

Section I—ICHE proposal

Cover Page

INSTITUTION: Indiana University-Purdue University Indianapolis (IUPUI)

CAMPUS: Indianapolis

COLLEGE: Purdue School of Science

DEPARTMENT/SCHOOL: Computer and Information Science

DEGREE PROGRAM TITLE: Doctor of Philosophy (Ph.D.) in Computer Science

SUGGESTED CIP CODE: 11.0701

PROJECTED DATE OF IMPLEMENTATION: August 2016

NEW DEGREE PROGRAM PROPOSAL SIGNATURE PAGE

Degree Title: Ph.D. in Computer Science

Name of academic unit offering the new degree: Purdue School of Science, IUPUI

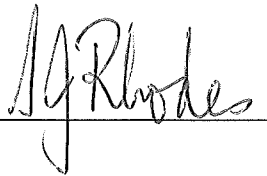
Include signatures from all involved programs:



9/24/2015

Shiaofen Fang, Professor and Chair
Department of Computer and Information Science, IUPUI

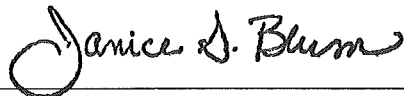
Date



Simon Rhodes, Dean
Purdue School of Science, IUPUI

Date

9/28/15



Janice Blum
Associate Vice Chancellor for Graduate Education, IUPUI

Date

10/1/15

Approval Recommended by the Graduate Council

Date

M.J.T. Smith
Dean of the Graduate School

Date

Debasish (Deba) Dutta
Provost

Date

Executive Summary

The Purdue School of Science at Indiana University-Purdue University Indianapolis (IUPUI) seeks to convert its currently “stewarded” Ph.D. program in Computer Science offered within the Department of Computer and Information Science (“CIS Department”) to a site-approved Ph.D. degree program. The CIS Department has been actively involved in Ph.D. training for over 10 years under the “stewardship” of the Department of Computer Science at PUWL. Although the Ph.D. program started slowly after the inception of the “stewardship” agreement in 2002, it has grown into a highly successful program in recent years -- as highlighted by the achievements of the faculty and the graduate students of the CIS Department. Given the experience and maturity of the CIS Department, the current “stewarded” arrangement is bureaucratically cumbersome and unnecessary. In its current form, it lacks the flexibility to be customized for local training needs and emerging opportunities. Also, it does not correctly attribute the degrees to the Indianapolis campus even when all course- and thesis-work is currently performed at IUPUI. Hence, the Purdue School of Science at IUPUI now seeks to convert its ongoing Ph.D. training program to a degree program that is site-approved for Indianapolis.

The proposed Ph.D. program in Computer Science at IUPUI will provide a focal point for scientific exchange and training that will be unique and much needed to support the local and central Indiana economy. Currently, there are no other Ph.D. programs in Computer Science in the metropolitan Indianapolis area. It is also clear that local Ph.D. training opportunities in Computer Science are desired by local employers, such as Interactive Intelligence, Salesforce Marketing Cloud, Dow AgroSciences, Anthem, Angie’s List, and Eli Lilly. The creation of a site-approved Ph.D. in Computer Science will serve also the goals of IUPUI by increasing the graduate research and training efforts with a focus that aligns and synergizes with the health science-oriented characteristics of the IUPUI campus. Aside from the obvious impact of the planned degree program on the local economy, nationally, the labor market for graduates with doctoral degrees in Computer Science is expected to grow 17.1% according to the U.S. Bureau of Labor Statistics projections and the proposed program will help IUPUI to exploit this new opportunity.

The CIS Department has a strong research program that is capable of supporting the proposed Ph.D. program. The CIS Department currently has 15 full time tenure-track faculty members who are committed to high quality research and teaching, with research foci on data mining, imaging/visualization, high performance and distributed computing, software engineering, and networking/network security. Faculty research efforts, in recent past, have been well funded by various agencies such as the NSF (including several CAREER awards in recent years), NIH, NASA, NIJ, DHS, and DoD.

1) Characteristics of the Program

- a) *Campus(es) Offering Program:* Indiana University-Purdue University Indianapolis (IUPUI)
- b) *Scope of Delivery Specific Sites or Statewide):* IUPUI
- c) *Mode of Delivery (Classroom Blended, or Online):* Classroom
- d) *Other Delivery Aspects (Co-ops, Internships, Clinicals, Practics, etc.):* Ph.D. students will be required to participate in research. Ph.D. students have the option to complete internships related to their plan of study.
- e) *Academic Unit Offering Program:* School of Science, IUPUI

2) Rationale for Program

a) Institutional Rationale (e.g. Alignment with Institutional Mission and Strengths)

IUPUI is identified as the urban research campus of Indiana University and, additionally, as a consequence of the presence of a contingent of health-related schools, is IU's "Health & Life Sciences" campus. Given the rapid growth and specialization of IUPUI over the past 46 years, IUPUI and the Purdue School of Science now seek to convert a well-established Purdue Ph.D. program in Computer Science currently operating within the Department of Computer and Information Science ("CIS Department") to a site-approved doctoral degree program in Computer Science that reflects the unique emphasis and mission of the CIS Department, encompassing specialized niches including computational research in the context of health sciences. This proposed program will build upon the existing research strengths in the CIS Department and will also leverage the life science resources available in Indianapolis and on the IUPUI campus to train the next generation of Computer and Computational Scientists to meet growing demand of the industry in Central Indiana. Given the ubiquity and importance of computation in all aspects of current society, including the health and life sciences, such a program will play a pivotal role in creating a computation-aware workforce, which is critical to today's knowledge economy, in the Central Indiana region.

The campus Vision Statement is very clear about the future direction of IUPUI: The IUPUI Vision is "to be the best urban research university by conducting world-class research, scholarship, and creative activities that develop knowledge and contribute to the economic growth and social advancement of Indiana and the nation and benefit humanity as a whole." Also, as indicated above, the notion of computation is expected to be central in all aspects of near- and long-term future and its impact on other sciences is expected to be profound. If IUPUI has to achieve its vision then Computer Science has to play a critical role in that journey.

These above-mentioned factors, together with an evolution of the IUPUI campus and changes in the local economy over nearly 50 years, makes Indianapolis-based doctoral programs not just an aspiration but also a pressing need to sustain the research and educational enterprise of Central Indiana, the home of many information technology, life

and health science, and manufacturing industries. Indeed, building the research strength of the Purdue School of Science at IUPUI has been of pressing importance to the campus for at least 39 years: the CIS Department began offering the M.S. degree in the early 1970s. However, due to various reasons, a Ph.D. program in the CIS Department was not available until early 2000's. A Memorandum of Understanding was approved by the Computer Science Department at the Purdue University and the CIS Department that paved the way for admitting Ph.D. students at IUPUI. Over the past 10 years, the program has grown significantly in size with 36 students currently enrolled. Hence, the status quo of the CIS Department in terms of maturity, size, and specialization, has outgrown the practical utility and need for the present, often cumbersome, system of oversight. The CIS Department is no longer new to Ph.D. training and it is on the cusp of a major expansion, being the recipient of many successful and prestigious grants (e.g., three NSF CAREER awards in recent past), continuous and expected hiring, and successful Ph.D. alumni. These factors will solidify the faculty base and is expected to enhance external funding significantly.

In addition, the burgeoning growth of the undergraduate student population at IUPUI seeking Science, Technology, Engineering and Mathematics (STEM) education, a thriving M.S. program in the CIS Department, the construction of yet another laboratory building in 2013, and increased external grant income, the conversion of the CIS Department's currently "stewarded" Ph.D. program to one that is specific to the Indianapolis campus will go far towards making IUPUI's abovementioned vision a reality. By directly offering a Ph.D. administered exclusively in Indianapolis, the CIS Department will be able to improve its reputation through inclusion of its own graduates in national ranking systems (e.g., those administered by the ACM/IEEE; currently, graduates are attributed to the "steward" department!) and directly act upon the goals set forth by recent external review teams. Further, although the commitment of the CIS Department to research is clear in all new faculty hires, for the department to be increasingly competitive in the recruitment of top faculty talent (and for these new hires to be successful), a robust, high quality graduate program at the Ph.D. level is an absolute necessity.

The impact of Ph.D. training is clear – over the past ten years or so, the faculty research output (both in terms of high-quality publications and external funding) has certainly been impacted, in the most positive manner, due to the presence of a dynamic and eager Ph.D. student body. Finally, a site-approved Ph.D. program provides tangible benefits to the undergraduate institutional mission: it is clear that the presence of an active Ph.D. program inspires undergraduate students in the STEM research enterprise. Conversely, active undergraduate student involvement in research provides opportunities for Ph.D. students to gain experience in mentoring and directing research projects. The positive educational synergism that occurs between an active Ph.D. program and undergraduate students in the same discipline of science cannot be overstated.

b) State Rationale

Science Pioneers, a non-profit organization, clearly articulates the importance of STEM education by stating (<https://www.sciencepioneers.org/parents/why-stem-is-important-to-everyone>), "Science, Technology, Engineering and Mathematics—STEM, and therefore, STEM education—are vital to our future—the future of our country, the future of our region and the future of our children. Besides, STEM is everywhere; it shapes our

everyday experiences.” Out of the STEM disciplines, Computer Science has the unique honor of positively impacting and empowering all the other STEM fields – this fact is emphasized in a report entitled, “Towards 2020 Science” created by a group of distinguished international scientists (http://research.microsoft.com/en-us/um/cambridge/projects/towards2020science/downloads/T2020S_ReportA4.pdf). The very first finding in the report says: “An important development in science is occurring at the intersection of Computer Science and the sciences that has the potential to have a profound impact on science. It is a leap from the application of computing to support scientists to ‘do’ science (i.e. ‘computational science’) to the integration of computer science concepts, tools and theorems into the very fabric of science. While on the face of it, this change may seem subtle, we believe it to be fundamental to science and the way science is practiced. Indeed, we believe this development represents the foundations of a new revolution in science.” Hence, it not only critical for IUPUI but also for the state of Indiana – and in particular the Central Indiana region – to recognize the importance of the CIS Department and let it flourish and significantly contribute to the development and growth of the central Indiana region and beyond.

This proposal aligns with two of the goals of the strategy paper “Reaching Higher, Achieving More” published by the Indiana Commission for Higher Education (ICHE). Firstly, the continued “mission driven” development of the current Ph.D. program in the CIS Department, drawing upon the proximity of the medical, dental, engineering, and public health, law, and business schools, provides a distinct but integrated approach to Computer Science research and education within Indiana’s academic landscape. Furthermore, the existing Ph.D. program and CIS Department are “workforce-aligned” – located in Indiana’s urban economic hub and providing unique opportunities for partnership, this program is integral to the delivery of high quality training to graduates with an emphasis on the skills required by the state’s major employers, such as Eli Lilly, Dow AgroSciences, Roche Scientific, Allison Transmission, Salesforce Marketing Cloud, Interactive Intelligence, Anthem, Angie’s List, and countless startups. The CIS Department is also actively engaged in the newly instituted “LGRAD” graduate training partnership between the School of Science and Eli Lilly – through this program, eligible and academically admissible Lilly employees can receive Ph.D. training through a leave-of-absence with a guarantee of employment upon graduation. Finally, the correct assignment of Purdue degrees earned at IUPUI to the Indianapolis campus through the institution of a site-approved program addresses a direct request made earlier by the ICHE. Clearly attributing the Ph.D. work conducted at IUPUI to the campus as opposed to a “steward” department will go a long way towards accurately reflecting the role and ongoing activities of IUPUI in the state.

c) Evidence of Labor Market Need

i) National, State, or Regional Need

Computer Science, as indicated earlier, is a unique field mainly due to its inherent nature of creating, changing, and improving new aspects of the continuously evolving

digital world. The latter does not only include the traditional Computer and Information Science domains, but also other scientific disciplines spanning from Biology and Medicine, to Psychology and Environmental Sciences, under the notion of data/computational science. Inter-disciplinary research, or even research on the border between Computer Science and other scientific fields, has been a constantly increasing trend; for instance, programs in National Science Foundation focus specifically on asking new domain-specific questions and finding the answers through computational modeling (e.g., Collaborative Research in Computational Neuroscience – CRCNS program). Additionally, all evidence from publically available data support the increasing need for Computer Science research. The National Association of Colleges and Employers (NACE, 2014) reports that a significant percentage of Computer Science or related field (e.g., Communications Technology and Computer Engineering) graduates find jobs, and most importantly seek graduate education. Indicatively, among the Computer Science graduates, 73.2% find jobs with average \$62,194 annual salary, and about 8% go to graduate school; among Computer Science-related graduates, an average of 72% find jobs and about 7% continue to graduate school. Interpreting the detailed NACE data, the global trend among these graduates is that the more technology application-oriented the degree, the lower the percentage of graduates continuing their education towards a higher terminal degree. Computer Science, being the foundation of computing, offers both core scientific and application-specific career options, and therefore, Computer Science Ph.D. degrees have been and are projected to be in high demand.

ii) Preparation for Graduate Programs or Other Benefits

A Ph.D. in Computer Science is a terminal degree. However, the constantly expanding research and development in academia and industry, and the need for computing in almost all scientific fields, render such degree a step toward post-doctoral training in different research domains, such as Bio-medicine, Business and Economics. Given the IUPUI campus characteristic of a highly diverse and inter-disciplinary collaboration environment, a Ph.D. in Computer Science will provide the degree benefits of the skilled workforce needed in the computing-related market, as well as produce researchers in highly projected trending areas in science and engineering. Additionally, IUPUI takes pride in being the leading institution that educates future employees, including research scientists, that stay in Indiana. A Ph.D. in Computer Science from IUPUI will have the training capacity to produce scientists for different types of industry, such as pharmaceutical (e.g., Eli Lilly and Company) and engineering (e.g., Rolls Royce and Cummins), and academic research position in IUPUI and other local universities.

iii) Summary of Indiana Department of Workforce Development and/or U.S. Department of Labor Data

The Bureau of Labor spotlight on statistics contains the following four statements: “Workers with more education often have higher earnings, but earnings vary within every education level.”; “In May 2014, the highest paid 10 percent of U.S. workers

(those at or above the 90th percentile) earned about 5 times as much as the lowest paid 10 percent (the 10th percentile).”; “The highest paid 10 percent of workers in the information industry earned nearly 6 times as much as the lowest paid 10 percent, with a 90-10 ratio of 5.8.”; and “It’s well known that some occupations typically pay more than others. For example, the median annual wage for information security analysts was \$88,890 in May 2014.” An interpretation of these statements is that well qualified job candidates with higher terminal degrees in fields of increasing trend, such as Computer Science, have better projected career outcomes. For a Ph.D. graduate in Computer Science, specifically, the median pay in 2012 was \$102,190, the total number of positions available was 26,700, and the job outlook was 15% (faster than average). According to the same report, “Employment of computer and information research scientists is project to grow 15 percent from 2012 to 2022, faster than the average for all occupations. Computer scientists are likely to enjoy excellent job prospects, because many companies report difficulties finding these highly skilled workers.” Additionally, there were 1,000-4,999 new research positions, with 10-19% demand growth and >\$75k average salary.

In Indiana, the same increasing trends are recorded for both Computer Science graduates (both B.S. and Ph.D.). This is reflected in the statistics reported by the Bureau of Labor (State-specific, May 2014), where the annual mean wage for computer and information research scientists is \$100,370, the highest among Computer Science-related jobs, with 5.1% mean wage RSA (relative standard error). In the return on investment report of the Indiana Commission for Higher Education, IUPUI CIS graduates are reported to be employed in a variety of industries, related to their degree or not, such as computer systems design (19%) and employment services (5%), while 11% continue their education towards higher degrees.

iv) National, State, or Regional Studies

One of Indiana’s strongest industries is life-sciences. In the BioCrossroads report “Using Post-Baccalaureate Education as a Competitive Advantage for Indiana’s Life Sciences Industry” (2012), it is described how the growing science, technology, healthcare and patient care sectors in Indiana require more workforce with higher-level post graduate degrees, and that current local programs cannot fulfill such needs. In the same report, it is noted that “If Indiana’s local colleges and universities can begin to develop credentialing and certificate programs that are professionally-focused, then those courses would serve as a bridge for the individual from a general education to a specific job. Local employers would benefit from a range of skills and knowledge that they need to be competitive.”

IUPUI is the only urban campus in Indiana, with life sciences playing a dominant role in the campus’ mission. This is a strong driving factor for developing Computer Science research in bio-health related domains, such as medical informatics and computational neuroscience, and thriving local and state-wide research collaborations. In 2013, IUPUI was recognized by *U.S. News & World Report’s*

annual *Best Colleges Report* for offering “Programs to Look For,” and in 2014, for the seventh year in a row, it was among the top ten “up-and-coming national universities.” Also, IUPUI is “one of only 11 universities selected by the National Science Foundation and the College Board to pilot an innovative introductory Computer Science course aimed at addressing critical regional and national shortages of trained Computer Scientists,” recorded in IUPUI’s annual performance report. Finally, in *Diverse: Issues in Higher Education* (2013), IUPUI was ranked among the “top 20 non-historically black colleges & universities for minorities.”

The dominant presence of the IU Medical School, among the largest in the country, the increasing demand for research in computing state and nation-wide, the increasing rates of research success and recognition of individual faculty (grants and publications), the urban environment, and the relatively low cost of living, are major factors rendering the CIS Department ideal for offering a site-approved a Computer Science Ph.D. at IUPUI.

v) *Surveys of Employers or Students and Analyses of Job Postings*

A simple search in online public domains also reveals the high demand of skilled Computer Scientists; for instance, in May 2015 a nation-wide search in *indeed.com* yielded 240,519 Computer Science jobs (2,191 in Indiana), with 5,442 requiring Ph.D. degrees (17 new such positions in Indiana). In the same month, there were thousands of positions posted for related fields, such as Data Science (3,526 jobs), Computational Science (2,966 jobs), Computational Statistics (870 jobs), and Computational Biology (1,055 jobs).

vi) *Letters of support*

Three letters of support are included in the Appendix—one from the Head of the Computer Science Department at the Purdue University – West Lafayette, Dr. Sunil Prabhakar, the second from the Chair of the External Review Committee (review completed in October 2014), Dr. Jeff Gray, from the University of Alabama, and the third from the Chairman, President and CEO of Eli Lilly and Company, Dr. John Lechleiter.

3) Cost of and Support for Program

a) Costs

- i) *Faculty and Staff:* The CIS Department currently has 15 tenured or tenure-track faculty members, who already serve as Advisors and Mentors for existing Ph.D. students. There are plans to hire 2-3 additional tenure-track faculty members in the coming years.
- ii) *Facilities:* As this program already exists at IUPUI, existing learning and teaching facilities will be used to support the program.

- iii) *Other Capital Costs (e.g. Equipment)*: As this program already exists at IUPUI, no additional costs are anticipated for capital equipment. Existing capital resources already in use will continue to be used.

b) Support

- i) *Nature of Support (New, Existing, or Reallocated)*: As this program already exists at IUPUI, mechanisms for support are already in place and currently utilized. These mechanisms for support will continue under an independent program.
- ii) *Special Fees above Baseline Tuition*: Ph.D. students in IUPUI's program currently are assessed the same tuition and fees as other School of Science graduate students at IUPUI. This is expected to continue and no additional or special fees are anticipated.

Table 1
Question 3a: Cost of and Support for the Program
Detail on Direct Program Costs
Indiana University-Purdue University Indianapolis
Ph. D. in Computer Science

	FTE	Year 1 2016-17	FTE	Year 2 2017-18	FTE	Year 3 2018-19	FTE	Year 4 2019-20	FTE	Year 5 2020-21
Personnel Services										
Faculty	0.5	\$ 45,000	1.2	\$ 108,000	1.7	\$ 153,000	2.3	\$ 207,000	2.9	\$ 261,000
Staff	-	-	-	-	-	-	-	-	-	-
Graduate Assistants	1.0	46,000	2.0	92,000	3.0	138,000	4.0	184,000	5.0	230,000
Total Personnel Services		\$ 91,000		\$ 200,000		\$ 291,000		\$ 391,000		\$ 491,000
Supplies and Expense										
General Supplies and Expense		\$ 43,200		\$ 97,200		\$ 140,400		\$ 183,600		\$ 237,600
Recruiting		-		-		-		-		-
Travel		-		-		-		-		-
Library		-		-		-		-		-
Total Supplies and Expense		\$ 43,200		\$ 97,200		\$ 140,400		\$ 183,600		\$ 237,600
Equipment										
New Equipment (see narrative)		\$ -		\$ -		\$ -		\$ -		\$ -
Equipment Replacement		-		-		-		-		-
Total Equipment		\$ -		\$ -		\$ -		\$ -		\$ -
Facilities (see narrative)		\$ -		\$ -		\$ -		\$ -		\$ -
Student Assistance										
Graduate Fee Scholarships		\$ 22,200		\$ 44,300		\$ 66,500		\$ 88,600		\$ 110,800
Fellowships		-		-		-		-		-
Total Student Assistance		\$ 22,200		\$ 44,300		\$ 66,500		\$ 88,600		\$ 110,800
Total Costs		\$ 156,400		\$ 341,500		\$ 497,900		\$ 663,200		\$ 839,400

4) Similar and Related Programs

a) List of Programs and Degrees Conferred

i) Similar Programs at Other Institutions

There are several traditional Computer Science Ph.D. programs in Indiana, with the largest being in the Department of Computer Science, Purdue University-West Lafayette (PUWL), the “steward” program under which the CIS Department is operating. Other Computer and Informatics Science Ph.D. programs are present at Indiana University-Bloomington (IUB) and the Computer Science and Engineering Ph.D. program in the University of Notre Dame. Each of these programs has a focus that makes them different in some but not in all ways. The proposed Computer Science Ph.D. program will complement existing programs in the state by not only becoming the only site-approved Ph.D. in Computer Science in Indianapolis but by also being a close partner to local industry and act as the explorer in the emerging areas related to Computer Science and its applications to health-related disciplines. For example, our Ph.D. graduates and candidates already work in the IT industry in Indianapolis. The independent Ph.D. program will enable us to better serve the local IT industry. One of the important focal areas in the CIS Department is in Computational Life Science. This focus is synergistic with, and complementary to, research being done in Biology, Physics, Medicine, Dentistry, Psychology and Engineering on the IUPUI campus.

ii) Related Programs at the Proposing Institution

There are no graduate-level degrees in Computer Science in the Indianapolis area or at IUPUI. The School of Informatics has an independent Indiana University Ph.D. in Informatics with a specialization in areas such as Bioinformatics.

b) List of Similar Programs Outside Indiana

All research universities beyond the confines of Indiana offer a Ph.D. in Computer Science. For example, the MIT, Carnegie Mellon University, Cornell University, University of California, Los Angeles, University of Illinois at Urbana-Champaign, Case Western Reserve University, and Ohio State University all offer a Ph.D. in Computer Science. All peer institutions of IUPUI offer a Ph.D. in Computer Science, including the University of Illinois at Chicago, University of Texas at Dallas, University of Wisconsin at Milwaukee, SUNY at Binghamton, CUNY City College, University of Central Florida, University of South Florida, University of Alabama Birmingham, and the Florida International University.

c) Articulation of Associate/Baccalaureate Program

Not Applicable.

d) Collaboration with Similar or Related Programs on Other Campuses

The CIS Department envisions becoming a focal point for computing research and to represent Purdue University well in this endeavor at the location of the state’s largest medical school. The CIS Department has had ongoing collaborations with other units

(Medical School, Dental School, School of Informatics, and School of Engineering). Faculty initiated collaborations have also been ongoing with disciplinary colleagues on the IUB and PUWL campuses. These collaborative efforts will continue to increase due to the presence of unique yet complementary areas of research expertise. All these aspects are value-added indirect benefits of a Ph.D. program that will be site approved.

5) Quality and Other Aspects of the Program

a) Credit Hours Required/Time to Completion

The proposed Ph.D. program requires 90 credit hours for completion. Minimally, 27 credit hours of in-class coursework are required (9 courses), including CSCI¹ 50300 (Operating Systems) and CSCI 58000 (Algorithm Design, Analysis and Implementation); the remaining 63 credit hours come from CSCI 69900 Research Ph.D. Thesis with the student's advisor. Ph.D. students may choose to complete more in-class coursework than the minimum requirement of 27 credits, reducing the 69900 research component accordingly. Students who have completed a Master's degree previously may be able to apply course credits toward the Ph.D. degree, thus reducing their credit hour requirement and time to completion. Such situations will be evaluated on a case-by-case basis by the Graduate Committee of the CIS Department.

Full-time status requires enrollment in 8 credit hours per semester (fall and spring); students who are employed for 16-20 hours weekly on a Student Academic Appointment are required to enroll in a minimum of 6 credit hours per semester to maintain full-time status. Typically, Ph.D. students enroll in 6-9 credit hours (combined coursework and/or research credits) up through the semester in which they complete their coursework and pass qualifying examinations. Once the student has completed all coursework, enrollment in 9-12 CSCI 69900 research credit hours is typical each semester. Registration for research credits in the summer session is possible, depending on a particular student's situation. A Ph.D. student typically would complete the program in 5 years (10 semesters). See Section II for a sample plan of study.

b) Exceeding the Standard Expectation of Credit Hours

Not applicable.

c) Program Competencies of Learning Outcomes

The Learning Outcomes for the proposed site-approved Ph.D. degree program in Computer Science are:

1. Demonstrate a sound and in depth understanding of general fundamental computing concepts (e.g., algorithms, programming languages, operating systems, etc.).
2. Demonstrate mastery of Computer Science in at least one sub-discipline of Computer Science.

¹ All courses offered by the CIS Department have a prefix of "CSCI".

3. Integrate sub-disciplines of Computer Science and other disciplines as applicable in problem solving and research.
4. Search, read and understand peer-reviewed computer area literature, and apply acquired knowledge in the selected field of study.
5. Present and communicate results to peers through international conference, posters, seminars and/or journal publishing.
6. Develop skills to design solid methods, algorithms, systems, and experiments to solve general computational problems with real data.
7. Teach effectively in labs or recitations in lower-level undergraduate Computer Science courses.
8. Think critically and creatively to invent new computational frameworks, methodologies, and systems.
9. Propose original research and conduct this research independently, including project design, analysis and conclusion.
10. Communicate and defend scholarly works.

d) Assessment

For the assessment of student applications and degree progress, the IUPUI Ph.D. will be operated in the same way as the current Purdue West Lafayette program. The program will be evaluated using the following parameters:

1. Number of applicants and admitted students
2. Number of students attending
3. Number of students supported on grants and from institutional sources
4. Academic profiles of attendees (GPAs, GRE scores, graduate degrees, previous institutions attended, ranking in previous institution)
5. Student performance in course work
6. Student performance on Cumulative Exams
7. Student research productivity (number of publications, presentations)
8. Awards and other special recognition
9. Time to degree completion
10. Number of graduates
11. Student placement: Number placed and quality of placements

Monitoring the above parameters will be the responsibilities of the Department Chair, the Director of Graduate Studies and the Departmental Graduate Committee. Each year, in early fall, the recruiting data (Items 1 and 2) from the previous year will be collected and summarized. Historical data (Item 4) on matriculating students will also be compiled at that time. Each annual cohort will be followed through graduation to collect the information for items 9 and 10. Pass rates on the Cumulative Exams will be collected for the previous year in the summer (Item 6). Course work performance will be monitored semester by semester (Item 5). To permit a long-term view of career trajectories, data regarding student research productivity, awards and job placement will be followed for three to five years post-graduation (Items 7, 8 and 11). The proportion of institutionally and grant-supported students (Item 3) will also be monitored annually. It is an important measure of program

effectiveness that institutional commitment and external research funding success be in balance.

e) Licensure and Certification

The Ph.D. program is not intended to prepare students for any specific licensures or certifications.

f) Placement of Graduates

Existing Ph.D. students have access to various career assistance resources on campus, including the Science PREPS office and many job and internship fairs conducted throughout the year. Current Ph.D. students also benefit from an access to Purdue University's CCO job banks and resources, including Science/Technology focused job fairs held on the West Lafayette campus.

The IUPUI Computer Science Ph.D. program has, so far, graduated following students and each has successfully found a position in industry and academia, as listed in the table below.

Year of graduation	Name	Current position	Research Advisor
2010	Qian You	Research Scientist, Amazon	Shiaofen Fang
2012	Omkar Tilak	Software Developer, Nimbula	Snehasis Mukhopadhyay
2013	Hongyuan Cai	R&D Engineer, Synopsys	Jiang Yu Zheng
2013	Yan Sui	Programming Sr. SME, Amdocs, Inc.	Xukai Zou
2013	Jing Wan	Data Scientist, State Farm	Shiaofen Fang
2013	Ferit Akova	Machine Learning and Computational Intelligence Scientist, Geisinger Neurosciences	Murat Dunder
2014	Rui Liu	Software Engineer, Interactive Intelligence	Yao Liang
2014	Wei Zhao	Assistant Professor, University of Indianapolis	Yao Liang
2015	Wei Peng	Core OS Software Engineer, Intel Corporation	Xukai Zou
2015 (pending)	Lahiru Pileththuwasan Gallege	Data Scientist, KPMG	Rajeev Raje

g) Accreditation

The proposed program will not be accredited as no accreditation mechanism exists for U.S. Ph.D. programs in Computer Science.

6) Projected Headcount and FTE Enrollment and Degrees Conferred

Institution/Location: Indiana University-Purdue University Indianapolis
 Program: Ph. D. in Computer Science
 Proposed CIP Code: 11.0701
 Base Budget Year: 2014-15

	Year 1 2016-17	Year 2 2017-18	Year 3 2018-19	Year 4 2019-20	Year 5 2020-21
Enrollment Projections (Headcount)					
PhD Program	8	16	24	32	40
Master of Arts Program	-	-	-	-	-
	8	16	24	32	40
Enrollment Projections (FTE)					
PhD Program	6	12	18	24	30
Master of Arts Program	-	-	-	-	-
	6	12	18	24	30
Degree Completion Projection	-				8

Section II—Academic Program Description (Appendix A & B format)

Information reported in Section I may be referenced.

1) Curriculum and Requirements²

a) *Admissions Requirements*

Applicants must have a four-year bachelor's degree or equivalent degree; great weight is placed on the quality of the institution. The applicant must have adequate Computer Science background, as determined by the Departmental Graduate Committee.

Applicants who begin a graduate program in Computer Science at another institution should complete at least a year in that program before applying. If the program is a master's program, completion of the program is typically required before registration at IUPUI. If the program is a doctoral program, evidence of eligibility to continue that program is required.

The following is recommended for course work:

- Proficiency in a programming language such as Java, C, or C++. Graduate students are expected to learn on their own whatever programming languages may be needed for the course they take.
- Understanding of the fundamental concepts of Computer Science.
- Familiarity with data structures and their implementations in different languages.
- An understanding of computer architecture, compilers, operating systems, the analysis of algorithms, networks, and programming languages.
- Knowledge of mathematics through differential equations, linear and matrix algebra, and numerical methods.

GPA: Entering students are expected to have a grade point average (GPA) equivalent to at least 3.50 (A = 4, B = 3, C = 2, D = 1, F = 0) in all their courses as well as in Computer Science and Mathematics courses. If the institution does not use an ABC...grading system and does not publish an official algorithm for converting its grades to such a system, applicants are then expected to be in the top ten percent of their class.

GRE: Scores on the Graduate Record Exam (GRE) must be submitted for admission consideration.

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

² A majority of the academic requirements are based on the ones used by the current "stewarded" Ph.D. program and are available at: <http://cs.iupui.edu/graduate/degrees/phd> and <https://www.cs.purdue.edu/graduate/curriculum/doctoral.html>.

of 79 or higher, or an IELTS band score of 6.5 or higher is required. Applicants submitting TOEFL scores must also meet the following section minimum requirements in addition to the minimum Total requirement: 18 Writing, 18 Speaking, 14 Listening, 19 Reading.

b) Curriculum Requirements

Successful completion of the doctoral program requires:

- 1 Research Orientation Course (CSCI C591)
- 2 Research Courses within first 3 semesters (CSCI 69900 Research. Ph.D. Thesis)
- Ethics Requirement
- 9 Courses (see Plan of Study)
- Research Credits (CSCI 69900 Research. Ph.D. Thesis)
- Qualifying Process
 - Qualifying Examination, Part 1
 - Qualifying Examination, Part 2
- Advisory Committee
- Approved Plan of Study
- Preliminary Examination
- Thesis Defense and Deposit
- Example Ph.D. Timeline

Research Orientation

The Research Seminar for First-Year Graduate Students (CSCI C591) introduces students to the Computer Science faculty and their research, and includes talks on how to conduct research as well as write, present, and review research papers and proposals. Students must complete this course in their first year.

Two more research courses (each 3 or more credits of CSCI 69900, Research. PhD Thesis must be completed by the end of the third semester. Students are expected to identify a faculty supervisor for each course, and work with that faculty member to define the research project. The courses may be supervised by the same or different faculty members. Students must write a report at the end of each of these research courses, and will be given a written formal evaluation of that report by the faculty member supervising the research. The report and the evaluation must be submitted to the Graduate Program Administrator upon completion of the semester; the reports will be considered by the Qualifying Examination, Part 2 committee. Only one research course can be taken per semester or summer. Students who are not doing a research course in the second semester must contact the Graduate Committee at least one month before registering for the third semester.

Ethics Requirement

All Ph.D. students must attend the ethics lecture of CSCI C591. In addition, all Ph.D. students must pass the responsible conduct of research (RCR) on-line test at www.citiprogram.org and forward the certificate to the Graduate Program Administrator.

Qualifying Process

To qualify for the doctoral program, students must pass the qualifying examination at the latest by the end of their fourth semester. The process consists of two parts taken in sequence. The Part 1 tests students for their breadth of knowledge in Computer Science and the ability to use that knowledge, while the Part 2 tests their knowledge and ability to conduct research.

Qualifying Examination, Part 1

The Qualifying Examination, Part 1 consists of passing four written Qualifying Course Examinations (QCEs), each from a different area. **At least** three QCEs have to be passed by the end of the third semester. Part 1 must be completed at the latest by the end of the fourth semester.

The QCEs have to be chosen from the following list of areas and courses:

- Algorithms (CSCI 58000)
- Artificial Intelligence, Data Mining, Information Retrieval (CSCI 57300, CSCI 59000 Machine Learning)
- Bioinformatics (CSCI 59000 Algorithms in Bioinformatics)
- Cryptography, Information Security (CSCI 55500)
- Databases (CSCI 54100)
- Distributed Computing (CSCI 53700)
- Programming Languages and Compilers (CSCI 50200, CSCI 56500)
- Scientific Visualization, Geometric Modeling, Graphics (CSCI 55000)
- Software Engineering (CSCI 50600)
- Systems and Networking (CSCI 50300, CSCI 53600)

The QCE must be in a course taught by a faculty member whose primary appointment is in the CIS Department. The QCE need not be taken in the same semester as the course is taken. Students may take more than four QCEs. A failed QCE may be repeated only with the permission of the Graduate Committee. QCEs are given at the end of the course.

Students who wish to take a QCE must register for the QCE 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.

Exceptions:

Students who have taken similar graduate courses outside the CIS Department may apply to the Graduate Committee for permission to take the QCEs without taking the courses.

Qualifying Examination, Part 2

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

Students are nominated for the 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 Director of the Graduate Program to schedule the examination.

Part 2 may be repeated once. Additional repetitions must be approved by the graduate committee, and will be granted only in special cases. The Graduate Committee reserves the right to appoint a committee and set an examination date for any student who has not completed the qualifying examination by the end of the fourth semester.

Advisory Committee

By the end of the semester in which the student completes the qualifying process, the student must form an Advisory Committee consisting of the proposed supervisor of the student's research, as Chair, plus two or more other faculty members, agreed upon by the student and the Chair, that are willing to serve. Qualified faculty from other departments may serve on the committee but may not form a majority of it. A proposed research supervisor not a faculty member in the CIS Department may be approved as a Co-Chair along with a Co-Chair in the CIS Department. Committee members from outside IUPUI may be approved but must be in addition to the members required. The Advisory Committee is listed on the plan of study form and becomes official upon final approval of the form.

Plan of Study

The plan of study must be approved by the Advisory Committee and the departmental Graduate Committee, and must be filed by the end of the semester in which the student completes the qualifying process.

The plan of study must include at least nine courses of which at least six must be Computer Science courses. Students may petition the Graduate Committee for an exception if they have a good reason to have fewer than six CSCI courses.

The nine courses must include CSCI 50300 and CSCI 58000 and the four courses chosen by the student to satisfy the Qualifying Examination, Part 1.

The remaining courses must be three-credit, level 5 or 6, non-individual courses approved by the student's Advisory Committee and the Graduate Committee.

A list of pre-approved courses from outside the CIS Department will be developed and listed on the departmental web site. Courses from outside the CIS Department not included on this list must be approved in advance by the Graduate Committee, via a petition process.

The courses on the plan of study cannot have been used to satisfy requirements for an undergraduate degree nor can they cause the student's doctoral plan of study to include courses from more than one master's program.

All courses listed on the plan of study must be graded in the usual manner so they can be included in computing a grade-point average (GPA). In particular, courses graded on a pass/no pass or satisfactory/unsatisfactory basis cannot be used.

The GPA on the plan of study must be at least 3.5.

A student receiving a grade lower than C- in a course on the plan will normally have to repeat the course.

If a course is repeated, only the last grade, even if lower, is used to compute all GPAs involving that course.

Courses from other institutions may be accepted with the approval of the student's Advisory Committee, the Graduate Committee, and the Graduate School. The minimum acceptable grade is B- or the equivalent.

Research Credits

The total number of hours of academic credit used to satisfy the graduate school's degree requirements consists of all graduate course credit hours that appear on the plan of study and research credit hours (CSCI 69900) with grades of S that appear on the transcript. At least 90 total credit hours are required.

For example, if a plan of study lists 27 credit hours an additional 63 research credits of CSCI 69900 with a grade of S are required to satisfy those degree requirements.

At least one-third of the total credit hours used to satisfy degree requirements must be earned while registered for doctoral study at IUPUI.

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 at the latest 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.

c) Sample Curriculum

Year 1	Semester 1	<ul style="list-style-type: none">• Research Seminar for First-Year Graduate Students (0 credits)• CSCI 50300 (3 credits, QCE)• CSCI 50600 (3 credits, QCE)• CSCI 56500 (3 credits)	Register for and take one or more written QCEs
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	Semester 2	<ul style="list-style-type: none">• CSCI 58000 (3 credits, QCE)• CSCI 54100 (3 credits, QCE)• CSCI 69900 (3 credits)	Register for and take one or more written QCEs
Year 2	Semester 3	<ul style="list-style-type: none">• CSCI 53600 (3 credits)• CSCI 53700 (3 credits)• CSCI 69900 (3 credits) (complete additional QCEs if necessary)	<ul style="list-style-type: none">• Complete Qualifying Examination, Part 1• Finalize research area and thesis advisor
	Semester 4	<ul style="list-style-type: none">• CSCI 50700 (3 credits)• CSCI 52000 (3 credits)• CSCI 69900 (3 credits) (complete additional QCEs if necessary)	<ul style="list-style-type: none">• Complete Qualifying Examination, Part 2• Form Advisory Committee• File Plan of Study
Year 3	Semester 5	CSCI 69900 research credits (9-12 credits per semester)	<ul style="list-style-type: none">• Take and pass the Preliminary Examination• Work on research and thesis writing
	Semester 6		
Year 4	Semester 7		
	Semester 8	CSCI 69900 research credits (9-12 per semester)	<ul style="list-style-type: none">• Defend the thesis• Schedule and complete thesis format review• Deposit thesis
Semester 9			
Year 5	Semester 10		

d) *Existing courses in the proposed curriculum*

Course Title: Compiling and Programming Systems

Course Number: CSCI 50200

Credit Hours: 3

Description: Basic principles of compilers and compiler design; control of translation, loading, and execution; symbolic coding systems; lexical and syntactic analysis; design and operation of assemblers and macroprocessors; and design of interpretive systems. Students are expected to complete a large programming project as part of the course.

Course Title: Operating Systems

Course Number: CSCI 50300

Credit Hours: 3

Description: Basic principles of operating systems; addressing modes, indexing, relative addressing, indirect addressing, stack maintenance; implementation of multitask systems; control and coordination of tasks, deadlocks, synchronization, and mutual exclusion; storage management, segmentation, paging, virtual memory, protection, sharing, and access control; file systems; resource management; and evaluation and prediction of performance.

Course Title: Concepts in Computer Organization

Course Number: CSCI 50400

Credit Hours: 3

Description: The fundamentals of computer hardware for computer scientists. An overview of the organization of modern computers, ranging from sequential to advanced machines. CISC, RICS, and vector processors; multiprocessors; virtual storage,

hierarchical memory; interaction with O/S; connection models; high-level programming support; and cost/performance analysis.

Course Title: Management of the Software Development Process

Course Number: CSCI 50600

Credit Hours: 3

Description: A survey of the fundamental principles and concepts of managing a software project. Topics include life cycle models, standards and goals, cost estimation, risk analysis, tool use, component reuse, traceability, metrics, and process control and improvement. Students are required to apply management concepts using a project-based approach.

Course Title: Object-Oriented Design and Programming

Course Number: CSCI 50700

Credit Hours: 3

Description: An advanced exploration of the object-oriented model and programming. Topics range from a review of the object model to advanced concepts such as abstraction mechanisms, standard library/packages, OO design using an OO language, and the syntax and the semantics of constructs. Prerequisite: 50600.

Course Title: Computational Methods in Analysis

Course Number: CSCI 52000

Credit Hours: 3

Description: A treatment of numerical algorithms for solving classical problems in real analysis with primary emphasis on linear and nonlinear systems of equations and on optimization problems; the writing, testing, and comparison of numerical software for solving such problems; and a discussion of the characteristics of quality software for implementing these algorithms.

Course Title: Data Communication and Computer Networks

Course Number: CSCI 53600

Credit Hours: 3

Description: Data communications: communication hardware technologies including local area and long-haul network hardware, circuit and packet switching, interfaces between computer and network hardware, and performance issues. Network architecture: protocol software and conceptual layering, reliable delivery over an unreliable channel, transport protocols, virtual circuits, datagrams, Internet working as a fundamental design concept, the client-server paradigm, naming and name binding, name servers, addressing and address resolution, routing and routing algorithms, congestion and flow control techniques, network file systems, distribution of computation, and DARPA Internet protocols TCP/IP as examples of protocol organization.

Course Title: Introduction to Distributed Computing

Course Number: CSCI 53700

Credit Hours: 3

Description: Introduction to the principles and methods in the design of distributed computing systems. It covers the fundamentals of distributed computing from four perspectives: underlying communication media, protocols and their implications; operating system issues; high-level language constructs; and distributed algorithms. Prerequisite: 50300 and 53600.

Course Title: Database Systems

Course Number: CSCI 54100

Credit Hours: 3

Description: Fundamentals for the logical design of database systems. The entity-relationship model, semantic model, relational model, hierarchical model, network model. Implementations of the models. Design theory for relational databases. Design of query languages and the use of semantics for query optimization. Design and verification of integrity assertions, and security. Introduction to intelligent query processing and database machines.

Course Title: Intelligent Systems

Course Number: CSCI 54900

Credit Hours: 3

Description: This course will discuss problems in the area of intelligent systems. Topics include the formalisms within which these problems are studied, the computational methods that have been proposed for their solution, and the real-world technological systems to which these methods have been applied.

Course Title: Computer Graphics

Course Number: CSCI 55000

Credit Hours: 3

Description: An introduction to computer graphics. Topics include the concepts, principles, algorithms, and programming techniques in 3D interactive computer graphics. Emphasis is on the development and applications of 3D graphic algorithms and methods.

Course Title: Data Visualization

Course Number: CSCI 55200

Credit Hours: 3

Description: An introduction to data visualization. It aims to provide a balanced coverage of both scientific visualization and information visualization, including algorithm design and implementation, software tools, and applications. Students will explore a variety of data representation and modeling techniques, their corresponding visualization algorithms, and practical visualization applications in scientific, engineering, and biomedical fields. Prerequisite: 55000.

Course Title: Cryptography

Course Number: CSCI 55500

Credit Hours: 3

Description: Concepts and principles of cryptography and data security. Cryptography (secret codes): principles of secrecy systems; classical cryptographic systems, privacy enhanced email; digital signatures. Proprietary software protection; information theory and number theory; complexity bounds on encryption; key escrow; traffic analysis; attacks against encryption; basic legal issues; e-commerce; the role of protocols.

Course Title: Programming Languages

Course Number: CSCI 56500

Credit Hours: 3

Description: An exploration of modern or unconventional concepts of programming languages, their semantics, and their implementations; abstract data types; axiomatic semantics using Hoare's logic and Dijkstra's predicate transformers; denotational semantics; functional, object-oriented, and logic programming; concurrency and Owicki-Gries theory. Example languages include ML, Ada, Oberon, LISP, PROLOG, and CSP.

Course Title: Data Mining

Course Number: CSCI 57300

Credit Hours: 3

Description: Data Mining has emerged at the confluence of artificial intelligence, statistics, and databases as a technique for automatically discovering summary knowledge in large datasets. This course introduces students to the process and main techniques in data mining, including classification, clustering, and pattern mining approaches. Data mining systems and applications will also be covered, along with selected topics in current research.

Course Title: Algorithm Design, Analysis and Implementation

Course Number: CSCI 58000

Credit Hours: 3

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

Course Title: Topics in Computer Science: Advanced Information Assurance

Course Number: CSCI 59000

Credit Hours: 3

Description: Advanced and emerging topics in information assurance, including selections from the following: penetration testing, formal verification of systems, formal models of information flow and protection, distributed system authentication, protocol

design and attack, computer viruses and malware, intrusion and anomaly detection models, multi-level security, active defenses, investigation and forensics, network firewalls, anonymity and identity, e-commerce support, database security models and mechanisms, secure group communication, wireless/sensor network security, cryptographic access control, secure multiparty computation, zero-knowledge proof, oblivious transfer, emerging security techniques such as digital provenance and moving target defense.

Course Title: Topics in Computer Science: Advanced Mobility and Cloud Computing

Course Number: CSCI 59000

Credit Hours: 3

Description: Mobile phones, originally conceived as purely for communication, are now transitioning to smart mobile devices that integrate mobility, communication and computation. Furthermore, several billions of such devices are being connected to the Internet. At the same time cloud computing is offering a paradigm shift in Internet computing. This multidisciplinary course is designed to explore the potentials of future mobile and cloud computing and their interplay. We discuss several cloud architectures. In addition, we focus on enabling technologies such as virtualization of servers, storage, and networking. Furthermore, we study how the cloud architecture supports major applications such as Big Data. Finally, we discuss the interplay between mobility and cloud computing from technical, economical, security and social aspects.

Course Title: Topics in Computer Science: Algorithms in Bioinformatics

Course Number: CSCI 59000

Credit Hours: 3

Description: This course discusses algorithm design and analysis techniques, with content and examples selected from the Bioinformatics domain. This course teaches students to solve computational problems in a methodological way. Existing algorithm design techniques are covered, including exhaustive search, greedy algorithm, dynamic programming, divide-and-conquer and graph-based formulation.

Course Title: Topics in Computer Science: Biometrics

Course Number: CSCI 59000

Credit Hours: 3

Description: This course covers three aspects of Biometrics. Theory: feature extraction and dimensionality reduction, model-based computer vision, unsupervised clustering and discriminative learning. Applications, such as: face, iris, ear, fingerprint recognition, DNA matching, biometrics fusion. Implementation: Matlab or C++.

Course Title: Topics in Computer Science: Image Processing and Computer Vision

Course Number: CSCI 59000

Credit Hours: 3

Description: Digital images are everywhere, being a dominant part of the data-driven science and technology. Image Computing involves synthesis (computer graphics), and

analysis (image processing and computer vision). While image processing includes low and mid-level analysis of images, e.g., filtering, enhancement, edge detection, segmentation, etc., computer vision involves also higher level processing such as object and scene recognition. This course focuses on various topics of image processing and computer vision: image formats, transforms, image encoding/decoding (jpeg), edge detection, motion estimation, video encoding/decoding (mpeg 1&2), mid-level edge and region-based feature extraction, deformable models, image segmentation, image registration, object detection, shape registration, and object recognition.

Course Title: Topics in Computer Science: Machine Learning

Course Number: CSCI 59000

Credit Hours: 3

Description: This course will provide an introductory to mid-level coverage of concepts and techniques in the field of machine learning with more emphasis given on statistical machine learning. Topics to be discussed include: Generative and discriminative models for classification and regression, posterior distributions and inference, conjugate distributions, model generalizability, kernel machines, dimensionality reduction, introduction to probabilistic topic models, graphical models and belief propagation, expectation-maximization, deterministic and stochastic inference. Prerequisites: Calculus, linear algebra, probability and random variables, basic knowledge of optimization techniques, Matlab/R programming.

Course Title: Topics in Computer Science: Multimedia

Course Number: CSCI 59000

Credit Hours: 3

Description: This is an introductory course in multimedia. We discuss various types of media, how they are created, edited, processed indexed, stored, transmitted, retrieved, and how to design an interface to access them. Students will gain hands-on experiences in establishing a multimedia database for Internet access. Implement PDA and mobile devices for multimedia display. We will also explore related underlying principles of multimedia technologies.

Course Title: Topics in Computer Science: Recommender Systems

Course Number: CSCI 59000

Credit Hours: 3

Description: Recommender systems have been widely used in e-commerce applications and have become more popular in the big-data era. This course serves as an introduction to recommender systems, and will cover both the fundamental concepts in recommender systems and the state-of-the-art methods and algorithms (e.g., collaborative filtering, matrix factorization methods, etc.). It also discusses the methodologies on how to model users, products and their interactions.

Course Title: Topics in Computer Science: Software Quality Assurance

Course Number: CSCI 59000

Credit Hours: 3

Description: This course is designed to teach students best practices in testing different classes of software systems. To accomplish this task, we start with an overview of software testing and its role in developing high-quality software. We then begin studying, in depth, traditional software testing methods, such as functional, structural, and integration testing. Finally, we finish the course by surveying contemporary software testing methods, such as exploratory testing, model-based testing, search-based testing, and non-functional testing. Students will have the opportunity to apply learned techniques on several programming projects throughout the semester.

Course Title: Topics in Computer Science: Trustworthy Computing

Course Number: CSCI 59000

Credit Hours: 3

Description: Cyberspace has transformed the daily lives of people for the better. The rush to adopt cyberspace, however, has exposed its fragility and vulnerabilities: corporations, agencies, national infrastructure and individuals have been victims of cyber-attacks. Therefore, major efforts are in progress are being made to the education in bolster education and training in cybersecurity. And this course is part of such efforts. The course covers the major areas of trustworthy computing systems such as: security, reliability, privacy, and usability. The course will expose the students to the state of the art issues trustworthy computing and tools for security in real organizations. In the course we will discuss the central concept of a security protocol, human-computer interface issues, access controls, cryptology, and distributed system issues. We will include our research results in field of trust management. Furthermore we will illustrate the trustworthiness concepts in a number of important applications, such as military communications, medical record systems, cash machines, mobile phones, and social networks. These are used to introduce more of the advanced technologies and concepts. It also considers information security from the viewpoint of a number of different interest groups, such as companies, consumers, criminals, police, and spies. Finally, we will discuss organizational and policy issues: how computer security interacts with law, with evidence, and with corporate politics; how we can gain confidence that a system will perform as intended; and how the whole business of security engineering can best be managed.

Course Title: Topics in Computer Science: Wireless Sensor Networks

Course Number: CSCI 59000

Credit Hours: 3

Description: This course studies the fundamental principles of wireless sensor networks. This course will expose students to the fundamental issues in designing and analyzing sensor networks and their information processing applications. Topics include sensor network architecture, MAC layer, routing and data dissemination, transport protocols,

sensor network operating systems, sensor network programming, querying, network management, and real-world applications.

Course Title: Advanced Topics in Distributed Systems

Course Number: CSCI 60300

Credit Hours: 3

Description: Design and control of distributed computing systems (operating systems and database systems). Topics include principles of namings and location, atomicity, resources sharing, concurrency control and other synchronization, deadlock detection and avoidance, security, distributed data access and control, integration of operating systems and computer networks, distributed systems design, consistency control, and fault tolerance. Prerequisite: 53700.

Course Title: Research Ph.D. Thesis

Course Number: CSCI 69900

Credit Hours: 1-18

Description: Formal research on Ph.D. thesis supervised by the faculty advisor.

Course Title: Research Seminar for First-Year Graduate Students

Course Number: CSCI C591

Credit Hours: 0-1

Description: The purpose of this seminar is to help beginning graduate students in Computer Science find research areas in which they are interested and faculty members with whom they would like to work.

e) Courses to be added

As Computer Science is a dynamically evolving discipline, the CIS Department will periodically assess and introduce new graduate courses into the Ph.D. curriculum. For example, in Fall 2015 the CIS Department is offering a new course on Trustworthy Computing (currently designated as CSCI 59000). Similar efforts will be continued in the future.

MURAT DUNDAR

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Dr. Dundar's area of expertise is in machine learning and data mining with a focus on non-parametric Bayesian models and inference, learning with partially-observed data, online and offline class discovery and modeling, semi-supervised, multi-instance, and multi-task learning. His research is mainly driven by real-world problems in hyperspectral image analysis and remote sensing, computer aided diagnosis/detection, bio-detection, and flow cytometry data analysis.

EDUCATION:

Ph. D. (2003) and M.S. (1999) in Electrical and Computer Engineering, Purdue University
B.S. (1997) in Electrical and Electronics Engineering, Bogazici University

PROFESSIONAL EXPERIENCE:

Associate Professor, Indiana University – Purdue University, Indianapolis, 2014-present
Assistant Professor, Indiana University – Purdue University, Indianapolis, 2008-2014
Research Scientist, Siemens Medical Solutions, 2003-2008

AWARDS, PROFESSIONAL SERVICE, AND SOCIETIES

NSF CAREER Award, 2013. Best paper award (International Conference on Pattern Recognition), 2010. Data mining practice prize (ACM SIGKDD), 2009. Reviewer for IEEE TGARS, TPAMI, TIP, TMI, SMC. PC member for IEEE ICDM, ACM SIGKDD, and SIAM SDM. Reviewer for NIH BMIT-B, NSF IIS panels. Member, IEEE and ACM SIGKDD.

SELECT RECENT PUBLICATIONS:

Halid Z. Yerebakan, Bartek Rajwa, Murat Dundar, "The Infinite Mixture of Infinite Gaussian Mixtures," in *Proceedings of the Advances on Neural Information Processing Systems (NIPS'14)*, Montreal, CA, Dec 2014.
Murat Dundar, Ferit Akova, Halid Z. Yerebakan, Bartek Rajwa, "A Non-parametric Bayesian Model for Joint Cell Clustering and Cluster Matching: Identification of Anomalous Sample Phenotypes with Random Effects," *BMC Bioinformatics* 15 (1), 314, 2014.
Murat Dundar, Halid Z. Yerebakan, Bartek Rajwa, "Batch Discovery of Recurring Rare Classes toward Identifying Anomalous Samples," In *Proceedings of the 20th Annual SIGKDD International Conference on Knowledge Discovery and Data Mining (SIGKDD'14)*, New York, USA, Aug 24-27 2014.
Murat Dundar, Ferit Akova, Yuan Qi, Bartek Rajwa, "Bayesian Nonexhaustive Learning for Online Discovery and Modeling of Emerging Classes," In John Langford and Joelle Pineau (Eds.), *Proceedings of the 29th International Conference on Machine Learning (ICML'12)*, Edinburgh, Scotland, June 26-July 1, 2012 (pp. 113-120). Omnipress, 2012.
Murat Dundar, Sunil Badve, Vikas Raykar, Rohit Jain, Olcay Sertel, Metin Gurcan, "A Multiple Instance Learning Approach toward Optimal Classification of Pathology Slides", *Proc. of 20th International Conference on Pattern Recognition*, August 23-26, Istanbul, Turkey, 2010 (Best scientific paper in Biomedical and Bioinformatics applications).

RECENT GRANTS:

NSF, CAREER: Self-adjusting Models as a New Direction in Machine Learning, 3/1/13-2/28/18, \$499K.
NIH, Automated Spectral Data Transformations and Analysis Pipeline for High-throughput Flow Cytometry, 7/1/12-6/30/14, Co-I, \$110K.
NIH, Machine-Learning Approach to Label-free Detection of new Bacterial Pathogens, 5/1/10-4/29/12, PI, \$190K.

BIOGRAPHICAL SKETCH OF DR. ARJAN DURRESI

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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 DESCRIPTION:

Dr. Durreesi's expertise 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, such as Internet, wireless, optical, multimedia, and so on. Important design goals for such systems include scalability, security, robustness, reliability, economic viability, manageability. His research explores the design space among various goals and constraints and tries to find desirable tradeoffs, which would enable the practical use of new solutions. Furthermore, he works to develop trust management systems, by using measurement theory to evaluate trust. His research has also been funded by NSF (PI of four projects), the States of Ohio and Louisiana, as well as university and industry sources such as OAI, TRW, Honeywell, and Spirent. Dr. Durreesi has been very active in organizing international conferences and workshops, such as IEEE AINA, HWISE, WAIS, and BioCom.

D. RECENT PUBLICATIONS:

Recent publications among 75 in journals, 177 in conference proceedings, and seven book chapters:

1. Murat Karakus, Arjan Durreesi, "A Scalable Inter-AS QoS Routing Architecture in Software Defined Network," in *Proceedings IEEE International on Advanced Information Networking and Applications (AINA)*, Gwangju, Korea, March 25-27, 2015, pp. 148-154
2. Harold Owens II, Arjan Durreesi, Raj Jain, "Reliable Video over Software Defined Networks," in *Proceedings IEEE International Global Communications Conference Globecom2014*, Austin, Texas, December 8-12, 2014, pp. 1974-1979
3. Yefeng Ruan, Lina Alfantoukh, Anna Fang, Arjan Durreesi, "Exploring Trust Propagation Behaviors in Online Communities," in the *Proceedings of The 17th International Conference on Network-Based Information Systems (NBIS-2014)*, Salerno, Italy, September 10-12, 2014, pp. 361-367
4. Ping Zhang, Arjan Durreesi, "Trust management Framework for Social Networks," *IEEE International Conference on Communications ICC2012*, Ottawa, Canada, June 10-15, 2012, pp. 1-6
5. Arjan Durreesi, Mimoza Durreesi, Leonard Barolli, "Network Trust Management in Emergency Situations," *Journal of Computer and System Sciences*, Vol. 77, No. 4, 2011, pp. 677-686

E. RECENT EXTERNAL GRANTS:

1. PI, An Application Delivery Platform for Mobile Apps on Global Clouds, NSF, 2012-2014
2. PI, RAPID: Using Lessons from the Disaster in Japan to Develop Communications for Emergency Situations, NSF, 2011-2012
3. PI, Large-Scale Distributed Scientific Experiments on Shared Substrate, NSF Computer and Network Systems, 2010-12.

Shiaofen Fang

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EDUCATION:

- Ph.D, Computer Science, University of Utah, 1992.
- M.S., Applied Mathematics, Zhejiang University, China, 1988.
- B.S. Mathematics, Zhejiang University, China, 1983.

APPOINTMENTS:

- 2007 – Present: Chair, Department of Computer and Information Science (CIS), Indiana University Purdue University Indianapolis (IUPUI)
- 2009 – Present: Professor, CIS Department, IUPUI
- 2002 –2009: Associate Professor, CIS Department, IUPUI
- 1996 –2002: Assistant Professor, CIS Department, IUPUI
- 1993 –1996: Research Staff, ISS, National University of Singapore.
- 1992 –1993: Assistant Professor, CAD program, School of Architecture, The Ohio State University.

RESEARCH INTEREST:

Dr. Fang's research interests are in visualization, biomedical imaging, computer graphics, and geometric modeling. His early work was focused on Volume Visualization and Volume Graphics, including deformable volume rendering, hardware assisted voxelization, and 3D microscopy visualization. His recent work has shifted more towards medical image analysis and visual analytics, including 3D image analysis for medical diagnosis, healthcare data visualization, and knowledge discovery through information visualization.

RECENT EXTERNAL RESEARCH GRANTS:

1. Health-Terrain: Visualizing Large Scale Health Data, PI, DoD (Army), \$661,035, 3/1/13 – 9/30/15.
2. 3D Facial Imaging on FASD, co-PI (PI: Tatiana Foroud), NIH, \$1,500,000, 06/01/08 – 05/31/13.
3. Mouse Model Neuro-Facial Dysmorphology: Translational and Treatment Studies, co-PI (PI: Feng Zhou), NIH, \$1,200,000, 06/01/08 – 05/31/13.
4. A Cross-Cultural Longitudinal Assessment of FASD, Co-PI (PI: Tatiana Foroud), NIH, \$662,733, 9/29/03 – 9/28/07.

RECENT PUBLICATIONS:

1. S. Fang, M. Palakal, Y. Xia, S. Bloomquist, et al. Health-Terrain: A Visual Analytics System for Health Data. *Journal of American Medical Informatics Association*, Accepted.
2. J. Wan, Z. Zhang, R. Rao, S. Fang, J. Yan, A. Saykin, L. Shen. Identifying the Neuroanatomical Basis of Cognitive Impairment in Alzheimer's Disease by Correlation- and Nonlinearity-Aware Sparse Bayesian Learning. *IEEE Trans. On Medical Imaging*, 2014 Jul;33(7):1475-87.
3. Q. You, S. Fang and P. Eubright, Iterative Visual Clustering for Learning Concepts from Unstructured Text Unstructured Text Data. *Intern. J. Software and Informatics*, 6:1, 2012, 43-59.
4. J. McLaughlin, S. Fang, et al. Interactive Feature Visualization and Detection for 3D Face Classification, *Intern. J. of Cognitive Informatics and Natural Intelligence*. 5(2), 2011, 1-16.
5. Q. You, S. Fang, J. Chen. GeneTerrain: Visual Exploration of Differential Gene Expression Profiles Organized in Native Biomolecular Interaction Networks. *J. Info. Visualization*, 2010; 9:1, 1-12.
6. S. Fang, J. McLaughlin, J. Fang, et al. Automated Diagnosis of Fetal Alcohol Syndrome Using 3D Facial Image Analysis, *Orthodontics and Craniofacial Research*, 2008;11:162-171.

Mohammad Al Hasan

Assistant Professor

Department of Computer and Information Science

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E-mail: alhasan@cs.iupui.edu

a. Professional Preparation

- Ph.D. in Computer Science, Rensselaer Polytechnic Institute, NY, 2009.
- M.S. in Computer and Information Science, University of Minnesota, Twin Cities, MN, 2002.
- BSc. in Computer Science and Engineering, Bangladesh University of Engg. and Tech. Dhaka, Bangladesh, 1999.

b. Appointments

- Assistant Professor, CIS Department, IUPUI, Indianapolis, IN, 2010-Present.
- Senior Research Scientist, eBay Research Labs, San Jose, CA, 2009-2010.
- Graduate Research Assistant, Rensselaer Polytechnic Institute, Troy, NY, 2004-2009
- Lecturer, Computer Science Department, North South University, Dhaka, Bangladesh, 2002-2003.

c. General Summary

Dr. Hasan is an expert on data mining, and applied machine learning. His current research interests include graph mining and social network analysis, privacy preserving data mining, link prediction, and ranking in web and e-commerce. He has published more than 50 peer-reviewed publications in top-tier data mining conferences and journals. His current research is funded through an NSF CAREER Award by National Science Foundation. Dr. Hasan is a Member of the ACM and IEEE.

d. Recent Publications

- i. Tanay Kumar Saha, Mohammad Al Hasan (2015). FS3: A sampling based method for Top-k Frequent Subgraph Mining. Wiley Journal of Statistical Analysis and Data Mining
- ii. Tanay Kumar Saha, Baichuan Zhang, and Mohammad Al Hasan (2015). Name Disambiguation from link data in a collaboration graph using temporal and topological features. Springer Journal on Social Network Analysis and Mining, 5 (1), 1-14
- iii. Mansurul Bhuiyan, and Mohammad Al Hasan (2015). An Iterative MapReduce Based Frequent Subgraph Mining Algorithm. IEEE Transactions on Knowledge and Data Engineering, 27 (3), 608-620
- iv. Mahmudur Rahman, Mansurul Bhuiyan, and Mohammad Al Hasan (2014). GRAFT: An Efficient Graphlet Counting Method for Large Graph Analysis. IEEE Transactions on Knowledge and Data Engineering, 26 (10), 2466-2478
- v. X. Wu, Mohammad Al Hasan, Jake Y Chen (2014). Pathway and Network Analysis in Proteomics. Journal of Theoretical Biology, 362, 44-52
- vi. Mahmudur Rahman, Mansurul Bhuiyan, Mahmuda Rahman, Mohammad Al Hasan (2013). GUISE: A Uniform Sampler for Constructing Frequency Histogram of Graphlets. Knowledge and Information Systems Journal, 38 (3), 511-534

e. Recent External Grants

- i. A Novel Framework for Mining Graph Patterns in Large Biological and Social Networks, NSF, \$547, 427 2012-17 (PI).

James H. Hill
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E-mail: hillj@cs.iupui.edu

Professional Preparation

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

Appointments

- CIS Department, IUPUI, Indianapolis, IN: Associate Professor, 2015 – present.
- CIS Department, IUPUI, Indianapolis, IN: Assistant Professor, 2009 – 2015.

General Summary

Dr. Hill's areas of research include domain-specific modeling, system emulation, heterogeneous software system composition and integration, real-time software instrumentation, software performance analytics, and static code analysis, and its application towards understanding the performance of large-scale software systems early in the software lifecycle. He has published more than 70 peer-reviewed publications, and has been invited to give more than 30 talks and 3 keynotes at international, national, regional, and campus level conferences/meetings. Dr. Hill's research has been sponsored by both public and private organizations, such as by National Science Foundation (NSF), Air Force Research Lab (AFRL), Office of Naval Research, Australian Defense Science and Technology Organization (DSTO), Lockheed Martin, Northrup Grumman, and Department of Homeland Security (DHS), totaling more than \$1.8 million in secured research dollars. Dr. Hill co-directs the Software Engineering and Distributed Systems group. He also manages the Software Engineering Working Group, which has graduated 25 undergraduate and graduate students, placing several at Fortune 500 companies, such as Yahoo, Apple, and Microsoft Research, and startup companies. Lastly, Dr. Hill has successfully transitioned several open-source technologies from his research, such as CUTS and Pin++, into practice in both the public and private sector.

Recent Publications

- i. Pati, Tanumoy, Sowmya Kolli, and James H. Hill. "Proactive modeling: a new model intelligence technique." *Software & Systems Modeling* (2015): 1-23.
- ii. **Hill, James H.**, and Dennis C. Feiock. "[Pin++: A Object-oriented Framework for Writing Pintools.](#)" In *Proceedings of the 2014 International Conference on Generative Programming: Concepts and Experiences*, pp. 133-141. ACM, 2014.
- iii. Mussbacher, G., Daniel Amyot, Ruth Breu, Jean-Michel Bruel, Betty Cheng, Philippe Collet, Benoit Combemale, Robert France, Rogardt Haldal, **James Hill**, Jörg Kienzle, Matthias Schöttle, Friedrich Steimann, Dave Stikkolorum, Jon Whittle. "[The Relevance of Model-Driven Engineering Thirty Years from Now.](#)" In *Proceedings of the ACM/IEEE 17th International Conference on Model Driven Engineering Languages and Systems*, pp. 183-200. ACM/IEEE, 2014.
- iv. Manjula Peiris, **James H. Hill**, Jorgen Thelin, Sergey Bykov, Gabriel Kliot, and Christian Konig. "[PAD: Performance Anomaly Detection in Multi-Server Distributed Systems](#)". *Proceedings of the 7th IEEE International Conference on Cloud Computing*, (2014).

Recent External Grants

- i. Reducing False Positive Reported By Static Code Analysis Tools, DHS, \$584,605, 2015-18 (PI).
- ii. Testing-as-a-Service: Static Code Analysis Tool Study, Lockheed Martin, Northrup Grumman, and Department of Homeland Security (via S²ERC), \$128,108, 2013-16 (PI).
- iii. System Execution Modeling Environment Research and Development, Australia Defense Science and Technology Organization (DSTO), \$581,211,000, 2009-16 (PI).

Yao Liang
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Indiana University-Purdue University, Indianapolis, IN 46202
Phone: 317-274-3473, Fax: 317-274-9742, Email: yliang@cs.iupui.edu

Professional Preparation

Xi'an Jiaotong University, China, Computer Engineering, B.S.	1982
Xi'an Jiaotong University, China, Computer Science, M.S.	1988
Clemson University, Clemson, SC, Computer Science, Ph.D.	1997

Appointments

Professor, Department of Computer and Information Science, Indiana University-Purdue University Indianapolis (IUPUI), 2013 – present
Associate Professor, Department of Computer and Information Science, IUPUI, 2007 – 2013
Assistant Professor, Department of Electrical and Computer Engineering, Virginia Tech, 2001 – 2007
Technical Staff Member, Alcatel USA, 1997 – 2001

General Summary

Dr. Yao Liang's research includes the areas of wireless sensor networks, adaptive network control and resource allocation, cyberinfrastructure, multimedia networking, machine learning, data mining, data fusion, hydro-informatics, data management and integration, nonlinear signal prediction, neural networks and applications, and distributed systems. He has received four NSF grants (Lead PI or PI), two NASA grants (Lead PI or PI), and one DOT grant (PI) at IUPUI, and brought over \$1.4M external funding into universities. Dr. Liang has published more than 60 papers on various prestigious journals and international conferences, and received two US patents. Dr. Liang has given invited talks and lectures at various universities in US, Europe and China. Dr. Liang is a Senior Member of IEEE, and a Member of ACM. 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.

Some Recent Publications

1. Wei Zhao, Yao Liang, Energy-Efficient and Robust In-Network Inference in Wireless Sensor Networks, *IEEE Transactions on Cybernetics*, 2014. DOI: 10.1109/TCYB.2014.2365541 (in press)
2. Miguel Navarro, Tyler W. Davis, German Villalba, Yimei Li, Xiaoyang Zhong, Newlyn Erratt, Xu Liang, and Yao Liang, Towards Long-Term Multi-Hop WSN Deployments for Environmental Monitoring: An Experimental Network Evaluation, *Journal of Sensor and Actuator Networks*, Vol. 3, No. 4, pp. 297-330, doi: 10.3390/jsan3040297, 2014.
3. Yao Liang, Yimei Li, An Efficient and Robust Data Compression Algorithm in Wireless Sensor Networks, *IEEE Communications Letters*, Vol. 18, No. 3, pp. 439-442, March 2014.
4. Yao Liang, and Rui Liu, Routing Topology Inference for Wireless Sensor Networks, *ACM SIGACOMM Computer Communication Review*, Vol. 43, No. 2, pp. 22-27, April 2013.
5. Tyler Davis, Xu Liang, Chen-Min Kuo, and Yao Liang, Analysis of Power Characteristics for Sap Flow, Soil Moisture and Soil Water Potential Sensors in Wireless Sensor Networking Systems, *IEEE Sensors Journal*, Vol. 12, No. 6, pp. 1933-1945, 2012.
6. Zhuotong Nan, Shugong Wang, Xu Liang, Thomas E. Adams, William Teng, and Yao Liang, Analysis of spatial similarities between NEXRAD Stage III and LDAS Combo precipitation data products, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, Vol. 3, No. 3, pp. 371 – 385, 2010.

Recent External Grants

- From Data to Users: A Prototype Open Modeling Framework, NSF, 7/15/2012 – 6/30/2014, \$88,495.
- EAGER: Collaborative Research: Network Inference and Data Collection Based on Compressed Sensing in Large-Scale Wireless Sensor Networking, NSF, 9/15/2012 – 8/31/2014, \$64,105.
- NeTS: Small: Collaborative Research: Compressed Network Tomography and Data Collection in Large-Scale Wireless Sensor Networking, NSF, 10/31/2013 – 9/30/2016, \$233,108.
- Improving Hydrologic Disaster Forecasting and Response for Transportation by Assimilating and Fusing NASA and Other Data Sets, University of Pittsburgh subcontract (NASA), 2/1/2014 – 1/31/2016, \$131,463.

Dr. Snehasis Mukhopadhyay
Department of Computer and Information Science
Indiana University Purdue University Indianapolis
723 W. Michigan St., SL 280
Indianapolis, IN 46202
Phone: (317) 274-9732 Fax: (317) 274-9742
Email: smukhopa@cs.iupui.edu

Professional Preparation

- ☐ B.E. in Electronics and Telecommunications, Jadavpur University, India, 1981 - 1985
- ☐ M.E. in Systems Science and Automation, Indian Institute of Science, Bangalore, India, 1985 - 1987
- ☐ M.S. in Electrical Engineering, Yale University, New Haven, CT, 1987 - 1991
- ☐ Ph.D. in Electrical Engineering, Yale University, New Haven, CT, 1987 - 1994

Recent 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

Brief Summary

Snehasis Mukhopadhyay is a 1996 National Science Foundation CAREER Award recipient. He has been the Acting Director of the Center for Bio-Computing at IUPUI from 2008 to 2011. He won the best paper award at the MICA International Conference. He is a co-author of more than one hundred journal and conference research papers, and has been supported by research funding from the NSF, NOAA, and NIH. He has made more than twenty five invited presentations. He has been a program committee member of many other conferences. He has served as an invited panelist or reviewer for national funding agencies.

Selected Recent Publications

1. Babbar-Sebens, M., Mukhopadhyay, S., Singh, V. B., & Piemonti, A. D. (2015). A web-based software tool for participatory optimization of conservation practices in watersheds. *Environmental Modelling & Software*, 69, 111-127.
2. Singh, V. B., Mukhopadhyay, S., & Babbar-Sebens, M. (2013, October). User Modelling for Interactive Optimization Using Neural Network. In *Systems, Man, and Cybernetics (SMC), 2013 IEEE International Conference on* (pp. 3288-3293). IEEE.
3. Lapish, C. C., Tirupattur, N.*, & Mukhopadhyay, S. (2013). Text Mining for Neuroscience: A Co-morbidity Case Study. In *Knowledge-Based Systems in Biomedicine and Computational Life Science* (pp. 117-136). Springer Berlin Heidelberg.
4. Bhuiyan, M.*, Mukhopadhyay, S., & Hasan, M. A. (2012, October). Interactive pattern mining on hidden data: A sampling-based solution. In *Proceedings of the 21st ACM international conference on Information and knowledge management* (pp. 95-104). ACM.
5. Tilak, O., Martin, R., & Mukhopadhyay, S. (2011). Decentralized indirect methods for learning automata games. *Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions on*, 41(5), 1213-1223.
6. Tilak, O., & Mukhopadhyay, S. (2010, December). Decentralized and partially decentralized reinforcement learning for distributed combinatorial optimization problems. In *Machine Learning and Applications (ICMLA), 2010 Ninth International Conference on* (pp. 389-394). IEEE.

Recent Grants:

- i. National Science Foundation (NSF): Collaborative Research: Fast Reinforcement Learning using Multiple Models and State Decomposition (PI with K.S. Narendra (Yale University) as the other PI), (Total: \$356,000), 2014-2017.
- ii. National Oceanic and Atmospheric Administration (NOAA): An interactive and participatory web-based optimization tool for supporting community learning and collaborative design of adaptation action plans in watersheds (co-PI), (\$100,000), 2014- 2015.
- iii. National Science Foundation (NSF): Spatial Interactive Optimization for Restoration of Upland Storage in Watersheds: Community Participation in the Design of Distributed Practices and Alternatives (co-PI), (\$ 410,000): NSF, 2010-2014.

Xia Ning

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Research Interests

Big-Data Analytics, Data Mining and Machine Learning

Education

University of Minnesota, Twin Cities
Ph.D., Computer Science & Engineering
M.S., Computer Science & Engineering
M.S., minor, Statistics

Minneapolis, MN
Sept. 2005 – Jul 2012
Sept. 2005 – Apr. 2009
Sept. 2005 – Apr. 2009

Chu Kochen Honors College, Zhejiang University
B.S., with honors, Computer Science

Hangzhou, China
Sept. 2001 – Jun. 2005

Experience

Indiana University - Purdue University Indianapolis
Assistant Professor, Computer & Information Science

Indianapolis, IN
Aug. 2014 – current

Indiana University
Adjunct Assistant Professor, Center for Computational Biology and Bioinformatics

Indianapolis, IN
Aug. 2015 – current

NEC Labs America
Research Staff Member, Autonomic Management Department

Princeton, NJ
Aug. 2012 – Aug. 2014

Academic Activities

Conference Services

BIBM 2015 proceeding co-chair, SDM 2015 session chair

PC Members

- ICHI2015, ICDM2015 Mobile data mining, BioKDD2015, CIKM2015, BESC2015, BigCom2015, ECML/PKDD2015, ICDM2015, MOD2015, KDD2015, IJCAI2015, SDM2015 Workshop on Machine Learning for Recommender Systems, SDM2015 Workshop on Big Data And Stream Analytics, NIPS MLCB2015, SDM2015, NIPS MLCB2014, Workshop IEEE BigData 2014 workshop on High Performance Big Graph Data Management, Analysis, and Mining; BESC2014, SDM2014 workshop on Heterogeneous Learning, ECML/PKDD2014, ICDM2014, SDM2014, RecSys2014
-

Awards & Honors

NEC Excellent Invention Award

2015

Grant

Recommendation Meets Search, DRIVE, IUPUI, role: PI
Computational Methods for Drug Discovery, IMMCS, IUPUI, role: PI

Rajeev R. Raje
Professor and Associate Chair
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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.

c. General Summary

Dr. Raje's expertise is in designing distributed and software-intensive systems. His current research interests include service-oriented computing, QoS-aware distributed systems, and associated software engineering issues such as various prediction models. He has published more than 115 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, Air Force Research Labs, Department of Homeland Security, Lockheed-Martin, and Northrup-Grumman), Office of Naval Research, National Science Foundation, Microsoft, Purdue Research Foundation, and Eli Lilly. He, as a PI or Co-PI, has received grant support worth more than five million dollars. Dr. Raje is a Senior Member of the ACM and IEEE.

d. Recent Publications

- i. Dimuthu Gamage, Lahiru Gallage, and Rajeev R. Raje, "A QoS and Trust Prediction Framework for Context-Aware Composed Distributed Systems", Proceedings of the IEEE ICWS, 2015.
- ii. Ruchika Malhotra, and Rajeev Raje, "An Empirical Comparison of Machine Learning Techniques for Software Defect Prediction", Proceedings of the BICT, 2014.
- iii. Andrew Olson, Rajeev Raje, Barun Devaraju, and Lahiru Gallege, "Learning Improves Service Discovery", Concurrency and Computation: Practice and Experience, 2014.
- iv. Lahiru S. Gallege, Dimuthu U. Gamage, James H. Hill, and Rajeev R. Raje, "Towards Trust-Based Recommender Systems for Online Software Services", Proceedings of the CSIIRW, 2014.

e. Recent External Grants

- i. Reducing False Positive Reported By Static Code Analysis Tools, DHS, \$584,605, 2015-18 (Co-PI).
- ii. Testing-as-a-Service: Static Code Analysis Tool Study, Lockheed Martin, Northrop Grumman, and Department of Homeland Security (via S²ERC), \$98,108, 2013-15 (Co-PI).
- iii. Modeling, Specifying, Discovering, and Integrating Trust into Distributed Real-time and Embedded (DRE) Systems, Air Force Research Lab (via S²ERC), \$79,000, 2011-13 (PI).

Fengguang Song
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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.
- Computer Science Lab, Samsung Research America-Silicon Valley, California: Senior Researcher, 2012-2013.

c. General Summary

Dr. Song's expertise is in advanced parallel architecture, linear algebra, 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 scales.

d. Selected Publications

[ICPP'15] Prateek Nagar, Fengguang Song, Luoding Zhu, Lan Lin, "LBM-IB: A Parallel Library to Solve 3D Fluid-Structure Interaction Problems on Manycore Systems", The 44th International Conference on Parallel Processing, Beijing, China, September 2015.

[ICS'14] Fengguang Song and Jack Dongarra, "Scaling Up Matrix Computations on Shared-Memory Manycore Systems with 1000 CPU Cores", The 28th ACM International Conference on Supercomputing, Munich, Germany, June 2014.

[ICS'12] Fengguang Song, Stanimire Tomov, Jack Dongarra, "Enabling and Scaling Matrix Computations on Heterogeneous Multi-Core and Multi-GPU Systems", The 26th ACM International Conference on Supercomputing, San Servolo Island, Venice, Italy, June 2012.

[SC'09] Fengguang Song, Asim YarKhan, Jack Dongarra, "Dynamic Task Scheduling for Linear Algebra Algorithms on Distributed-Memory Multicore Systems", ACM/IEEE Conference on Super-computing, Portland, OR, November 2009.

[HPDC'07] Fengguang Song, Shirley Moore, Jack Dongarra, "Feedback-Directed Thread Scheduling with Memory Considerations", The 16th IEEE International Symposium on High-Performance Distributed Computing, Monterey Bay, CA, June 2007.

e. Recent Grants

- i. A Parallel Library of the Immersed-Boundary Method for Extreme-Scale 3D Fluid-Structure-Interaction Problems, Grant to Enhance Interdisciplinary Research and Education, 01/01/2015 - 12/31/2015, Institute of Mathematical Modeling and Computational Science (iM2CS), \$7,800, IUPUI.
- ii. 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.
- iii. NSF Jetstream project, 12/01/2014 - 11/30/2019, \$6,576,101, Senior Investigator, IUPUI.

Curriculum Vitae GAVRIIL TSECHPENAKIS

EDUCATION

POSTDOCTORAL

Rutgers University, NJ Computer Science Dec 2006

GRADUATE

National Technical University of Athens, Greece PhD, Electr & Comp Eng Jun 2003

UNDERGRADUATE

National Technical University of Athens, Greece Dipl.-Ing., Electr & Comp Eng Feb 1999

ACADEMIC APPOINTMENTS

Associate Professor (tenured) Jul 2014--present
Indiana University-Purdue University Indianapolis, *Dept. of Computer and Information Science*

Assistant Professor (tenure-track) Aug 2010--Jun 2014
Indiana University-Purdue University Indianapolis, *Dept. of Computer and Information Science*

Research Assistant Professor Jul 2008--Jul 2010
University of Miami, FL, *Dept. of Computer Science*

Visiting Assistant Professor Jan 2007--Jun 2008
University of Miami, FL, *Dept. of Electrical and Computer Engineering*

RESEARCH INTERESTS

Domains: computer vision, machine learning, computational neuroscience and physiology, clinical image analytics. Theory-specific: physics-based deformable models, learning-based classification and prediction, hierarchical/latent-state graphical learning models, part-based object recognition, 3D shape estimation and tracking of articulated and deformable structures, 3D shape from 2D data, 2D/3D motion analysis, temporal change-point detection.

SUMMARY

- 2013: NSF CAREER Award (Division of Biological Infrastructure)
- 2010--2014: Two federal-funded projects (National Science Foundation) as the sole principal investigator at the Assistant Professor rank (including the CAREER Award), with budget summing up to \$900K (secured funding until 2018)
- 2013: Indiana University Collaborative Research Grant (funding rate ~5%)
- 2010--2012: Two NIH grants at the Assistant Professor rank as co-Investigator
- 2008--2012: Completed eight funded projects (five federal and three other grants; see below)
- 2010--2013: Four invited talks (not including job interviews and conference presentations)
- 1999--2013: 22 journal and 37 peer review conference papers (all "top-tier"), 7 book chapters, 8 abstracts

RECENT GRANTS

CAREER: Modeling the Structure and Dynamics of Neuronal Circuits in the *Drosophila* larvae using Image Analytics, NSF/DBI, \$573K, 2013--2018, PI.

ABI Innovation: Modeling the *Drosophila* Brain with Single-neuron Resolution using Computer Vision Methods, NSF/DBI, \$319K, 2011--2014, PI.

A Novel Retinal Imaging Approach to Diagnose Glaucoma. IUCRG, 60K, 2013--2014, co-PI.

Construction and profiling of biodegradable cardiac patches for the co-delivery of bFGF and G-CSF growth factors, NIH, \$275K, 2010--2012, co-I.

In situ Protein-Protein Interaction Networks (isPIN) of Neurons, NIH, \$2.3M, 2009--2011, co-I.

Mihran Tuceryan

Professor

Department of Computer and Information Science
Indiana University-Purdue University Indianapolis (IUPUI)

Phone: (317) 274-9736

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E-mail: tuceryan@cs.iupui.edu

a. Professional Preparation

- Ph.D., Computer Science, University of Illinois, Urbana, 1986.
- B.S., Computer Science and Engineering, Massachusetts Institute of Technology, 1978.

b. Appointments

- CIS Department, IUPUI, Indianapolis, IN: Professor, 2012–Present.
- CIS Department, IUPUI, Indianapolis, IN: Associate Professor, 1997–2012.
- Research and Development, Texas Instrument, Inc., Dallas, Texas: Member of Technical Staff, 1995–1997.
- European Computer-Industry Research Centre, Munich, Germany: Senior Research Scientist, 1992–1995.
- Computer Science and Engineering, MSU, East Lansing, Michigan: Assistant Professor, 1986–1992.

c. General Summary

Dr. Tuceryan's expertise is in computer vision and its applications to visualization, medical image understanding, and forensic imaging applications. His current research interests include developing devices for capturing 3D images of impression evidence in crime scenes and developing methods and algorithms to analyze them; analyzing liver biopsy images with the aim of automatically rating for non-alcoholic fatty liver disease (NAFLD). He has been awarded 3 US patents and has published 68 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 National Institute of Justice and National Science Foundation. Dr. Tuceryan is a Senior Member of the ACM and IEEE.

d. Recent Publications

- i. Aboli Phadke, Ryan Rybarczyk, Rajeev R. Raje, Mihran Tuceryan, "Incorporating Mobile Devices in Indoor Tracking," 3rd International Conference On Network Infrastructure Management Systems, Mumbai, India, 2014.
- ii. Chouvatut, V.; Madarasmi, S. & Tuceryan, M. "3D face and motion estimation from sparse points using adaptive bracketed minimization," Multimedia Tools and Applications, Springer US, vol. 63, pp. 569-589, 2013.
- iii. Ruwan Egoda Gamage, Abhishek Joshi, Jiang Yu Zheng, Mihran Tuceryan. "A High Resolution 3D Tire and Footprint Impression Acquisition for Forensics Applications," Proc. of Workshop on Applications of Computer Vision (WACV), Clearwater, Florida, pp. 317-322, January, 2013.
- iv. Chouvatut, V.; Madarasmi, S.; Tuceryan, M. "3D Face and Motion from Feature Points Using Adaptive Constrained Minima," IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, vol. E94.A, pp. 2207-2219, 2011.

e. Recent External Grants

- i. Mihran Tuceryan and Jiang Yu Zheng, "Digitizing device to capture track impressions," National Institute of Justice, \$253,120, 2010 (PI).
- ii. Mihran Tuceryan and Jiang Yu Zheng, "Advanced In-Car Video System," subcontract from Institute for Forensic Imaging (IFI), \$96,743. (Original grant from National Institute of Justice to IFI for \$270,000, 2007.)

Yuni Xia

Associate Professor

Department of Computer and Information Science
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a. Professional Preparation

- Ph.D. in Computer Science, Purdue University, 2005.
- M.S. in Computer Science, Purdue University, 2002.
- B.E. in Computer Science, Huazhong University of Science and Technology, 1996.

b. Appointments

- CIS Department, IUPUI, Indianapolis, IN: Associate Professor, 2012-Present.
- CIS Department, IUPUI, Indianapolis, IN: Assistant Professor, 2005-2012.

c. General Summary

Dr. Xia's research is on data mining with a focus on mining data streams and uncertain data. She is currently working on designing new algorithms which incorporates data probabilistic information into the mining process in order to extract more accurate and reliable patterns from the data. She also collaborates with researchers in medicine and healthcare and works on biomedical data mining. She has published more than 50 peer-reviewed publications in journals and conference proceedings. Her current and past research has been funded, as the PI or Co-PI, by the National Science Foundation, IBM, Department of the Army and State of Indiana.

d. Recent Publications

- i. Jiaqi Ge, Yuni Xia, Towards Efficient Sequential Pattern Mining in Temporal Uncertain Databases, The Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD), 2015.
- ii. Jiaqi Ge, Yuni Xia, Mining Uncertain Sequential Patterns in iterative MapReduce, The Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD), 2015.
- iii. Shiao-fen Fang, Mathew Palakal, Yuni Xia, Sam Bloomquist, Thanh Minh Nguyen, Anand Krishnan, Shenghui Jiang, Weizhi Li, Jeremy Keiper, Shaun Grannis. Health-Terrain: A Visual Analytics System for Health Data. Journal of American Medical Informatics Association, Accepted, 2014.
- iv. 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.

e. Recent External Grants

- i. Health-Terrain: Visualizing Large Scale Health Data, Department of the Army, Co-PI, 2013-2015
- ii. Development of Key Technologies for Big Data Analysis and Management Software Based on Next Generation Memory, ETRI, Co-PI, 2012-2015.
- iii. Large Scale Sensor Stream Analysis and Mining for Geriatric Care, IBM Research, PI, 2010-2013.
- iv. DisProt Database: A Central Repository of Information on Intrinsically Disordered Proteins, NSF, Co-PI, 2009-2013.

Jiang Yu Zheng

Professor

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a. Professional Preparation

- Ph.D. in Control Engineering, Osaka University, Osaka, Japan, 1990.
- M.S. in Control Engineering, Osaka University, Osaka, Japan, 1987.
- B.S. in Computer Science, Fudan University, Shanghai, China, 1983.

b. Appointments

- CIS Department, IUPUI, Indianapolis, IN: Professor, 2011-Present.
- CIS Department, IUPUI, Indianapolis, IN: Associate Professor, 2001-2011.
- School of Computer Science and System Engineering, Kyushu Institute of Technology, Fukuoka, Japan: Associate Professor, 1994-2001.
- ATR Communication System Research Lab, ATR International, Kyoto, Japan: Research Associate, 1990-1993.

c. General Summary

Dr. Zheng's expertise is in computer vision, image processing, multimedia, virtual reality, robotics and intelligent transportation systems. His current research interests include image and video analysis, intelligent vehicles, and multimedia data indexing and visualization. He has published more than 150 peer-reviewed publications and has received several research paper awards. His current and past research has been funded by NIJ, DOT, Toyota, NICT Japan, Purdue Research Foundation, Indiana University, Osaka University, Japan, Japan NSF, etc. Dr. Zheng is a Senior Member of the IEEE.

d. Recent Publications

- i. S Luo, C Yan, K Wu, JY Zheng, "Smoke detection based on condensed image", Elsevier Journal - Fire Safety Journal, 75, 23-35, 2015.
- ii. M Kilicarslan, JY Zheng, "Detecting walking pedestrians from leg motion in driving video" 2014 IEEE 17th International Conference on Intelligent Transportation Systems (ITSC), 2014.
- iii. S Wang, S Luo, Y Huang, JY Zheng, P Dai, Q Han, "Railroad online: acquiring and visualizing route panoramas of rail scenes", Springer Journal - The Visual Computer 30 (9), 1045-1057, 2014.
- iv. S Bagheri, JY Zheng, "Temporal Mapping of Surveillance Video", 22nd International Conference on Pattern Recognition (ICPR), 4128-4133, 2014.
- v. A Jazayeri, H Cai, JY Zheng, M Tuceryan, "Vehicle detection and tracking in car video based on motion model", IEEE Transactions on Intelligent Transportation Systems, 12 (2), 583-595, 2011.

e. Recent External Grants

- i. Vehicle testing scenario generation, Toyota CSRC, \$1,500,000, 2014-15 (Co-PI).
- ii. Analyzing and mining big data of driving video for collision avoidance, DOT (via OSU), \$25,000, 2014-16 (PI).
- iii. Device to digitize track impression, NIJ, Co-PI, 2010-2013, \$253,000.

Xukai Zou

Associate Professor

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a. Professional Preparation

- Postdoctoral fellow, University of Nebraska-Lincoln, Lincoln, NE, June 2002—July 2013
- Ph.D. in Computer Science, University of Nebraska-Lincoln, Lincoln, NE, 2000.
- M.S. in Computer Science, Huazhong University of Science and Technology, Wuhan, China, 1986.
- B.E. in Computer Science, Zhengzhou University, Zhengzhou, China, 1983.

b. Appointments

- CIS Department, IUPUI, Indianapolis, IN: Associate Professor, 2009-Present.
- CIS Department, IUPUI, Indianapolis, IN: Assistant Professor, 2003-2009.
- Computer Science Department, Zhengzhou University, Zhengzhou, China: Associate Professor, 1993-1998.
- Computer Science Department, IUPUI, Zhengzhou University, Zhengzhou, China: Lecturer/Assistant Professor, 1986-1993.

c. General Summary

Dr. Zou's expertise is in designing secure system and application protocols/systems. His current research interests include Applied cryptography, network security, trusted collaborative computing, group key management, access control, authentication, electronic voting, medical and genomic data security and privacy.. He has published close to 100 peer-reviewed publications and has also served as an associated editor for several international journals. His current and past research has been supported, as the PI or Co-PI, by National Science Foundation, Department of Veterans Affairs, Cisco, and Northrup-Grumman.

d. Recent Publications

- i. Y. Sui, **X. Zou**, Y. Du, and F. Li, *Design and Analysis of a highly user-friendly, secure, privacy-preserving, and revocable authentication method*, IEEE Transactions on Computers, 63(4), pp. 902-916, 2014.
- ii. **X. Zou**, H. Li, Y. Sui, W. Peng, and F. Li, *Assurable, Transparent, and Mutual Restraining E-voting Involving Multiple Conflicting Parties*, INFOCOM'14, 4/28-5/2, 2014, p. 136--144.
- iii. W. Peng, F. Li, **X. Zou**, and J. Wu, *Behavioral Malware Detection in Delay Tolerant Networks*, IEEE Transactions on Parallel and Distributed Systems, 25(1), pp. 53--63, 2014.
- iv. W. Peng, F. Li, **X. Zou**, and J. Wu, *A Two-stage Deanonymization Attack Against Anonymized Social Networks*, IEEE Transactions on Computers, 63(2), pp.290--303, 2014.

e. Recent External Grants

- i. NSF #1262984, REU Site: Enhancing Undergraduate Experience in Mobile Computing Security, 6/1/2013--5/31/2016, \$360K, Co-site leader.
- ii. Northrop Grumman, MovingCloud: Create Moving-target Defense in Cloud by Learning from Botnets, 10/1/2012--9/31/2013, \$117K, Co-PI.



DEPARTMENT OF COMPUTER SCIENCE

Sunil Prabhakar
Professor and Department Head

June 29, 2015

Dr. Shiaofen Fang
723 W. Michigan St., SL280
Indianapolis, IN 46202

Dear Dr. Fang:

Thank you for sharing with us your proposal for transitioning the PhD program in CS at IUPUI from one that is stewarded by the Purdue West Lafayette CS department to an independent Purdue University, Indianapolis program.

The department has had an opportunity to discuss the matter. We are proud of the progress that your program has made and are pleased to support an independent Purdue University, Indianapolis Computer Science PhD program.

I am writing to express our department's support for the proposed transition. We wish you all the best in launching this new program.

Sincerely,

A handwritten signature in black ink, appearing to read "Prabhakar", with a stylized flourish underneath.

Sunil Prabhakar
Purdue University, Department of Computer Science
Professor and Department Head
sunil@purdue.edu

THE UNIVERSITY OF
ALABAMA
COMPUTER SCIENCE

College of Engineering

Department of Computer Science

Prof. Simon Rhodes
Dean, School of Science
IUPUI

June 15, 2015

Dear Dean Rhodes:

I offer my strong support for the site-approved Ph.D. program proposal submitted by the Department of Computer and Information Science (CIS).

Over the past decade, I established a deep collaboration with the IUPUI CIS Department, mainly through research collaborations with Profs. Raje and Tuceryan for many years. An existing collaboration with the Department is on a Google CS4HS project focused on CS Education, in which Michele Roberts in the Department is training several dozen Indiana high school teachers on the future CS Principles College Board AP course. During Fall 2014, I served as the Chair of the External Review Committee that carried out a comprehensive assessment of all the programs (undergraduate and graduate) offered by the CIS Department.

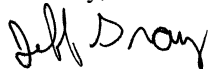
The Review Committee was most impressed by the achievements of the CIS Department, in many areas (e.g., faculty size, student enrollment, research expenditures, and CAREER recipients) over the past 8 years. The major focus of the Review Committee discussion was the topic of the joint nature of the Ph.D., to which the following recommendation was made:

"The Committee suggests a stepwise process toward increased autonomy through leveraging the Indianapolis brand and campus identity (e.g., life sciences). The Committee believes that the Department has reached a level of maturity such that it is in a position to begin seeking additional autonomy from the Purdue University-West Lafayette (PUWL) campus, and encourages that actions leading to eventual autonomy be developed through discussions with the key PUWL administrators."

I would like to reemphasize this recommendation with my belief that a site-approved Ph.D. program at the CIS Department will continue to build upon the Department's recent progress and will propel the CIS Department to the next level of excellence. It is a well-known fact that Computer Science, as a discipline, is well poised to positively impact all aspects of daily life in the future. Hence, it is critical to create well-trained Computer Scientists that can improve the quality of life in the State of Indiana and beyond – the CIS Department, due to its past accomplishments and its unique focus with the core specialties across the IUPUI campus, can certainly help achieve this goal.

In summary, I not only endorse this proposal by the CIS Department, but also believe that it is the much needed course of direction for IUPUI and Indiana.

Sincerely,



Jeff Gray, Ph.D. - Professor
ACM Distinguished Member
Carnegie Foundation Professor of the Year (Alabama, 2008)
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John C. Lechleiter, Ph.D.

Chairman, President, and Chief Executive Officer

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May 11, 2015

Simon J. Rhodes, Ph.D.
Dean, School of Science
IUPUI
402 North Blackford Street, LD 222
Indianapolis, IN 46202

Dear Dr. Rhodes,

I am pleased to offer my support for your proposals for independent Ph.D. degrees in the School of Science at IUPUI. My colleagues at Lilly and I have been pleased to witness the emergence of the School of Science as an excellent research and learning institution and key asset in our shared ambition to make Indiana a hub of discovery and innovation. IUPUI graduates of the current Ph.D. programs awarded through the West Lafayette campus hold important positions in both our research laboratories and in other areas of our company. We have benefitted from the outstanding training they received. Clearly, you are ready to operate your own Ph.D. programs.

We have been particularly pleased with the benefits to our employees who have taken advantage of the opportunity to enhance their qualifications and contributions to our discovery mission by studying for the Ph.D. through the LGRAD program that we developed together. They are well prepared to assume higher levels of responsibility in their research groups. Moreover, this training is beneficial to the company as we seek to develop our own scientists as leaders in their fields of inquiry and to retain the best and brightest.

We also realize that your undergraduate degree students (the vast majority of whom are from Indiana) enjoy opportunities to have significant engagements in research. These research experiences help develop important skills that Indiana employers seek in new hires. Enriching the research environment by solidifying the Ph.D. degree programs will further improve the education and preparation of your undergraduates.

I believe that approval of the independent status you are requesting will strengthen your programs even further by allowing them to participate in national rankings and by making them fully eligible for external funding programs that are restricted to those with independent doctoral degrees. All of us in Indiana's life sciences community, and other contributors to our economy and quality of life, will share the benefits.

Sincerely,