beginner” (Premier Press, 2001)
- C# Programming for the Absolute Beginner (Premier Press, 2002)
- PHP/MySQL Programming for the Absolute Beginner (Premier Press, 2003)
- Beginning Flash Game Programming for Dummies (Wiley Press, 2005)
- Game Programming – The L Learning Line (Wiley Press, 2006)
- HTML /XHTML /CSS All in One for Dummies (Wiley Press, 2008)
- PHP 6 /MySQL Programming for the Absolute Beginner (Premier Press, 2009)
- JavaScript & AJAX for Dummies (Wiley Press. 2010)
b. Magazine Articles
- Teach yourself Game Programming with Scratch (Feature story: The Old Schoolhouse Magazine, May 2012)
- The Tech Homeschooler – Monthly column on the use of computing, coding, and technology for those who choose to teach partially or completely at home.

c. Book Chapters
- Text Editing with Emacs - Published in several Linux books for Prima Tech, and released as a standalone publication in 2002

4. Conference Presentations
- HTML5 is the new foundation of the Web – Indy Drupal Camp, September 2011
- Build your Own Video Game! Adding Computing to your Curriculum Midwest Homeschool Convention Cincinnati OH May 2012

5. Selected Software Releases
- SIMILE – A custom XML language with parser and editor for building synchronized instructional materials from browser history. (GPL)
- Miracle – A tool for teaching algorithmic programming. Students enter an algorithm and it is converted to one of a number of programming languages. (GPL)
- Abniac – A very simple 7-opcode assembly language simulator. Can be used to teach even children how an assembly language works. (GPL)
- dbLib – A PHP module that automates building a 3-tier application by introspection of a MySQL database (GPL)
- gameLib.py – A Python game engine providing another layer on top of pyGame / SDL. This library encapsulates the main look and provides a much improved sprite object as well as basic GUI capabilities. (GPL)
- SimpleGame.js – A JavaScript / HTML5 library that vastly simplifies the creation of web and mobile games with the HTML5 canvas. (GPL)

6. Selected Course Development
- CSCI 23000 Computing I – This was the traditional Computing I course offered by the CS department since its inception. Goal of course redesign was to make course more attractive to a wide range of students will still retaining focus on learning algorithm development and essential computer science skills. Currently taught in Python.
- CSCI 24000 Computing II – This advanced programming course is intended for experienced programmers ready to transition to a study of formal computer science. The course uses a historical view of programming languages using multiple languages (C, C++, and Java) to illustrate and practice concepts including pointers, compound variables, stack and heap, object-oriented programming, makeFiles, exception-handling, and object serialization.
- CSCI N341 Client-side Web Development – This course has gone through several iterations. Current version focuses on client-side web development in JavaScript and jQuery.
- CSCI N342 Server-side Web Development – Illustrates the development of multi-tiered web applications with a focus on server-side development in PHP. Strong database management focus including data normalization and implementation in MySQL.
- CSCI N351 Multimedia Development – Intended for majors and non-majors. This course begins with digital representation of analog signals, and describes how Nyquist's law is used in multiple forms of media. Students study audio, raster images, vector images, 3D scenegraphs, procedural and U/V textures, animation, and video. In addition, various forms of compression and file formats are explored for each media type. All exercises are done with open-source software tools.
- CSCI N451 Web Game Development – Teaches 2D game development with multiple tools. Begins with a pre-built HTML5 game engine for quick success. Students then dig into Python / PyGame for more detailed study of the game development process. Students finish the class with a web, mobile, or console game of their own design.
Mohammad Al Hasan
Assistant Professor
Department of Computer and Information Science
Indiana University-Purdue University Indianapolis (IUPUI)
Phone: (317) 274-3862
Web: http://www.cs.iupui.edu/~alhasan
E-mail: alhasan@cs.iupui.edu

a. Professional Preparation

<table>
<thead>
<tr>
<th>Institute</th>
<th>Degree</th>
<th>Date awarded</th>
</tr>
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<tbody>
<tr>
<td>Rensselaer Polytechnic Institute, Troy, NY</td>
<td>PhD, Computer Science</td>
<td>August 2009</td>
</tr>
<tr>
<td>University of Minnesota, Twin Cities, MN</td>
<td>MS, Computer Science</td>
<td>August 2002</td>
</tr>
<tr>
<td>Bangladesh University of Engineering and Technology, Dhaka, Bangladesh</td>
<td>BSc (Engg.), Computer Science and Engineering</td>
<td>July 1998</td>
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b. Appointments

<table>
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<tr>
<th>Institution</th>
<th>Role</th>
<th>Inclusive Dates</th>
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</thead>
<tbody>
<tr>
<td>Indiana University Purdue University Indianapolis, IN</td>
<td>Assistant Professor, Computer and Information Science</td>
<td>August 2010 – Present</td>
</tr>
<tr>
<td>eBay Inc, San Jose, CA</td>
<td>Senior Research Scientist</td>
<td>July 2009 – August 2010</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute, Troy, NY</td>
<td>Teaching / Research Assistant, CS Dept.</td>
<td>August 2004 – June 2009</td>
</tr>
<tr>
<td>University of Minnesota, Twin Cities, Minneapolis, MN</td>
<td>Teaching / Research Assistant, CS Dept.</td>
<td>September 1999 – December 2002</td>
</tr>
<tr>
<td>Ahsanullah University of Science and Technology, Dhaka, Bangladesh</td>
<td>Lecturer, Computer Science</td>
<td>August 1998 – September 1999</td>
</tr>
</tbody>
</table>

d. Recent Publications


e. Synergistic Activities

- Organizing committee member SDM’14, PC member ICDM’14, CIKM’14, BiGData’14, SDM’14, ICDM’14.
- Journal article reviewer IEEE TKDE, IEEE TNNLS, DMKD, ACM TWEB, KAIS (Springer), IJAIT, VLDB, JMLR, PLOS One, ACM Survey
- Tutorial Speaker, KDD’13, ICDM’13
- NSF IIS Panel Reviewer Fall 2010, Spring 2012, NSF SBIR Fall 2013; Grant Proposal reviewer, Louisiana Board of Regents in Fall 2013 and Netherland Organization for Scientific Research in Spring 2013,
- Indiana State Science Fair Judge, 2012 - 2014

g. Collaborators & Other Affiliates

Member: IEEE, SIAM, ACM
Mohammad Hasan’s Doctoral Advisor: Mohammed J Zaki
Doctoral Students: Mahmudur Rahman, Mansurul Bhuiyan, Tanay Saha, Baichuan Zhang, and Vachik Dave

h. Recent Grants

NSF CAREER: A novel framework for mining graph patterns in large biological and social networks (Principal Investigator), 547-427, March 2012 – February 2017
James H. Hill, M.S., Ph.D.
Assistant Professor
Department of Computer and Information Science
Indiana University-Purdue University Indianapolis (IUPUI)
Phone: (317) 274-8527
Web: http://www.cs.iupui.edu/~hillj
E-mail: hillj@cs.iupui.edu

a. Professional Preparation
2009  Ph.D. in Computer Science, Vanderbilt University, Nashville, TN
2006  M.S. in Computer Science, Vanderbilt University, Nashville, TN
2004  B.S. in Computer Science, Morehouse College, Atlanta, GA

b. Appointments
6/2013 – 5/2014  Advisory Board, Department of Continuing Education, IUPUI
8/2009 – present  Assistant Professor of Computer Science, IUPUI

c. General Summary

Dr. Hill’s research focuses on evaluating performance of software systems during early phases of the software lifecycle. His interests are in model-driven engineering, software system emulation, software system instrumentation, software performance analytics, and its application towards understanding performance properties of large-scale software system early in the software development lifecycle. Dr. Hill has published more than 55 peer-reviewed research papers since 2007 (more than 40 in rank while at IUPUI). The applied nature of his research has results in research artifacts currently being used in both academia and industry.

d. Recent Publications

The 16th IEEE International Symposium on Object/Component/Service-Oriented Real-Time Distributed Computing (ISORC), Paderborn, Germany.


e. **Synergistic Activities**

Reviewer for IEEE Software, IEEE Computer, NSF Panels, and many conferences; Steering committee for (and co-organizer of) Model-Driven Engineering for High Performance and Cloud workshop; Chairmanship on the organizing committee of MODELS, OOPSLA, and many other conferences.

g. **Collaborators & Other Affiliates**

Dr. Mohammad Hasan (IUPUI); Dr. Rajeev Raje (IUPUI); Dr. Christian Rogers (IUPUI); Mr. Clayton Nicholas (IUPUI); Mrs. Michelle Roberts (IUPUI); Dr. Bart Miller (University of Wisconsin, Madison); Mr. Andy Harris (IUPUI); Dr. Gregory Klass (Georgetown University); Dr. Eric Burger (Georgetown University); Mr. Kenneth Miller (University of Texas at Dallas); Dr. Jorgen Thelin (Microsoft Research); Dr. Sergey Bykov (Microsoft Research); Dr. Gabriel Kliot (Microsoft Research); Dr. Christian Konig (Microsoft Research); Dr. Jules White (Vanderbilt University); Dr. Douglas Schmidt (Vanderbilt University)

h. **Recent Grants**

1. System Execution Modeling Environment Research and Development – Phase 5, Australia Defense Science and Technology Organization (DSTO), 1/1/2014 - 12/31/2016, $120,000 USD.


Yao Liang  
Professor  
Department of Computer and Information Science  
Indiana University-Purdue University Indianapolis, Indianapolis, IN 46202  
Phone: 317-274-3473  
Web: http://cs.iupui.edu/people/yao-liang  
Email: yliang@cs.iupui.edu

a. Professional Preparation

1997  Ph.D. in Computer Science, Clemson University, Clemson, SC  
1988  M.S. in Computer Science, Xi'an Jiaotong University, Xi'an, China  
1982  B.S. in Computer Engineering, Xi'an Jiaotong University, Xi'an, China

b. Appointments

2013 – present  Professor, Department of Computer and Information Science, Purdue School of Science, Indiana University-Purdue University Indianapolis (IUPUI)  
2007 – 2013  Associate Professor, Department of Computer and Information Science, IUPUI  
2001 – 2007  Assistant Professor, Department of Electrical and Computer Engineering, Virginia Tech  
1997 – 2001  Technical Staff Member, Alcatel USA, Raleigh, NC

c. General Summary

Dr. Yao Liang’s research focuses on the areas of wireless sensor networks, cyberinfrastructure, adaptive network control and resource allocation, quality of service, machine learning, data mining, data fusion, hydro-informatics, data management and integration, distributed systems, and nonlinear signal prediction. He has led an interdisciplinary and multi-institutional NSF projects on developing sophisticated theoretical framework and protocols for energy-efficient and reliable data collection, and dynamic network routing topology tomography in environmental monitoring wireless sensor networks. He has also recently led an interdisciplinary and multi-institutional NASA project and collaborating with hydrologists to innovatively infuse NASA’s newly available remote sensing data and models into National Weather Service’s core operation to enhance its decision making and weather forecasting performance for flooding and drought disaster management. He also has substantial experiences and knowledge on building real-world testbed and prototype systems, such as building wireless sensor network testbed for environmental monitoring (NSF projects) and the development of the Hydrological Integrated Data Environment (HIDE) prototype system (NASA project). In addition, he has intensive research and development experiences in telecommunications industry over his four years service as a technical staff member at Alcatel, USA. He is a co-author of the work “Application of wireless sensor networks for environmental monitoring” which has received the Outstanding Student Paper Award from American Geophysical Union, 2009. He is a recipient of the University Trustees Teaching Award in 2011.

d. Recent Publications (* indicates student authors)


e. Synergistic Activities
- Senior Member, IEEE
- Editorial board member: *International Journal of Distributed Sensor Networks* (since 2014); *The Open Cybernetics and Systems Journal* (since 2007)
- Member, Hydrological Information System of CUAHSI (Consortium of Univ. for the Adv. of Hydrologic Science Inc.), 2003 – 2006
- NSF proposal panelists
- Invited talk speaker at various universities in USA, Europe and China

f. Collaborators and Other Affiliations

Students supervised by Dr. Yao Liang: M. Navarro, W. Zhao, R. Liu, Y. Li, N. Erratt, X. Zhong, S. Lochan, F. Huang, Q. Yu, W. Peng, S. Bhendigeri, M. Kishore, N. Ravindran, M. Han, D. Bhatnagar, C. Nicholson, N. Vijayaraghavan, M. Balmakhtar, D. Wen, R. Wang, J. Hu

g. Recent Grants (funded)
2. Improving Hydrologic Disaster Forecasting and Response for Transportation by Assimilating and Fusing NASA and other Data Sets, subcontract PI, DOT, Duration: 2014-2016
3. EAGER: Collaborative Research: Network Inference and Data Collection Based on Compressed Sensing in Large-Scale Wireless Sensor Networking, Lead PI, NSF, Duration:2012-2014
5. Improving Pennsylvania Department of Transportation Hydrologic Disaster Forecasting and Response by Assimilating and Fusing NASA and Other Data Sets, subcontract PI, NASA, Duration: 2012-2013
EDUCATION AND TRAINING
Shandong University, China  B.Sc. in Biochemistry 1995
Institute of Genetics, Chinese Academy of Sciences  M.Sc. in Molecular Genetics 1998
Indiana University School of Medicine, Indianapolis IN  Ph.D. in Structural Biology 2004
Indiana University School of Medicine, Indianapolis IN  Postdoc in Computational Biology 2011

ACADEMIC POSITIONS
Indiana University Purdue University Indianapolis, Indianapolis, IN
  Research Assistant Professor, Computer and Information Science  2011-present
Indiana University School of Medicine, Indianapolis, IN
  Research Assistant Professor, Pharmacology and Toxicology  2011-present

HONORS
Annual Outstanding Student Award, Shandong University  1994
Outstanding Departmental Poster Presentation Award, IU School of Medicine  2002
Travel award, 10th SCBA International Meeting  2004

TEACHING ACTIVITIES
- C572 Molecular Modeling. (Invited lecturer ) Dates: 2005

STUDENT SERVICE
Master students
- Abhinav Kuru (M.Sc., 2011);
- Divya Neelagiri (M.Sc., 2012);
- Sonali Ranalkar (M.Sc., 2013);
- Nilesh Ghadge (M.Sc., 2013);
- Atchyutha Cherukuri (M.Sc., expected 2014);
- Hema Kasi (M.Sc., expected 2014);
- Sandeep Kumar (M.Sc., expected 2015);
- Mahesh Yerram (M.Sc., expected 2015)

Ph.D. students
- Valerie Fako (Ph.D. candidate, Co-mentor, expected 2015)

Postdoctoral fellow
- Ravi Yadav (2012-2013)

PROFESSIONAL SERVICE
Associate Editorial Board Member, Int. J. Biochem Mol Biol  2011-prst
Advisory Board Member, Current Cancer Drug Target  2013-prst

RESEARCH SUPPORT
Active:

Start-Up Fund (Liu) 2012-2015
The start-up fund provided by Indiana University School of Medicine and IUPUI School of Science is to help Dr. Liu establish her laboratory and independent research career in computational biology and drug discovery.

Pending

NIH R01 (PI) “In-vivo Chemical Probes Targeting Dimerization Core Unit of Survivin” Total direct: $1,250,000.

NIH R01 (PI) “In vivo chemical probes targeting the ‘undruggable’ DNA binding site of STAT3” Total direct: $1,250,000

Past

IUPUI IM2CS-GEIRE (Liu) “Analysis of protein-protein interactions by identification and investigation of the dimerization cores” 2012-2013 Total: $15,000

ACS Institutional Award (Liu) “A novel approach targeting “undruggable” oncogenic protein dimers for drug discovery” 2013-2014 Total: $40,000

PUBLICATIONS (*co-corresponding authors).


8. Fako V.E.; Zhang, J.T.; and Liu, J.Y. Mechanism of Orlistat Hydrolysis by the Thioesterase of Human Fatty Acid Synthase. ACS Catalysis (under revision)

9. Wang, C*; Kesi, H.*; and Liu, J.Y. Parallel vs anti-parallel conformation of nonphosphorylated STAT1 (*authors contributed equally) (manuscript in preparation, expected to be submitted in June 2014)

10. Qi, J; Wang, C; Dong, Z; Liu, J; Liu, J.Y.*; Zhang, J.T.* A novel small molecule targeting the dimeric interface of survivin (manuscript in preparation, expected to be submitted in June 2014)


12. Yadav, RP; and Liu, J.Y. Distinct properties of conserved 14-3-3 human isoforms revealed by molecular dynamic simulation and SAXS (manuscript in preparation, expected to be submitted in August 2014).
Professional Preparation

- B.E. in Electronics and Telecommunications, Jadavpur University, India, 1981 - 1985
- M.S. in Electrical Engineering, Yale University, New Haven, CT, 1987 - 1991
- Ph.D. in Electrical Engineering, Yale University, New Haven, CT, 1987 – 1994

Appointments

- July 2010-Present: Professor, Computer & Information Science, IUPUI; co-director, Institute of Mathematical Modeling and Computational Science, IUPUI.
- 2001 – July 2010, Associate Professor, Computer & Information Science, IUPUI
- 2000 - 2006, Associate Director (Bioinformatics), School of Informatics, Indiana University
- 1995 - 2001, Assistant Professor, Computer & Information Science, IUPUI
- 1997 - 1997, Reader, Electronics & Telecommunications Engg, Jadavpur University
- 1994 - 1995, Visiting Assistant Professor, Computer & Information Science, IUPUI
- 1987 - 1993, Research and Teaching Assistants, Electrical Engineering, Yale University

Selected Recent Products


Other Significant Products


Synergistic Activities

1. Editorial Board Member, Journal of Bioengineering & Biomedical Science, 2010
5. Invited participant and session leader for the break-out session on “Data Management and Mining” at the NSF Workshop on Biomedical Informatics, Menucha, Oregon, 2007.

Recognitions and Honors

2014: Trustees’ Teaching Award, IUPUI
2005: Co-author, One of the Top Bioinformatics Papers, Biological Research Information Center Bioinformatics Online Newsletter, 2005
2000: The paper “Multi-agent Adaptive Dynamic Programming”, co-authored with my graduate student Joby Varghese, was selected as one of the ten best papers in the MICAI, 2000, International conference.
1996: NSF CAREER Award.
1996: Honored by the computer science club at IUPUI as the best professor for 300-500 level courses.
1995: The NET (Network for Excellence in Teaching) award at IUPUI.

Collaborators & Other Affiliations
Collaborators and Co-Editor: M. Babbar-Sebens, J. Bidwell, J. Mostafa, K. S. Narendra, M. Palakal,

Graduate and Postdoctoral Advisors
K. S. Narendra, Dept of Elec. Eng, Yale University
BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors in the order listed on Form Page 2. Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

<table>
<thead>
<tr>
<th>NAME</th>
<th>POSITION TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palakal, Mathew</td>
<td>Executive Associate Dean, School of Informatics &amp; Computing, Professor of Computer Science</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>eRA COMMONS USER NAME (credential, e.g., agency login)</th>
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</tr>
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<tbody>
<tr>
<td>mpalakal</td>
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**EDUCATION/TRAINING** *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

<table>
<thead>
<tr>
<th>INSTITUTION AND LOCATION</th>
<th>DEGREE (if applicable)</th>
<th>MM/YY</th>
<th>FIELD OF STUDY</th>
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<tbody>
<tr>
<td>Concordia University, Montreal, Canada</td>
<td>B.S.</td>
<td>05/79</td>
<td>Computer Science</td>
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<tr>
<td>Concordia University, Montreal, Canada</td>
<td>M.S.</td>
<td>05/83</td>
<td>Computer Science</td>
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<tr>
<td>Concordia University, Montreal, Canada</td>
<td>PhD.</td>
<td>05/87</td>
<td>Computer Science</td>
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**A. Positions and Honors**

**Positions and Employment**

2013 - present  Executive Associate Dean, School of Informatics & Computing  
Indiana University Purdue University, Indianapolis

2006 - 2013  Associate Dean, Research & Graduate Programs, School of Informatics  
Indiana University Purdue University, Indianapolis

2001 - present  Professor of Department of Computer and Information Science  
Indiana University Purdue University, Indianapolis

1997 - 2006  Chairman, Department of Computer and Information Science  
Indiana University Purdue University, Indianapolis

1994 - 2001  Associate Professor of Computer and Information Science  
Indiana University Purdue University, Indianapolis

1988 - 1994  Assistant Professor of Computer and Information Science  
Indiana University Purdue University, Indianapolis

1987 - 1988  Visiting Assistant Professor of Computer Science  
Concordia University, Montreal, Canada

**Other Experience and Professional Memberships (short list)**

2001  Reviewer, Bioinformatics

2001  Reviewer, IEEE Transactions on Neural Network

2002-2003  Reviewer, Bioinformatics

2006-  Editorial Board, International Journal of Data Mining and Bioinformatics, Inderscience

2005-2008  Bioinformatics Poster Chair for ACM SAC International Symposium

2004-2013  Bioinformatics Track co-chair for ACM SAC International Symposium

2010-2011  ACM International Symposium on Applied Computing, Program Co-Chair

2010  International Symposium in Biocomputing 2010, Program Co-Chair

**Honors**

2013  Excellence in Service Recognition Award, ACM SIGAPP

2000  Teaching Excellence Recognition Award, Community Learning Network

1998  Teaching Excellence Recognition Award, Computer & Information Science

1997  IUPUI, School of Science Teaching Award

1996  Professor of the Year Award, Computer Science Club

1995  Professor of the Year Award, Undergraduate Programs, Computer Science Club
C. Selected Peer-reviewed Publications (Selected from over 100 peer-reviewed publications)


Rajeev R. Raje
Professor
Department of Computer and Information Science
Indiana University-Purdue University Indianapolis (IUPUI)
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a. Professional Preparation

☐ Ph.D. in Computer Engineering, Syracuse University, Syracuse, NY, 1994.
☐ M.S. in Computer Engineering, Syracuse University, Syracuse, NY, 1994.
☐ B.E. in Electrical Engineering, University of Bombay, Bombay, India, 1984.

b. Appointments

☐ CIS Department, IUPUI, Indianapolis, IN: Professor, 2009-Present.
☐ CIS Department, IUPUI, Indianapolis, IN: Associate Professor, 2002-2009.
☐ CIS Department, IUPUI, Indianapolis, IN: Assistant Professor, 1996-2002.
☐ CIS Department, IUPUI, Indianapolis, IN: Visiting Assistant Professor, 1994-1996.
☐ ECE Department, Syracuse University, Syracuse NY: Research Assistant, Aug 1988-Aug 1989.

c. General Summary

Dr. Raje’s expertise is in designing distributed software systems. His current research interests include service-oriented computing, QoS-aware mobile and distributed systems, and associated software engineering issues. He has published more than 100 peer-reviewed publications and has also been an invited speaker on many occasions. His current and past research has been funded, as the PI or Co-PI, by the Security and Software Engineering Research Center (funding from Air Force Research Labs, Department of Homeland Security, Lockheed-Martin, and Northrup-Grumman), Office of Naval Research, National Science Foundation, Microsoft, and Eli Lilly. He, as a PI or Co-PI, has received grant support worth more than five million dollars. Dr. Raje is a member of the ACM and IEEE.

d. Recent Publications

Relevant


Other Papers


e. Synergistic Activities


f. Collaborators & Other Affiliates


ii. Graduate Advisor: Daniel J. Pease – Syracuse University.


h. Recent Grants

i. A Distributed Framework for Indoor Location Tracking, Purdue Research Foundation, $17,241, 2013-14 (Joint PI)


Michele Roberts

Professional Preparation
- MBA, Indiana Wesleyan, 1995
- MA, Indiana State University (1978)
- BS, Central College (1976)

Appointments
- April, 2014 – Present, Senior Lecturer, Department of Computer and Information Science, Indiana University Purdue University Indianapolis (IUPUI), Indianapolis, IN.
- January, 1999 – Lecturer, Department of Computer and Information Science, Indiana University Purdue University Indianapolis (IUPUI), Indianapolis, IN.
- August, 1998 – December, 1998 – Visiting Lecturer, Department of Computer and Information Science, Indiana University Purdue University Indianapolis (IUPUI), Indianapolis, IN.

Education-Related Honors and Awards
Poster Presentation
- *Data-Driven Broadened Participation*, Presented at SIGSCE 2014

Internal Grants (funded)
- Curriculum Enhancement Grant, 2013 (Co-PI)
- Gateway Department Grant, 2008-2009 (PI: M Roberts)
- Integrative Department Grant, 2007-2008 (PI: M Roberts)

External Grants (funded)

External Grants (non-funded)
- Improving Teacher Training, 2003, (PI: Kim Nyugen)
- A Pilot Program for Accelerating Technology Integration in the K-12 Classroom, 1999 (PI: Mathew Palakal)

Patents
Fengguang Song
Assistant Professor
Department of Computer and Information Science
Indiana University-Purdue University Indianapolis (IUPUI)
Phone: (317) 274-7265
Web: http://www.cs.iupui.edu/~fgsong
E-mail: fgsong@cs.iupui.edu

a. Professional Preparation
☐ Postdoc Research Associate, Innovative Computing Laboratory, University of Tennessee, 2010-2012.
☐ Ph.D. in Computer Science, University of Tennessee at Knoxville, TN, 2009.
☐ M.S. in Computer Science, University of British Columbia, Vancouver, Canada, 2002.
☐ B.S. in Computer Science Zhengzhou University, Zhengzhou, China, 1996.

b. Appointments
☐ CIS Department, IUPUI, Indianapolis, IN: Assistant Professor, 2013-Present.

c. General Summary
Dr. Song’s expertise is in parallel, distributed systems, and high performance computing. He currently conducts research at the frontiers of computer science towards exascale computing and big data science discovery across different disciplines. In particular, he focuses on parallel algorithms, software, and advanced architectures for scientific computing, life science, simulation, and knowledge discovery. He designs innovative algorithms and software systems that can scale on large high-end systems with heterogeneous many-cores and accelerators at extreme scale.

d. Recent Publications

Relevant


Other Papers


e. Synergistic Activities
i. Reviewer for TPDS, JPDC, ParCo, TACO, Supercomputing.
ii. Technical program committee members for SC’14, IPDPS’14, EuroMicro’14.
iii. Co-chair of International Workshop on High Performance Big Graph Data Management, Analysis, and Mining (in conjunction with IEEE BigData 2014).

g. Collaborators & Other Affiliates
i. Collaborators: Juan Colmenares (Samsung Research America), Jack Dongarra (UTK), Bilel Hadri (NICS), Jilong Kuang (Samsung Research America), Hatem Ltaief (KAUST), Shirley Moore (UT-El Paso), Rajeev Raje (IUPUI), Stanimire Tomov (UTK), Mihran Tuceryan (IUPUI), Daniel Waddington (Samsung Research America), Asim YarKhan (UTK), Luoding Zhu (IUPUI).
ii. Graduate Advisor: Jack Dongarra, University of Tennessee at Knoxville.
iii. Recent Graduate Research Associates: Jeffery Kriske, Prateek Nagar, Sanjay Akella.

h. Recent Grants
i. Scalable Manycore Software System for Scientific Computing, Grant to Enhance Interdisciplinary Research and Education, 01/01/2014 - 12/31/2014, Institute of Mathematical Modeling and Computational Science (iM2CS), $8,000, IUPUI.
Gavriil Tsechpenakis  
Associate Professor  
Department of Computer and Information Science  
Indiana University-Purdue University Indianapolis (IUPUI)  
Web: cs.iupui.edu/~gavriil  
E-mail: gavriil@cs.iupui.edu

a. Professional Preparation  
POSTDOCTORAL: Rutgers University, NJ, Computer Science, Dec 2006  
GRADUATE: National Technical University of Athens, Greece, PhD, Electr & Comp Eng, Jun 2003  

b. Appointments  
Associate Professor (tenured)  
Indiana University-Purdue University Indianapolis, Dept. of Computer and Information Science  
Jul 2014--present

Assistant Professor (tenure-track)  
Indiana University-Purdue University Indianapolis, Dept. of Computer and Information Science  
Aug 2010--Jun 2014

Research Assistant Professor  
University of Miami, FL, Dept. of Computer Science  
Jul 2008--Jul 2010

Visiting Assistant Professor  
University of Miami, FL, Dept. of Electrical and Computer Engineering  
Jan 2007--Jun 2008

c. General Summary  
2013: NSF CAREER Award  
2010--2013: Two federal-funded projects (National Science Foundation) as the sole principal investigator (including the CAREER Award), with budget summing up to $900K (secured funding until 2018)

2013: Indiana University Collaborative Research Grant (Funding rate ~5%)  
2010: Two federal-funded subcontracts (National Institutes of Health) transferred to IUPUI from University of Miami  
2008-2012: Completed five fully funded projects  
2010--2013: Four invited talks (not including job interviews and conference presentations)  
2007: Best reviewer’s award at the most significant Computer Vision conference (Int'l Conference of Computer Vision)  
1999--2013: 20 journal and 35 peer review conference papers (all “top-tier”), 7 book chapters, 8 abstracts

d. Recent Publications  


e. Synergistic Activities

LOCAL: Indianapolis Project Seed internships for K-12, 2012--present

NATIONAL: National Science Foundation, Panel reviewer, 2010


g. Collaborators & Other Affiliates

Akira Chiba (Biology, University of Miami), Vincent Lemmon (Neurological Surgery, University of Miami), Michael Kim (Molecular and Cellular Pharmacology, University of Miami), Brian Samuels (Glick Eye Institute, Indiana University), Kenneth Muller (Physiology and Biophysics, University of Miami), Laura Bianchi (Physiology and Biophysics, University of Miami), Larry Cohen (Physiology, Yale University School of Medicine), John Nicholls (Scuola Internazionale Superiore di Studi Avanzati, Italy), Jaime Eugenin (Biology, Universidad de Santiago de Chile), Fotios Andreopoulos (Biomedical Engineering, University of Miami), Radka Stoyanova (Radiation Oncology, University of Miami), Meng Lin (Optometry, University of California, Berkeley), Brandon Lujan (Ophthalmology, University of California, Berkeley), Philip Rosenfeld (Bascom Palmer Eye Institute, University of Miami), Jianhua Wang (Bascom Palmer Eye Institute, University of Miami), Shuliang Jiao (Bascom Palmer Eye Institute, University of Miami), Monica Driscoll (Molecular Biology and Biochemistry, Rutgers University), Robert Cowen (Rosenstiel School of Marine & Atmospheric Science, University of Miami), Carol Neidle (Modern Foreign Literatures, Boston University).

h. Recent Grants


Curriculum Vitae

Mihran Tuceryan
Department of Computer & Information Science
Indiana University Purdue University Indianapolis
723 W. Michigan St, SL-280K
Indianapolis, IN 46202-5132
Phone: (317) 274-9736
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Education

Ph.D., Computer Science, University of Illinois, Urbana, 1986
B.S., Computer Science and Engineering, Massachusetts Institute of Technology, 1978

Professional Experience

• Indiana University Purdue University Indianapolis (IUPUI), Indianapolis, Indiana, Professor, (August 2012 – Present)
• Indiana University Purdue University Indianapolis (IUPUI), Indianapolis, Indiana, Associate Professor, (March 1997 – July 2012).
• Technical University of Munich (TUM), Munich, Germany, Visiting Professor, (July – December 2004), (on sabbatical leave from IUPUI).
• Texas Instruments, Dallas, Texas, Member of Technical Staff, (October 1995 – March 1997).
• European Computer-Industry Research Centre (ECRC), Munich, Germany, Senior Research Scientist, (September 1992 – September 1995).
• Michigan State University, East Lansing, Michigan, Assistant Professor in Computer Science, (September 1986 – August 1992).

Honors

2005 Senior Member, Institute of Electrical and Electronics Engineers (IEEE)
2006 IU Trustees Teaching Award (TTA), Indiana University

Patents

US Patents Awarded


Selected Peer-reviewed publications(reverse chronological order)


Current and Past Research Support

Xukai Zou  
Associate Professor  
Department of Computer and Information Science  
Indiana University-Purdue University Indianapolis (IUPUI)  
Phone: (317) 278-8576  
Web: http://www.cs.iupui.edu/~xkzou  
E-mail: xkzou@cs.iupui.edu  

a. Professional Preparation  
University of Nebraska-Lincoln, USA Computer Science Ph.D., 2000  
Huazhong University of Science & Technology, China Computer Science M.S., 1986  
Zhengzhou University, China Computer Science B.S., 1983  

b. Appointments  
July 2009 - present, Associate Professor, Department of Computer Science, IUPUI  
August 2003 – June 2009, Assistant Professor, Department of Computer Science, IUPUI  
1993 - 1997 Associate Professor, Dept. of Computer Science, Zhengzhou University, P.R. China.  
1986 - 1992 Lecturer/Assistant Professor, Dept. of Computer Science, Zhengzhou University, P.R. China.  

Other Professional Appointments  
2002 - 2003 Post doctoral research associate and Lecturer, Department of Computer Science & Engineering, University of Nebraska- Lincoln, Lincoln, NE, USA.  
2001 - 2002 Software Architect, ACE information resource Inc., NJ, USA.  

c. General Summary  
My area of expertise is cryptography and network security, particularly, group key management, secret sharing, access control, biometrics and user authentication, moving target defense, secure digital provenance, secure electronic voting, health information security and personal genomic data privacy, and social, delay tolerant, and mobile security. My research is mainly driven by fundamental security needs in computing/networking systems and real applications such as user authentication, medical/genomic data security/privacy and secure online voting and election. I have published over 90 peer-reviewed papers, including 5 book chapters and 45 peer-reviewed papers since 2007, and also three monographic books. My research has been supported by National Science Foundation, the Department of Veterans Affairs, and Industry such as Cisco and Northrop Grumman. I have served as associated editor for three international journals, and program co-chair, program committee member, and reviewer for a lot many international conferences and journals. I also served on NSF panelist and as panel reviewer for NIH.  

d. Recent Publications (* indicates student authors)  

e. Synergistic Activities

- NSF Panelist (2008, 2010) and NIH grant external reviewer.
- Director of TEGO (Trusted Electronics and Grid&Group Obfuscation) Research and Education Center
- Associate Editor (AE) of International Journal of Computers and Applications (2003-), Associate Editor (AE) of International Journal of Security and Networks (2009-), Associate Editor of the Journal Communications (2010-), Program Co-Chair for three International Conferences and reviewer or TPC member for many International Journals and Conferences such as IEEE Transactions on Computers, IEEE Transactions on Dependable and Secure Computing, IEEE Transaction on Parallel and Distributed Computing, ACM Transactions on Information and System Security.

f. Collaborators & Other Affiliates

(i) Collaborators:
Peng Liu, Penn State University, Eliza Yingzi Du, QualComm, Jake Chen, Indiana University, Feng Li, IUPUI, Li Bai, Temple University, Jie Wu, Temple University, Elisa Bertino, Purdue University, Fabio Maino, Cisco System Inc.
(ii) Graduate and Postdoctoral Advisors:
Postdoctoral advisor : Prof. Byrav Ramamurthy, University of Nebraska-Lincoln.
Ph.D. advisors: Profs. Spyros Magliveras and Byrav Ramamurthy, University of Nebraska-Lincoln.

h. Recent Grants
3. CISCO, Building A Secure Video Streaming Framework for Dynamic and Anonymous Subscriber Groups, 07/15/08--07/15/09, Sole PI.
NAME
Yuni Xia

CONTACT INFORMATION
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Email: yuxia@gmail.com

EDUCATION
Ph.D., Computer Science, Purdue University, 2005.
M.S., Computer Science, Purdue University, 2002
B.S., Computer Science and Engineering, Huazhong University of Science and Technology, China, 1996

ACADEMIC APPOINTMENTS
2012 – Present Associate Professor of Computer and Information Science, IUPUI
2005 – 2012, Assistant Professor of Computer and Information Science, IUPUI
2003 Research Intern, IBM TJ Watson Research Center, NY
1999 – 2005 Research Assistant, Purdue University

AWARDS AND HONORS
1. Best Demo Award, International Conference on Database System for Advanced Application (DASFAA), 2011
2. Scalable Data Analytics Innovation Award, IBM, 2010
3. Techpoint Mira Award, with Senior Care Navigation System development team at My Health Care Manager LLC, Indiana TechPoint Organization, 2010
4. Research Venture Award, IUPUI, 2009
5. Trustee’s Teaching Award, IUPUI, 2009
6. Real Time Innovation Award, IBM, 2008

GRANTS, FELLOWSHIPS AND AWARDS
3. Large Scale Sensor Stream Analysis and Mining for Geriatric Care, PI, IBM Research, 2010.
4. DisProt Database: A Central Repository of Information on Intrinsically Disordered Proteins, Co-PI (one month summer and one graduate student, PI: Keith Dunker), National Science Foundation(NSF), 2009-2012.
7. NSF-EHCS (EHS), SM: Development of SYMBIOTE; A Reconfigurable Logic Assisted Data Stream Management System for Multimedia Sensor Networks, Co-PI (0.3 month summer and one graduate student, PI: Jaehwan Lee), National Science Foundation(NSF), 2008-2010.

Recent Publications (from 46 publications)
2. Chandima Hewa Nadungodage, Yuni Xia, John Lee, Myungcheol Lee, Choon Seo Park, GPU Accelerated Item-Based Collaborative Filtering for Big-Data Applications, proceedings of the IEEE International Conference on Big Data (IEEE BigData) 2013.

3. Chandima Hewa Nadungodage, Yuni Xia, Jaehwan John Lee, Yi-cheng Tu, Hyper-Structure Mining of Frequent Patterns in Uncertain Data Streams, Journal of Knowledge and Information Systems (KAIS), 2013.


7. Jiaqi Ge, Yuni Xia, A Discretization Algorithm for Uncertain Data, the 21st International Conference on Database and Expert Systems Applications (DEXA), 2010.


9. Jiaqi Ge, Yuni Xia, Chandima Hewa Nadungodage. Classify Uncertain Data with Neural Network, the 14th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD), 2010.

10. Biao Qin, Yuni Xia, Rakesh Sathyesh, Sunil Prabhakar, Yicheng Tu, uRule: A Rule Based Classifier for Data with Uncertainty, the IEEE International Conference on Data Mining (ICDM), 2009.

TEACHING
CSCI340: Discrete Computational Structures
CSCI441: Client Server Databases
CSCI443: Database Systems
CSCI481: Introduction to Data Mining
CSCI541: Database Management Systems
CSCI573: Data Mining
CSCI590: Advanced Database Systems

SERVICES

Program Committee on more than 10 Conferences,
Panelist, National Science Foundation, CISE, 2007, 2009, 2011
a. Professional Preparation

- 1983, BS, Computer Science, Fudan University, China
- 1987, MS, Control Engineering, Osaka University, Japan
- 1990, PhD, Control Engineering, Osaka University, Japan

b. Appointments

- 1990-1993, Research Associate, ATR Communication System Lab, Advanced Telecommunication Research Institute, Japan
- 1994-2001, Associate Professor, School of Information Science and Engineering, Kyushu Institute of Technology, Japan
- 2001-2011, Associate Professor, Department of Computer Science and TASI, IUPUI
- 2011-Current, Professor, Department of Computer Science, IUPUI

c. General Summary

Dr. Zheng works in the areas of image, video, multimedia, computer vision, virtual reality, pervasive computing, and intelligent transportation systems. His current research interests include 3D measuring and modeling, dynamic image processing and tracking, scene representation for various environments, intelligent vehicle, and sensor network. His research was supported by NIJ, NICT and TOYOTA. Dr. Zheng has published 150 papers in journals and conferences as main author and he is a senior member of IEEE.

d. Recent Publications


e. Synergistic Activities


iii. Grant review NSF Panels, NPRP, US-Israel Binational Science Foundation

iv. Hosting international researchers: Yaping Huang, Shengchun Wang, Seng Luo, Ryo Fujishiro, Koki Ishida

g. Collaborators & Other Affiliates

- Yaobin Chen, Lauren Christopher, Stanley Chien, TASI, IUPUI
- Mihran Tuceryan, CS Department, IUPUI
- Chen Yu, Department of Cognitive Science, IUB
- Bing Zhang, NICT, Japan

- Transportation Active Safety Institute, IUPUI
- Invited research professor at National Inst. of Inf. and Comm. Tech., Japan 2009
- Invited professor, Osaka University, Japan in 2007

h. Recent Grants

NIJ: (1) Co-PI, 2008-2009, Advanced In-car Video System, $270,000
(2) Co-PI, 2010-1013, Device to digitize track impression, $253,000

NICT: PI, Sensor Network over 2D Communication LAN Sheet, $50,000

TOYOTA: Co-PI, 2014-2016 Vehicle testing scenario generation $1,500,000