THE UNIVERSITY OF NEW MEXICO
DEPARTMENT OF COMPUTER SCIENCE
Academic Program Review Self-Study

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0 Introduction: General Characteristics of the Department

0.A Summary

An Executive Summary that provides a one to two-page summary/abstract of the information contained within the Self-Study Report.

This document presents the 2019 self-study for the Department of Computer Science at the University of New Mexico. The self-study was prepared as part of the Department's Academic Program Review (APR). The Department emphasizes high-quality high-expectation teaching, and 100% of the tenure-stream faculty are research-active. The Department is ABET-accredited, undergoing intensive scrutiny of its undergraduate program every six years. The department has changed since the last review with the retirement of senior faculty after long careers in the department. The department has hired new faculty to replace these vacancies, emphasizing new trends in computer science, enhancing the diversity of its faculty significantly, and enhancing its connections to other programs at UNM.

Enrollments in CS at UNM follow those of the rest of the country, albeit with a lag, and with historically large swings both up and down. However, over the last decade our enrollments have been steadily rising; overall, undergraduate enrollments have nearly tripled since 2010. We anticipate continued growth over the next several years, owing to renewed national emphasis on STEM (Science, Technology, Engineering, and Mathematics) fields.

The Computer Science Department is well known nationally and internationally. Current research funding (Section 5.D) comes from various sources, the single largest being the National Science Foundation (43%), and annual research expenditures in the Department are approximately $3 million per year. Faculty publications appear in international venues, and department faculty are regularly invited to lecture in other countries. Our emeriti faculty had placed an emphasis on publishing textbooks, and their titles remain widely used, distributed, and translated into multiple languages. Computer Science graduate students come to UNM from around the world, although international recruiting has been a challenge recently.

The Computer Science Department, as of January 2019, consists of 18 tenure-track faculty and two full-time lecturers. (One of the tenure-track positions is currently unfilled and the Department is searching for a replacement.) The research areas, public service, and related endeavors of these faculty are listed in Chapter 5. The CVs may be found in Appendix J on page 159. The Department has nine full-time staff members supporting both administrative and academic functions (seven) and computing facilities (two). One twenty-hour-per-week work-study student supplements the staff. The Computer Science Department plays an active role in both technological and educational activities in Albuquerque and the State of New Mexico. Our community collaborators include The Santa Fe Institute, Los Alamos and Sandia National Labo-

ratories, and many private and public companies. The department interacts regularly with the Albuquerque Public Schools as well as with the community and four-year colleges of New Mexico, including a decade-long statewide articulation effort to smooth student transitions from 2-year to 4-year programs. Further details of these collaborations are found in Section 5 where individual faculty research and outreach efforts are listed.

The major research and creative efforts of the department are measured in the research, funding, and outreach efforts of its faculty and students. These are catalogued in Section 5, with faculty CVs in Appendix J on page 159. The Department is well known for its wide range of interdisciplinary research, which has spanned connections with biology, biomedicine, physics, and chemistry. In recent years, it has developed significant momentum in more core areas, including computer science theory, theoretical approaches to programming languages, cybersecurity, high-performance computing, and data science.

The undergraduate and graduate programs are continually changing to meet the education and research requirements of the State of New Mexico and the nation. The field of computing continues to evolve rapidly, and the Department strives to maintain a balance between updating the program to reflect important changes and avoiding fads. Our assessment mechanisms, both for our graduate and undergraduate programs, support an evolving curriculum where new courses are regularly introduced to meet the changing needs, while the accreditation procedures safeguard the foundations of sound computing in mathematics, computer architecture, algorithms and data structures, and programming languages. Thus, the curriculum continues to preserve basic skills and evolves to meet changing educational and research needs.

The self-study shows a department that has the potential to rise in terms of research prominence, is excellent in several research specialties, offers rigorous degree programs, values teaching, has a diverse faculty and student body, and is generally well run. Notable issues raised by the self-study include: insufficient response to the surge in enrollments owing to lack of funds for operating expenses (TAs/graders); lack of growth in faculty size, in contrast with national trends; lagging faculty salaries, relative to national trends (around 10th percentile among comparable departments in the CRA Taulbee survey); lack of staffing for recruiting, outreach, and development activities; lack of specialized teaching laboratories; and lack of communal space for students.

0.B Brief history of the Department

A brief description of the history of each degree/certificate program offered by the unit.

The Computer Science Department, originally known as Computing and Information Sciences Department (CIS), began in the late 1970s. Before joining the School of Engineering, being renamed the Computer Science department, and receiving PhD-granting powers from the State of New Mexico in 1979, CIS was a loose confederation of professors from the Mathematics and Computer Engineering faculties that taught software-related courses. At the end of

1978, for example, CIS consisted of six tenure-track faculty and one lecturer. From this period, we recall two remarkable outcomes: Jack Dongarra received a PhD in 1980 to begin an illustrious career in high-performance computing—currently University Distinguished Professor at the University of Tennessee; his advisor Cleve Moler, chair of the department, developed the MATLAB scientific programming language and would go on to found MathWorks corporation. The formal introduction of the CIS Department into the School of Engineering in 1979 initiated the modern Computer Science Department. The first PhD degree was awarded in 1990. By 2019, the CS Department has grown to 18 tenure-track faculty and two full-time lecturers. Details about the current faculty's research and teaching, along with public and other outreach activities appear in Section 5.

0.C Departmental leadership and governance

A brief description of the organizational structure and governance of the unit, including a diagram of the organizational structure.

The Computer Science Department is one of six departments in the UNM School of Engineering, and the CS Department Chair sits on the School's Leadership Council. The leadership and governance of the department is lightweight, with a single half-time Department Chair, a supporting Associate Chair, and a few sitting committees: the Graduate Committee, the Undergraduate Committee, and the Promotion and Tenure Committee. Other routine department jobs are assigned annually to one or two faculty (e.g., colloquium, graduate admissions, course scheduling), and most strategic decisions are made by consensus-building and a formal vote in faculty meetings, held weekly or bi-weekly. Ad hoc committees are appointed from time to time; for example, one ad hoc committee redesigned the PhD program requirements four years ago.

The Department Chair is responsible for all personnel decisions, including salaries, faculty assessment, and teaching and committee assignments. The Associate Chair coordinates the graduate and undergraduate programs and sits on the committees responsible for curriculum organization and review. The faculty discuss and approve most curricular and academic decisions, such as, for example, annual review of graduate students' progress.

The department has an Advisory Board. The board is governed by a formal charter, with the following mission: The Advisory Board exists to promote and support the Computer Science Department. At the request of the department chair, the members of the Board are asked to help in the following matters: providing advice on strategic plans of the department; providing advice on educational matters, including curriculum development, providing guidance and inspiration to students, and program accreditation; engaging with faculty and staff to help them better fulfill their duties towards the departmental mission; acting as advocates and ambassadors of the department towards the university leadership and the community outside UNM; supporting departmental activities towards economic development, including inspiring and enabling commercialization efforts; assisting in identifying resources

to meet the department's strategic goals. The board meets twice a year. The current members of the board are Jeffrey Cangialosi (CIO, Molina Healthcare; UNM CS alumnus); Anna Carey (undergraduate student); Tony Giancola (entrepreneur, UNM CS alumnus); Diksha Gupta (graduate student); Bill Hart (Sandia National Lab); Jarett Jones (undergraduate student); Samantha Lapin (entrepreneur, UNM Nuclear Engineering alumna); George Luger (professor emeritus); Cris Moore (Santa Fe Institute; former UNM CS faculty); Antonio Pedroncelli (CIO, Western Sky Community Care; UNM alumnus); Rick Russell, Chair (IBM, retired; UNM CS alumnus); Brian Stinar (entrepreneur, UNM CS alumnus).

0.D External accreditation - ABET

Information regarding specialized/external program accreditation(s) associated with the unit, including a summary of findings from the last review, if applicable. If not applicable, indicate that the unit does not have any specialized/external program accreditation(s).

The Department's undergraduate program consists of a single Bachelor of Science in Computer Science program, which has been continuously accredited by ABET - Computing Accreditation Commission (previously CSAB). The last review cycle included a site visit by ABET evaluators in October 2017, and was concluded with a final statement in August 2018, granting accreditation to September 2024. The accreditation documents are included in Appendix A on page 62; the summary of the evaluation reads:

> Computer Science Program. Program Concern: Criterion 2, Program Educational Objectives. The program's process for the review of its educational objectives is new. There is the potential it may not become fully operational and systematically utilized in the future.

Our process for the periodic review of the educational objectives is indeed new, but it is straightforward and well documented so after three semesters of use we foresee no difficulty in following it in the future.

While our outcomes assessment mechanisms were fully endorsed by our accreditation review, in 2018 ABET CAC promulgated a new set of mandatory student learning outcomes. In light of this change, we are using this year to rework our assessment mechanisms for the next cycle of accreditation.

0.E Previous Academic Program Review process

A brief description of the previous Academic Program Review Process for the unit. The description should: note when the last review was conducted; provide a summary of the findings from the Review Team Report; indicate how the Unit Response Report and Initial Action Plan addressed the findings; and provide a summary of actions taken in response to the previous APR.

The Department periodically undergoes an Academic Program Review process. The last review was conducted in 2010. The Academic Program Review Team members were Fred Chong (Chair), Bob Sloan, Darrell Whitley, and Phil Ganderton.

The Review Team's report is included in Appendix B on page 73. To summarize, the report described a small department with faculty comparable to a top-40 department, with a growing research emphasis and a strong emphasis on undergraduate education, but that its actual ranking could only improve with an expansion of faculty ranks. It noted that a strength of the department was its diverse student population, along with diversity in faculty hiring, and observed that the department had a particularly good atmosphere for attracting women and minorities. It found that the department's needs were not well understood in the University and the School of Engineering. It recommended that the department could benefit from more targeted development (fundraising) efforts; that it could benefit from increased enrollment leading to increased TA and faculty allocation; that it needed an additional student advisor to improve both graduate and undergraduate advising (noting the deficiencies present in the advisement of pre-majors); that it should be given additional TA allocation to convert undergraduate to graduate TAs in lower-division courses. If given additional faculty lines, the report recommended investing in computer security, saw opportunities in the relationship between CS and social science, and found us lacking in expertise in software engineering. The report found an imbalance in faculty demographics, with very few full and associate professors, noted the need for senior faculty to lead medium-to-large scale research proposals, and recommended hiring the next chair externally. The report noted duplication of effort between the CS department and the Electrical and Computer Engineering department. The report foresaw retention problems for faculty, and recruitment problems for graduate students as a result of low salaries. The report recommended that CS should be given control over computer laboratories, comparable to science laboratories. The report recommended that a process be defined for approving special IT needs of CS. The report offered numerous suggestions for enhancing the department's accreditation efforts. Lastly, the report found that CS needed improved building space.

The department's Response and Initial Action Plan is included in Appendix B on page 73. The department concurred with the recommendations of the Review Team. The initial action plan outlined the following issues residing primarily within the department: 1. Continue to mentor recent faculty hires and help them launch successful teaching and independent research programs; 2. Plan for Chair succession by conducting External Chair Search in AY 2010-2011; 3. ABET re-accreditation in 2011-2012; 4. Develop 4+1 BS+MS program; 5. Promote understanding and appreciation of CS throughout UNM; 6. Work with SOE ESS and University College advising to improve pre-major advising. The initial action plan further outlined the following issues residing primarily outside the department: 1. Appoint a committee led by academics with IT administration representation to address IT issues related to research and teaching, with the authority to approve special IT needs throughout the academic units of the university; 2. Teaching laboratory with computers scheduled and controlled by CS; 3. Renovation of existing space to improve faculty/student recruiting and retention, provide additional research laboratory and improve

usage of existing space, and to address safety issues; 4. Add 1 FTE advisor in CS, as recommended in the report to improve student advising; 5. Additional funding to upgrade undergraduate TA lines to graduate TA lines, and to bring TA salaries in line with RA salaries; 6. Develop plan for department growth, either by dedicating new resources or creating a new academic unit that leverages existing resources.

We now summarize the actions taken as outlined in the initial action plan. The department's then-recent hires have become successful senior faculty (Luan, Moses, Crandall, Hayes), but we lost some to industry (Kniss), early move to another university (He), and recruitment by other universities around tenure time (Arnold). We conducted an external chair search and hired Prof. Michalis Faloutsos, who took over in January 2013 but resigned in August 2015. We then conducted another external chair search, which failed, at which point Prof. Stefanovic was appointed internally. Our ABET accreditation was completed successfully in 2011-12, as well as in 2017-18. We developed the 4+1 BS+MS program, and this program is now available across the School of Engineering. To promote understanding and appreciation of CS, we continued to work extensively on research collaborations with many parts of UNM, and we developed an introductory course on computational thinking, CS108 CS for All, and succeeded in placing it in the UNM Core. We held meetings with SOE ESS and University College advising; however, the issues of pre-major advising were only resolved with the complete overhaul of pre-major advisement in the School of Engineering and its transfer to the departments in 2016.

The building hosting the department, Farris Engineering Center, was renovated in 2016–2017. This has resulted in an increase in net space available to the department, from 15615 sqft to 20284 sqft, along with improvements in lighting, ventilation, and safety. It is to be hoped that the remaining issues identified in the initial action plan as residing outside the department will also be resolved in the fullness of time.

We now summarize other actions in response to the Review Team's report. Our faculty hiring has remained diverse, such that of the present 19 faculty members, seven are women. Our student population is ever more diverse, reflecting the demographic trends in New Mexico. In line with the report's recommendations, the department has engaged more with NCWIT, and currently participates in a Learning Circle to enhance the success of women undergraduate students. Our enrollments have vastly increased, but without a growth in either faculty or TA lines. We now have two student advisors rather than one, but the two are now responsible for advising pre-majors as well. While we did not receive new faculty lines for targeted expansion, among our most recently hired assistant professors Prof. Vasek and Prof. Kogan do work at the intersection of CS and social science. When Prof. Roman joined the faculty after serving as Dean of the School of Engineering, he brought expertise in software engineering; this has been the only increase in faculty size. The passage of time has changed the faculty demographics, and today it is better balanced. Since the time of the report, we have participated in, and led, large multi-institution collaborative research projects. We worked with the ECE de-

partment to improve the cross-listing of courses and reduce the duplication of effort in teaching. However, as focus in computer engineering as a whole shifts to software, duplication of efforts in research and teaching remains a concern. As we mentioned in our response in 2010, either forming a Computer Science and Engineering department, or a College of Computing, could be ways of resolving this issue. Faculty retention has become a serious problem; in addition to losing faculty to industry we have lost to lesser known but better-funded universities; when we were able to make successful counteroffers, significant internal salary disparities resulted. We were able to increase RA salaries, and, to a lesser extent, TA salaries; however, we are unable to compete with universities that can offer multiple years of guaranteed support to incoming PhD students.

1 Student Learning Goals and Outcomes

The unit should have stated student learning goals and outcomes for each degree/certificate program and demonstrate how the goals align with the vision and mission of the unit and university. (Differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

1.A Vision and mission of the unit

Provide a brief overview of the vision and mission of the unit and how each offered degree/certificate program addresses the vision and mission of the unit.

The last adopted vision and mission statement for our department is in Appendix C on page 89.

Our B.S. program addresses the vision and mission of the unit in that it lays a broad foundation for the science of computation that will serve students well in any computational endeavour. This breadth is also reflected in our elective course offerings. The M.S. program also lays a broad foundation that educates students both in core computer science and in broad and interdisciplinary endeavours.

The Ph.D. program fits into our vision and mission differently because it is a research degree. One of the great strengths of our department is the unique and strong research profile of the faculty. This is also reflected in our Ph.D. students and alumni.

1.B Relationship of the unit's vision and mission to UNM's vision and mission

Describe the relationship of the unit's vision and mission to UNM's vision and mission. In other words, to assist the university in better showcasing your unit, please explain the importance of its contribution to the wellbeing of the university, including the impact of the unit's degree/certificate program(s) on relevant disciplines/fields, locally, regionally, nationally, and/or internationally?

UNM's mission statement is available at `http://www.unm.edu/welcome/mission.html` and is reproduced here:

UNM's Mission

The University will engage students, faculty, and staff in its comprehensive educational, research, and service programs.

- UNM will provide students the values, habits of mind, knowledge, and skills that they need to be enlightened citizens, to contribute to the state and national economies, and to lead satisfying lives.
- Faculty, staff, and students create, apply, and disseminate new knowledge and creative works; they provide services that enhance New Mexicans' quality of life and promote economic development; and they advance our understanding of the world, its peoples, and cultures.
- Building on its educational, research, and creative resources, the University provides services directly to the City and State, including health care, social services, policy studies, commercialization of inventions, and cultural events.

Our department's three degree programs provide opportunities to New Mexico citizens, create economic impact, and fulfill the need for trained computing professionals in the state. Furthermore, computing is changing the way people live their lives and understanding this can be both enriching and empowering. Understanding computing technology is becoming more and more important in modern democracies.

Our department's internationally visible research program also creates economic impact through inventions and enriches the lives of New Mexicans. It also improves the quality of all three degree programs through research opportunities for students and career development for faculty.

Our department's outreach efforts are especially important in light of the discrepancy between how important computing is the modern workforce and our democracy, compared to how far behind New Mexico's K-12 schools are with computing instruction.

1.C Overall program goals and student learning outcomes for each degree

List the overall program goals and student learning outcomes for each degree/certificate program within the unit. Include an explanation of how they are current and relevant to the associated discipline/field. In accordance with the Higher Learning Commission's criteria for accreditation, student learning goals and outcomes should be articulated and differentiated for each undergraduate and graduate degree and post-graduate and certificate program.

1.C.1 Bachelor of Science program

The Computer Science program is accredited by the Computing Accreditation Commission of ABET. The following *Program Educational Objectives* are taken directly from our last ABET accreditation self-study, written in June 2017:

Within 4 years of graduation, graduates of our program will have:

- Established themselves as practicing professionals who contribute to the economic development of the region, state and nation or are engaged in advanced education in computer science, software engineering or related areas.
- Demonstrated their ability to work in accordance with the professional standards of ethics expected of computer scientists and software engineers.
- Demonstrated their ability to adapt to changing technology and economic conditions by acquiring new skills and seeking opportunities for personal and professional development.

As of the 2017 ABET self-study we had the following eleven *Student Outcomes*:

- A. An ability to apply knowledge of computing and mathematics as appropriate to the discipline
- B. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- C. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- D. An ability to function effectively on teams to accomplish a common goal
- E. An understanding of professional, ethical, legal and social issues and responsibilities
- F. An ability to communicate effectively in both written and oral form
- G. An appreciation of the impact of computing on individuals and society
- H. Recognition of the need for and ability to engage in continuing professional development
- I. An ability to use current techniques, skills and tools necessary for computing practice
- J. An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way which demonstrates comprehension of the tradeoffs involved in design choices
- K. An ability to apply design and development principles in the construction of software systems of varying complexity

1.C.2 Master of Science program

The Outcomes assessed for our M.S. program are:

1. CS Fundamentals: Exhibit knowledge of engineering and science fundamentals appropriate for the discipline and/or specialization.
2. Communication: Be able to communicate effectively.
3. Critical Assessment: Demonstrate the ability to critically assess information in the discipline and/or specialization.

1.C.3 Doctor of Philosophy program

The five outcomes for the Ph.D. program are:

1. Knowledge of Computer Science fundamentals appropriate for discipline and specialization.
2. Depth of knowledge in specialization.
3. Ability to conduct original and independent research.
4. Ability to perform critical review of literature in Computer Science and area of specialization.
5. Ability to communicate effectively.

1.D Primary constituents and stakeholders

Describe the unit's primary constituents and stakeholders. Include an explanation of: (1) how the student learning goals and outcomes for each degree/certificate program are communicated to students, constituents, and other stakeholders; and (2) how satisfaction of the student learning goals and outcomes for each degree/certificate program would serve and support students' academic and/or professional aspirations. Provide specific examples.

The constituents of the department are the students in both the undergraduate and graduate programs, the staff, and the faculty. Other stakeholders include:

- Our alumni
- Our Advisory Board
- Prospective students
- Students at UNM or otherwise that can benefit from our course offerings and outreach without being part of any of our degree programs
- The employers who hire our graduates

- The Ph.D. programs that admit our undergraduate and Master's program graduates (*e.g.*, a few recent examples are Cornell, Brown Univ., and U.C. Santa Barbara)
- Departments at other institutions that hire our Ph.D. graduates as faculty (*e.g.*, Univ. of Michigan and CU Boulder) or post-docs (*e.g.*, Rice Univ., Princeton)
- Other research institutions that hire our Ph.D. graduates
- Local research collaborators (*e.g.*, Sandia National Labs)
- Other research collaborators

Program Objectives for the all three programs are posted on the Dept. website.

The program outcomes for the B.S. program align with ABET's suggested outcomes, and have been discussed by the faculty. All of the outcomes serve as a good foundation whether a student continues their studies in graduate school or enters the workforce.

The program outcomes for the M.S. program represent the additional strengths that a student should develop beyond their undergraduate degree to fulfill the needs of stakeholders that are specific to our graduate programs. Although the list of three outcomes (fundamentals of computer science, ability to communicate, and ability for critical assessment) are no longer formally part of any processes that involve the entire faculty since we eliminated the M.S. oral exam, these three outcomes are often individually the subject of faculty discussions about our M.S. curriculum and graduate curriculum in general.

The program outcomes for the Ph.D. program are a superset of those for the M.S. program, and add depth of knowledge and the ability to conduct a literature survey. These are integral to the process of conducting independent research, and are very important to the stakeholders that are specific to hiring our Ph.D. graduates. Because the rubric of these five outcomes is filled out during every student's dissertation defense, they become an integral part of the committee's overall discussion and the feedback given to the student's Ph.D. advisor.

1.E Outreach and community activities

Discuss and provide evidence of outreach or community activities (local, regional, national, and/or international) offered by the unit including: (1) how these activities relate to the unit's achievement of its student learning goals; and (2) the impact of these activities on the academic and/or professional success of students. (These activities could include activities such as colloquia, case competitions, conferences, speaker series, performances, community service projects, research, etc.)

As discussed in Section 5, the faculty engage in outreach via involvement in organizations such as NCWIT, WiCS, NASA Swarmathon, CSforAll, CRA-W, the New Mexico Supercomputing Challenge, and ADVANCE at UNM.

1.F Strategic planning efforts

Discuss how the unit's strategic planning efforts have evolved in relation to student learning goals and outcomes of its degree/certificate program(s), serving its constituents and stakeholders, and contributing to the wellbeing of the university and UNM community. Include an overview of the unit's strategic planning efforts going forward. For example, discuss the strengths and challenges of the unit, including the steps it has taken to maximize its strengths and address both internal and external challenges.

As per our last ABET visit, the Department now has a formal process for our Advisory Board to review and approve the student learning outcomes for the B.S. program. The advisory board also provides feedback about the graduate programs.

The Advisory Board composition is meant to represent as closely as possible the breadth of our main stakeholders.

2 Teaching and Learning: Curriculum

The unit should demonstrate the relevance and impact of the curriculum associated with each degree/certificate program. (Differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

2.A Detailed description of the curricula for each degree/certificate program

Provide a detailed description of the curricula for each degree/certificate program within the unit. Include a description of the general education component required and program- specific components for both the undergraduate and graduate programs. If applicable, provide a justification as to why any bachelor's degree program within the unit requires over 120 credit hours for completion.

2.A.1 Bachelor of Science program

Figure 1 shows the core curriculum for the B.S. in Computer Science degree. This is in addition to core UNM requirements. Informally, after the introductory courses (CS 152, with a prerequisite of either CS 105 or CS 108) the curriculum can be conceptually divided into three concurrent threads:

- Theory: CS 261, CS 361, CS 362, and CS 375
- Programming and software development: CS 251, CS 351, CS 460, and CS 357
- Systems: CS 241, CS 341, CS 481

Students also are required to take three 400-level Computer Science technical electives. These are typically taken later in the student's coursework.

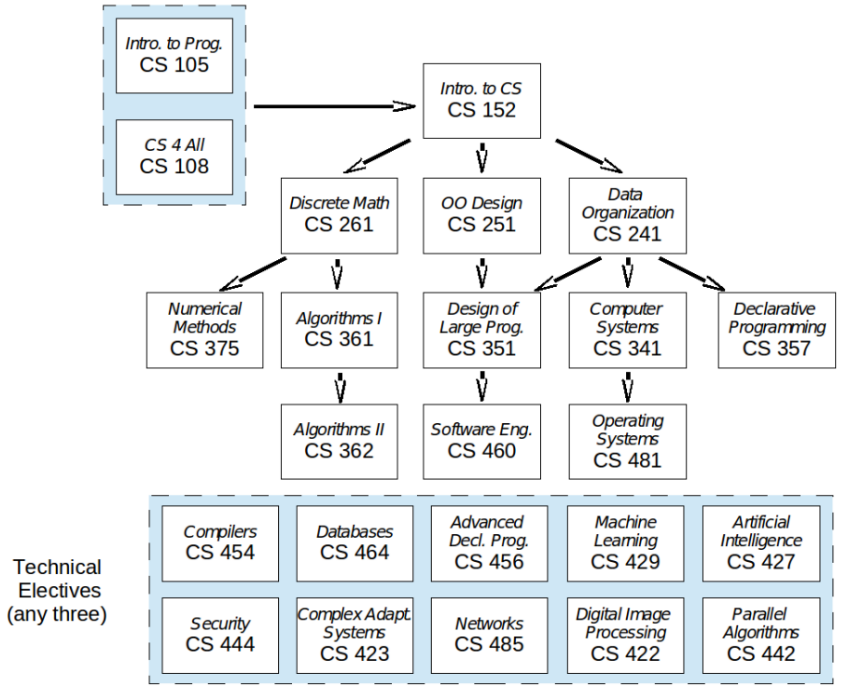


Figure 1: B.S. Curriculum.

2.A.2 Master of Science program

We have offered the Master of Science in Computer Science degree since 1973. The purpose of the master's degree program is to prepare students to work as professionals in the computer science field.

The Master of Science in computer science has two options: Plan I (thesis option) and Plan III (course work only option).

In addition to the University-wide requirements for admission to graduate study, the prospective M.S. or Ph.D. candidate must submit verbal, quantitative and analytical GRE scores (general test) as well as satisfy the following criteria for admission to graduate study:

- Knowledge of computer science equivalent to CS 152L, 251L, 261, 341L, 351L, 357L, 361L, 362, 441, 460 and 481.
- Knowledge of mathematics essential to computer science equivalent to MATH 162, 163, 314 and STAT 345.

Students lacking adequate undergraduate training may be admitted, at the discretion of the admissions committee. The committee will institute a provision requiring deficiencies to be upgraded satisfactorily. Course work required to remove the deficiencies in undergraduate background will not be credited toward the graduate degree. Each student will be assigned a graduate advisor.

The admission and graduation requirements for the Master's, in addition to the curriculum, are detailed in Appendix D on page 92. The core curriculum involves taking two courses from each of three core areas (Mathematical Methods, Empirical Methods, and Engineering and Systems Building Methods). Plan I students additionally take two three-credit electives and six credit hours of "Master's Thesis" (CS 599), and write and defend a Master's thesis. Plan III students take four 3-credit electives, two of which are required to be regularly numbered courses that meet at a scheduled time and two of which can be seminars, reading groups, reading and research, *etc.*

Shared credit program: The School of Engineering offers a Shared Credit Program designed to allow students to complete a BS and MS, or a BS and MEng degree in five years (depending upon the student's mathematics preparation upon entering UNM as a first-year student). To accomplish this, some courses are counted towards both the Bachelors and Masters degrees. For students pursuing a shared credit program within the School of Engineering, up to 12 hours of coursework may be shared between the two degrees. (Some undergraduate programs may not be able to accommodate the full 12 hours of shared credit.)

The shared credit program allows Computer Science undergraduate students to count 12 credit hours towards both their undergraduate Bachelors of Science degree and towards a Master's degree in Computer Science. Specifically, students admitted to the shared credit program may:

- Count CS561 towards both their MS theory core and as CS362 in their undergraduate core requirements

- Count up to three other 500-level graduate classes as both CS electives towards their B.S. degree and as core or elective classes (as appropriate) in their M.S. coursework.

An example schedule for this program, which we refer to as the "4 + 1" program, is in Appendix D on page 92.

2.A.3 Doctor of Philosophy program

The Ph.D. in Computer Science is offered through a cooperative program involving the Computer Science Departments at the University of New Mexico, New Mexico State University (Las Cruces, NM) and the New Mexico Institute of Mining and Technology (Socorro, NM). Doctoral students at the University of New Mexico may specialize in areas of current interest to the University of New Mexico faculty, or, by special arrangement, they may work in areas of interest to faculty at either of the other two universities.

The requirements for the Ph.D. program are detailed in Appendix E on page 96.

Ph.D. Core Curriculum

The core curriculum consists of three areas, theoretical foundations, computer systems, and empirical methods. Courses in the core curriculum are expected to be introductory in nature, teachable by multiple faculty with regular rotations, and when possible not cross-listed with undergraduate equivalents. The core curriculum is as follows:

- Theory (CS 561, CS 500, CS 550)
- Systems (CS 554, CS 585, CS 587)
- Empirical methods (CS 530, CS 533)
- The language requirement can be satisfied by taking at least one of CS 550, CS 554, CS 558.

The Empirical Methods core is currently short one or two courses. Until that is remedied students will have no flexibility in the empirical core, but it is anticipated that at least one additional course will be added.

Students are required to achieve a 3.5 grade point average in the core courses. Students entering with an earned M.S. in Computer Science or closely related discipline may be exempted from some of the core course requirements at the discretion of the Graduate Program Committee.

The Research Milestone

The milestone is a validation by a small committee of CS faculty on behalf of the Department that the student has demonstrated the ability to conduct independent research at a level appropriate for developing and completing a dissertation in the department.

Requirement: Within $2\frac{1}{2}$ calendar years of matriculation, each Ph.D. student is required to write and successfully defend a paper or report documenting significant technical research by the student. The paper should describe the student's body of work and be written in a style that is appropriate for submission to a peer-reviewed computer science conference.

The Process: Ordinarily, Ph.D. students will select a subject area advisor for the milestone project at the beginning of their second year in the program and register for the Research Practicum. The Practicum will provide intensive supervision for one semester, in collaboration with the subject area advisor, as the student develops a milestone project and begins to research it. All students are required to have submitted the milestone paper and presented it to a committee of three CS faculty by the fourth week of the Fall semester of their 3rd year (5th semester in the program, or 6th semester for January admits). The Committee consists of the Practicum instructor, the subject area advisor, and an additional member appointed by the Graduate Committee. If the Committee determines that either the paper or the presentation are not satisfactory, the student has the rest of the semester to work with the Committee to produce a satisfactory outcome. If the student fails to pass the milestone by January (beginning of the 6th semester in the program), then the student will be asked to leave the program.

Students who successfully complete the milestone before their third semester in the program (both the paper and presentation) can be exempted from the Practicum at the discretion of their advisor.

In addition to this process, all students will continue to receive annual evaluations from the department.

Committee on Studies

As soon as possible after passing the comprehensive coursework, the student will choose a faculty advisor and form a Committee on Studies. This must take place in the first semester in the program for a student already in possession of a graduate degree, and at any rate before 24 credit hours of graduate study are completed in the program.

The committee consists of a chairperson and three to four other faculty members. The chair must be a regular faculty member approved by the student's graduate unit. At least one faculty member must be from a department other than Computer Science, and one may be from a university other than the one at which the student is enrolled (but only if this faculty member plays a significant role in the student's research area). The committee will act as advisor to the student for the remainder of the program, help the student in drafting a plan of studies consistent with the student's preferred orientation, review the choice of a dissertation topic, and meet at least once a semester with the student to review the progress made and suggest changes if necessary.

A student may ask for a change in the composition of the committee, or even select another advisor. In so doing, however, the student nullifies the decisions taken by the original committee and thus may have to repeat some steps, at the discretion of the new committee.

Ph.D. Candidacy

Application to Candidacy: At least one semester prior to taking the Candidacy examination (and typically just after passing the Comprehensive examinations), the student must file a form with the Graduate School, describing the course work for the degree and various other relevant facts. See the Graduate Bulletin for more details.

Candidacy Examination: The student should have chosen a dissertation area by the time he or she has passed the comprehensive examinations. The choice of the topic is reviewed by the Committee on Studies, which accepts or rejects it according to criteria such as originality, feasibility, and preparedness.

Once the student has completed the necessary preliminary work on the dissertation topic (such as a literature survey), written a formal dissertation proposal (i.e., a short paper outlining the proposed research and presenting evidence that it is original, innovative, and that it can be done), and received faculty approval, the candidacy examination must be scheduled (officially, through the Graduate School, with at least two weeks notice). The Candidacy examination is, in effect, the second part of the Comprehensive examinations.

During this examination, the Committee on Studies, as well as any faculty member or graduate student who wishes to attend, hears a presentation by the student on the proposed topic of research. The student defends his or her choice of topic and must demonstrate an adequate command of the subject matter in answering questions from the audience.

At the conclusion of the examination, the Committee on Studies meets to decide whether to admit the student to candidacy, that is, whether to enter with the student into a contract stipulating that the student will be awarded a Ph.D. upon completion of the research program as outlined in the dissertation proposal and amended during the examination.

Ph.D. Residency Requirements

Every Ph.D. student must spend at least one academic year in full-time residence at the University during the course of the program, preferably before passing the comprehensive coursework. One academic year of full-time residence means two consecutive semesters (Fall-Spring or Spring-Fall) during which the student carries a full-time load (*i.e.*, a minimum of 9 credit hours, which may include dissertation) and has no obligation to an employer—other than the Department, and even then on at most a half-time basis—to perform any service other than progress toward the degree. During this period, the student must register for CS 592, take appropriate classes, and meet with faculty members to discuss progress toward the degree.

Ph.D. Dissertation Information

This is the most important part of the program. A dissertation is expected to demonstrate the candidate's ability to do research at a professional level, to contribute significantly to the development of Computer Science, and to communicate effectively. It must be written in such a way that persons who have a moderate knowledge of the background on which it draws can read it

and appreciate the contributions it makes. Needless to say, the style should demonstrate the candidate's ability to write clearly and concisely (not to mention correctly); the dissertation style, quality, and significance to the Computer Science community must meet the standards of publication in scholarly journals. Every Ph.D. candidate is expected to submit for publication at least one article dealing with the work performed for the dissertation before the degree is granted (although such submission is by no means sufficient grounds for granting the degree).

Defense of Dissertation: The final step in the process is the defense of dissertation. This is a publicly announced colloquium to which the faculty and graduate students of the Computer Science and other interested departments are invited and which anybody who so wishes may attend. The candidate explains what the dissertation has accomplished and compares it with the aims stated in the dissertation proposal, explaining any discrepancy or change of orientation. The quality of the presentation is an integral part of the defense; the candidate must demonstrate the ability to speak clearly, make good use of carefully prepared graphical aids, and convey in a relatively short time the essence of the work. After the presentation questions and criticism from the audience are entertained.

Following the defense, the Committee on Studies meets to determine whether the candidate has successfully met all of the requirements for the Ph.D.; if such is the case, the Committee will so certify to the Graduate School, which will confer the degree.

Dissertation Committee: Dissertation committees will consist of at least 4 members approved for graduate instruction by the UNM Dean of graduate studies, two of whom must hold regular, full-time UNM faculty appointments. The dissertation director must be a regular (tenured or tenure-track) full-time member of the UNM faculty.

At least one of the members must be from the student's graduate unit (department).

A required external member must hold a regular full-time appointment outside of the student's unit/department at UNM. This member may be from UNM or another accredited institution.

One of the committee members may be a non-faculty expert in the student's major research area.

All committee members who are not regular UNM faculty must be approved for graduate instruction specifically for the student's graduate unit (department) by the Dean of Graduate Studies. (To do this a current Curriculum Vitae and the social security number of the outside committee member is needed.)

2.B Contributions to and/or collaboration with other internal units within UNM

Discuss the significance of the unit's contributions to and/or collaboration with other internal units within UNM,

such as offering general education core courses for undergraduate students, common courses for selected graduate programs, courses that fulfill pre-requisites of other programs, courses that are electives in other programs, cross-listed courses, etc.

Regarding contributions to and/or collaboration with other internal units within UNM, a few highlights include:

- Prof. Moses's CS 108, which is part of UNM's core curriculum and is also a key part of outreach efforts to New Mexico high schools
- Prof. Bridges is the director if the Center for Advanced Research Computing (CARC), which offers the Computational Science & Engineering (CSE) Certificate Program that includes CS courses
- Prof.'s Estrada, Bridges, and Crandall represent the CS Dept. for UNM's Critical Technology Studies Program, which is run out of the Honor's College
- Prof. Moses is a key personnel for ADVANCE at UNM, "an eclectic and experienced group of faculty and staff developing partnerships that will create sustainable changes in the UNM climate, contributing to increased success and satisfaction for women and minority faculty" (`https://advance.unm.edu/about-us/`)
- Prof. Crandall is a co-PI on the UNM Scholarships for Service program, funded by the National Science Foundation
- Several classes are cross-listed with the Electrical and Computer Engineering Dept. and support their Computer Engineering Bachelor's program
- CS 108, CS 150, and CS 151 are taken by a significant number of non-CS majors

2.C Modes of delivery for teaching courses

Discuss the efficiency and necessity of the unit's mode(s) of delivery for teaching courses.

Most of our courses are delivered in lecture or lab format. We have a special classroom with over 70 Linux workstations (B146 in the basement of the Centennial Engineering Center) where many of our lab classes are taught. However, this classroom is not equipped for any kind of distance learning, such as the ITV (Instructional Television) program.

At the discretion of the instructor, courses may be offered through UNM's ITV program. Typically, the branch campuses (*e.g.*, Los Alamos, Gallup, *etc.*) offer all the courses a student needs for the B.S. degree at the 100- and 200-level and the 300- and 400-level classes are available over ITV. Graduate classes are also offered over ITV, but recently we have not offered these classes in this format as consistently, owing in part to a shortage of suitable classrooms. Prof. Estrada has twice taught the CS 429/529 Machine Learning course as an "online synchronous" course using Zoom.

2.D Strategic planning efforts

Discuss the unit's strategic planning efforts going forward for identifying, changing and/or examining areas for improvement in its curricula.

We recently made significant changes to our undergraduate curriculum (especially CS 351 and the 100-level programming courses) as detailed above. The undergraduate committee is currently developing a proposal to allow 200-level electives so that students can pursue intellectual interests and application areas within computer science earlier in the program.

For the M.S. program, we are not currently considering any major changes. A challenge that we plan to address soon is that fewer and fewer of our graduate classes are being offered over ITV, making it difficult for remote M.S. students to make progress in the program. We are looking into strategies for offering more of our graduate courses online.

We recently overhauled our Ph.D. program, including revamping the core curriculum, adding two new courses, and implementing a research milestone requirement (see Section 2.A.3). Now that students in the new program are far enough along to be considering the research milestone requirement and we have offered the new courses more than once, the faculty need to discuss the Ph.D. program and what adjustments should be made.

3 Teaching and Learning: Continuous Improvement

The unit should demonstrate that it assesses student learning and uses assessment to make program improvements. In this section, the unit should reference and provide evidence of the program's assessment plan(s) and annual program assessment records/reports. (Differentiate for each undergraduate and graduate degree/certificate program and concentration offered by the unit.)

3.A Assessment process and evaluation of the student learning outcomes

Describe the assessment process and evaluation of the student learning outcomes for each degree/certificate program by addressing the items below. Describe the overall skills, knowledge, and values that are expected of all students at the completion of the program (refer to the program learning goals outlined in Criterion 1). Explain how the current direct and indirect assessment methods were established and are administered as program-level assessments including how they are used to measure the student learning outcomes. Also, provide a description of the courses in which the assessment methods are administered and the extent to which students are expected to meet the relevant student learning outcomes. Explain and provide evidence of how the program has progressively improved, evolved and/or maintained the quality and effectiveness of its assessment structure and activities in order to reflect, sustain and/or maximize student learning (i.e., refer to updated assessment plans, annual assessment reports, assessment maturity scores, etc.)

3.A.1 Bachelor of Science program

The goals and outcomes for the B.S. degree were presented in Section 1.C.1. Here we describe the assessment process. In Fall 2010, the Computer Science Department adopted the current A-K program outcomes and began using a rubric-based method of outcomes assessment. The rows of each assessment rubric are performance indicators and the columns are performance levels. There are three performance levels: Exceeds expectations, Meets expectations, and Does not meet expectations. For the purposes of computing averages (and other summary statistics), the three performance levels are assigned numerical values of [4-5] for Exceeds expectations, [3-3.9] for Meets expectations, and [1-2.9] for Does not meet expectations. With the exception of Outcome F, which, although a single outcome, has separate assessment rubrics for oral and written communication, there is one rubric per outcome.

The assessment of a given outcome begins when the Chair of the Undergraduate Committee, based on the Outcome Assessment Schedule, asks the instructor for a given course to perform an assessment of a specific outcome in a given semester. The course instructor then selects one (or more) homework problem(s), exam question(s), or oral presentation(s) which he or she believes to be appropriate instruments for the assessment of the outcome. The course instructor is requested to carefully consider the rubric and its criteria when making this choice. The work of every student in the class is then evaluated by indicating the performance level best describing the student's work for each of the relevant criteria. The course instructor then computes the overall assessment for each student using a formula specific to each outcome. The formulas are based on three operations: min, max, and avg. The min operation is used when complete assessment of an outcome statement requires that two or more criteria must be satisfied while the max operation is used when one criterion is sufficient. The avg. operation is used to combine positive indicators of a single ability. The overall assessments for all students are then averaged so that the assessment results in a single number.

Since 2013, this process has been greatly facilitated by the existence of a Google Docs directory with subdirectories for each semester, and subdirectories within these for each requested outcome assessment (labeled by outcome and course number). Contained in each outcome assessment directory is a custom designed spreadsheet based on the rubric specific to that outcome. This spreadsheet contains all of the information contained in the printed rubric, and the performance criteria are displayed to the user when the column headings are moused over. In addition, the summary statistic formula for the outcome is built into the spreadsheet so that the summary statistic is automatically computed, eliminating a potential source of error in the outcome assessment process. The reaction by the faculty to the standardized process of outcome assessment using rubrics implemented as spreadsheets in a publicly accessible repository has been positive overall. Indeed, the rate of completion of requested outcome assessments has significantly increased relative to the paper rubric and file-based system.

In addition to completing one assessment per student in the class, the course instructor also uploads copies of representative student work (oral presentations are excluded from this requirement). The evaluator is instructed to upload one piece of student work per performance level when possible. These are included with the completed spreadsheets in the directory for that outcome assessment. Significantly, all faculty members have access to this directory, and those who are requested to perform outcome assessments can examine the completed spreadsheets and uploaded examples of student work from previous semesters. The use of rubrics implemented as spreadsheets contained in directories with representative examples of student work contributes to consistency of the outcome assessment process over multiple semesters and among different faculty members.

3.A.2 Master of Science program

The outcomes for the M.S. program were presented in Section 1.C.2. Assessments are performed based on the following:

1. CS Fundamentals: The overall GPA for the student's MS courses is used.
2. Communication: The student's GPA in courses that they count towards the Empirical Methods core is used. These courses all involve presentations that are part of the student's grade, such as in-class oral presentations or poster sessions about course research projects.
3. Critical Assessment: The student's GPA in courses that they count towards the Engineering and Systems Building core is used. These courses all involve evaluating tradeoffs in systems designs.

Prior to the 2016/2017 assessment the GPA was a component of assessing "CS Fundamentals" in addition to an oral exam, and the other two outcomes were assessed based entirely on the oral exam. The Master's oral exam consumed a large amount of faculty time, especially when MS graduates per year exceeded 60 in 2015 and 2016. Because this amount of effort was not justified by the information that could be gleaned from the assessments beyond student GPA, the faculty voted to eliminate the M.S. oral exam and base M.S. program assessments on GPA in courses that enable each outcome.

3.A.3 Doctor of Philosophy program

The outcomes for the Ph.D. program were presented in Section 1.C.3. Assessments are performed by the students dissertation defense committee, using the Outcomes Assessment Rubric. The form is filled out by the Chair of the committee with input from the rest of the committee during the private discussion that follows a student's defense presentation. The Outcomes Assessment Rubric for our Ph.D. program is shown in Appendix E on page 96.

3.A.4 Exit interviews

In addition to the above assessment mechanisms, the department conducts informal exit interviews. Each semester, students graduating from each of the three degree programs are encouraged to visit the Associate Chair for a 5-minute interview. The interview covers topics such as feedback about the degree program as a whole, feedback about specific courses, courses they think we should offer, if they had difficulty with signing up for classes they need, *etc.*

3.B Impact of the annual assessment activities

Synthesize the impact of the annual assessment activities for each degree/certificate program by addressing the items below. How have the results/data of each of the aforementioned program-level assessment methods been used to support and inform quality teaching and learning? How have the results/data from the program's assessment methods and activities been used for program improvement, curricular improvement and/or to maximize student learning? Overall, explain how the program strategically monitor the short- and/or long-term effects and/or impact of it changes/improvements.

Assessments going back to 2013 are available in Appendix G on page 106.

3.B.1 Bachelor of Science program

The process of acting on assessments for the undergradaute program follows 2-year cycles. The results of the assessment/action process for the three two-year cycles since the last accreditation visit are summarized below:

Cycle 1 (2012-2013):

- Development/approval/implementation of CS 108 Computer Science for All to promote growth of major
- Assessment of 2.7 for Outcome B (problem solving) in CS 152 in fall 2013
- All other outcome assessments meet or exceed expectations

Cycle 2 (2014-2015):

- CS 105 Introduction to Programming or CS 108 Computer Science for All is made a prerequisite for CS 152 to remedy poor Outcome B assessment in CS 152 in Fall 2013
- Assessment of 2.9 for Outcome C (design of systems) in CS 460 in spring 2015
- All other outcome assessments meet or exceed expectations

Cycle 3 (2016-2017):

- Reassessment of 4.2 for Outcome B (problem solving) in CS 152 in fall 2016 and 4.0 in CS 251 in spring 2017 show improvement relative to fall 2013.

- Reinvention of CS 351 Design of Large Programs by overhaul of its syllabus and splitting it into separate lecture and laboratory sections taught cooperatively by two faculty, in effect, doubling the teaching resources devoted it, to remedy poor Outcome C assessment in CS 460 in Spring 2015.

- All outcome assessments (as of this date) meet or exceed expectations

More details follow.

Cycle 1 (2012-2013)

The faculty has long recognized that many students enter the University of New Mexico poorly equipped to study technical subjects, including computer science. This concern, together with a reduction in the number of computer science majors overall, led to the creation by Professor Melanie Moses of a radical new web-based course for high school science teachers called CS4ALL. In this course, the science teachers in New Mexico public schools were instructed in computer science concepts and methods, including simulation and modeling in the NetLogo programming language. The online lectures were developed and delivered by UNM faculty including Professors Moses and Ackley, Professor Emeritus Ed Angel, and the department's lecturer Joel Castellanos. The idea was that the high school teachers, after taking the course themselves, would take the online material and use it as the basis for their own CS4ALL-based courses at New Mexico high schools.

Note: Since 2014, CS4ALL has been offered as a web-based course, CS 108 Computer Science For All, to all students at UNM. In 2016, CS 108 was made part of UNM's Common Core, where it will contribute to increasing enrollments in introductory computer science courses and growth of numbers in the major.

Cycle 2: 2014-2015

In 2014, all departments in the UNM School of Engineering were instructed by the dean to submit plans for complying with the mandate from the provost that it must be possible to complete every undergraduate degree programs by fulfilling degree requirements totaling 120 credits or less. The intention of the provost's mandate was to increase retention and shorten the time to degree completion. As a requirement for the BS degree, computer science had its own 128-credit minimum credit requirement. Contemporaneously, the dean instructed the departments to permit dual use of up to six credits of mathematics courses towards completion of a minor in mathematics. Within the school, this primarily affected computer science, since no other engineering majors included a minor requirement.

In response to these mandates, the undergraduate committee did an analysis of minimum numbers of credits required for a BS in computer science as a function of choice of minor. It was discovered that, given the dean's instruction on dual use of six credits of mathematics, there existed multiple plans of study for students in Computer Science based on different choices of minor,

including mathematics and earth and planetary science, that could actually be completed in less than 120 credits, were it not for the supernumerary minimum credit requirement. Accordingly, the undergraduate committee proposed that the 128-credit minimum credit requirement should be eliminated, and this change was approved by the faculty at large in a regular faculty meeting.

In spring 2014, the undergraduate committee met to discuss the outcome assessment data from Cycle 1. The committee noted that in fall 2013 the result of the scheduled assessment of Outcome B in CS 152 Computer Programming Fundamentals indicated a need for improvement in computer-based problem solving. The committee considered the root causes of this poor assessment and then devised remedies. On the basis of the anecdotal experience of the two committee members who had most recently taught CS 152, Patrick Kelley and Joel Castellanos, the committee came to believe that the problem was the vastly disparate levels of prior knowledge possessed by students in CS 152 as the first course in the major. This experience ranged from students with no prior knowledge of computer programming, to students with some familiarity (a plurality), to students who were expert programmers in Python or Java (a small but disproportionately vocal minority). In order that all students could be accommodated, CS 152 assumed no prior knowledge of computer science.

In devising a remedy, the undergraduate committee considered several additional factors. First, the School of Engineering had recently developed a course in engineering mathematics to be taken in their first semester at UNM by all students intending to major in engineering. Computer science had been invited to participate or to develop an alternative plan of its own. Professor Williams suggested that a comparable course for students intending to major in computer science should be developed and taught. Second, as a 1-credit course, CS 293 Ethics and Social Responsibility, had always been taught as an overload. As such, the course had been rotated through the faculty, with no single faculty member teaching it with any regularity. Prof. Kelley argued that CS 293 should be made a 3-credit course and that as a researcher with a deep interest in issues of privacy and social policy pertaining to computers, he would be an ideal person to teach it. This would give students more opportunity to practice written and oral communication, and eliminate the problem of the course's orphan overload status. All of these considerations led the undergraduate committee to formulate a proposal which was presented to the faculty at large in a regular faculty meeting in spring 2014.

The undergraduate committee's plan had four parts. First, all students would be required to take either CS 105 Introduction to Programming or CS 108 Computer Science for All prior to taking CS 152 their freshman year. The syllabus of CS 152 would be modified to include more advanced topics and this change would be pushed forward so that more advanced topics would be included in CS 241 Introduction to Computer Systems and CS 251 Intermediate Programming, with the overarching goal of better preparing students for CS 351 Design of Large Programs. Second, a new required course to be taken in the first semester, CS 161 Mathematics for Computer Science would be developed. Third, CS 293 Ethics and Social Responsibility would be expanded into

a regular 3-credit course to be taught by Prof. Kelley. Finally, to remain within the provost's 120-credit mandate, the minor requirement for the computer science major would be made optional. Students would be given the option of a so-called internal minor, consisting of three 400-level technical electives.

In fall 2014, the faculty at large debated this proposal at length. Objections to the proposal (or elements of the proposal) primarily concerned teaching load implications and reluctance to abandon the long-standing minor requirement. It was pointed out that replacing the minor requirement with additional technical electives in computer science would require students to take a disproportionately large number of computer science courses in their senior year relative to other years. A counterproposal to eliminate CS 375 Numerical Computing instead of the minor to accommodate the expanded CS 293 Ethics and Social Responsibility was put forward. This was tabled. There was no enthusiasm for developing and teaching a new course, CS 161 Mathematics for Computer Science. In the end, the faculty approved (by consensus) the new CS 105 or CS 108 prerequisite for CS 152, the sole remedy that could be accomplished without elimination of either CS 375 or the minor requirement. The faculty viewed the proposal to expand CS 293 and to (in effect) pay for it by making CS 375 a technical elective positively, but no formal approval was given. The associate chair was directed by the faculty to submit the proposal to the Faculty Senate for approval. This was accomplished in spring 2015 and the department implemented it beginning with the fall 2015 semester.

Cycle 3: 2016-2017

In spring 2015, the result of the scheduled assessment of Outcome C in CS 460 Software Engineering indicated a need for improvement in design, implementation and evaluation of computer-based systems. Based on its own long-standing policy, the undergraduate committee met to consider the root causes of this poor assessment and to devise remedies.

In spring 2016, the undergraduate committee met to discuss the results of outcome assessment in Cycle 2. In attempting to identify the root cause of the poor assessment result in CS 460, the committee's attention quickly focused on CS 351 Design of Large Programs, the capstone course in the major, and the immediate prerequisite of CS 460. To understand the committee's belief that CS 351 was the culprit, a bit of exposition on the history of this singularly important course is in order. Prior to 2011, CS 351 had been exclusively taught by tenure-track faculty. While this course is the sole 4-credit course in the undergraduate program, the 4-credit number probably doesn't accurately reflect the amount of effort students expend to complete the sequence of large coding projects required in CS 351. Prior to CS 351, the size of programs written by students was (and remains) comparatively small, rarely exceeding several hundred lines of code. Historically, the philosophy of CS 351 was to require students to complete programming projects so large (many thousands of lines of code) that the specification, design, debugging, and testing of these projects by ad hoc and/or unprofessional practices would quite simply be impossible. The phrase "sink or swim" was an oft-repeated shorthand for the philosophy

underlying this course. A corollary of the greater than usual student workload expected of students in CS 351 was the workload demand placed on the faculty teaching it, which far exceeded that required by any other course in the curriculum. This workload was exacerbated by the fact that CS 351 is offered every semester, and (to avoid the possibility of student cheating), design, specification, and implementation of a new sequence of projects is required every semester. Over time, these factors led to a reluctance on the part of the tenure-track faculty to volunteer to teach this course and an overreliance on lecturers. Indeed, in the last five years, this course has been taught exclusively by a single very dedicated lecturer, Joel Castellanos. However, in recent years, student complaints had grown, and many of these focused on the quality of the project specifications and the fact that projects were assigned with incomplete and ambiguous specifications. It became obvious to the committee that CS 351 was sorely overdue for a major overall in its design and conception, primarily to lower the egregious workload demands placed on the single faculty member teaching it. In the course of these meetings, many other problems with CS 351 were identified:

- The class lacked intellectual cohesion and organizational framework.
- Its contents varied significantly from one semester to another.
- It offered an immersive programming experience with limited guidance and mentoring and without specific learning outcomes in terms of academic knowledge.
- It came across as training by fire, leaving many behind.
- It did not build gradually on knowledge and skills.
- It centered predominantly on the programming experience and less so on the development of design skills.
- It often introduced advanced topics and algorithms that detracted from the mission of the course.
- The effort was not carefully paced, resulting in surges of work and all-nighters, which reinforced negative preconceptions of what computer science graduates end up doing.
- Students who passed the class felt that it was a great experience, a badge of honor. However, the opinion was expressed that this is precisely the kind of class which literature on retaining underrepresented groups in STEM fields identifies as being most damaging.

In spring 2016 the Undergraduate Committee conceived a plan to overhaul CS 351. This plan had two parts:

- Divide CS 351 into two interlinked 2-credit sections, with responsibility for each section residing with different faculty members. The first section, CS 351X, would be a lecture course, taught by a tenure-track faculty member. The second section, CS 351L, would be a laboratory section, taught by a lecturer. The lecturer would have responsibility for choosing the project, developing the specification, and implementing it. The primary purpose of the laboratory section will be exposition of the semester project and mentoring students while they complete it. Overall, this division of CS 351 into two sections represents an actual doubling of the faculty workload resource devoted to CS 351 by the department each semester.

- Creation of a repository of at least a half a dozen CS 351 project specifications and model implementations, which the faculty member teaching the lecture section will be able to cycle through so that no project will be repeated in any 3 year period.

In fall 2016 Prof. Catalin Roman was persuaded to take on the responsibility for designing and teaching the reimagined CS 351 lecture course, and he presented the proposal to revise CS 351 on behalf of the undergraduate committee to the full faculty at a regular faculty meeting. The proposal was unanimously approved. In spring 2017 the syllabi for the reimagined CS 351 course were prepared by Prof. Roman and the Associate Chair shepherded them through the approval process by the Faculty Senate. The two courses were taught for the first time in fall 2017; Prof. Roman taught the lecture section and a lecturer taught the laboratory section.

Cycle 4: 2018-2019

As a result of greatly increased enrollments (Table D-1), the current practice of assessing the outcomes for all students in a given course is creating an unduly high workload for faculty. In June 2017 the chair instructed the undergraduate committee chair to explore the best practices for outcomes assessments based on sampling, as well as the possibility of concentrating the instruments in a smaller number of courses, preferably higher-level ones.

The priority of the Undergraduate Committee in this cycle was to be a major revision of the outcome assessment process. This was done for two reasons: (1) so that new accreditation requirements and best practice recommendations from ABET can be incorporated; and (2) so that the outcome assessment process makes more modest demands on the time of faculty who would otherwise be engaged in research, teaching, and service. This latter goal will be accomplished by using systematic sampling of student work when completing outcome assessments, instead of the current system, which requires all student work in a given class to be evaluated. Significantly, it is the undergraduate committee's intention to retain key elements of the current process which have been highly successful, namely: (1) the use of standardized rubrics; (2) the use of summary formulae to compute performance metrics; and (3) the use of the

online repository to document the process. At the same time, though not originally planned, the Undergraduate Committee is completing a revision of the assessment schedules in response to the ABET-mandated change in the student learning outcomes.

3.B.2 Master of Science program

While the formal assessment mechanisms for the M.S. program did not factor into any major changes in the program since the last Academic Program Review self study, these mechanisms have served as a valuable source of feedback for the changes that were made in response to other assessment mechanisms (specifically exit interviews and faculty input based on advisement experiences). Two examples are:

- The quantitative measures show an increase in 2017/2018. This is a direct result of our shared credit (*i.e.*, "4 + 1") program, which encourages the best students from our undergraduate program to enter our Master's program.
- The 2015/2016 assessment shows the "Critical assessment" outcome as being only partially met, with a 2.83 score and a performance benchmark of 3.0. This was a direct result of temporarily lowering our standards for M.S. program admissions in 2014.

3.B.3 Doctor of Philosophy program

For the Ph.D. program, like the M.S. program, exit interviews and faculty input based on advisement experiences are more valuable for decision making than the formal assessment mechanisms. Furthermore, the number of Ph.D. graduates per year is too small for any quantitative measures to allow for comparisons from year to year. However, the assessment rubric is a valuable discussion point during the committee discussion at a student's dissertation defense. Also, the validation that our Ph.D. students meet or exceed expectations from year to year is a key "sanity check" for the program.

3.B.4 Exit interviews

Although exit interviews are no longer a formal process in the Department, they still serve as a valuable feedback mechanism. Often the results of exit interviews simply confirm faculty experiences from advisement, but in some cases they refine this input. As examples:

- The Department was aware that our limited course offerings (due to resource constraints) were causing scheduling problems for students—for example, required classes being full or no classes being offered in a student's final semester that could fulfill a specific requirement. Exit interviews indicated that this problem was most poignant for the Master's students.

- While we know that having female representation on the faculty is important to female students, having this confirmed in exit interviews serves to underline the importance of this aspect of our department.

4 Students: Undergraduate and Graduate

The unit should have appropriate structures in place to recruit, and retain graduate students. (If applicable, differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

4.A Admission and recruitment

Discuss the unit's admission and recruitment processes (including transfer articulation(s)) and evaluate the impact of these processes on enrollment.

4.A.1 Bachelor of Science program

The School of Engineering (SOE) at the University of New Mexico (UNM) administers a pre-majors program. First-year students admitted to UNM who declare engineering or computer science as their intended major are eligible for enrollment in SOE with pre-major status if they meet all the following requirements:

1. ACT Math score of 25 or higher;
2. ACT English and Science scores of 19 or higher; and
3. ACT Reading score of 18 or higher.

Before August of 2016, students with this status received advisement, tutoring, and other forms of help aimed at enhancing student success through the Engineering Student Services program, administered by the SOE. Once a student was admitted into a particular program, advising responsibilities shifted to the SOE department in which that program is located. In response to campus-wide advisement restructuring, since August 2016 students with pre-major status immediately receive advisement from the department.

First-year students declaring engineering or computer science as a major who do not initially meet the above criteria are admitted into the UNM University College. These students, as well as students from other degree-granting colleges at UNM, from the non-degree status at UNM, or from other accredited institutions, can transfer to SOE pre-major status once they meet the following criteria:

1. Completion of Math 150 (Pre-Calculus Math) and Math 123 (Trigonometry) or equivalent with a grade of C or better;
2. Minimum 2.20 cumulative GPA for all completed courses;

3. Minimum 2.50 GPA in classes required in the computer science major, including prerequisite classes;

4. Completion of no more than 24 credits that count toward a major in the SOE, exclusive of credits in communications skills, humanities, social and behavioral sciences, one arts and foreign languages;

5. Accumulation of no more than 9 attempted credit hours with grades of D+, D, D-, F, WF or NC other than those subject to removal by academic renewal or use of the repeat policy; and

6. Any courses required for an SOE curriculum cannot have been attempted more than three times. An attempt includes receiving any letter grade (A through F), WP, WF, W, WNC, CR, NC, I, or AUDIT. For the purposes of this requirement, course work taken at other institutions is treated identically to course work taken at the University of New Mexico.

A student who has course credits beyond those described above may apply directly for admission to an SOE program skipping pre-major status. Students applying to the computer science program originate from one of three places: the SOE Pre-Majors program; from another university, college or community college; or from another academic unit within UNM.

Recruitment efforts by the School of Engineering's Engineering Student Success Center include an annual open house, visits to schools, and a Senior Day. Our Department also engages in various outreach efforts across the state and by offering CS 108 in the core UNM curriculum.

Table 1 shows undergraduate admissions. The low admissions in 2015 and 2016 is not reflected in enrollments, and is likely an artifact of changes in admissions procedures.

Year	Enrolled	Underrepresented	Female
2009	119	55 (46.2%)	20 (16.8%)
2010	174	77 (44.3%)	24 (13.8%)
2011	189	86 (45.5%)	29 (15.3%)
2012	219	103 (47.0%)	36 (16.4%)
2013	183	96 (52.5%)	32 (17.5%)
2014	155	71 (45.8%)	32 (20.6%)
2015	36	11 (30.6%)	3 (8.3%)
2016	34	19 (55.9%)	6 (17.6%)
2017	292	132 (45.2%)	61 (20.9%)
2018	318	162 (50.9%)	57 (17.9%)

Table 1: BS program admissions.

4.A.2 Master of Science and Doctor of Philosophy programs

Prospective graduate students apply through a central UNM system. We require transcripts, a letter of intent, and three letters of recommendation. While

we impose no GRE score cutoffs beyond those imposed by UNM's Office of Graduate Studies, we typically look for the GRE Quantitative scode to be at least 152 (old GRE 670) and the Verbal score to be at least 158 (old GRE 570). There is also no hard cutoff for GPA, but typically we look for at least a 3.0 (out of 4.0) GPA in a student's last two years of undergraduate study. Because of the wide array of schools, both in the U.S. and internationally, that our graduate students come from each applicant is reviewed on a case-by-case basis by at least two faculty. TA offers are made to top Ph.D. program applicants, and these top applicants are also brought to the attention of faculty members who may be interested in offering an RAship.

A key tool for recruitment for the M.S. program is the shared credit program. Because our undergraduate students are well-prepared for a traditional M.S. degree offering such as ours, recruiting them into the M.S. program increases both the numbers and the quality of the students in our M.S. program substantially. This program can also serve to increase the diversity of our M.S. program students, but whether this has happened yet or not is not obvious in the data.

The department has discussed Ph.D. recruitment extensively in faculty meetings and retreats, but have not come up with a satisfactory solution for increasing the number, quality, and diversity of our Ph.D. applicants. In 2017 we emailed a copy of our department flyer to students in the ENGINE database (a voluntary database of students from underrepresented groups around the country who are interested in graduate school). It is not clear if this had any impact on our Ph.D. applicant pool.

Table 2 shows M.S. program admissions. Note the aforementioned "bubble" of poorly-prepared students that were admitted in 2014. Table 3 shows Ph.D. program admissions. The trend of increasing numbers of female students admitted into the Ph.D. program is encouraging, and may be a reflection of our faculty profile.

Year	Enrolled	Underrepresented	Female
2009	17	1 (5.9%)	4 (23.5%)
2010	28	2 (7.1%)	6 (21.4%)
2011	40	10 (25.0%)	9 (22.5%)
2012	25	1 (4.0%)	6 (24.0%)
2013	34	6 (17.6%)	8 (23.5%)
2014	98	8 (8.2%)	21 (21.4%)
2015	60	5 (8.3%)	14 (23.3%)
2016	30	6 (20.0%)	5 (16.7%)
2017	49	13 (26.5%)	13 (26.5%)
2018	52	10 (19.2%)	7 (13.5%)

Table 2: MS program admissions.

Year	Enrolled	Underrepresented	Female
2009	13	0 (0.0%)	0 (0.0%)
2010	30	4 (13.3%)	6 (20.0%)
2011	31	5 (16.1%)	6 (19.4%)
2012	27	6 (22.2%)	8 (29.6%)
2013	13	1 (7.7%)	1 (7.7%)
2014	21	0 (0.0%)	3 (14.3%)
2015	24	1 (4.2%)	5 (20.8%)
2016	19	2 (10.5%)	4 (21.1%)
2017	26	9 (34.6%)	9 (34.6%)
2018	28	2 (7.1%)	12 (42.9%)

Table 3: Ph.D. program admissions.

4.B Enrollment, persistence/retention, and graduation trends

Provide an analysis of the unit's enrollment, persistence/retention, and graduation trends, including an explanation of the action steps or initiatives the unit has taken to address any significant challenges or issues highlighted in these trends.

The Department is going through a period of increasing enrollments with decreasing resources. Table 4 shows enrollments in selected core undergraduate classes from 2010 to 2018. While undergraduate enrollments in these core classes seem to have leveled off in the past three years, Table 5 shows the enrollments for the two main classes that feed into our core curriculum: CS 105 and CS 108, showing a clear upward trend.[1] Table 6 shows enrollments in our 400-level technical electives, and there is also a clear upward trend.

Year	CS 105	CS 108	Total
2013	175	0	175
2014	185	0	185
2015	163	51	214
2016	244	66	310
2017	251	194	445
2018	272	233	505

Table 5: Enrollments in 100-level classes that feed into our Bachelor's of Science program. CS 108 numbers may include dual-credit high school students.

[1] In Fall 2018 we could not schedule enough sections to meet the demand for CS105 because of insufficient computer labs.

Year	CS 152	CS 241	CS 251	CS 261	CS 293	CS 341	CS 351	CS 357	CS 361	CS 362	CS 460	CS 481	Total
2010	174	79	107	65	43	38	59	37	36	33	25	34	730
2011	243	73	117	65	40	56	41	53	46	25	30	30	819
2012	199	87	110	85	41	34	56	40	35	32	25	46	790
2013	245	98	140	117	39	72	60	50	60	28	28	25	962
2014	289	120	182	129	61	66	64	50	54	45	27	53	1140
2015	303	129	183	125	60	47	61	53	57	42	40	43	1143
2016	285	138	182	139	58	77	75	62	76	51	38	59	1240
2017	243	137	201	141	101	78	101	85	78	54	52	37	1308
2018	227	140	173	90	102	66	74	78	78	63	76	76	1243

Table 4: Enrollments in selected core undergraduate classes.

Year	CS 423	CS 427	CS 429	CS 444	CS 464	CS 485	Total
2010	8	4	5	0	0	29	46
2011	0	4	2	6	14	21	47
2012	9	20	2	19	16	22	88
2013	6	19	0	29	14	36	104
2014	0	22	5	29	13	17	86
2015	3	20	2	11	20	22	78
2016	0	19	9	11	18	24	81
2017	11	0	11	33	20	32	107
2018	6	19	16	28	19	24	112

Table 6: Enrollments in selected undergraduate electives.

The department also teaches three 100-level courses that are taken by a significant number of non-CS students. CS 150 is primarily for business and health sciences majors, and CS 151 is taken almost exclusively by engineering majors that are within the School of Engineering but not within Computer Science. CS 108 is a mix of Computer Science students and non-CS students (considerable majority), and serves (or at least it was our intention that it should serve) as a recruiting tool to bring students into our program. CS 108 is part of UNM's core curriculum. Table 7 shows the enrollments in these three courses.

Year	CS 108	CS 150	CS 151	Total
2010	0	512	432	944
2011	0	643	399	1042
2012	0	634	420	1054
2013	0	702	484	1186
2014	0	545	515	1060
2015	51	547	394	992
2016	66	556	411	1033
2017	194	518	399	1111
2018	233	483	387	1103

Table 7: Enrollments in 100-level classes with a significant number of non-CS students. CS 108 numbers may include dual-credit high school students.

Table 8 shows enrollments in selected core graduate classes. There is a clear upward trend in our graduate enrollments. The "bubble" in 2014 and 2015 was mostly due to a cohort of Master's students that were admitted into the M.S. program (at the behest of the administration) that would normally not have been admitted based on our admissions standards. The recent upward trend in graduate enrollments in 2017 and 2018 is likely due in part to our "4 + 1" B.S./M.S. program, which has attracted many excellent students into the M.S. program.

Two new courses were created to support our new Ph.D. program. The enrollments for those courses are shown in Table 9. It is expected that these

Year	CS 500	CS 561	CS 529	CS 530	CS 564	CS 585	CS 554	CS 558	Total
2010	24	23	22	27	0	21	0	26	143
2011	24	36	18	21	14	25	8	28	174
2012	34	29	20	21	20	31	0	12	167
2013	14	27	0	26	24	28	13	18	150
2014	16	44	52	59	39	37	15	29	291
2015	32	94	73	24	50	24	0	36	333
2016	21	25	63	29	34	25	0	47	244
2017	32	23	42	28	27	33	0	29	214
2018	25	36	38	27	32	34	18	44	254

Table 8: Enrollments in selected core graduate classes.

courses will be offered once a year going forward and have more substantial enrollments as we clear the pipeline for the old Ph.D. requirements and prime the pipeline for the new.

Year	CS 533	CS 600	Total
2016	0	8	8
2017	20	0	20
2018	20	10	30

Table 9: Enrollments in newly created courses for the Ph.D. program.

Tables 10, 11, and 12 show the graduates for our three degree programs. There is a clear upward trend in B.S. graduates. M.S. graduates are slightly down after the "bubble" created by the aforementioned students admitted into the M.S. program in 2014 and 2015. Ph.D. graduates do not show any clear trends because they are a smaller population.

Year	Graduated	Underrepresented	Female
2010	21	6 (28.6%)	4 (19.0%)
2011	20	5 (25.0%)	4 (20.0%)
2012	27	6 (22.2%)	3 (11.1%)
2013	21	5 (23.8%)	3 (14.3%)
2014	25	5 (20.0%)	2 (8.0%)
2015	27	8 (29.6%)	2 (7.4%)
2016	44	14 (31.8%)	4 (9.1%)
2017	45	12 (26.7%)	7 (15.6%)
2018	63	15 (23.8%)	9 (14.3%)

Table 10: BS program graduates.

Year	Graduated	Underrepresented	Female
2010	28	2 (7.1%)	2 (7.1%)
2011	22	0 (0.0%)	8 (36.4%)
2012	17	1 (5.9%)	4 (23.5%)
2013	35	2 (5.7%)	5 (14.3%)
2014	29	1 (3.4%)	7 (24.1%)
2015	65	8 (12.3%)	18 (27.7%)
2016	64	5 (7.8%)	9 (14.1%)
2017	37	4 (10.8%)	7 (18.9%)
2018	26	3 (11.5%)	8 (30.8%)

Table 11: MS program graduates.

Year	Graduated	Underrepresented	Female
2010	8	0 (0.0%)	1 (12.5%)
2011	4	0 (0.0%)	0 (0.0%)
2012	6	0 (0.0%)	0 (0.0%)
2013	9	0 (0.0%)	3 (33.3%)
2014	10	0 (0.0%)	3 (30.0%)
2015	7	0 (0.0%)	0 (0.0%)
2016	10	0 (0.0%)	2 (20.0%)
2017	6	1 (16.7%)	1 (16.7%)
2018	11	3 (27.3%)	3 (27.3%)

Table 12: Ph.D. program graduates.

Cohort	4-year	5-year	6-year
2007/2008	13%	39%	50%
2008/2009	0%	21%	27%
2009/2010	17%	31%	59%
2010/2011	0%	11%	35%
2011/2012	10%	41%	52%
2012/2013	11%	57%	62%
2013/2014	18%	31%	N/A
2014/2015	6%	N/A	N/A

Table 13: B.S. program graduation rates. Data from IDI dashboard.

Cohort	UNM overall	School of Eng.	Computer Science
2009/2010	78%	50%	25%
2010/2011	74%	57%	28%
2011/2012	77%	56%	42%
2012/2013	78%	62%	34%
2013/2014	79%	61%	31%
2014/2015	80%	57%	No data
2015/2016	80%	57%	No data
2016/2017	79%	57%	47%

Table 14: Retention rates for the undergraduate program. Data from IDI dashboard.

Table 13 shows our 4-, 5-, and 6-year graduation rates for cohorts going back to 2007/2008. The low (6%) 4-year graduation rate for the 2014/2015 cohort may be due to an irregularity in the data, as described below. Ignoring that data point, the rates show improvement over time.

Table 14 shows retention over time for the University as a whole, the School of Engineering, and our department. While our Department has a lower retention overall, there is a trend of improvement over time. Two years of data are

missing from the table at the department level, this is because the IDI dashboard crashes when trying to access the departmental data for those years.

We believe that some kind of irregularity in student tracking may explain some of the missing data and outliers in the data presented above. The irregularity appears to have occurred in 2014/2015 when a large group of students was marked as computer science one semester (Fall 2014) and then marked as something else the next semester (Spring 2015). Figure 2 shows the student flow from the IDI dashboard for the Fall 2014 cohort. The figure is reproduced from the IDI dashboard. The low 4-year graduation rate in Table 13 and missing retention data in Table 14 may be at least partially explained by this irregularity.

4.C Advisement process for students

Discuss the unit's advisement process for students, including an explanation of how the unit has attempted to improve or address issues regarding its advising practices (i.e., consult with the college's designated professional advising manager and/or the program's designated professional advisor; refer to the advising: outcomes, assessment practices, assessment data; etc.).

Undergraduate: Pre-Computer Science students, who have not yet entered the program, are advised by our advisement staff. Upon being admitted into the Computer Science B.S. program, students are assigned a faculty advisor. Each semester when students register for classes, an advisement hold is placed on their account and they cannot sign up for any classes until they meet with their faculty advisor. This ensures that throughout their time in the program they are getting advice from both the advisement staff and a faculty member.

Graduate: Graduate students are assigned an advisor upon admission. Before they can register for courses in their first semester they must meet in person with their faculty advisor to complete a form that is intended to identify deficiencies in their undergraduate preparation. This form is shown in Appendix F on page 101. For example, a student who has not taken something equivalent to our CS 341 (Computer Organization and Design) will be advised that they must take this course in our Department before taking any graduate-level systems courses. After their first semester, as with undergraduate students, a hold is placed on their account so that they must meet with their faculty advisor at least once per semester, before signing up for courses. For Ph.D. students and M.S. students who engage in research with a faculty member their faculty advisor is changed to be the same faculty member as their research advisor. Ph.D. students are also evaluated once per year, a process that requires them to fill out a form with their advisor about their progress in the Ph.D. program. This form is shown in Appendix F.

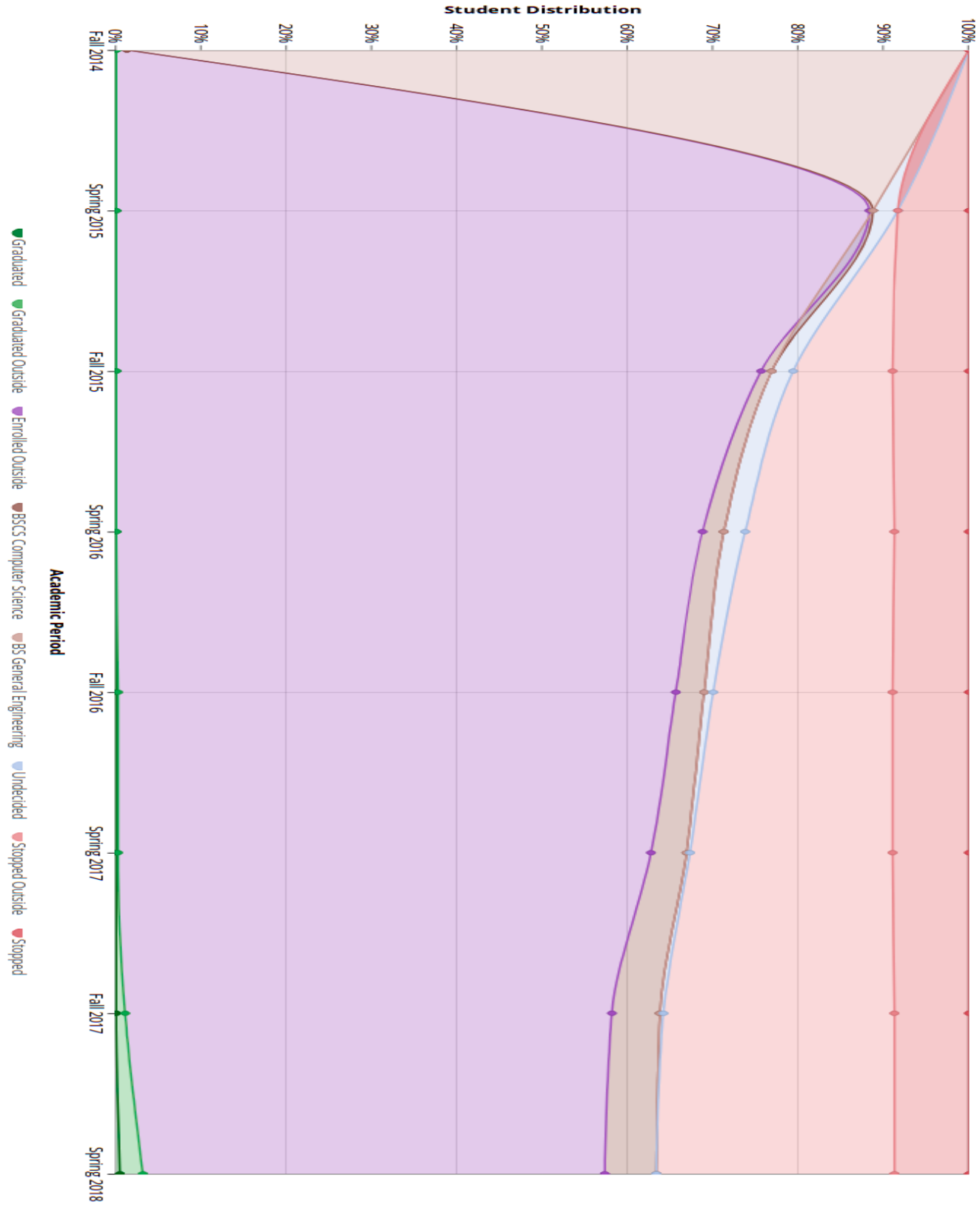


Figure 2: Student flow from IDI dashboard (`https://analytics.damoursystems.com/universities/university-of-new-mexico-main-campus/flow/`).

Semester	Advisement time (hours)
Spring 2014	444
Summer 2014	149
Fall 2014	466
Spring 2015	454
Summer 2015	221
Fall 2015	635
Spring 2016	539
Summer 2016	299
Fall 2016	508
Spring 2017	452
Summer 2017	182
Fall 2017	880
Spring 2018	581
Summer 2018	155

Table 15: Advisement in hours, by semester.

Table 15 shows the amount of time staff spent advising Computer Science students per semester since 2014. The steady increase in advisement load can be assumed to have also been experienced by faculty, but because faculty do not use LoboAchieve to clock students in and out for advisement that data is not available. Advisement load is just one of many strains on the department that comes with increasing enrollments.

4.D Student support services

Discuss any student support services that are provided by the unit and evaluate the relevancy and impact of these services on students' academic success.

In addition to support services at the University (*e.g.*, Center for Academic Program Support) and College (*e.g.*, Engineering Student Services) levels, our department has a tutor program where students who have recently taken classes in our core curriculum hold regular hours in a lab environment. This is in addition to TAs and graders for any given course, and has been a very successful program in terms of how many of our undergraduate students utilize this service. We hire four tutors every semester. Tutors hold non-overlapping office hours to ensure availability all through the week and on Saturdays. We maintain diversity in hiring tutors. In Fall 2018, our tutors served over 500 visits that included 41% female student visits.

4.E Success of graduates

Discuss the success of graduates of the program by addressing the following questions: Where graduates are typically placed in the workforce? Are placements consistent with the program's learning goals? What methods are used to measure the success of graduates? What are the results of these measures?

For B.S. and M.S. students the exit survey is the main method for determining where students are placed. Many of our students in both programs enter software development jobs in industry locally or nationally. Two local companies, Van Dyke Software and RiskSense, employ a significant number of our alumni and both companies have provided positive feedback about our graduates.

A large number of students go to work for one of the local national labs, especially Sandia National Labs. One of our Scholarships for Service M.S. students accepted an offer from the National Security Agency.

A significant number of students enter Ph.D. programs, either in our department or in other CS departments around the country. Recent examples include Cornell, U.C. Santa Barbara, and Brown University.

For the Ph.D. program, in addition to exit surveys we also can refer to the Taulbee surveys. In the years 2015–2018, 12 of our Ph.D. graduates went into a position in industry (at least 8 of these were research positions), 8 accepted postdoctoral research positions, 4 went into a government position, 3 unknown, 1 accepted a teaching position at a University, and 1 is self employed.

Many of our Ph.D. alumni hold tenure-tack faculty positions at universities in the U.S. (*e.g.*, University of Nebraska—Lincoln) and abroad (*e.g.*, University of Cambridge (UK); Instituto Tecnológico Autónomo de México, Jordan University of Science and Technology, Carleton University (Canada), Loughborough University (UK)). One of our recent Ph.D. alumni is a tenure-track Assistant Professor at the University of Michigan (ranked 11th for Computer Science Dept.'s by U.S. News); one is a tenure-track Assistant Professor at Mississippi State University; one is a tenured Associate Professor at the University of Colorado; one is a tenured Associate Professor (Biostatistics and Medical Informatics) at the University of Wisconsin. Many recent alumni are in research positions in industry (Microsoft Research, Google, Amazon, Visa Research). A number have joined government research labs—not only Sandia and Los Alamos, but also Lawrence Livermore.

Here are some summary statistics about our graduates' employment. The original data were provided by the UNM Alumni Relations Office in February 2019 and included the last known employer for each graduate. Out of a total of 2297 alumni reported (BS, MS, and PhD), employer information was present for 897. We then manually categorized the employers as follows: industry, 571; research/government labs, 123; universities/graduate school, 113; government, 39; non-profits, 29; academic, 9; research/universities, 7; self-employed, 6.

4.F Strategic planning efforts

Discuss the unit's strategic planning efforts going forward to improve, strengthen and/or sustain its structures, processes, and/or rates for recruiting, retaining, and graduating students.

For our undergraduate program, we have recently implemented changes to improve recruitment, retention, and graduation, including re-thinking our

100-level programming courses and CS 351. The undergraduate committee continues to discuss other proposals to improve the curriculum both early in the program and throughout.

For the graduate program, recruiting top applicants, especially from underrepresented groups and domestic students, is a top priority. The M.S. curriculum is well established and serves the students and constituents well. The shared credit "4 + 1" program has helped with M.S. program recruitment substantially. We recently overhauled our Ph.D. curriculum, but Ph.D. students choose which institutions to apply/attend based more on research than on the curriculum. Our department has a robust, exciting, and unique research program, but we lack a cohesive strategy for advertising this in a way that reaches potential Ph.D. students.

5 Faculty

The faculty (i.e., continuing, temporary, and affiliated) associated with any of the unit's degree/certificate program(s) should have appropriate qualifications and credentials. The faculty should be of sufficient number to cover the curricular requirements of each degree/certificate program. Also, the faculty should be able to demonstrate sufficient participation in relevant research and service activities. (If applicable, differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

5.A Composition of the faculty and their credentials

After completing the Faculty Credentials Template, discuss the composition of the faculty and their credentials. Include an overall analysis of the percent of time devoted by each faculty to the relevant degree/certificate program(s) and his/her roles and responsibilities.

The Faculty Credentials Template is shown in Appendix H on page 151.

Because we only offer one degree at each level (Bachelor's, Master's, and Ph.D.) there is no need to distinguish between faculty members in terms of the percentage of their time devoted to each degree. Each faculty member is fully engaged in both the undergraduate and graduate programs. There are two exceptions: of our two full-time lecturers, one is devoted entirely to the B.S. program while one focuses mostly on the B.S. program but also teaches in and supports the graduate program. Also, our research faculty (*i.e.*, not tenure-track) are often involved in teaching and outreach in support of our degree programs, but not all of them and it is not a requirement for their position.

5.B Faculty course-load

Explain the process that is utilized to determine and assign faculty course-load. Discuss the efficiency of this process (i.e., how does the unit determine faculty assignment to lower division vs. upper division courses). Include an analysis of faculty-to-student ratio and faculty-to-course ratio (based on the total number of credit hours taught).

Tenure-track faculty teach three courses per year, with the option to reduce this load using research funds as per the UNM School of Engineering's policy.

Faculty submit their teaching preferences for the year to a committee. Many considerations go into assigning faculty to courses, but for the last two years (and going forward) special effort has been (and will be) made to ensure that 100- and 200-level courses are taught by tenure-track faculty with enough regularity that any students coming through the program will see multiple tenure-track faculty in their first two years.

Full-time lecturers teach six courses per year, but this can be reduced for course development.

5.C Professional development activities

Discuss and provide evidence of the professional development activities for faculty within the unit including how these activities particularly have been used to sustain research-related agendas, quality teaching, and support students learning and professional development at the undergraduate and graduate level.

The main professional development activities of the faculty come from their research activity, which is described in the next section. This development comes from not only performing research, but also takes broader forms from service on program committees and panels, attending conferences, reviewing the literature, attending talks in our Dept. Colloquium, *etc.* Faculty also take advantage of UNM's tuition remission program, to take courses on foreign languages, physics, chemistry, biology, dance, *etc.*

Pre-tenure faculty are assigned an advisor from among the tenured faculty. Typically, a junior faculty and their advisor will meet roughly once a month to discuss career development, including grant proposals, the tenure process, *etc.*

5.D Research/creative work and efforts

Discuss and provide evidence of the research/creative work and efforts of the faculty within the unit at the undergraduate and graduate level. Explain the adequacy and/or significance of the research/creative work and efforts in supporting the quality of the unit and/or the program(s).

Fiscal year	Research expenditures
FY2010	$2.748 million
FY2011	$3.212 million
FY2012	$3.651 million
FY2013	$3.743 million
FY2014	$3.378 million
FY2015	$2.752 million
FY2016	$3.662 million
FY2017	$4.016 million
FY2018	$3.002 million

Table 16: Research expenditures per year.

All tenure-track faculty in the department are research active. Details are in the vitae, and research expenditures per year for the Department are shown in

Table 16.

Graduate and undergraduate students are involved in faculty research programs, and faculty generally teach in their area of expertise so the continual professional development that comes with being research active benefits the curriculum and instruction in those courses.

5.E Involving faculty in student retention and success

Explain and provide evidence of the efforts and strategies by the unit to involve faculty in student retention and ensure students' academic success at the undergraduate and graduate level (i.e., faculty advising efforts, student engagement activities, etc.)

One of the great strengths of our Department with respect to student retention and success is the diversity of our faculty. The following summarizes the faculty gender and ethnicity by rank:

- Assistant Professor: 6 (3 Female including 1 Hispanic)
- Associate Professor: 3 (1 Female including 1 Hispanic)
- Professor or Distinguished Professor: 8 (1 Female including 1 African American)
- Lecturers: 2 (2 Female including 1 Hispanic)
- Research Full Professor: 1
- Research Assistant Professor: 2 (1 Female including 1 Hispanic)

Faculty oversee and are involved with many student organizations as well as organizations that include both students and faculty, such as WiCS, ADVANCE at UNM, CS GSA, and an ACM chapter.

5.F Vitae

Provide an abbreviated vitae (two pages or less) or summary of the educational background and professional experiences of each faculty member. (If the unit has this information posted on-line, then provide links to the information.)

Appendix J on page 159 contains the following for each faculty member:

- A credentials template, including: Areas of Expertise, Interdisciplinary Interests, Current Departmental and University Committees, Extracurricular Activities Related to Academic Objectives, Major Awards/Recognition/*etc.* from the past five years, and Outreach Efforts and Public Service.
- For research faculty, a 2-page bio in NSF or a related format.

Highlights of our faculty (see Appendix J) include:

- Service on NSF panels and top-tier publication venue program committees; organizing conferences, workshops, and tutorials; *etc.*

- Five NSF CAREER awards
- Internal awards, including three School of Engineering Research Excellence Awards, three institutional teaching and service awards, two UNM Faculty of Color Research Awards, and four UNM STC Creative Awards
- External awards, such as Deepak Kapur's Herbrand Award, Lydia Tapia's Borg Early Career Award, and many best paper awards
- External collaborations with local research institutions (*e.g.* the Santa Fe Institute, Sandia National Lab, and Los Alamos National Lab), companies, and non-profits (*e.g.* StopBadware)
- Outreach via involvement in organizations such as NCWIT, WiCS, NASA Swarmathon, CSforAll, CRA-W, the New Mexico Supercomputing Challenge, and ADVANCE at UNM
- A broad range of interdisciplinary interests, including biology, sociology, medical physics, seismology, journalism, *etc.*

5.G Strategic planning

Discuss the unit's strategic planning efforts going forward to improve, support, and/or optimize its faculty.

The department needs more faculty lines to keep up with increasing demand for our programs and to reach a critical mass to compete for larger research grants. While other universities have created entire Colleges of computing around what used to be Computer Science Departments, our Department has remained roughly the same size (in terms of faculty) for the last three decades.

6 Resources and Planning

The unit has sufficient resources and institutional support to carry out its mission and achieve its goals.

6.A Resource allocation and planning

Explain how the unit engages in resource allocation and planning that are effective in helping it carry out its mission and achieve its goals. If the unit has an advisory board, describe the membership and charge and discuss how the board's recommendations are incorporated into decision-making. Include a discussion of how faculty research is used to generate revenue or apply for grants. How is the revenue gained from research being distributed to support the unit and its degree/certificate programs?

The department receives state funding for its educational mission and general operation (I&G). The allocation to the department is determined by the School of Engineering. The current practice is that the allocation among departments is based on historical precedent. This year's allocation to CS is $2.84 million. The department annually carries out multiple budgeting exercises; however, as faculty and staff salaries account for over 95% of the allocation,

and the remainder must be used for TAs, graders, and basic office functions, the room for discretionary planning is nil.

Over the last four years there have been several small budget cuts as well as one-time pullbacks. In consequence, the state allocation no longer fully covers all the necessary functions. The shortfall is made up in part through the following additional resources: curriculum fees, collected for all CS courses ($152,000 in FY2018); undergraduate differential tuition, collected for courses taken by CS undergraduates ($118,000 in FY2018); graduate differential tuition, collected for courses taken by CS graduate students ($55,000 in FY2018). These sources, however, are strictly constrained in how the funds can be used. (We use curriculum fees mainly to maintain the computing and networking facilities in our computer lab and our one teaching lab. We use the graduate differential tuition to support TAs for graduate-level classes. We use the undergraduate differential tuition to support TAs and graders for undergraduate-level classes; however, owing to the drop in the state allocation we have had to support a portion of student advisors' salaries from this source.)

The department's advisory board was discussed in Section 0. It is not involved in operational decisions on resource allocation.

Most externally funded research is assessed a facilities and administration charge, typically 51.5%. These funds are collected by the UNM Office of the Vice President for Research and used to support central research support offices and campus-wide research initiatives. A variable portion is returned to the colleges, which support college-wide research endeavors and return a portion to the departments. The overall fraction of generated F&A that has been returned to the CS department has varied between 0 and 15%. We strive to return at least 5% to the PIs, and use the remainder for two purposes: (1) contribution to the plant fund to maintain and upgrade research computing infrastructure; and (2) contribution to new faculty startup funds.

6.B Budget

Provide an analysis of information regarding the unit's budget including support received from the institution and external funding sources. Include a discussion of how alternative avenues (i.e., external and grant funding, summer bridge programs, course fees, differential tuition, etc.) have been explored to generate additional revenue to maintain the quality of the unit's degree/certificate program(s) and courses.

See above. The signal difference between the situation at the time of the previous APR and today is the loss of fiscal autonomy of the department. Previously, the department held on to monies from vacant faculty lines and sabbaticals, and could use it to supplement TA positions and build strategic reserves. Today these are pulled back by the School of Engineering and/or UNM; they have typically been partly returned to the department, but late in the fiscal year, such that they could not be used effectively. Furthermore, any annual surplus is now subject to being swept by the central administration. As a result, the department is no longer capable of strategic planning, and even aspects of regular operation, such as the allocation of TAs or graders to courses, can be unpredictable.

6.C Staff

Discuss the composition of the staff assigned to the unit and their responsibilities (including titles and FTE). Include an overall analysis of the sufficiency and effectiveness of the staff in supporting the mission and vision of the unit.

Department staff includes 9 positions, all 1.0 FTE. The positions and their main responsibilities are:

- Department Administrator: assistant to the Chair; training and supervision of staff and student employees; hiring students, staff, and faculty; coordinate departmental activities and events; building coordinator including prox-card building security; course scheduling; data collection; faculty summer contracts; creation of departmental office policies and procedures; compliance with UNM rules and guidelines
- Administrative Assistant I: assistance to department chair, faculty, and department administrator; payroll entry; student hiring
- Administrative Assistant II: purchasing; travel arrangements; large purchases using Lobomart; reimbursements; general ledger management; incoming graduate student database maintenance; graduate admissions-related duties
- Program Advisement Coordinator: student advisement
- Senior Student Program Advisor: student advisement
- Accountant 2: oversees all financial operations including annual budgets; categorization of reserves; proposal assistance/submission including budget and budget justification creation; monthly reconciliations; departmental financial oversight
- Fiscal Services Tech: accounting; purchasing; reimbursements; graduate contracts; proposal assistance including budget and budget justification creation
- IT Services Specialist: development and maintenance of specialized research and teaching computing infrastructure; Linux system administration; instructional virtual machine and virtual network management and support; research machine configuration
- IT Services Specialist: development and maintenance of specialized research and teaching computing infrastructure; Linux system administration; Linux system support; instructional database configuration

6.D Library resources

Discuss and provide evidence of the adequacy of the library resources that are available and/or utilized to support the unit's academic and research initiatives.

The University Library system includes a dedicated Centennial Science and Engineering Library, located adjacent to our building. The library maintains electronic subscription to the ACM Digital Library, IEEE Xplore, and Springer publications, satisfying the majority of access needs for research and teaching in computer science. Even when the library does not subscribe to a journal (e.g., *Journal of Functional Programming*) articles can be obtained through inter-library loan, with a quick turnaround time and at no cost to the user. The library's physical book holdings are largely obsolete but include some gems of early computing literature. There is a designated Engineering Librarian as the point of contact for faculty wishing to order new books or subscriptions.

6.E Strategic planning efforts

Discuss the unit's strategic planning efforts going forward to improve, strengthen, and/or sustain the sufficient allocation of resources and institutional support towards its degree/certificate program(s), faculty, and staff.

As described above, the regular budgetary and human resources are determined above the departmental level. We continue to make the case that a strong and well-resourced computer science department is at the core of a successful university today. We are not hopeful that in the present state of the economy in New Mexico in general, and the fiscal situation of UNM in particular, this message will result in additional institutional support. Therefore, we are turning to alternative sources of support, viz., private and industrial. Together with the School of Engineering leadership, we have been engaging in more active development efforts, especially targeting our own alumni in the software industry.

7 Facilities

The facilities associated with the unit are adequate to support student learning as well as scholarly and research activities.

7.A Space

Provide an updated listing from UNM's current space management system of the spaces assigned to your unit. Discuss the evolution and sufficiency of the amount of space your unit has been assigned by category (e.g., offices, support spaces, conference rooms, classrooms, class laboratories, computing facilities, research space, specialized spaces, etc.). Include an analysis of the square footage-to-student ratio and square footage-to-faculty ratio. Explain if the unit has any spaces outside or in other locations that are not documented in UNM's space management system.

Table 17 from the space management system reports the space currently occupied by the department. This space corresponds to 1014.2 sqft per faculty, or 31.6 sqft per student. In addition to the space currently occupied by the department, space in the basement of Farris Engineering Center has been assigned to the department but remains unfinished, Table 18.

Category	Total Area (sqft)
Chair Office	206
Conference	984
Faculty Office	3093.5
GUI Lab	107
Lab	4206
Post Doc Office	357
RA Office	3868.25
Reception	292
Res. Fac.	128
Research Faculty Office	56.5
Server	982
Server room	156
SSG Lab	412
Staff Office	1036
Storage	539
Student Computer Lab	962
Student Org. Office	154
Study Space	207
TA Office	422
TA/Graders Office	196
Teaching Computer Lab	1920
Total	20284.25

Table 17: Assigned and occupied space

Category	Total Area (sqft)
Robotics & Makers Space	1905

Table 18: Assigned unfinished space

The current facilities as identified by UNM's space management system are mostly sufficient to support the existing level of scholarly and research activities. One gap we have identified during our year in the renovated space is that we lack a seminar-size room that could be used for research talks and student group meetings. Additional office and research lab space will be necessary to allow the department to grow.

The current facilities, however, are inadequate to support student learning at the current enrollment levels, as we detail below.

Computer Science does not have any spaces not documented by UNM's space management system.

7.A.1 Computing Facilities

The Department has over 200 general-purpose workstations and servers running Ubuntu Linux, Microsoft Windows, and Apple OS X. The department network infrastructure consists of a switched 10 GB fiber backbone, which links the campus network and supports the principal departmental servers.

Department workstations connect via 864 10/100/1000 ethernet ports on Brocade 7450 and 7750 switches that are connected by 10 GB fiber to the infrastructure.

The infrastructure utilizes ldap, dns, dhcp hosted on virtual machines on a blade enclosure. The blade enclosure also allows for rapid deployment of student and research virtual machines.

A Network Appliance with a 100TB of storage provides department storage for student, faculty, and research storage. The appliance allows for fast backup to a snapshot server to stage for a LTO4 tape backup for disaster recovery.

The department hosts a student laboratory with 20 Ubuntu workstations with GPU cards and 24 hour access for students. A 74 seat computer classroom in the Centennial Engineering Center has workstations for hands-on learning. In order to facilitate cutting-edge research the department has invested in advanced GPU servers and compute nodes available for use by researchers and students.

The Department has four class C addresses subnetted into multiple vlans for use by the department workstations and desktops. There is also a separate connection to the Albuquerque Gigapop for research use, which bypasses the UNM backbone and provides IPV6 connections.

7.B Adequacy of facilities

Discuss the unit's ability to meet academic requirements with the current facilities. Explain the unit's unmet facility needs. If applicable, describe the facility issues that were raised or noted in the last APR. What were the outcomes, if any?

As described above, the last APR found our space utterly inadequate. The renovation of Farris Engineering Center has greatly improved the quality of our office space and research lab space, and has also increased the amount of usable space, which is now adequate for our current number of faculty, graduate students, and postdocs.

However, current facilities are inadequate to support student learning. Computer Science holds 47–52 computer labs every semester (data from 2013–2018). Each of these labs has a class cap at the capacity allowed by the room. The vast majority of these courses meet with cap, with only a few sections having any available seats. No additional computer labs are available on campus. This is felt especially hard in the introductory classes. Thus, the lack of computer lab classrooms is limiting the number of students Computer Science is able to serve. Additional teaching computer labs would allow Computer Science faculty to increase course enrollments. Computer Science would also benefit from a departmentally controlled classroom with facilities allowing online

course offerings. Finally, we require a departmentally controlled classroom which would provide a more customizable furniture layout to meet the needs of novel offerings such as CS 259 Data Structures with Java, which call for both a computer lab and small group discussion spaces. Furthermore, while the renovation of Farris Engineering Center resulted in some excellent communal student spaces, these were not allocated to computer science. Such spaces would be highly beneficial to student learning and, what is more important, to the *esprit de corps* among the students.

7.C Planning efforts

Discuss any recent space management planning efforts of the unit relative to the teaching, scholarly, and research activities of the faculty associated with the unit. Include an explanation of any proposed new initiatives that will require new or renovated facilities.

Recent space management planning efforts were made during the planning and subsequent renovation of the Farris Engineering Center. Huge efforts were made to maximize the utility of space assigned to Computer Science. These efforts have resulted in a space that meets the current research and scholarly needs of the department but unfortunately does not adequately provide for the learning needs of the students, nor does it provide for the ability to grow. A current initiative is to raise funds to finish the assigned 1920 sqft. space in the basement of Farris Engineering Center as a robotics and maker space. Another initiative is our request to the School of Engineering, currently pending decision, for a 960 sqft. space, also in the basement, for a customizable teaching lab.

7.D Goals and priorities

Discuss the unit's facility goals and priorities for the future and the timelines associated with them. Include a description of short-term goals (1–3 years) (e.g., renovation requests) and long-term goals (4–10 years) (e.g., new facilities) and how they align with UNM's strategic planning initiatives.

Please see above. No longer-term planning is feasible.

8 Peer comparisons

The degree/certificate program(s) within the unit are of sufficient quality compared to relevant peers. (If applicable, differentiate for each undergraduate and graduate degree and certificate program offered by the unit.)

8.A Analysis

Discuss the distinguishing characteristics of the degree/certificate program(s) within the unit after completing the Peer Comparison Template provided as Appendix H (i.e., examination of student enrollment rates, degrees/certificates offered, number of tenure-track faculty, research/creative work of faculty, etc.). Include an analysis of the unit's degree/certificate program(s) based on comparisons with similar or parallel programs: at

	# students	# fac	s/f	USNWR	csrankings	exp*	exp/fac*
UNM	642	19	33.8	#75	#89	2.7M	142K
Ariz.	506	28	18.1	#43	#77	3.6M	128K
Utah	723	49	15.1	#43	#29	7.9M	161K
Okla.	592	16	37.0	#111	—	1.7M	106K

Table 19: Comparison with nearby peer institutions. Key: total number of enrolled students (BS, MS, PhD); total number of faculty (tenure-track and teaching); student-faculty ratio; ranking according to US News & World Report; ranking according to csrankings.org (Emery Berger, UMass Amherst CS); research expenditures (source: petersons.com); research expenditures per faculty.

any of UNM's 22 peer institutions (i.e., http://oia.unm.edu/facts-and-figures/index1.html); at other peer institutions identified by the unit; and designated by relevant regional, national, and/or professional agencies.

From the institutions' publicly accessible information we have compiled available data for all 22 designated UNM peer institutions (Appendix I on page 155). Here we focus on a subset of three peer institutions for which we have more complete data, and which, like UNM, are their states' flagship universities: University of Arizona (Department of Computer Science within the College of Science), University of Utah (School of Computing (includes Computer Engineering) within the College of Engineering), and University of Oklahoma (School of Computer Science within the College of Engineering); all three are our neighbor states. All four departments offer BS, MS, and PhD degrees.

The findings are in Table 19.[2] Our student-to-faculty ratio is high, as at Oklahoma.[3] Our research expenditures are more like those at Arizona or Utah. Our reputational ranking is far below Arizona or Utah; as noted in the previous APR, only an increase in size can help us improve that. Our publications-based ranking is also lower. In part this stems from our lack of numbers in core CS areas versus interdisciplinary research, which is not tracked by csrankings.org.

[2]These are the best comparative data we could find. We use the same total number of faculty for both ratios, rather than trying to exclude teaching faculty or to identify additional non-tenure-track research faculty. US News & World Report rankings are largely reputation-based, while csrankings.org rankings are entirely publication-based, and narrowly focused on core CS areas.

[3]Oklahoma, however, is hiring two additional faculty this year "in the areas of artificial intelligence, machine learning, high-performance computing, and/or network science."

In this context we also report a comparison between UNM and its 22 peer institutions with respect to CS faculty salaries. The report was produced by the Computing Research Association in May 2017.

Reports for Users at Academic Units: Faculty Salary Summary Report

Report Parameters

Focus Academic Unit	**University of New Mexico (CS)**
Comparison Group	UNM's Peer Institutions Approved by the Higher Education Department
Group Size	22 Academic Units
Year	2016
Only from Academic Units on	9 month Academic Year (21)

	Full Professor				Associate Professor			Asst Prof	Non-Tenure Track		
	In rank 16+ years	In rank 8-15 yrs	In rank 0-7 years	All Years	In rank 8+ years	In rank 0-7 years	All Years		Teach	Research	Postdoc
Based on All Incumbent-level Reporting											
N Depts	14	17	15	17	15	17	17	17	11	6	5
N Indiv	74	66	71	212	50	64	117	107	70	21	21
10 %tile	$118,713	$116,415	$121,000	$117,320	$89,446	$98,493	$93,770	$89,822	$51,918	$41,000	$52,500
25 %tile	$136,978	$128,697	$127,950	$131,122	$96,680	$107,000	$101,361	$94,000	$65,233	$46,067	$55,000
50 %tile	$156,039	$145,653	$137,793	$145,905	$105,000	$115,219	$110,355	$98,400	$73,920	$78,750	$56,776
75 %tile	$175,841	$172,822	$159,780	$171,008	$115,522	$121,420	$119,476	$103,000	$84,783	$100,000	$60,000
90 %tile	$213,746	$193,433	$187,231	$196,127	$124,273	$132,453	$130,106	$107,680	$97,737	$121,407	$65,557
Based on All Department Averages											
N Depts	17	19	17	20	18	19	20	20	14	7	6
50 %tile	$154,300	$147,092	$148,288	$149,337	$102,342	$112,943	$109,099	$97,156	$73,297	$74,025	$56,325
% diff*	-1.1%	1.0%	7.6%	2.4%	-2.5%	-2.0%	-1.1%	-1.3%	-0.8%	-6.0%	-0.8%
University of New Mexico (CS)											
Average	$201,324		$131,625	$173,444	$95,953	$93,031	$94,127	$87,906			
% diff**	30.5%		-11.2%	16.1%	-6.2%	-17.6%	-13.7%	-9.5%			
N Indiv	3		2	5	3	5	8	3			

* % diff from 50 %tile of All Incumbent-level Reporting. ** % diff from 50 %tile of All Department Averages.

Only the median will display when the number of academic units is less than 10. When the number of units falls below 3 the median also will not display.

This report was generated by CRA's Taulbee Survey Online application on May 23, 2017 4:38:53 PM EDT.

8.B Planning efforts

Discuss the unit's strategic planning efforts going forward to improve, strengthen, and/or sustain the quality of its degree/certificate program(s) in relation to peer institutions.

Our planning efforts begin with an understanding of our existing strengths and a realization of our weaknesses and the environment in which we exist.

Since its inception the Department has emphasized high-quality high-expectation teaching, and this remains a core strength of the department. Our programs are rigorous and not for every student, but those who complete a degree program in the department are well prepared for their subsequent careers. Some of the most prestigious companies in information technology, including Amazon, Microsoft, and Google, make targeted recruiting visits to the department, based on our reputation and track record. Almost uniformly, our alumni express gratitude for the CS education they received at UNM and say that it has served them well over the years. We should build on this strength by recruiting top high-school students more aggressively to enter our undergraduate program, and by offering more competitive fellowships for entering graduate students.

Since the early 1990s, the department has emphasized research excellence and dedicated itself to enhancing its research profile without compromising its educational standards. We have achieved this through careful faculty hires, and by adding two high-quality lecturers to help cover some of our undergraduate courses. 100% of our faculty members are now research active, and the department legitimately has an international reputation in several areas, as seen in faculty resumes.

The department committed early in its development to interdisciplinary research, which has paid off, both in enhancing the department's reputation and our ability to obtain extramural research funding. Our faculty are successful and we have been, for the most part, able to retain them; and we have been able to recruit high-quality new hires and graduate students. Northern New Mexico is a world-renowned center for interdisciplinary studies, beginning with the Manhattan Project at Los Alamos during WWII and continuing today with the high-profile Santa Fe Institute (SFI). Proximity to Los Alamos and Sandia National Laboratories as well as SFI is a strength for the department, and one that we have built on in our research and teaching programs.

UNM is a minority-serving institution, New Mexico is one of the early minority-majority states, and the department benefits from an unusually diverse student body. Although our student body is diverse, until recently our faculty was not. Over the past decade this has dramatically changed. However, retaining the women and underrepresented minority hires we have made is revealed to be a continuing challenge, one that is being addressed by committed leadership in the department.

External research funding is a second area of concern. Grants are increasingly competitive, and new funding models tend to squeeze out small departments such as ours. There is more emphasis on large institution-wide and cross-institutional grants, which require significant institutional commitments. Although we can compete on an individual basis, we struggle to obtain ade-

quate institutional commitments to compete for larger grants.

Many years, indeed decades, of cuts to the department's I&G budget have left us unable to cover the faculty, staff, and student salaries needed for the mission of the department. Stagnant faculty salaries, many now at the 10th percentile or below among comparable-sized public institutions (CRA Taulbee Survey), present a sharp risk for faculty retention.

Over the past 10–15 years, interest across campus in interdisciplinary research and teaching has exploded. This, together with projected increased enrollments for STEM fields, has created demand for additional CS faculty. At the center of nearly all interdisciplinary activities is a significant computing component—computer modeling of scientific and medical phenomena; extraordinary computational demands for collecting, storing, and managing large data sets; computational algorithms to analyze large complex data sets; and all forms of applied machine learning. Although the Department emphasizes interdisciplinary research and teaching, the current faculty is overstretched, and there are many more opportunities on campus for cross-department and cross-college collaborations and for CS-supervised Research Assistantships than the current faculty can reasonably support. At the same time, the field of computer science proper continues to expand, placing new demands on faculty for service courses (e.g., supporting the IFDM program) and to offer a complete curriculum to CS undergraduate majors and graduate students, as well as an increasing number of undergraduate minors seeking to improve their job prospects.

The department receives little funding from private or industrial donations. This is a weakness and prevents us from responding adequately to decreases in public support for education. Part of the issue is that we are a young department with relatively few alumni, and the other part of the problem is that fundraising for CS seems to work differently than for the other engineering disciplines. While we have positive experiences working with the current development staff in the School of Engineering, we believe that we cannot fully address this issue until we have our own development officer, hired with deep expertise in fundraising in information technology.

A ABET Accreditation Documents

415 North Charles Street Baltimore, MD 21201
+1.410.347.7700 www.abet.org

August 29, 2018

Garnett Stokes
President
University of New Mexico
MSC05 3300
1 University of New Mexico
Albuquerque, NM 87131-0001

Dear Dr. Stokes :

I am pleased to transmit to you the findings of the Computing Accreditation Commission (CAC) of ABET with respect to the evaluation conducted for University of New Mexico during 2017-2018. Each of ABET's Commissions is fully authorized to take the actions described in the accompanying letter under the policies of the ABET Board of Directors.

We are pleased that your institution has elected to participate in this accreditation process. This process, which is conducted by approximately 2,000 ABET volunteers from the professional community, is designed to advance and assure the quality of professional education. We look forward to our continuing shared efforts toward this common goal.

Sincerely,

Michael R. Lightner

President

Enclosure: Commission letter and attachments

415 North Charles Street Baltimore, MD 21201
+1.410.347.7700 www.abet.org

August 29, 2018

Christos Christodoulou
Dean
School of Engineering
1 University of New Mexico
MSC01 1140
Albuquerque, NM 87110

Dear Dr. Christodoulou :

The Computing Accreditation Commission (CAC) of ABET recently held its 2018 Summer Meeting to act on the program evaluations conducted during 2017-2018. Each evaluation was summarized in a report to the Commission and was considered by the full Commission before a vote was taken on the accreditation action. The results of the evaluation for University of New Mexico are included in the enclosed Summary of Accreditation Actions. The Final Statement to your institution that discusses the findings on which each action was based is also enclosed.

The policy of ABET is to grant accreditation for a limited number of years, not to exceed six, in all cases. The period of accreditation is not an indication of program quality. Any restriction of the period of accreditation is based upon conditions indicating that compliance with the applicable accreditation criteria must be strengthened. Continuation of accreditation beyond the time specified requires a reevaluation of the program at the request of the institution as noted in the accreditation action. ABET policy prohibits public disclosure of the period for which a program is accredited. For further guidance concerning the public release of accreditation information, please refer to Section II.A. of the 2017-2018 Accreditation Policy and Procedure Manual (available at www.abet.org).

A list of accredited programs is published annually by ABET. Information about ABET accredited programs at your institution will be listed in the forthcoming ABET Accreditation Yearbook and on the ABET web site (www.abet.org).

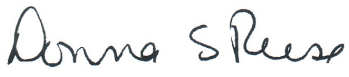
It is the obligation of the officer responsible for ABET accredited programs at your institution to notify ABET of any significant changes in program title, personnel, curriculum, or other factors which could affect the accreditation status of a program during the period of accreditation stated in Section II.H. of the 2017-2018 Accreditation Policy and Procedure Manual (available at www.abet.org).

ABET requires that each accredited program publicly state the program's educational objectives and student outcomes as well as publicly post annual student enrollment and graduation data as stated in Section II.A.6. of the Accreditation Policy and Procedure Manual (available at www.abet.org).

ABET will examine all newly accredited programs' websites within the next two weeks to ensure compliance.

Please note that appeals are allowed only in the case of Not to Accredit actions. Also, such appeals may be based only on the conditions stated in Section II.L. of the 2017-2018 Accreditation Policy and Procedure Manual (available at www.abet.org).

Sincerely,



Donna Reese, Chair

Computing Accreditation Commission

Enclosure: Summary of Accreditation Action
Final Statement

cc: Garnett Stokes, President
Charles B. Fleddermann,
John L. Schnase, Team Chair

8/29/2018

Computing Accreditation Commission

Summary of Accreditation Actions
for the
2017-2018 Accreditation Cycle

University of New Mexico
Albuquerque, NM

Computer Science (BS)

Accredit to September 30, 2024. A request to ABET by January 31, 2023 will be required to initiate a reaccreditation evaluation visit. In preparation for the visit, a Self-Study Report must be submitted to ABET by July 01, 2023. The reaccreditation evaluation will be a comprehensive general review.

Computing Accreditation Commission

Final Statement of Accreditation
to

UNIVERSITY OF NEW MEXICO

Albuquerque, NM

2017-2018 Accreditation Cycle

FINAL STATEMENT FOR REVIEW AND COMMENT

This is a confidential statement from the Computing Accreditation Commission to the institution. It is intended for internal use only and is not for release except as allowed by policies of ABET.

I. INTRODUCTION

The University of New Mexico (UNM) is a public university located in Albuquerque, New Mexico. It is the state's flagship research institution, the largest post-secondary institution in the state in total enrollment, and one of New Mexico's largest employers. Founded in 1889, UNM offers bachelors, masters, doctoral, and professional degree programs in a wide variety of fields. Its Albuquerque campus encompasses over 600 acres and serves about 27,000 students with a faculty of about 3000 members. UNM is categorized as an R1 doctoral university (highest research activity) in the Carnegie Classification of Institutions of Higher Education and is notable for being the only Hispanic-servicing R1 institution in the United States.

The following program at the institution was reviewed during the 2017-18 cycle for possible accreditation under the CAC/ABET "Criteria for Accrediting Computing Programs" (*Criteria*) dated October 29, 2016:

- BS Degree in Computer Science evaluated under the General Criteria and the Computer Science Program Criteria. The BS program in Computer Science was previously evaluated in the 2011-12 cycle and accredited at that time.

The program listed above was evaluated by the peer review team shown below.

- Program Evaluator: Chandra N. Sekharan, Loyola University
- Team Chair: John L. Schnase, NASA Goddard Space Flight Center
- Editor One: Pearl Wang, George Mason University
- Editor Two: James H. Aylor, University of Virginia

Please note that program accreditation decisions are made solely by the respective Commissions of ABET. Reference to the professional affiliations of the volunteer peer evaluators in no way constitutes or implies endorsement or recommendation of the programs by the listed professional affiliations.

II. REPORT OF FINDINGS

The *Criteria* is composed of the General Criteria and Program Criteria. Each criterion provides the underlying principles that each program must meet. A program must meet both the General Criteria and all applicable Program Criteria to be accredited.

This section contains the report of the findings at the time of the visit. It also includes an evaluation of any information provided by the program during the due process response.

CAC considers the following comments to relate directly to its accreditation actions. Actions will depend on the program's range of compliance or non-compliance with the criteria. This can be determined from the following terminology:

- Deficiency: A deficiency indicates that a criterion, policy, or procedure is not satisfied. Therefore, the program is not in compliance with the criterion, policy, or procedure.

- Weakness: A weakness indicates that a program lacks the strength of compliance with a criterion, policy, or procedure to ensure that the quality of the program will not be compromised. Therefore, remedial action is required to strengthen compliance with the criterion, policy, or procedure prior to the next review.

- Concern: A concern indicates that a program currently satisfies a criterion, policy, or procedure; however, the potential exists for the situation to change such that the criterion, policy, or procedure may not be satisfied.

- Observation: An observation is a comment or suggestion that does not relate directly to the current accreditation action but is offered to assist the institution in its continuing efforts to improve its programs.

Computer Science Program

The Computer Science Program is offered by the Computer Science Department in the University of New Mexico's School of Engineering. The School is one of 12 academic schools and colleges in the University and comprises six academic departments. The School of Engineering initiated the current Computer Science Department in 1979. The department now has 16 full-time faculty members, a total undergraduate enrollment of 338 full-time students, and, in the 2016-17 academic year, awarded bachelor's degrees to 50 graduates.

Status of Shortcomings from the Previous Review

The following is the status at the time of the visit.

Program Concerns:

1. Criterion 4, Continuous Improvement. The following factors contribute to this concern:
   a. The assessment and evaluation process largely depends on the faculty member that is teaching the course, both from an instrument design as well as an evaluation perspective. This may lead to results that do not consistently represent the extent to which student outcomes are being attained.
   b. Since the assessment of outcomes (e) and (g) occurs early in the program, before most of the enabling courses, there is a potential that a true assessment of their attainment is not being measured.

   Status: The concern has been resolved.

2. Criterion 7, Facilities There is a concern that a capital improvement grant on the order of $10 million from the state, may not be realized or may not be realized in a timely manner, in order for the program to continue to meet this criterion.

   Status: The concern has been resolved.

Findings from the Current Review

Program Weakness

1. Criterion 2, Program Educational Objectives. Criterion 2 requires that the program have a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of its program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria. The program has identified the constituencies it serves and has established an advisory board comprising representatives from its constituent groups to assist in the review of its educational objectives. However, the board meets irregularly, and its review and actions related to the program's educational objectives are poorly documented. Without a well-documented, systematically-utilized process for the review of program educational objectives, the program's ability to ensure that they remain consistent with the institutional mission, the

program's constituents' needs, and these criteria is less effective. The program, therefore, lacks strength of compliance with the criterion.

Due-process response: In September 2017, the faculty adopted a formal process that provides for a review of the program's educational objectives and the review and revision of the program's student outcomes by the department's undergraduate committee. These reviews will occur annually each fall. Any revisions must be approved by the department's advisory board. The process was followed in the September meeting, and no revisions to either program objectives or student outcomes were proposed at that time. In November 2017, the department's advisory board met and adopted a formal charter that regulates its membership, describes the roles and responsibilities of its members, describes its governance structure, and fixes its meeting schedule at twice per year. No action was proposed with respect to program educational objectives at that time. The program provided documentation that included minutes from the advisory board meeting and the advisory board charter.

Due-process evaluation: The program has adopted a new process for the periodic review of its program educational objectives and documenting actions relating to those reviews. The program's undergraduate committee and advisory board have convened once under the new process and demonstrated its effectiveness. Given the newness of the process, there is the potential that it may not become fully operational and systematically utilized in the future. The weakness is now cited as a concern.

Program Observation

1. The Computing Accreditation Commission (CAC) of ABET has adopted new criteria for computing programs which will go into effect for all programs during the 2019-20 review cycle. The changes in these new criteria impact Criterion 3, Criterion 5, and the program criteria for Computer Science, Information Systems and Information Technology programs. The CAC encourages you to familiarize yourselves with the new Criteria document as soon as possible so you can adopt the new student outcomes, transition your assessment processes, and make any other program changes that may be necessary to ensure that your program is in compliance with these new criteria by the time of its next Comprehensive Review.

III. SUMMARY

The following is a summary of this evaluation for the University of New Mexico during the 2017-18 cycle:

Computer Science Program

Program Concern:

- Criterion 2, Program Educational Objectives. The program's process for the review of its program educational objectives is new. There is the potential that it may not become fully operational and systematically utilized in the future.

B Previous APR Documents

Report of the Academic Program Review Team
for the Department of Computer Science
at the University of New Mexico

Fred Chong (Chair), Bob Sloan, Darrell Whitley, Phil Ganderton
Spring 2010

Introduction

The Review Team was very impressed with the quality of the UNM Computer Science Department, especially given its small size. The quality of the faculty and students is well above the ranking of the department. We observe, however, that there are a number of actions that the University and School of Engineering could take to better support the department and better realize its potential in ranking, funding, and student output. In particular, the Computer Science Department could be better understood and evaluated within the University, undergraduate interested in CS could be better advised, and space for CS needs to be significantly improved. These issues are critical to future retention and recruitment, and to maintain the positive trajectory of the department.

Department Quality

The Computer Science Department has stellar faculty comparable to a top 40 or, in some cases, a top 10 department. The faculty have an excellent per capita funding rate of $192K per faculty member. This is comparable to top 40 departments. The faculty have received numerous awards. For example, Melanie Moses was a Microsoft Faculty Fellowship Finalist in 2008, for which only 11 faculty members were selected nationwide. Almost of all of these finalists come from the top 10 schools, most from the top 5 schools. Deepak Kaupr received the Herbrand award, the highest honor in his research specialty. Stephanie Forrest is one of the top-cited CS researchers in the world, with an H-index that places her in the top 200. Additionally, the faculty includes several NSF CAREER award winners and an Intel Fellowship winner. Perhaps even more impressive is the quality of some of the doctoral graduates from the department. One CS alumnus was also a Microsoft Faculty Fellowship Finalist. Another CS Alumnus was hired as a faculty member at the University of Colorado at Boulder, a top 40 department.

While the department has grown significantly in its research emphasis, it has also maintained its strong emphasis on undergraduate education. The Review Team interviewed several undergraduate students and they were all very positive about the program. In-department advising was viewed as excellent. The Review Team interviewed the department's two lecturers and found them to be very energetic and well-integrated into the department. The lecturers appeared very motivated to improve the program and to be involved in department initiatives to improve recruitment and retention of students.

CS is Different

Although the CS department is of high quality, we observe that this relatively new discipline could be better understood in the University and the School of Engineering. Overall, we observe that CS seems to have been at the bottom of the list for resources (eg new space), but seems to be of similar quality and productivity as other departments in the SOE. We hypothesize that priorities appear to be somewhat historical and that new metrics are needed to more accurately evaluate CS value to the University and the SOE.

Leadership

Informed leadership is a critical means of promoting a better understanding of CS and to better leverage the CS department's strengths. University and SOE metrics should be revisited. We understand that there is an ongoing search for a new Dean for the SOE. It is our hope that the new Dean will recognize CS strengths and invest resources to help the department reach its full potential.

We observe that CS could benefit from more targeted development efforts. Development for CS follows a different demographic and a different model than many other engineering disciplines. A short-term (eg 2 years) tasking of a development person to CS needs could yield significant benefits. It also seems to us that CS faculty have had more difficulty receiving internal UNM awards than external awards (note the many external awards above).

CS and ECE faculty have some good research collaborations and these appear to be growing. Often Computer Engineering faculty in ECE departments are a minority and have more common interests with CS than EE (or optics or sensor networks or whatever happens to be a local specialization in ECE). Also, Computer Engineering is the natural conduit for CS strengths in biology to be applied to Bioengineering. There may be natural ways to exploit common interests across departments that benefits both departments.

We note that both the Computer Engineering program and Computer Science Department appear to have a high degree of redundancy at the freshman and sophomore level. We have been told that previously these classes were only taught in Computer Science. The replication of these classes seems unnecessary and perhaps wasteful given the size of the two programs. On the other hand, crosslisted classes at the senior and graduate level that exploit the unique strengths of Computer Science and Computer Engineering could benefit both parties.

The CS Pipeline

We suggest that CS could benefit significantly from increased enrollment. Increased enrollment gives the potential of increased TA and faculty FTE. CS is doing extremely well for a department of 17 faculty, but a look at top 40 (and lower) ranked departments reveals that almost all competitive departments are larger in terms of undergraduate enrollments.

We observe that there may be breakdown in the pipeline from freshman admission to the declaration of the CS major. Once a student declares CS, retention is excellent -- 80% as

compared to national averages around 30%. Only 42 out of 550 students, however, declare CS from the SOE pool of engineering students. From our interviews with students, it would appear that better informed advising at the SOE and University College could substantially improve this conversion rate. Specifically, the students commented that:

- SOE and U College advising not useful for CS ("clueless")
- told “CS has no advisor” (not true)
- told “Can’t talk to CS advisor until you are a major” (not true)

Note that such deficiencies of advising would almost certainly result in an ABET deficiency. Given that students universally lauded CS internal advising, we recommend that SOE and University College advisors refer students interested in CS directly to CS advisors as soon as possible. The CS advisor, however, currently handles both graduate and undergraduate advising. We recommend an additional FTE to separate these duties as they are in most departments of this stature.

We also note that a primary strength of UNM is its diverse student population. Recruitment of diverse populations into CS could be a strong differentiating factor for UNM in national STEM initiatives. We recommend developing this strength and pursuing possible funding in programs such as NSF's Broadening Participation in Computing program. Diversity in faculty hiring is also strong component of strengthening student diversity.

Furthermore, CS should be given TA FTE to convert undergraduate to graduate TAs in their lower division courses. More TA FTE will significantly help graduate student recruitment and PhD production. If possible, increased enrollment should also result in increases in faculty FTE. The CS department is comparable to a top 40 department in many aspects, but PhD production and faculty FTE need to be improved. More TA FTE could substantially increase PhD output, and add additional graduates per year to an existing output of 5-10 per year.

Areas of Investment

If given additional FTE, we examine what strategic areas might best receive investment. The department has invested quite well for such a small number of FTE. We note that CS is nationally recognized in Computer Security. This recognition notwithstanding, we find that CS is under-invested in this area. An additional FTE in this area could greatly increase productivity and visibility. Looking to the future, we see opportunities in the relationship between CS and Social Science. In particular, research in issues of privacy, security, and networks (natural, social, and computer interconnections) are excellent opportunities for future investment.

Additionally, the students noted a need for greater expertise in Software Engineering. Future trends also indicate opportunities in databases, large-scale data, and large-scale systems. Addressing issues of scale, especially as applied to computational science, could allow CS to better leverage nationally-recognized regional strengths at LANL, Sandia, and the Sante Fe Institute.

Senior Leadership

The CS department has very few full and associate professors and is in need of more senior and mid-career leadership. As Prof. Forrest's tenure as chair is due to end, an external chair search is recommended.

We also note that, although the excellent junior faculty have successful individual research programs, CS faculty only just started to plan medium-scale collaborative projects. These efforts are hindered by a lack of mid-career and senior faculty to lead such projects. Additional hires at the associate level are recommended.

Finally, we note that the ERC self study is a start at a strategic plan for the department, but that more strategic planning would be beneficial for the department.

Retention

A highly-successful faculty indicates a danger of retention problems in the future, especially as the economy recovers at other institutions. Conversations with faculty revealed several potential retention issues. Low graduate RA stipends make it difficult to recruit and retain students. Low faculty salaries make outside offers more attractive. We note that more internal recognition, mentioned earlier, is a low-cost means of increasing retention.

Finally, we understand that the University is streamlining processes and making the transition to a more research-oriented institution. Although things have improved, we observe that faculty need more support for rapid proposals and for navigating IP agreements. We note that a 5-day internal lead time on proposals is not competitive with peer institutions, which often have a lead time of hours.

Special IT needs

One of the key areas that CS is unique is in special needs in IT for research and teaching. Notably, the department's nationally-recognized security research and teaching are a challenge (an extremely worthwhile challenge) for any University IT organization. Additional needs for performance and flexibility also exist in data mining, networking, and systems research and teaching.

Although our conversation with the CIO was very encouraging, we recommend that a process be defined for approving special IT needs. The current approval rests with security personnel within the CIOs office. We recommend a committee led by academics with IT administration representation. To encourage the university mission of research, we feel that it is important to give the approval body a vested interest in this mission, as well as IT security and reliability.

We also recommend that the CS department be given control over computer laboratory facilities comparable to science laboratories. A computer lab is not just a collection of machines on some desks -- it requires 3 hour time slots and rapidly changing software. The latest educational studies and literature suggest that a true laboratory environment is essential to effective learning.

These laboratories need to be administered by CS technical support staff and additional FTE are recommended.

Math

We note that the decline of the Mathematics and Statistics department is significant issue for CS, which is strongly related to both disciplines. The lack of a strong M and S department would adversely affect recruiting of CS undergraduates, training of undergraduate and graduate students in CS-related mathematics, and essential collaboration of CS faculty with experts in mathematics and statistics.

Space

As mentioned earlier, CS space needs are critical. CS needs dedicated laboratory space. More importantly, CS needs improved building space. Not only is this a recruitment and retention issue, it is apparently a safety and code issue. At least one team member spent additional time visiting various labs and examining the space used my computer science more closely. The Computer Science department does a good job of grouping together students and creating a work environment where teams of student closely interact. It is possible that the Computer Science would have adequate space, but the way space is currently used is inefficient. A carefully thought out architectural plan could go a long way toward making the current space more functional and enjoyable at reasonable cost.

Other Specific questions:

1. How does the department's research expertise match up with current trends in Computer Science? Are there areas where we are ahead? Are there noticable gaps?

The CS department clearly has strengths in computation at the interface between biology and computation. Much of this research is also cutting edge. There is also a strong theme of computer security in the department. And there is a clear emphasis on algorithms. There is also a number of faculty with interest and expertise in artificial intelligence.

There is some expertise in high performance computing, but a case could be made for additional hires in the area.

Similarly, while there is a strong theme of computer security in the department, security is an application area for some of this research and it is in some sense a secondary theme for many of the researchers who work in security. Again, a case could be made for additional hires in this area to reinforce and anchor current computer security research in the department.

One area that is noticeably missing in the department is software engineering. The department needs to access for itself if this is a strategic decision, or an deficit in the program. Clearly, it is difficult for a small department to cover all areas of Computer Science while still keeping the necessary critical mass of faculty in core areas of research.

2. Would you hire one of our Ph.D. graduates for a tenure-track position in your Department? Why or why not?

Perhaps. One of the team member's home-school Dean has expressed a strong preference for hiring students who earned their Ph.D.'s in top-20 departments, or else had a post-doc in a top-10 department. Exceptions have been made for some new Ph.D.'s with excellent publication records, and some U. NM students appear to have such records. However, it is definitely the exception rather than the rule to hire such students.

Another team member's institution hires the best people from strong research groups from a diverse set of institutions. In fact, we have often found that having a Ph.D. from a top-10 ranked institution is not always a good indicator of quality given the ability of Ph.D. students to become lost in over-sized research teams. An excellent Ph.D. student from UNM with a strong record would be highly competitive.

3. Would you send your daughter to UNM if she planned to major in computer science? Why or why not?

One team members would answer no. Because he wants a daughter (or son) who is going to major in computer science to be someplace where both the computer science department *and the mathematics department* are very strong. If the mathematics department were stronger, then yes: the computer science undergraduate program seems to be very good, and the atmosphere for women seems to be very good.

Another team member would say yes, particularly for a daughter. Computer Science departments have real difficulty attracting women and minorities to the undergraduate major. The CS department at UNM seems to have a particularly good atmosphere. The department could be more involved at a national level in this area;

for example, the National Center for Women in Information Technology (NCWIT) promotes a number of best practices to both promote and enhance diversity efforts.

4. How do the physical infrastructure, staffing level, and graduate stipends of the department compare to similar departments at other universities?

The graduate stipends are lower than in comparable departments elsewhere; this is particular true if UNM is competing with higher ranked CS departments for students. The lower graduate stipend likely has a negative impact on Ph.D. student recruitment.

The fact that the CS department at UNM continues to recruit high quality graduate students also suggests that it national reputation is better than national rankings such as the US News and World Report ranking would suggest. The CS department also benefits from it association with the National Labs in New Mexico, and it particular its connections with the Santa Fe Institute.

Nevertheless, to continue to attract high quality Ph.D. students, the CS department needs to improve graduate stipends to keep pace with national averages as reported in the CRA "Taulbee Survey."

As discussed earlier, the quality of the physical space is below average. Correcting this problems seems to be a priority for the University. This is also an opportunity to make the most of the space that Computer Science occupies.

Staffing is at the low end of the "new normal" range for the current environment of economic stress and near-universal understaffing. Advising and technical support staffing will need increases if undergraduate enrollment is increased.

5. What changes does the committee recommend in the two years remaining until out next ABET accreditation visit?

The Department should reconsider its objectives in light of the technical ABET definition of objectives as *measurable* things that a program expects of its graduates around 3–5 years after graduation. Incidentally, these objectives are supposed to be a medium-high level "10,000-foot view" of what the Department hopes to achieve. A program is also welcome to spell out even more general high level "30,000-foot view" goals that may not be measurable. Very high

level goals are not "objectives" in the narrow ABET sense, and might instead go in, for example, a mission statement.

Furthermore, the department must show that it is in fact measuring its success with each objective it has. These measurements may be qualitative rather than quantitative, but some data must be collected and examined on some regular schedule.

There is room for real efficiency gains in the UNM School of Engineering in general by moving the task of measuring objectives to the School of Engineering. Whereas learning outcomes are often measured at least in part by measurements in courses, by definition objectives have to be mentioned by doing such things as surveying young alumni and employers. It makes sense to have an Associate Dean of Engineering figure out the methodology and supervise the collection of measurement data instead of having each individual department wrestle with this.

The Department should consider carefully whether it has data showing that it is meeting the educational outcome it has set for itself that "[all students will have] an ability to function on multidisciplinary teams." If that is among the program's educational outcomes, then the Department must show that they are measuring success with this goal, and taking corrective action if they are not meeting it. Alternatively, the Department could weaken this outcome to

"function on teams," as ABET CAC (computing) does not require a multidisciplinary goal, and it can sometimes be very difficult for Computer Science programs to achieve such a goal.

If the Department is finding its current measurement paradigm for outcomes onerous, it could modify it. Since outcomes are to be achieved *by every student* by the time of graduation, it is sufficient for each outcome to be measured in one or two required courses, typically required courses that come later rather than sooner. Measurements in the very first course probably don't contribute much, and measurements in elective courses can never give evidence that "every student" possesses a specific ability. There is nothing wrong with the Department's current system; it is simply an option to do a little less measuring work.

Based on discussion, the Department is now making sure that all students practice and demonstrate their ability to communicate effectively orally inside the discipline of computer science. However, this did not show up clearly in written materials in the self study for this visit.

The advising problem with students not yet admitted to the CS major in University College and in the Engineering School's pre-major mentioned elsewhere in this report must be addressed. If the visiting ABET team uncovers this problem, they will definitely rate it as either a Weakness or a Deficiency.

6. What should the department do to improve its national rankings?

National rankings, such as those published by US News and World Report are partly based on fact and partly on opinion polls. Department Chairs across the country are asked to rank other departments, and such opinions are often more impressionistic than factual. (A number of department chairs have also informally noticed that if a chair does not send in the US News and World Report survey, the ranking of that department drops significantly.)

Given the high quality of the Computer Science Department at UNM, if the department had 34 faculty instead of 17 and could also double Ph.D. graduation rates, funding levels and other metrics, it would no doubt be close to being ranked 40th (or better) in the nation. At the same time, the US News and World Report ranking of 79 seems wrong to us. The 2009 ``Taulbee Survey'' of the Computer Research Association (CRA) is the most recent and reliable source of factual information about Computer Science Departments nationwide. It reports summary information for departments ranked 36 and above, as well as departments ranked 37 to 145. The US News and World Report ranking would place CS at UNM in middle of the 37-to-115 ranked departments. CS at UNM is smaller than the average of this group (17 faculty compared to national average of 20), while its funding is almost double the national median (which is 103K per faculty compared to approximately 200K at UNM), and its Ph.D. production appears to be near the average, which is 7.6 students per year.

Computer Science departments ranked 25 to 36 according to the CRA Taulbee survey have a median funding level of 195K per captia and a mean funding level of 209K per captia. When viewed this way, the funding of faculty in the CS department at UNM is on par with much higher ranked departments.

In summary, the Computer Science Department is doing an excellent job, but it is hampered by its small size. The average number of faculty in a department ranked 1-to-36 is 36 faculty.

In terms of more practical advice, the department can attempt to increase the number of Ph.D.s that it graduates.

However, assuming an excellent output of 1 Ph.D. per year for every 2 faculty, the department cannot expect to graduate much more than 9 Ph.D.s per year given the size of the faculty. Certainly, continuing to recruit and graduate high quality Ph.D. students is important.

The department might do more to publicize its accomplishments. Many department widely distribute electronic newsletters to highlight and publicize major events.

Summary

We wish to thank UNM, the SOE, and the Computer Science Department for their hospitality during our visit. We found the department programs, faculty and students to be of extremely high quality and to have significant future potential. In a nutshell, we see a future where more undergraduate enrollment leads to more FTE, resulting in higher ranking and visibility, better recruitment of graduate and undergraduate students, and increased external funding.

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Academic Program Review Response and Action Plan
Department of Computer Science
Stephanie Forrest, Dept. Chair
September 9, 2010

1 CS Goals and Future Directions

The Computer Science Dept. has the following objectives:

1. Excellence in teaching and research
   (a) B.S. graduates prepared for top-tier graduate programs and employment as software professionals.
   (b) M.S./Ph.D graduates receive offers from top-tier employers
   (c) Rank among the top 40 departments nationally
   (d) Maintain ABET accreditation
2. Emphasis on interdisciplinary research and teaching
   (a) Links with other departments and colleges
   (b) Strong collaborations with external research laboratories
3. Broadening participation of underrepresented groups
4. Industrial partners and sponsors

1.1 CS Dept. Future Directions

In the 2006-2010 time frame, nearly 1/3 of the CS faculty retired, and 6 Assistant Professors were hired. Integrating these new faculty, mentoring them, and adjusting our curriculum to accommodate their interests and expertise is a major current focus for the department.

CS enrollments at UNM fluctuate similarly to those in the rest of the country. The department is currently rebounding from a precipitous decline following the dot com bust, and enrollments are projected to grow over the next several years.

2 Department Quality

The Review Team report was complimentary about CS faculty quality and suggested that the Department could promote increased understanding of our discipline in the School of Engineering and the University. The Department is unsure how to address this comment.

The report states that the department performs on a per-faculty level that is commensurate with a national ranking of 25-36. It further states that the department is unlikely to break into the top 40 ranking without significant growth. This issue could be addressed either by dedicating new

resources to the CS Department, or by combining existing resources to form a larger and more visible academic unit. The second alternative could be pursued either by creating a Computer Science and Engineering Dept. (a common strategy at other universities) or an independent School of Computing (the current national trend). The department is willing to pursue any of these options but would need significant institutional momentum and backing to implement.

3 Leadership

This response addresses the "Leadership" and the "Senior Leadership" sections of the report. The current Chair is on a one-year extension of her original 4-year term, and the Associate Chair is eligible to retire. There are no obvious internal candidates among the current faculty, and a task force convened by the Dean last year determined that an External Chair search is the best option for the department. The report identifies a need for senior-level faculty to lead medium- and large-scale collaborative research projects. This highlights the importance of hiring an External Chair with stellar research leadership credentials.

4 The CS Pipeline

The report identified significant problems with advising for CS students in the period between Freshman admission and admission to the CS major. The Department has been aware of these issues generally but never succeeded in identifying clearly where the breakdowns occur. We are grateful to the committee for investigating this issue so carefully.

In response to this concern, we prepared as requested a one-page summary of advising guidelines for students interested in CS. We prepared one version for advisors in Engineering Student Services and a slightly different one for advisors in University College Advisement. We delivered them to Steve Peralta in ESS,Wynn Goering, and Vanessa Harris in University College. The CS Coordinator for Program Advisement met recently with University College Advisors Kyle Beenhower and Will McClary, and she is scheduled to attend the Univ. College Advisor's Staff Meeting Oct. 5.

In response to this concern, the CS Coordinator for Program Advisement (i.e., the student advisor) spent one morning per week all summer sitting in the SOE Freshman Orientation Advising sessions. She met approximately 30 incoming Freshman who have expressed interest in CS as a major: Reviewing their academic record; advising them on a plan for admission to CS; scheduling follow-up advising in the CS Dept.; and distributing the CS Dept. Freshman Merit Scholarship application form. Several of the 30 were also interested in IFDM and the Coordinator (Lynne Jacobson) discussed interactions between CS and IFDM degree requirements. One immediate result was an additional 6 applications for the CS Merit Scholarship offered to entering Freshmen who plan on majoring in CS. The CS Coordinator for Program Advisement met several times with Tonya Bryant (IFDM Advisement Coordinator) to educate her about CS Degree requirements and to improve the printed information given to students about program requirements for combining a CS major with IFDM participation.

The department is participating in a SOE-wide $3 million NSF STEP proposal to be submitted soon, which is aimed specifically at increasing retention rates in underclassmen. If awarded, the grant will provide mentoring and internships for undergraduates to improve retention and give them work experience. We hope that this program will supplement improvements in the advising

process for potential computer science majors.

The report recommends that the department participate in national STEM initiatives. This is a good suggestion. However, in the immediate future the department prefers to invest its efforts in mentoring, supporting, and retaining the new female (2) and minority (3) Assistant Professors who have been hired over the past 4 years. The department believes that seeing these important new hires through the tenure and promotion process is a more immediate priority than more indirect efforts at the national level, especially because our student population is already significantly more diverse than most other CS programs in the U.S.

The report recommends upgrading TA lines for low-level classes from Undergrad to Grad-level TAs. More graduate TA lines would enhance our classroom teaching, and it would allow the department to recruit more graduate students to its program. The department concurs that this should be a high priority, especially as enrollments increase over the next few years, and to help support the university's initiatives in graduate education. Converting these lines would entail significant cost increases. Over the next few years, it is unlikely that the department will receive the resources to act on this recommendation.

5 Retention

The report predicts that the department will have an increasing number of faculty retention issues over the next several years. The current Chair concurs, having handled two faculty retentions herself almost entirely from existing CS resources. The department will not be able to support future retention packages out of its own resources, especially recurring salary increases.

The report identified low graduate RA stipends as a potential source of retention problems. The department has addressed this concern by raising its RA stipends significantly. Previously, Academic Year salaries in CS ranged from $12,150 to $15,300, with an average of $13,500. Beginning in the Fall Semester 2010, the range for RAs is $16,000 to $20,000. For comparison, the Taulbee Survey reports the following RA AY salaries: Depts Ranked 25-36 ($16,977); Depts ranked 13-24 ($20,677); Depts ranked 1-12 ($22,380).

One problem created by this policy is the inequity between RAs and graduate TAs, who are still paid between $12,150 and $13,330, We estimate that it would cost an additional $25,740 per year to address this inequity. Our estimate is based on the following calculation: TAs are currently paid $6723/semester ($13446/AY) and we hire about 10 TAs/semester at a total annual cost of $134,460; increasing the TA salary to current RA minimum rate for the AY would cost $16,020 annually per TA (total cost $160,200).

To upgrade undergraduate TAs to graduate TAs for a few selected classes (CS 152, 241, and 251) would cost an additional $66,045 per year. We currently hire about 2458 hours per year of undergrad TAs to cover those three classes. Most are paid the minimum wage of $7.50 hour for a total cost to the department of $18,435 per AY. We would need 4 new TA slots to cover the hours that are currently done by undergrads ($84,880, which includes $23,000 for tuition). This estimate does not include the cost of undergrad TAs for CS 150 and 151, which cost an additional $57,675 per year.

To put this in perspective, the two combined lines (grad and undergrad) are budgeted at $219,217, and the department currently spends about $223,460 a year on TAs.

6 Special IT Needs

The report emphasized the special needs that CS departments have for IT support for research and teaching. The report recommends that a "process be defined for approving special IT needs." The department feels that this is the single most important recommendation of the report, and one that can be addressed for essentially zero cost.

On June 18, the CS Chair sent a letter to Acting SOE Assoc. Dean for Research, John Wood, outlining immediate CS needs in this area. This letter has been forwarded to the OVPR, and to date we have received no response or acknowledgment of our requests. A copy of the letter is attached to this document.

The APR report also recommended giving the CS Dept. control over computer teaching laboratories, comparable to science laboratories. The Department has no space for such laboratories and has requested SOE's help to provide space and equipment for a new teaching laboratory.

7 Space

The report highlights problems with existing CS space and the need for new space dedicated to laboratories. Since the report was written, a $3.8M capital project request for Farris Renovation Phase I was submitted by UNM to the state of NM. This project, if funded, would not address outstanding HVAC, insulation and window upgrades for energy efficiency, elevator upgrades, and important space reprogramming issues in the Dept. In addition, the Provost and the Dean of Engineering have each committed $100,000 to a limited remodel of the CS Department Offices and first floor.

8 ABET

The report made a number of suggestions regarding the 2011-2012 ABET reaccreditation process, primarily focused on how we define and measure educational objectives and on pre-major advising. The department is planning to review and update its educational objectives and assessments this Fall, in line with the suggestions contained in the report. As mentioned earlier, the department has already taken some steps to address the advising pipeline issue but we will need cooperation from other units, which may require assistance from Scholes Hall in order to implement effectively.

9 Action Plan

The plan is divided into two subsections: Issues that the department can address on its own, and issues that the department cannot address without outside help.

9.1 Issues that reside primarily in the department

1. Continue to mentor recent faculty hires and help them launch successful teaching and independent research programs.

2. Plan for Chair succession by conducting External Chair Search in AY 2010-2011.
3. ABET re-accreditation in 2011-2012.
4. Develop 4+1 B.S.+M.S. program.
5. Promote understanding and appreciation of CS throughout UNM.
6. Work with SOE ESS and University College advising to improve pre-major advising.

9.2 Issues that reside primarily outside the department

1. Appoint a committee led by academics with IT administration representation to address IT issues related to research and teaching, with the authority to approve special IT needs throughout the academic units of the university.
2. Teaching laboratory with computers scheduled and controlled by CS.
3. Renovation of existing space to improve faculty/student recruiting and retention, provide additional research laboratory and improve usage of existing space, and to address safety issues.
4. Add 1 FTE advisor in CS, as recommended in the report to improve student advising.
5. Additional funding to upgrade undergraduate TA lines to graduate TA lines, and to bring TA salaries in line with RA salaries.
6. Develop plan for department growth, either by dedicating new resources or creating a new academic unit that leverages existing resources.

C Vision Statement

2013 Mission and Vision

Dept of Computer Science, UNM

Mission: Our mission is to: (a) conduct high-impact high-visibility research, (b) offer high-quality education at both undergrad and graduate level, (c) have major economic impact in NM state and nationally.

Goals:

(G.1) Focus research activity into highly-visible interdisciplinary initiative/centers. We plan to create at least two initiatives/centers of excellence by 2015. We envision centers/initiatives with world-wide reputation around each of our areas of focus, with 2-3 faculty forming the core and another 2-3 faculty peripherally supporting the initiative. A key aspect of maximizing the impact of our work is to focus it on multidisciplinary areas and niche topics.

(G.2) Increase enrollment and student success. We want to **triple our undergraduate graduation** by and **double our PhD and ME graduation** by 2017. The establishing of world-renowned centers of excellence will (a) help recruit top-notch students, and (b) ensure their professional placement upon graduation. The undergraduate program will increase through systematic and long-term efforts, for attracting and nurturing students, such as the *CS 4 All,* an NSF funded program that started in 2012, targeting high-school students, and active monitoring of students success.

(G.3) Become a catalyst for economic development through startups and technology transfer. We want to enable the creation of **two startups per year** and support the growth of industry via technology transfer (**double our patent filing and licensing**) and student placement of local industry. We will cultivate a spirit of entrepreneurship and appreciation of impact. Excellence in research in unique and niche areas will provide unprecedented opportunities for technology transfer.

Hire excellent faculty and increase faculty size to 24 by 2018. Although this is not part of the mission, we consider this as an essential step to fully deliver on our mission. Several statistical analyses show the relationship of size to the visibility of a Department with 25-30 being an optimized point. Reaching 24 faculty is a critical step for achieving our mission goals.

Areas of competence and focus:

We envision develop a “brand” using the following strategic areas of strength, although we will also be flexible and open to particular opportunities. The focus areas should mature into initiatives/centers that will lead to international recognition help us increase enrollment and facilitate the creation of opportunities for our students.

1. Human-centric security and privacy: There is hardly any need to discuss the importance of security and privacy, as they are both national priorities and essential concerns of everyday life for humans, enterprises, and countries (e.g. espionage and electronic warfare). Our unique take on this issue that security and privacy should consider “humans in the loop”: it should protect people not devices and it should consider human and psychological weaknesses in its system design. Thus, the area combines (a) Systems and Network Security, (b) Datamining, (c) Computational Psychology, (d) Human Computer Interaction, (e) Game Theory, and (f) Policy and Decision Making.

2. Computing in the Large: This area focuses on seeing computation as an operation over massive data, distributed variable-component systems, over failure-prone components. In other words, this area sits at the intersection of three well-defined areas: (a) Big Data, (b) high-performance computing, and (c) distributed computation and applications. A unique take here is the assumption of: (a) real world systems with faulty components, (b) erroneous or incomplete data, and (c) the balance between accuracy of solution versus timeliness of execution.

3. Complex Bio-Computational Evolutionary Systems: This area focuses on modeling, understanding and controlling the emerging behaviors of large autonomous and mobile systems. One key novelty of the area of focus lies in the tight integration of biological systems (e.g. ant colony behavior) with man-made systems (e.g. rescue robots). Another unique aspect of the area is the ability to self-learn in the face of unknown conditions, and capable of mobility at all scales (from robots, to insect level, to proteins, down to DNA level) at either the individual or group level. This area will have significant impact in both

Biology, and Computer Science, and the emerging field of Network Science.

Note that the focus areas 1 and 2 are also major interests for Sandia and National Labs, the current collaboration of which, we are aggressively expanding. Area 3 is of strategic importance to UNM's biology and medical school, and aligned with the interests of the Santa Fe Institute.

Cross-cutting areas: It is easy to see that the key focus areas include and rely on contributions from other areas such as Machine Learning and AI, Datamining, and Theory of Algorithms, and complex systems. Furthermore, note that all three areas are by definition interdisciplinary and therefore sit at the intersection of several well-established areas.

Specific metrics of success: We will evaluate the success of our trajectory through the following partial list of key metrics:

a. The creation of highly visibility initiatives and centers around each area of focus.
b. The student success both in terms of graduation numbers, graduation rate and professional placement for both undergraduate and graduate students.
c. The number of successfully licensed patents, the income from technology transfer, and the number of start-up companies out of the Department.

D Master's Program Documents

Admission - Master of Science in Computer Science

In addition to the University-wide requirements for admission to graduate study, the prospective Master of Science (M.S.) or Doctor of Philosophy (Ph.D.) candidate must submit verbal, quantitative and analytical GRE scores (general test) as well as satisfy the following criteria for admission to graduate study:

1. Knowledge of computer science equivalent to CS 152L, 251L, 261, 341L, 351L, 357L, 361L, 362, **460 and **481.
2. Knowledge of mathematics essential to computer science equivalent to MATH 162, 163, **314 and STAT **345. *(**See Keys and Symbols Reference)*

Students lacking adequate undergraduate training may be admitted, at the discretion of the admissions committee, with the understanding that course work required to remove the deficiencies in undergraduate background is not applicable to the graduate degree.

Each student is assigned a graduate advisor. The student should see his or her graduate advisor before registering for the first time. The student and the advisor together work out a course of studies which meets the student's career objectives and which constitutes a coherent program satisfying the graduation requirements. No course shall be counted toward the required credit hours which has not been agreed on by the student and the advisor as a part of this coherent program. It is the responsibility of the student to meet the requirements and to keep the department office informed of compliance with them; i.e., the student is **required** to meet with his or her graduate advisor at least once a semester to review progress toward the degree and to have **academic hold removed** so student will be allowed to register.

Options to graduate: Plan I or Plan III

Plan I

In addition to all Graduate Studies requirements for the master's degree, the department also requires the following:

1. 32 credit hours of approved graduate courses.
2. At least 2 credit hours of CS 592 (Colloquium), taken at UNM.
3. At least 26 of the 32 credit hours must be in courses offered by the Computer Science department at the 500-level or above.
4. Completion of a minimum of two courses from each category a) Mathematical Methods b) Empirical Methods and c) Engineering/System Building Methods (required B-).
5. Passing the master's examination (examination is the defense of thesis)

Plan III

In addition to all Graduate Studies requirements for the master's degree, the department also requires the following:

1. 32 credit hours of approved graduate courses.
2. At least 2 credit hours of CS 592 (Colloquium), taken at UNM.
3. In addition to Colloquium, at least 24 of the 32 credit hours must be in courses offered by the Computer Science Department at the 500-level or above.
4. Same as #4 in Plan I.

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www.cs.unm.edu

CURRICULUM FOR MASTER OF SCIENCE
COMPUTER SCIENCE

32 Hours Required for Graduation

Name:_____ **UNM ID#**_____

MATHEMATICAL METHODS				
Course # ***Required B- or better***	**Cr**		**Grade**	**Sem/Yr**
CS 500: Intro Theory of Computation	3			
CS 530: Geometric & Probabilistic Methods	3			
CS 550: Prog. Languages & Systems	3			
CS 558: Software Foundations	3			
CS 561: Algorithms/Data Structure	3			

EMPIRICAL METHODS				
Course # ***Required B- or better***	**Cr**		**Grade**	**Sem/Yr**
CS 512: Intro Comp Graphics/Adv. Image Synthesis	3			
CS 522: Digital Image Processing	3			
CS 523: Complex Adaptive Systems	3			
CS 527: Principles of Artificially Intelligent Machines	3			
CS 529: Introduction to Machine Learning	3			
CS 547: Neural Networks	3			

ENGINEERING/SYSTEM BUILDING METHODS				
Course # ***Required B- or better***	**Cr**		**Grade**	**Sem/Yr**
CS 554: Compiler Construction	3			
CS 580: Specification of Software Systems	3			
CS 585: Computer Networks	3			
CS 587: Advanced Operating Systems	3			
Add'l course: CS 442: Intro to Parallel Processing	3			
Add'l course: CS 544: Intro to Cybersecurity	3			
Add'l course: CS 564: Intro to Database Mgmt.	3			

CS ELECTIVES or 3-6crhrs GRADUATE COURSES*				
***w/CS faculty approval related to CS from outside the department**				
Course #	**Cr**		**Grade**	**Sem/Yr**
Elective CS or Grad Credit:	3			
Elective CS or Grad Credit:	3			

CS ELECTIVES or THESIS RESEACH				
Course #	**Cr**		**Grade**	**Sem/Yr**
CS 599 or Elective CS:	3			
CS 599 or Elective CS:	3			

COLLOQUIUM				
Course #	**Cr**		**Grade**	**Sem/Yr**
CS 592: Colloquium	1			
CS 592: Colloquium	1			

BS+MS Sample Schedule Variant 1
MS Course Option
Coursework-Oriented Example with Focus on Software Engineering
(as of Fall 2014: 120 credits for BS; 32 credits for MS; 12 credits shared (boldface))

course	credits
Year 1, Fall Semester	
English 101	3
CS 152	3
Math 162	4
lab science I	4
Year 1, Spring Semester	
English 102	3
CS 251	3
CS 261	3
Math 163	4
lab science II	4
Year 2, Fall Semester	
CS 241	3
ECE 238	4
Math 314	3
lab science III	3
CS 293	1
Year 2, Spring Semester	
CS 351	4
lab science IV	3
English comm. elective	3
core	6
Year 3, Fall Semester	
CS 361	3
CS 375	3
Stat 345	3
minor/core/electives	6
Year 3, Spring Semester	
CS 357	3
CS 561 for CS 362	3
CS 564 as *CS elective*	3
minor/core/electives	6

course	credits
Year 4, Fall Semester	
CS 341	3
CS 527 as *CS elective*	3
CS 558 as *CS elective*	3
minor/core/electives	6
Year 4, Spring Semester	
CS 460	3
CS 481	3
minor/core/electives	8
BS requirements met at end of Year 4	
Year 5, Fall Semester	
CS 592 (colloquium)	1
CS 522	3
CS 554	3
CS 585	3
Year 5, Spring Semester	
CS 592 (colloquium)	1
CS 581	3
CS 544	3
CS 580	3
MS requirements met at end of Year 5	

E Ph.D. Program Documents

CS PhD Outcomes Assessment Rubric

To be completed by committee chair in consultation with exam committee.

Student: Degree program/concentration: PhD-CS

DATE:

Outcome	Unacceptable (1)	Marginal (2)	Acceptable (3)	Exceptional (4)	Rating
1) Knowledge of Computer Science fundamentals appropriate for discipline and specialization	No evidence of PhD level knowledge of Computer Science	Rudimentary knowledge of Computer Science exhibited in written document and oral presentation	Knowledge of Computer Science fundamentals evident in written and oral presentation	Demonstrated mastery of appropriate fundamentals of Computer Science	
2) Depth of knowledge in specialization	Only rudimentary knowledge in specialization	Some knowledge of specialization demonstrated	Demonstrates appropriate level of knowledge in specialization	Demonstrates knowledge of specialization comparable to experienced practitioner	
3)Ability to conduct original and independent research	No evidence of planning and execution of research program.	Some useful research results with some evidence of original work	Carried out good research program, achieved useful and novel results.	Excellent planning and execution of research program. excellent results	
4) Ability to perform critical review of literature in Computer Science and area of specialization	Rudimentary literature review	Some review of the literature, but little critical evaluation	Comprehensive review of literature with evidence of critical thinking about needs for further research in area.	Extensive review of literature with critical evaluation comparable to a review article in literature.	
5) Able to communicate effectively	Dissertation poorly written. Oral exam not well planned or presented. Unable to answer questions.	Dissertation mostly clearly written. Presented main point clearly. Able to answer some but not all of the questions posed by committee	Well written and well organized dissertation. Well organized and clear presentation. Good ability to answer questions	Excellent job of writing and organizing dissertation. Well organized talk. Able to respond to questions and facilitate further discussion of results	
Overall Assessment	**Unacceptable (1)**	**Marginal (2)**	**Acceptable (3)**	**Exceptional (4)**	

Comments (use back if necessary):

What curricular or process changes can you suggest to improve student performance in these areas (use back if necessary)?:

Form to be sent to department/program grad committee and SoE Associate Dean for Academics

Doctor of Philosophy in Computer Science

The Doctor of Philosophy in Computer Science (Ph.D.) is offered through a cooperative program involving the Computer Science departments at the University of New Mexico, New Mexico State University (Las Cruces, NM) and the New Mexico Institute of Mining and Technology (Socorro, NM). Doctoral students at the University of New Mexico may specialize in areas of current interest to the University of New Mexico faculty, or, by special arrangement, they may work in areas of interest to faculty at either of the other two universities.

Graduation Requirements

In addition to all Graduate Studies requirements for the Ph.D. degree the department also requires the following:

- 4 credit hours of CS 592 Colloquium, taken from the University of New Mexico. If the student enters the program with a master's degree, the requirement is reduced to 2 credit hours of CS 592.
- At least 24 of the credit hours, exclusive of dissertation, must be completed at one of the three New Mexico universities.
- At least 30 credit hours, exclusive of dissertation, must be in courses numbered 500 or above. Of these credit hours, at most 12 may come from individual study courses (at the University of New Mexico, CS 551 and CS 650). If the student enters the program with a master's degree, the requirement is reduced to 18 credit hours in courses numbered 500 and above–at most 9 of these credit hours may come from individual study courses.
- Passing marks on the comprehensive course work, on the oral candidacy examination and on a final oral examination in the student's area of specialization.
- Every student who has passed the comprehensive course work requirement must give one Colloquium before graduation, surveying the student's work to date.
- Teaching requirement for the doctorate: As a requirement for the Ph.D. in Computer Science, all students complete a one-semester teaching assignment. Typically and preferably, this assignment involves running a class section, including classroom lecturing; there is, however, some flexibility in tailoring this assignment to each particular student. The student is encouraged to fulfill this requirement early in his or her studies, as the teaching experience is expected to help solidify the student's mastery of core Computer Science material.

Research Milestone Requirement

All Ph.D. students must also complete a Research Milestone. The milestone is a validation by a small committee of CS faculty on behalf of the department that the student has demonstrated the ability to conduct independent research at a level appropriate for developing and completing a dissertation in the department.

Within 2.5 calendar years of matriculation, each Ph.D. student is required to write and successfully defend a paper or report documenting significant technical research by the student. The paper should describe the student's body of work and be written in a style that is appropriate for submission to a peer-reviewed computer science conference.

Ordinarily, Ph.D. students select a subject area advisor for the milestone project at the beginning of their second year in the program, and register for CS 600 Computer Science Research Practicum. The Practicum provides intensive supervision for one semester, in collaboration with the subject area advisor, as the student develops a milestone project and begins to research it. All students are required to have submitted the milestone paper and to have presented it to a committee of three CS faculty by the fourth week of the Fall semester of their 3rd year (5th semester in the program, or 6th semester for January admits). The Committee consists of the Practicum instructor, the subject area advisor, and an additional member appointed by the Graduate Committee. If the Committee determines that either the paper or the presentation is not satisfactory, the student has the remainder of the semester to work with the Committee to produce a satisfactory outcome. If the student fails to pass the milestone by January (beginning of the 6th semester in the program), then the student is asked to leave the program. Students who successfully complete the milestone before their third semester in the program (both the paper and presentation) can be exempted from the Practicum at the discretion of their advisor.

In addition to this process, all students will continue to receive annual evaluations from the department.

Students must complete the comprehensive course work and research milestone as noted above. Upon completion of the course work the student is allowed to work toward the dissertation. The student's advisor and the graduate advisor or department chairperson then appoint a dissertation committee which determines the student's remaining program of study and conduct the candidacy examination. The candidacy examination verifies that the student possesses the specialized knowledge required for his/her area of research and ensures that the proposed dissertation topic is adequate in scope, originality and significance. The student is admitted to candidacy for the doctorate upon completion of the comprehensive course work and candidacy examination, with the approval of the doctoral committee and the Dean of Graduate Studies. Finally, the committee evaluates the student's doctoral dissertation and conducts the final oral examination on the student's area of specialization.

Ph.D. Comprehensive Course Work

All students pursuing a Ph.D. degree are required to complete at least 18 credit hours of comprehensive course work to provide knowledge in core areas of computer science. Students must also take at least two additional CS graduate-level courses in their area of research specialization.

Students must choose two courses from each category below. Students must achieve a minimum cumulative GPA of 3.5 for the comprehensive courses.

Systems	Credits	Grade	Semester
CS 554 Compiler Construction	3		
CS 585 Computer Networks	3		
CS 587 Advanced Computer Operating Systems	3		

Theory	Credits	Grade	Semester
CS 500 Intro to the Theory of Computation	3		
CS 550 Programming Languages and Systems	3		
CS 561 Algorithms and Data Structures	3		

Empirical Methods	Credits	Grade	Semester
CS 530 Geometric & Probabilistic Methods in CS	3		
CS 533 Experimental Methods in CS	3		

Students are also required to complete a language requirement by taking at least one of the following:

Language Requirement	Credits	Grade	Semester
CS 550 Programming Languages and Systems	3		
CS 554 Compiler Construction	3		
CS 558 Software Foundations	3		

F Advisement documents

Student Name:

Advisor:
Advisor's Email:

Advisor Signature: _____ Date_____

New Graduate Student Advisement Check Sheet

1. Determine student's goals and interests:

    a. degree goal - MS or PHD

    b. research interests -

2. Determine academic deficiencies in the following areas:

    Theory Yes_____ No_____
    Recommended remedial courses_____

    Languages Yes_____ No_____
    Recommended remedial courses_____

    Systems Yes_____ No_____
    Recommended remedial courses_____

3. Review MSCS requirements and/or PHD comprehensive course work.

Course enrollment recommendations: *

Course_____ credit hours_____ Course_____ credit hours_____

Course_____ credit hours_____ Course_____ credit hours_____

Additional advisement comments:

*Domestic students:
With research assistantship – 12 CS graduate credit hours required (for credit, not audit)
With teaching assistantship – 9 CS graduate credit hours required (for credit, not audit)
Without assistantship – part or fulltime

*International Students:
With research assistantship – 12 CS graduate credit hours required (for credit, not audit)
Without teaching assistantship – 9 credit hours required, may include undergrad leveling courses

THE UNIVERSITY OF NEW MEXICO

Department of Computer Science

PhD Student Annual Review
Department of Computer Science
University of New Mexico

Student name: _____

Advisor's name: _____

First semester as a PhD student in CS at UNM: (MM/YY)_____

Progress on Coursework and Other Official Milestones:
If appropriate, list the core courses that you have taken towards your PhD degree and your grade.

Core course	**Grade**
GPA in core courses:	

Research milestone and teaching requirement for students entering the program on or after 2016 (mark with an X all that apply)

	I completed the research milestone
	I have not completed the research milestone, but I took the Research Practicum course
	I completed the teaching requirement

Within 2 1/2 calendar years of matriculation, each Ph.D. student is required to write and successfully defend a paper or report documenting significant technical research by the student.
Students must complete one-semester teaching requirement, or equivalent.

Dissertation status: (mark with an X all that apply)

	I am still looking for a research advisor
	I have an advisor but I have not found a topic
	I identified a topic and an advisor for my dissertation
	I have formed a committee for my dissertation
	I have defended my dissertation proposal. List month and year (/)
	I expect to defend my dissertation on: (/)

THE UNIVERSITY OF NEW MEXICO.

Department of Computer Science

Progress Report

Briefly summarize your academic progress over the past year. Possible milestones include, but are not limited to: literature review or initial assessments for a particular research direction, paper(s) submitted or accepted, grants or proposals written, serving as a reviewer for conferences, mentoring students, talks and poster presentations, leadership positions and service, external collaborations and internships.

Academic Goals

Briefly summarize your plans for the next academic year. For example: I will try to solve the open problem XYZ, research the problem XYZ, submit a paper on XYZ to the [conference/journal] in [month/year]. Address how you will achieve these goals and give tentative timelines. Identify areas of weaknesses and how you plan to overcome these weaknesses. All goals should be easily measurable by someone outside of your area of research.

THE UNIVERSITY OF NEW MEXICO

Department of Computer Science

To be filled by the Academic or Research Advisor. .

Advisor's Evaluation

Please provide a brief description of the student's achievements and evaluate his/her progress towards graduation. Comment on their strengths and weaknesses if relevant.

Progress: **[ ] Unsatisfactory [ ] Adequate [ ] Good [ ] Excellent**

_____ _____

Advisor's signature Date

To be filled by the faculty committee. .

Committee's Evaluation

Please record a summary of the committee discussion to evaluate the student's progress

Recommendation: **[ ] Needs urgent action [ ] Needs improvement [ ] Adequate**

G Assessments

Periodic Report on Program Assessment of Student Learning

Academic year: Fall '13 – Spring '14
Department/Program: Computer Science
Degree program(s): Bachelors of Science
Person(s) preparing report: Michalis Faloutsos
Date submitted: 10/14/14

1. Describe the actions and/or plan revisions that were implemented during this reporting period in response to the previous period's assessment results.

The assessment results for the academic year Fall '12 / Spring '13 were less than 50% complete.

However, no changes to the curriculum were indicated. Although the heavy reliance on lecturers rather than regular faculty in core software engineering courses such as CS 251 and CS 251 was discussed at length by the undergraduate committee in its Oct. meeting.

1. a) List the student learning outcomes (SLOs) that were assessed during this reporting period. If the assessment was performed in a way that is different from that described in your approved assessment plan, please describe the reasons for this and how the assessment was performed.

In Fall '13 the following ABET Outcome assessments were performed:

Outcome B, An ability to analyze a problem and identify and define the computing requirements appropriate to its solution, was assessed in CS 152 by Joel Castellanos (Lecturer). The summary assessment was 2.7/5.0.

Outcome A, An ability to apply knowledge of computing and mathematics appropriate to the discipline was assessed in CS 261 by Shuan Luang (Assoc. Prof.). The summary assessment was 7/5.0.

Outcome E, An understanding of professional, ethical, legal and social issues and responsibilitieswas assessed in CS 293 by Patrick Kelly (Asst. Prof.). The summary assessment was 4.0/5.0.

Outcome G, An appreciation of the impact of computing on individuals and society was assessed in CS 293 by Patrick Kelly (Asst. Prof.) . The summary assessment was 3.97/4.0.

Outcome D, An ability to function effectively on teams to accomplish a common goal was assessed in CS 351 by Joel Castellanos (Lecturer). The summary assessment was 4.92/5.0.

Outcome J, An ability to apply mathematical foundations, algorithmic principles,

and computer science theory in a way which demonstrates the tradeoffs involved in design choices, was assessed in CS 361 by Tom Hayes (Asst. Prof.) The summary assessment was 3.91/4.0.

In Spring '14 the following ABET Outcome assessments were performed:

Outcome H, Recognition of the need for and an ability to engage in continual professional development, was assessed in CS 152 by Brooke Chenowith (Lecturer). The summary assessment was 3.8/5.0.

Outcome I, An ability to use current techniques, skills and tools necessary for computing practice, was assessed by Joel Castellanos (lecturer) in CS 351. The summary assessment was 4.1/5.0.

Outcome K, An ability to apply design principles in the construction of software systems of varying complexity was assessed in CS 357 by Lance Williams (Assoc. Prof.). The summary assessment was 3.24/5.0.

Outcome A, An ability to apply knowledge of computing and mathematics appropriate to the discipline was assessed in CS 261 by Shuan Luang (Assoc. Prof.). The summary assessment was 4.0/5.0.

Outcome FW, An ability to communicate effectively in written form, was assessed in CS 460 by David Ackley (Assoc. Prof.). The summary assessment was 4.3/5.0.

Outcome H, Recognition of the need for and an ability to engage in continual professional development, was assessed in CS 152 by Dorian Arnold (Asst. Prof.). The summary assessment was 3.9/5.0.

Outcome FO, An ability to communicate effectively in oral form, was scheduled to be assessed in CS 460 by David Ackley (Assoc. Prof.) but was not completed.

Outcome I, An ability to use current techniques, skills and tools necessary for computing practice, was scheduled to be assessed n CS 460 by David Ackley (Assoc. Prof.) but was not completed.

b) Describe any developmental work that was done on your assessment plan, including developing new SLOs, creating new measurement methods, or amending your assessment plan.

Extra effort was made by the Undergraduate Committee in Fall '13 / Spring '14 to remedy low faculty compliance with outcome assessment requests in the Fall '12 / Spring '13 academic year. This was extremely successful with 12/14 requested assessments being completed.

i) c) Describe the results of the assessment. What did you learn about strengths and

weaknesses of student learning in your program?

One weakness was identified, namely, the Outcome B assessment in CS 152 in Fall '13. This outcome is concerned with the ability to analyze a problem and identify the computing requirements necessary for its solution.

One strength was identified, namely, the Outcome D assessment in CS 351 in Fall '13. This outcome is concerned with the ability to function on teams.

1. Summarize the faculty discussion of the assessment data. Describe any actions, program revisions, or assessment procedure revisions that were recommended by the faculty. If the faculty review was performed in a way that is different from that described in your approved assessment plan, describe the reasons for this and how the faculty review was performed.

Outcome assessment results were discussed at a meeting of the Undergraduate Committee in October '14. The low outcome B assessment was flagged as worrisome since CS 152 prepares students for the software engineering sequence in the major. However, the result was partly discounted because it is inconsistent with recent prior assessments of Outcome B. The recommendation of the UGC was to examine the issue at the end of the current outcome assessment period and to interview the lecturer to see if the result indicates a real problem or is simply an outlier.

1. What will you assess during the next reporting period? How will you perform the assessment? Does this differ from your approved plan?

   The plan for Outcome Assessment for Fall '14 and Spring '15 is based on the Outcome Assessment Schedule in use by the Computer Science its last accreditation and most recently revised in Fall '12. The use custom rubrics for each ABET outcome implemented as Google doc spreadsheets and Google directories for archival of example student work is considered to be a great improvement in outcome assessment practice by the dept. faculty responsible for performing outcome assessments.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Computer Science	Bachelors of Science

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: Fall '15 / Spring '16

Submitted By (include email address):

Date Submitted to College/School/Branch for Review:

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

ABET Outcomes A-K are assessed using a schedule that ensures that every outcome is assessed at least twice in every two year period.

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

Specific assessments are performed in Spring and Fall of odd and even numbered years as specified by the outcome assessment schedule.
This report describes assessments done in Fall '15 and Spring '16.

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome	Course	Assessment Measures incl. Measure Type (Direct or Indirect)*	Instructor	Result	Analysis	Recommendations for Improvement/ Changes*
ABET B	**CS 152 Fall '15**	**Final Exam Questions**	**Castellanos**	**3**	**Meets expectations**	**none**
ABET A	**CS 261 Fall '15**	**Homework Problems**	**Creel**	**3.6**	**Meets expectations**	**none**
ABET E	**CS 293 Fall '15**	**Student Essays**	**Kelly**	**3.4**	**Meets expectations**	**none**
ABET G	**CS 293 Fall '15**	**Final Project**	**Kelly**	**3**	**Meets expectations**	**none**
ABET D	**CS 351 Fall '15**	**Peer Evaluation of Group Project**	**Castellanos**	**4.9**	**Exceeds expectations**	**none**
ABET J	**CS 361 Fall '15**	**Final Exam Questions**	**Hayes**	**3.8**	**Meets expectations**	**none**
ABET H	**CS 152 Spring '16**	**Lab Assignment**	Castellanos	**4.2**	**Meets expectations**	**none**
ABET I	**CS 351 Spring '16**	**Final Programming Project**	Castellanos	**4.6**	**Exceeds expectations**	**none**
ABET K	**CS 357 Spring '16**	**Reading + Questionnaire**	Williams	**3.2**	**Meets expectations**	**none**
ABET D	**CS 460 Spring '16**	**Observation + Student Reports**	Roman	**5**	**Exceeds expectations**	**none**
ABET F	**CS 460 Spring '16**	**Student Presentations**	Roman	**4.3**	**Meets expectations**	**none**
ABET I	**CS 460 Spring '16**	**Student Presentations**	Roman	**4.2**	**Meets expectations**	**none**
ABET H	**CS 481 Spring '16**	**Take Home Exam**	Arnold	**3.2**	**Meets expectations**	**none**

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

The assessment plan, together with rubric spreadsheets, detailed descriptions of assessment instruments, and representative examples of student work, are all stored on a UNM.CS.ABET Google drive and can be accessed by any faculty member.

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

All learning outcomes were met based on numerical summary scores computed using detailed rubrics associated with each outcome.

Based on this year’s assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

The assessment process worked quite well last year. All but one requested outcome were assessed and in all cases expectations were met or exceeded.

Describe any changes to the assessment plan or the SLOs that are in progress based on this year’s or previous year’s assessment.

The assessment plan is working as designed and no changes are necessary.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

During Fall '15 and Spring '16, the Undergraduate Committee (Williams, Kelly, Castellanos, Creel) met twice to discuss the results of outcome assessment. The committee noted the high rate of completion of outcome assessments (13 / 14) and the fact that in all cases expectations were met or exceeded. No modification of the outcome assessment plan was recommended.

Describe any curricular or course changes that are currently in progress based either on this year's assessment, or on previous year's assessment results.

In Spring '16, the Undergraduate Committee (Williams, Kelly, Castellanos, Creel) proposed:

1) An additional programming course in the freshman year to better prepare students for CS 152
2) Making CS 293 a 3 credit course to improve student communication skills

During Spring '16, at a full faculty meeting, the faculty approved the recommendations of the Undergraduate Committee. CS 105 is now a required prerequisite for CS 152. The faculty approved the idea of CS 293 being made a 3 credit course. The faculty also voted to allow students to take 3 additional technical electives in lieu of the minor requirement . The faculty voted to eliminate the requirement for CS 375.

An ad hoc Undergraduate Curriculum Working Group (Williams, Bridges, Stefanovic, Castellanos, Creel) has also met on multiple occasions and discussed modifications to CS 351 with the idea of increasing student retention and easing faculty workload. These discussions have resulted in a concrete proposal to split CS 351 (currently 4 credits and taught by a lecturer) into two 2 credit courses: the first a lecture course taught by regular faculty; the second a lab course taught by a lecturer. The working group also proposed an additional 200 level course on application programming.

During Fall '16, at a full faculty meeting, the proposal to split CS 351 into two courses and the proposal for a new 200 level course on application programming were presented and discussed at length by the full faculty. The faculty also recommended (in light of Patrick Kelly's retirement) that the proposal to make CS 293 a 3 credit course be tabled for the indefinite future.

Describe your plans for assessment of student learning during the upcoming academic year.

During Fall '16 and Spring '17 we will complete the outcome assessments specified by the dept.'s outcome assessment schedule, using spreadsheets which can be found in the UNM.CS.ABET Google drive.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Computer Science	Bachelors of Science

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2016/2017

Submitted By (include email address): Jed Crandall (crandall@cs.unm.edu)

Date Submitted to College/School/Branch for Review:

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

ABET Outcomes A-K are assessed using a schedule that ensures that every outcome is assessed at least twice in every two year period.

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

Specific assessments are performed in Spring and Fall of odd and even numbered years as specified by the outcome assessment schedule.
This report describes assessments done in Fall 2016 and Spring 2017.

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome	Course	Assessment Measures incl. Measure Type (Direct or Indirect)*	Instructor	Result	Analysis	Recommendations for Improvement/ Changes*
ABET A	**CS 361 Fall '16**	**Homework and Exams**	**Luan**	**3.7**	**Meets expectations**	**none**
ABET B	**CS 152 Fall '16**	**Programming Assignment**	**Castellanos**	**4.2**	**Meets expectations**	**none**
ABET B	**CS 293 Spring '17**	**Programming Assignment**	**Chenoweth**	**4.0**	**Meets expectations**	**none**
ABET C	**CS 460 Spring '17**	**Design Document**	**Roman**	**3.0**	**Meets expectations**	**See below**
ABET FW	**CS 293 Fall '16**	**Written Assignment**	**Kapur**	**3.4**	**Meets expectations**	**none**
ABET FO	**CS 351 Fall '16**	**Oral Presentation**	**Castellanos**	**4.6**	**Meets expectations**	**none**
ABET FW	**CS 460 Spring '17**	**Written Assignment**	**Roman**	**3.6**	**Meets expectations**	**none**
ABET H	**CS 341 Fall '16**	**Written Assignment**	**Bridges**	**4.5**	**Meets expectations**	**none**
ABET H	**CS 460 Spring '17**	**Requirement Specification**	**Roman**	**3.7**	**Meets expectations**	**none**
ABET I	**CS 481 Spring '17**	**Programming Assignment**	**Arnold**	**4.1**	**Meets expectations**	**none**
ABET J	**CS 357 Spring '17**	**Homework Problems**	**Williams**	**4.2**	**Meets expectations**	**none**

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

The assessment plan, together with rubric spreadsheets, detailed descriptions of assessment instruments, and representative examples of student work, are all stored on a UNM.CS.ABET Google drive and can be accessed by any faculty member.

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

All learning outcomes were met based on numerical summary scores computed using detailed rubrics associated with each outcome.

Based on this year’s assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

The assessment process worked quite well last year. We will be largely retaining the same assessment process, modulo some modifications to the schedule detailed below under "Describe your plans for assessment of student learning during the upcoming academic year."

Describe any changes to the assessment plan or the SLOs that are in progress based on this year’s or previous year’s assessment.

The assessment plan is working as designed and no changes are necessary.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

During Fall '16 and Spring '17, the Undergraduate Committee (Williams, Chenoweth, Castellanos, Moses) met to discuss the results of outcome assessment, and all Dept. faculty were part of a discussion about the ABET accreditation process and the outcomes. No modification of the outcome assessment process was recommended,but slight modifications were made to the outcomes to be more consistent with ABET's example outcomes.

Describe any curricular or course changes that are currently in progress based either on this year's assessment, or on previous year's assessment results.

In spring 2015, the result of the scheduled assessment of Outcome C in CS 460 Software Engineering indicated a need for improvement in design, implementation and evaluation of computer-based systems. Based on its own long-standing policy, the undergraduate committee met to consider the root causes of this poor assessment and to devise remedies.
In spring 2016, the undergraduate committee met to discuss the results of outcome assessment in Cycle 2. In attempting to identify the root cause of the poor assessment result in CS 460, the committee's attention quickly focused on CS 351 Design of Large Programs, the capstone course in the major, and the immediate prerequisite of CS 460. To understand the committee's belief 45that CS 351 was the culprit, a bit of exposition on the history of this singularly important course is in order. Prior to 2011, CS 351 had been exclusively taught by tenure-track faculty. While this course is the sole 4-credit course in the undergraduate program, the 4-credit number probably doesn't accurately reflect the amount of effort students expend to complete the sequence of large coding projects required in CS 351. Prior to CS 351, the size of programs written by students was (and remains) comparatively small, rarely exceeding several hundred lines of code. Historically, the philosophy of CS 351 was to require students to complete programming projects so large (many thousands of lines of code) that the specification, design, debugging, and testing of these projects by ad hoc and/or unprofessional practices would quite simply be impossible. The phrase "sink or swim" was an oft-repeated shorthand for the philosophy underlying this course. A corollary of the greater than usual student workload expected of students in CS 351 was the workload demand placed on the faculty teaching it, which far exceeded that required by any other course in the curriculum. This workload was exacerbated by the fact that CS 351 is offered every semester, and (to avoid the possibility of student cheating), design, specification, and implementation of a new sequence of projects is

required every semester. Over time, these factors led to a reluctance on the part of the tenure-track faculty to volunteer to teach this course and an overreliance on lecturers. Indeed, in the last five years, this course has been taught exclusively by a single very dedicated lecturer, Joel Castellanos. However, in recent years, student complaints had grown, and many of these focused on the quality of the project specifications and the fact that projects were assigned with incomplete and ambiguous specifications. It became obvious to the committee that CS 351 was sorely overdue for a major overall in its design and conception, primarily to lower the egregious workload demands placed on the single faculty member teaching it. In the course of these meetings, many other problems with CS 351 were identified:

> The class lacked intellectual cohesion and organizational framework.
> Its contents varied significantly from one semester to another.
> It offered an immersive programming experience with limited guidance and mentoring and without specific learning outcomes in terms of academic knowledge.
> It came across as training by fire, leaving many behind.
> It did not build gradually on knowledge and skills.
> It centered predominantly on the programming experience and less so on the development of design skills.
> It often introduced advanced topics and algorithms that detracted from the mission of the course.
> The effort was not carefully paced, resulting in surges of work and all-nighters, which reinforced negative preconceptions of what computer science graduates end up doing.

Students who passed the class felt that it was a great experience, a badge of honor. However, the opinion was expressed that this is precisely the kind of class which literature on retaining underrepresented groups in STEM fields identifies as being most damaging.
In spring 2016 the Undergraduate Committee conceived a plan to overhaul CS 351. This plan had two parts:

- Divide CS 351 into two interlinked 2-credit sections, with responsibility for each section residing with different faculty members. The first section, CS 351X, would be a lecture course, taught by a tenure-track faculty member. The second section, CS 351L, would be a laboratory section, taught by a lecturer. The lecturer would have responsibility for choosing the project, developing the specification, and implementing it. The primary purpose of the laboratory section will be exposition of the semester project and mentoring students while they complete it. Overall, this division of CS 351 into two sections represents an actual doubling of the faculty workload resource devoted to CS 351 by the department each semester.

- Creation of a repository of at least a half a dozen CS 351 project specifications and model implementations, which the faculty member teaching the lecture section will be able to cycle through so that no project will be repeated in any 3 year period.

In fall 2016 Prof. Catalin Roman was persuaded to take on the responsibility for designing and teaching the reimagined CS 351 lecture course, and he presented the proposal to revise CS 351 on behalf of the undergraduate committee to the full faculty at a regular faculty meeting. The proposal was unanimously approved. In spring 2017 the syllabi for the reimagined CS 351 course were prepared by Prof. Roman and the Associate Chair shepherded them through the approval process by the Faculty Senate. The two courses will be taught for the first time in fall 2017; Prof. Roman will teach the lecture section and a lecturer will teach the laboratory section.

Describe your plans for assessment of student learning during the upcoming academic year.

As a result of greatly increased enrollments (Table D-1), the current practice of assessing the outcomes for all students in a given course is creating an unduly high workload for faculty. In June 2017 the chair instructed the undergraduate committee chair to explore the best practices for outcomes assessments based on sampling, as well as the possibility of concentrating the instruments in a smaller number of courses, preferably higher-level ones.

The priority of the Undergraduate Committee in fall 2017 will be a major revision of the outcome assessment process. This will be done for two reasons: (1) so that new accreditation requirements and best practice recommendations from ABET can be incorporated; and (2) so that the outcome assessment process makes more modest demands on the time of faculty who would otherwise be engaged in research, teaching, and service. This latter goal will be accomplished by using systematic sampling of student work when completing outcome assessments, instead of the current system, which requires all student work in a given class to be evaluated. Significantly, it is the undergraduate committee's intention to retain key elements of the current process which have been highly successful, namely: (1) the use of standardized rubrics; (2) the use of summary formulae to compute performance metrics; and (3) the use of the online repository to document the process.

Periodic Report on Program Assessment of Student Learning

Academic year: 2013-2014
Department/Program: CS
Degree program(s): Masters
Person(s) preparing report: M. Faloutsos
Date submitted: 2014-10-14

1. Describe the actions and/or plan revisions that were implemented during this reporting period in response to the previous period's assessment results.

There were no major changes implemented in this period as the program has come from a major overhaul in the near past.

2. a) List the student learning outcomes (SLOs) that were assessed during this reporting period. If the assessment was performed in a way that is different from that described in your approved assessment plan, please describe the reasons for this and how the assessment was performed.

The scores the MS students who completed oral exams are primarily based:
- Communication skills: quality of presentation
- Technical competency: ability to answer technical questions
- Breadth of knowledge: GPA

b) Describe any developmental work that was done on your assessment plan, including developing new SLOs, creating new measurement methods, or amending your assessment plan.

The graduate committee outlined guidelines for the expected rigor of the exam in terms of the areas above.

c) Describe the results of the assessment. What did you learn about strengths and weaknesses of student learning in your program?

Some of the presentations were relatively poor, indicating poor communication skills.

3. Summarize the faculty discussion of the assessment data. Describe any actions, program revisions, or assessment procedure revisions that were recommended by the faculty. If the faculty review was performed in a way that is different from that described in your approved assessment plan, describe the reasons for this and how the faculty review was performed.

The faculty discussed the effectiveness of the oral exam in assessing the students ability on the three learning outcomes. Overall, the process was deemed satisfactory.

4. What will you assess during the next reporting period? How will you perform the assessment? Does this differ from your approved plan?

No changes are planned for the assessment process.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Master of Science in Computer Science	Master's

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: AY14-15

Submitted By (include email address): bridges@cs.unm.edu

Date Submitted to College/School/Branch for Review: 1/26/16

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

All outcomes are assessed within two to three years, at the end of their examination at the end of the program

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results**	**Analysis**	**Recommendations for Improvement/ Changes***
Knowledge of CS Fundamental		**Faculty at MS Exam (Direct)**	**N/A**	**3.44/5**	**Satisfactory**	-
Written and Oral Communication		**Faculty at MS Exam (Direct)**	**N/A**	**3.40/5**	**Satisfactory**	-
Critically Assess and Apply CS Information		**Faculty at MS Exam (Direct)**	**N/A**	**3.29/5**	**Satisfactory**	-
			N/A			
			N/A			
			N/A			

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

On file at CS Department Main Office and electronically with School of Engineering office.

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

Each outcome was satisfactorily met.

Based on this year's assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

None.

Describe any changes to the assessment plan or the SLOs that are in progress based on this year's or previous year's assessment.

None.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Department Graduate Committee and Graduate Director

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None.

Describe your plans for assessment of student learning during the upcoming academic year.

Department is transitioning to include a Plan III Coursework-only MS, where assessment will be performed by a committee of faculty members examining a portfolio of student course results in their final semester in the program.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Master of Science in Computer Science	Master's

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2015-2016

Submitted By (include email address): Patrick Bridges (bridges@cs.unm.edu)

Date Submitted to College/School/Branch for Review: 12/5/2016

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

One year

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results (AVG/MED)**	**Analysis**	**Recommendations for Improvement/ Changes***
CS Fundamentals		**CS MS Exam and GPA**	**3.0**	**3.03/3**	**Met**	**None**
Communication		**CS MS Exam Presentation**	**3.0**	**3.08/3**	**Met**	**None**
Critical Assessment		**CS MS Exam Presentation**	**3.0**	**2.83/3**	**Partially Met**	**None**
			If applicable			
			If applicable			
			If applicable			

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

Full Assessment data on file in CS department office; spreadsheet of assessment scores included in SOE shared drive

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

The first two outcomes were completely met, with students demonstrating scores on average and on median above the performance benchmark. The media MS students also did well at assessing critical information, though a sizeable number of students scoring 2 (Marginal) in this area. No student scored unacceptable

Based on this year's assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?
Given the acceptable performance by the majority of students in all areas and that no student performed unacceptably, no changes are recommended.

Describe any changes to the assessment plan or the SLOs that are in progress based on this year's or previous year's assessment.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Associate Chair and CS Graduate Committee

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None

Describe your plans for assessment of student learning during the upcoming academic year.

We plan to continue with the current assessment process.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Master of Science in Computer Science	Master's

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2016-2017

Submitted By (include email address): Jed Crandall (crandall@cs.unm.edu)

Date Submitted to College/School/Branch for Review: November 2nd, 2017

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

One year

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results (AVG/MED)**	**Analysis**	**Recommendations for Improvement/ Changes***
CS Fundamentals		**GPA**	**3.2**	**3.4/3.6**	**Met**	**None**
Communication		**GPA in Empirical Methods Core**	**3.2**	**3.5/3.7**	**Met**	**None**
Critical Assessment		**GPA in Eng.&Sys Bldng. Core**	**3.2**	**3.7/4**	**Met**	**None**

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

Full Assessment data on file in CS department office; spreadsheet of assessment scores included in SOE shared drive

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

All three outcomes were completely met, with students demonstrating scores on average and on median above the performance benchmark.

Based on this year's assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

Given the acceptable performance by the majority of students in all areas and that no student performed unacceptably, no changes are recommended.

Describe any changes to the assessment plan or the SLOs that are in progress based on this year's or previous year's assessment.

Due to the Department creating a Plan III for the MS that removed the requirement of a final oral presentation, assessments are now performed entirely based on grades in courses. Overall GPA is a good indicator of a student's understanding of CS fundamentals. A student's GPA in our Empirical Methods core classes is a good indicator of communication because all of these courses include some kind of writeup or presentation---

typically poster presentations---as well as a significant amount of group work. For critical assessment, a student's GPA in our Engineering and Systems Building core classes is a good indicator because these classes all contain content about engineering tradeoffs and societal impact issues.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Associate Chair and CS Graduate Committee (Crandall, Bridges, Stefanovic, Hayes, Luan)

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None

Describe your plans for assessment of student learning during the upcoming academic year.

We plan to continue with the current assessment process.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Master of Science in Computer Science	Master's

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2017-2018

Submitted By (include email address): Jed Crandall (crandall@cs.unm.edu)

Date Submitted to College/School/Branch for Review: September 28th, 2018

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

One year

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results (AVG/MED)**	**Analysis**	**Recommendations for Improvement/ Changes***
CS Fundamentals		**GPA**	**3.2**	**3.70/3.83**	**Met**	**None**
Communication		**GPA in Empirical Methods Core**	**3.2**	**3.63/3.67**	**Met**	**None**
Critical Assessment		**GPA in Eng.&Sys Bldng. Core**	**3.2**	**3.72/4.00**	**Met**	**None**

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

Full Assessment data on file in CS department office; spreadsheet of assessment scores included in SOE shared drive

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

All three outcomes were completely met, with students demonstrating scores on average and on median above the performance benchmark.

Based on this year's assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

Given the acceptable performance by the majority of students in all areas and that no student performed unacceptably, no changes are recommended.

Describe any changes to the assessment plan or the SLOs that are in progress based on this year's or previous year's assessment.

Due to the Department creating a Plan III for the MS that removed the requirement of a final oral presentation, assessments are now performed entirely based on grades in courses. Overall GPA is a good indicator of a student's understanding of CS fundamentals. A student's GPA in our Empirical Methods core classes is a good indicator of communication because all of these courses include some kind of writeup or presentation---

typically poster presentations---as well as a significant amount of group work. For critical assessment, a student's GPA in our Engineering and Systems Building core classes is a good indicator because these classes all contain content about engineering tradeoffs and societal impact issues.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Associate Chair and CS Graduate Committee (Crandall, Bridges, Stefanovic, Hayes, Lakin, Mueen)

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None

Describe your plans for assessment of student learning during the upcoming academic year.

We plan to continue with the current assessment process.

Periodic Report on Program Assessment of Student Learning

Academic year: 2013-2014
Department/Program: CS
Degree program(s): PhD
Person(s) preparing report: M. Faloutsos – Jared Saia
Date submitted: 2014-10-14

1. Describe the actions and/or plan revisions that were implemented during this reporting period in response to the previous period's assessment results.

2. a) List the student learning outcomes (SLOs) that were assessed during this reporting period. If the assessment was performed in a way that is different from that described in your approved assessment plan, please describe the reasons for this and how the assessment was performed.
   The scores for PhD students are primarily based on:

   - Research contribution as seen by the quality of the research
   - Written communication skills written: quality of dissertation
   - Oral communication skills: oral defense of dissertation
   - Critical thinking and breadth of knowledge: dissertation and oral defense Q&A

   b) Describe any developmental work that was done on your assessment plan, including developing new SLOs, creating new measurement methods, or amending your assessment plan.

There were no major changes in our assessment plan.

   c) Describe the results of the assessment. What did you learn about strengths and weaknesses of student learning in your program?

3. Summarize the faculty discussion of the assessment data. Describe any actions, program revisions, or assessment procedure revisions that were recommended by the faculty. If the faculty review was performed in a way that is different from that described in your approved assessment plan, describe the reasons for this and how the faculty review was performed.

Committee Discussion
- All students that graduated this spring had sufficiently high scores
- 1 PhD student had a low score in literature review. However, this student was able to procure a Post doc at Rutgers
- The committee did not feel that any SLO which was a cause for concern for our students

There was a faculty discussion on providing more formal early feedback to the students through a more rigorous yearly evaluation (ie enhancing the current process).

4. What will you assess during the next reporting period? How will you perform the assessment? Does this differ from your approved plan?

There are not changes in our assessment plan.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Doctor of Philosophy in Computer Science	Ph.D.

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: AY14-15

Submitted By (include email address): bridges@cs.unm.edu

Date Submitted to College/School/Branch for Review: 1/26/16

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

All outcomes are assessed within three years, at the end of their examination at the end of the program

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

Third year

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results**	**Analysis**	**Recommendations for Improvement/ Changes***
Knowledge of CS Fundamental		**Faculty at Ph.D Exam (Direct)**	**N/A**	**3.5/5**	**Satisfactory**	-
Written and Oral Communication		**Faculty at Ph.D. Exam (Direct)**	**N/A**	**3.25/5**	**Partially Met**	**Research Practicum Course, Colloquium professional improvement topics**
Conduct Independent Research		**Faculty at Ph.D. Exam (Direct)**	**N/A**	**3.5/5**	**Satisfactory**	-
Depth of Knowledge in Specialization		**Faculty at Ph.D. Exam (Direct)**	**N/A**	**3.5/5**	**Satisfactory**	
Ability to critically review literature		**Faculty at Ph.D. Exam (Direct)**	**N/A**	**3.75/5**	**Satisfactory**	
			N/A			

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

On file at CS Department Main Office and electronically with School of Engineering office.

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

Each outcome was satisfactorily met with the exception of student ability to effectively communicate written and oral information, which could use some modest improvement. Ph.D. student presentation quality was deemed reasonable, but not at the level that the faculty would desire.

Based on this year’s assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

None.

Describe any changes to the assessment plan or the SLOs that are in progress based on this year’s or previous year’s assessment.

None.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Department Graduate Committee and Graduate Director

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

The contents of CS592 Colloquium have been modified to include professional development presentations on effective oral and written presentation of computer science material. A research practicum course for future Ph.D. students is also in the process of being created to provide Ph.D. students additional instruction, experience, and assessment on presenting technical materials.

Describe your plans for assessment of student learning during the upcoming academic year.

We plan to continue using our existing process.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Doctor of Philosophy in Computer Science	Doctoral

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2015-16

Submitted By (include email address): Patrick Bridges (bridges@cs.unm.edu)

Date Submitted to College/School/Branch for Review: December 5, 2016

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

One year

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results (AVG/MED)**	**Analysis**	**Recommendations for Improvement/ Changes***
CS Fundamentals		**Coursework and GPA**	**3.0**	**4.0/4.0**	**Met**	
Depth of Knowledge		**Dissertation Defense**	**3.0**	**4.0/4.0**	**Met**	
Conduct Research		**Dissertation Defense**	**3.0**	**4.0/4.0**	**Met**	
Assess Literature		**Dissertation Document**	**3.0**	**3.5/3.5**	**Met**	
Communicate		**Dissertation Defense**	**3.0**	**4.0/4.0**	**Met**	
			If applicable			

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

Available on SOE Shared Drive

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

Each outcome was met, with all students scoring at or above the desired benchmark lvel

Based on this year’s assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

None

Describe any changes to the assessment plan or the SLOs that are in progress based on this year’s or previous year’s assessment.

None.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Associate Chair, CS Graduate Committee

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None

Describe your plans for assessment of student learning during the upcoming academic year.

Plan to continue with current plan.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Doctor of Philosophy in Computer Science	Doctoral

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2016-2017

Submitted By (include email address): Jed Crandall (crandall@cs.unm.edu)

Date Submitted to College/School/Branch for Review: November 2nd, 2017

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

One year

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results (AVG/MED)**	**Analysis**	**Recommendations for Improvement/ Changes***
CS Fundamentals		**Coursework and GPA**	**3.0**	**4.0/4.0**	**Met**	
Depth of Knowledge		**Dissertation Defense**	**3.0**	**4.0/4.0**	**Met**	
Conduct Research		**Dissertation Defense**	**3.0**	**4.0/4.0**	**Met**	
Assess Literature		**Dissertation Document**	**3.0**	**3.75/4.0**	**Met**	
Communicate		**Dissertation Defense**	**3.0**	**4.0/4.0**	**Met**	

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

Available on SOE Shared Drive

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

Each outcome was met, with all students scoring at or above the desired benchmark level

Based on this year's assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

None

Describe any changes to the assessment plan or the SLOs that are in progress based on this year's or previous year's assessment.

None.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Associate Chair, CS Graduate Committee

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None

Describe your plans for assessment of student learning during the upcoming academic year.

Plan to continue with current plan.

School of Engineering
Annual Program Report of Assessment of Student Learning Outcomes

Title of Degree or Certificate Program	**Degree Level** *(Certificate, Associate, Bachelors, Master's, etc.)*
Doctor of Philosophy in Computer Science	Doctoral

Name of Academic Department: Computer Science

Name of College/School/Branch: School of Engineering

Academic Year/Assessment Period: 2017-2018

Submitted By (include email address): Jed Crandall (crandall@cs.unm.edu)

Date Submitted to College/School/Branch for Review: September 28th, 2018

Date Reviewed by College Assessment and Review Committee (CARC) or the equivalent:

State whether ALL of the program's student learning outcomes (SLOs) are targeted/assessed/measured within one year, two years, OR three years:

One year

If the program's SLO's are targeted/assessed/measured within two years or three years, please state whether this assessment record focuses on SLOs from the first year, second year, or third year:

NOTE: Please make sure that all relevant data/evidence are submitted with the final draft of this annual program assessment record. Refer to the "Annual Assessment Cycle Process" diagram for guidance.

What Student Learning Outcomes were assessed during this reporting period? List in the table below.

For each SLO, indicate in the table how the SLO was assessed, briefly indicate what results were obtained, what analysis of the data indicated with regard to student learning, and what recommendations have been made regarding the program curriculum.

Student Learning Outcome		**Assessment Measures incl. Measure Type (Direct or Indirect)***	**Performance Benchmark**	**Results (AVG/MED)**	**Analysis**	**Recommendations for Improvement/ Changes***
CS Fundamentals		**Coursework and GPA**	**3.0**	**3.7/4**	**Met**	
Depth of Knowledge		**Dissertation Defense**	**3.0**	**3.8/4**	**Met**	
Conduct Research		**Dissertation Defense**	**3.0**	**3.4/3**	**Met**	
Assess Literature		**Dissertation Document**	**3.0**	**3.4/3**	**Met**	
Communicate		**Dissertation Defense**	**3.0**	**3.4/3**	**Met**	
			If applicable			

Indicate where your assessment plan and the full set of assessment data from this year for this program can be accessed.

Available on SOE Shared Drive

Based on the results and analysis provided for the student learning outcome(s) listed in the table above, for EACH student learning outcome, please state if the outcome was met, partially met, or not met. Briefly explain why:

Each outcome was met, with all students scoring at or above the desired benchmark level

Based on this year's assessment, what suggestions do you have for changes to the assessment process or the SLOs for your program?

None

Describe any changes to the assessment plan or the SLOs that are in progress based on this year's or previous year's assessment.

None.

List what groups (committees, faculty meetings, department leadership, etc.) within your program reviewed the assessment results either from the current year, or from previous years, during the current academic year.

CS Associate Chair, CS Graduate Committee (Crandall, Bridges, Stefanovic, Hayes, Lakin, Mueen)

Describe any curricular or course changes that are currently in progress based either on this year’s assessment, or on previous year’s assessment results.

None

Describe your plans for assessment of student learning during the upcoming academic year.

Plan to continue with current plan.

H Faculty Credentials Template

APR Criterion 5: Faculty Credentials Template

Directions: Please complete the following table by: **1**) listing the full name of each faculty member associated with the designated department/academic program(s); **2)** identifying the faculty appointment of each faculty member, including affiliated faculty (i.e., LT, TTI, TTAP, AD, etc.); **3**) listing the name of the institution(s) and degree(s) earned by each faculty member; **4)** designating the program level(s) at which each faculty member teaches one or more course (i.e., "X"); and **5)** indicating the credential(s) earned by each faculty member that qualifies him/her to teach courses at one or more program levels (i.e., TDD, TDDR, TBO or Other). Please include this template as an appendix in your self-study for Criterion 5A.

Name of Department/Academic Program(s): Computer Science

NOTE: Please add rows to the table as needed.

Full First and Last Name	**Faculty Appointment** Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	**Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s)** (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	**Program Level(s)** (Please leave blank or provide "N/A" for each level(s) the faculty does not teach at least one course.)		**Faculty Credentials** • Faculty completed a terminal degree in the discipline/field (TDD); • Faculty completed a terminal degree in the discipline/field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
1. Abad-Mota, Soraya	LT	University of New Mexico, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
2. Bridges, Patrick	TP	University of Arizona, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
3. Carr, Robert	RF	Carnegie Mellon, PhD in Mathematics	Undergraduate	N/A	TDO
			Graduate	N/A	
			Doctoral	N/A	
4. Chenoweth-Creel, Brooke	LT	University of Indiana at Bloomington, MS in Computer Science	Undergraduate		Other: MS degree in the discipline
			Graduate	N/A	
			Doctoral	N/A	
5. Crandall, Jedidiah	TP	University of California at Davis, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
6. Estrada-Piedra, Trilce	TTAP	University of Delaware, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		

Full First and Last Name	**Faculty Appointment** Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	**Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s)** (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	**Program Level(s)** (Please leave blank or provide "N/A" for each level(s) the faculty does not teach at least one course.)		**Faculty Credentials** • Faculty completed a terminal degree in the discipline/field (TDD); • Faculty completed a terminal degree in the discipline/field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
7. Fricke, George Matthew	RF	University of New Mexico, PhD in Computer Science	Undergraduate	N/A	TDDR
			Graduate		
			Doctoral		
8. Hayes, Thomas	TAP	University of Chicago, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
9. Jacobson, Bruna	RF	University of New Mexico, PhD in Computer Science	Undergraduate	N/A	TDDR
			Graduate	N/A	
			Doctoral	N/A	
10. Kapur, Deepak	TDP	Massachusetts Institute of Technology, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
11. Kogan, Marina	TTAP	University of Colorado at Boulder, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
12. Lakin, Matthew	TTAP	University of New Mexico, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
13. Luan, Shuang	TP	University of Notre Dame, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
14. McClurg, Jedidiah	TTAP	University of Colorado at Boulder, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		
15. Moses, Melanie	TP	University of New Mexico, PhD in Biology	Undergraduate		Other: terminal degree outside of the discipline and a record or research and scholarship in the discipline
			Graduate		
			Doctoral		
16. Mueen, Abdullah	TTAP	University of California at Riverside, PhD in Computer Science	Undergraduate		TDDR
			Graduate		
			Doctoral		

Full First and Last Name	**Faculty Appointment** Continuing • Lecturer (LT) • Probationary/Tenure Track - Instructor (TTI) or Asst. Prof. (TTAP) • Tenured - Assoc. Prof. (TAP), Prof. (TP), or Dist. Prof. (TDP) • Prof. of Practice (PP) Temporary • Adjunct (AD) • Term Teacher (TMT) • Visitor (VR) • Research Faculty (RF)	**Institution(s) Attended, Degrees Earned, and/or active Certificate(s)/Licensure(s)** (e.g., University of New Mexico—BS in Biology; University of Joe Dane—MS in Anthropology; John Doe University—PhD in Psychology; CPA License—2016-2018)	**Program Level(s)** (Please leave blank or provide "N/A" for each level(s) the faculty does not teach at least one course.)		**Faculty Credentials** • Faculty completed a terminal degree in the discipline/field (TDD); • Faculty completed a terminal degree in the discipline/field and have a record of research/scholarship in the discipline/field (TDDR); • Faculty completed a terminal degree outside of the discipline/field but earned 18+ graduate credit hours in the discipline/field (TDO); OR • Other (Explain)
17. Roman, Gruia-Catalin	TP	University of Pennsylvania, PhD in Computer Science and Engineering	Undergraduate Graduate Doctoral	 	TDDR
18. Saia, Jared	TP	University of Washington, PhD in Computer Science	Undergraduate Graduate Doctoral	 	TDDR
19. Stefanovic, Darko	TP	University of Massachusetts at Amherst, PhD in Computer Science	Undergraduate Graduate Doctoral	 	TDDR
20. Tapia, Lydia	TAP	University of Texas at Austin, PhD in Computer Science	Undergraduate Graduate Doctoral	 	TDDR
21. Vasek, Marie	TTAP	University of Tulsa, PhD in Computer Science	Undergraduate Graduate Doctoral	 	TDDR
22. Williams, Lance	TAP	University of Massachusetts at Amherst, PhD in Computer Science	Undergraduate Graduate Doctoral	 	TDDR
23.			Undergraduate Graduate Doctoral	 	
24.			Undergraduate Graduate Doctoral	 	
25.			Undergraduate Graduate Doctoral	 	
26.			Undergraduate Graduate Doctoral	 	
27.			Undergraduate Graduate Doctoral	 	

I Peer Comparisons

APPENDIX H
PEER COMPARISON TEMPLATE

With the understanding that not all programs are included in every peer institution, this template can be adjusted to remove institutions which do not have similar programs, add institutions that the unit deems adequate, or add columns that the unit feels reflect a certain characteristic that is not already mentioned. However, please do not remove any columns.

	Total University Enrollment	Unit Undergraduate Degrees/Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	Status/Ranks/ Comparisons (i.e., program goals, curriculum, faculty, and students, etc.)	Other (please specify)
University of New Mexico	24,393 (2018)	BS	BS - 495	MS PhD	MS – 74 PhD - 73	19		
Arizona State University	71,946 (2016)	BS	BS - 2,891	MS PhD	MS – 970 PhD - 289	94		
Florida International University	56,886 (2017)	BS	BS – 1,162	MS PhD		43		
New Mexico State University	26,278 (2017)	BS	BS - 250	MS PhD	—*	13		
Oklahoma State University - Stillwater	24,895 (2017)	BS	BS - 157	MS PhD		16		
Texas A&M University	68,825 (2017)	BS	BS – 1,047	MS PhD	MS – 243 PhD - 111	55		
Texas Tech University	38,209 (2018)	BS	BS – 246*	MS PhD	MS – 62 PhD - 46	13		
The University of Tennessee	28,894 (2018)	BS	BS – 598*	MS PhD		38		
The University of Texas at Arlington	42,496 (2018)	BS	BS – 1,363	MS PhD	MS- 747 PhD - 132	47		
The University of Texas at Austin	51,832 (2018)	BS		MS PhD		45		

	Total University Enrollment	Unit Undergraduate Degrees/Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	Status/Ranks/ Comparisons (i.e., program goals, curriculum, faculty, and students, etc.)	Other (please specify)
The University of Texas at El Paso	25,078 (2018)	BS	BS - 798	MS PhD	MS – 72 PhD - 33	18		
University of Arizona	44,831 (2017)	BS	BS - 440*	MS PhD	MS- 34 PhD - 32	28		
University of California-Riverside	23,278 (2017)	BS		MS PhD	MS - 166 PhD - 80	34		
University of Colorado-Boulder	34,595 (2018)	BS		MS PhD		58		
University of Colorado-Denver	15,232 (2018)	BS		MS PhD		13		
University of Houston	46,324 (2018)	BS		MS PhD	MS – “200” PhD – “100”	27		
University of Iowa	30,201 (2018)	BA, BS		MS PhD		25		
University of Kansas	28,447 (2018)	BS	BS - 502	MS PhD		43		
University of Missouri-Columbia	30,870 (2017)	BS		MS PhD		45		
University of Nebraska-Lincoln	25,820 (2018)	BS	BS – 905*	MS PhD		32		
University of Nevada-Las Vegas	30,471 (2017)	BS	BS – 761*	MS PhD		18		
University of Oklahoma-Norman	31,250 (2016)	BS	BS - 519	MS PhD	MS – 54 PhD - 19	16		
University of Utah	39,931 (2018)	BS	BS - 506	MS PhD	MS – 94 PhD - 123	48		

	Total University Enrollment	Unit Undergraduate Degrees/Certificates Offered	Unit Undergraduate Student Enrollment	Unit Graduate Degrees/Certificates Offered	Unit Graduate Student Enrollment	Total # of Unit Faculty	Status/Ranks/ Comparisons (i.e., program goals, curriculum, faculty, and students, etc.)	Other (please specify)
Other (please name)								
Other (please name)								

J Faculty Bios

Soraya Abad-Mota

Lecturer III

A. Areas of Expertise

- Databases: modeling and management. Data semantics representation.
- Information Extraction from textual sources.

B. Interdisciplinary Interests

- Part of the Information Management Group in the OHI-Guayaquil Project (2014-2015). The Consortium Biotica/Consulsua was established in Guayaquil, Ecuador to measure the Ocean Health Index in the Gulf of Guayaquil following the methodology developed by B. Halpern et al. from U.C. Santa Barbara. The Consortium was hired by the Secretaría Técnica del Mar (SETEMAR).

C. Current Departmental and University Committees

- Departmental Undergraduate Curriculum Committee
- Departmental NCWIT Committee

D. Extracurricular Activities Related to Academic Objectives

- N/A

E. Major Awards, Recognitions, etc. from the past five years

- Outstanding Teaching Award (Premio a la Destacada Labor Docente) (2011) (nominated by students and faculty). Universidad Simón Bolívar, Caracas, Venezuela.

F. Outreach Efforts and Public Service

- Evaluator at the Ronald McNair Program Conference, UNM, October 2018.

Soraya Abad-Mota

e-mail: soraya@unm.edu
Phone: +1-505-277-3052
Update: November 2018

Education

Doctor of Philosophy (2006)
University of New Mexico. Computer Science.

Master of Science (1992)
Rutgers University. Computer Science.

Magister en Ciencias de la Computación (1983)
Universidad Simón Bolívar. Caracas, Venezuela.

Ingeniero en Computación (1980)
Universidad Simón Bolívar. Caracas, Venezuela.

Academic Experience/Positions

Lecturer III (January 2018-today) UNM, Computer Science Department.

Visiting Faculty/Instructor (May 2014-Dec 2014 and January 2016-December 2017)
University of New Mexico (UNM)
Electrical and Computer Engineering Department (Sep 2013-2017): Visiting Faculty.
Computer Science Department (2014-2017): adjunct on several courses.
UNM, Continuing Education (2016): UNMCE SIPI (Southwestern Indian Polytechnic Institute) Adjunct Faculty. 2016 Spring Trimester. MVD/Tapestry Project (April to August 2016).

Profesor Titular (1993-2013, full professor since 2007, retired on summer 2013)
Universidad Simón Bolívar (USB)
Departamento de Computación y Tecnología de la Información

Coordinadora Académica de los programas de Ingeniería en Computación y postgrados en Computación (Jan. 2009- Feb. 2013)
(Director of the Academic Programs in Computing Engineer, MSc in Computer Science and Doctorate in Computer Science)

Instructor (Summer 1991)
Rutgers University. New Brunswick, New Jersey.

Profesor Asistente (1983-1987) (Assistant Professor)
Universidad Simón Bolívar. Departamento de Matemáticas y Computación.

International Projects

OHI-Guayaquil (2014-2015) Measure the Ocean Health Index in the Gulf of Guayaquil following the methodology developed by B. Halpern et al. from U.C. Santa Barbara. Dr. Abad-Mota participated in the project as part of the Information Management Group.

Grants

Hydroclimatic Data Repository for Risk Assessment in Venezuela. (2006-2010)
Project Researcher and Leader. Funding Agency: Fonacit (Venezuela's NSF).
Amount: $500K

Distinctions

- Outstanding Teaching Award (Premio a la Destacada Labor Docente) (2011) (nominated by students and faculty)

Publications

Books

Lelys Bravo de Guenni, Soraya Abad-Mota, Isabel Llatas, Abraham Salcedo, Laura Delgado, Santiago Ramos, Karenia Córdova. **"HIDROX: Repositorio de Datos Hidroclimáticos para la gestión de riesgos epidemiológicos y ambientales"**. USB-UCV-Fonacit 2012. ISBN: 987-9-8012596-2-6.

Soraya Abad-Mota. **"Document Interrogation. Architecture, Information Extraction, Approximate Answers."** Lambert Academic Publishing 2009. ISBN: 978-3-8383-1032-9. (PhD Dissertation)

Conference Papers: about 20 papers with a total of over 100 citations.

Professional Experience

Technological Consultant: 1986-2006 for a variety of private and governmental organizations.
Professional positions: 1980-1983.

Languages

Spanish (native) and English (fluent)

Patrick G. Bridges

Professor and Director of Center for Advanced Research Computing

A. Areas of Expertise

- Operating Systems
- High Performance Computing
- Computer Networking

B. Interdisciplinary Interests

- Data Management
- Research Cyber-infrastructure

C. Current Departmental and University Committees

- Chair, UNM IT Research Technology Committee
- School of Engineering Promotion and Tenure Committee
- Department of Computer Science Graduate Committee

D. Extracurricular Activities Related to Academic Objectives

- Systems Track Co-chair, 2019 ACM/IEEE Supercomputing Conference
- General Co-chair, 2019 IEEE Cluster Computing Conference

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- Judge, New Mexico Supercomputing Challenge

Patrick G. Bridges

1711 Vassar Dr. NE – Albuquerque, NM 87106
cell: (505) 314-4676 • **office:** (505) 277-3032 • **fax:** (505) 277-6927
email: bridges@cs.unm.edu

Professional Preparation

Mississippi State University — **Mississippi State, MS**
B.S. in Computer Science — *May 1994*

University of Arizona — **Tucson, AZ**
Ph.D. in Computer Science — *December 2002*
Dissertation Title: "Composing and Coordinating Adaptations in Cholla"

Appointments

University of New Mexico — **Center for Advanced Research Computing**
Director, Albuquerque, NM — *June 2018 – present*

University of New Mexico — **Department of Computer Science**
Full Professor, Albuquerque, NM — *July 2017 – present*

University of New Mexico — **Center for Advanced Research Computing**
Interim Director, Albuquerque, NM — *September 2016 – May 2018*

University of New Mexico — **Department of Computer Science**
Associate Department Chair, Albuquerque, NM — *August 2015 – August 2017*

University of New Mexico — **Department of Computer Science**
Associate Professor, Albuquerque, NM — *July 2009 – June 2017*

Sandia National Laboratories — **Scalable System Software Department**
Faculty Sabbatical Appointment, Albuquerque, NM — *July 2010 – June 2011*

University of New Mexico — **Department of Computer Science**
Assistant Professor, Albuquerque, NM — *January 2003 – June 2009*

Five Recent Publications

[1] Terry Jones, George Ostrouchov, Gregory A. Koenig, Oscar H. Mondragón, and Patrick G. Bridges. An evaluation of the state of time synchronization on leadership class supercomputers. *Concurrency and Computation: Practice and Experience*, 30(4), 2018.

[2] Scott Levy, Kurt B Ferreira, and Patrick G. Bridges. Evaluating the viability of using compression to mitigate silent corruption of read-mostly application data. In *Proceedings of the 2017 IEEE International Conference on Cluster Computing*, 2017.

[3] Oscar Mondragón, Patrick G. Bridges, Kurt B. Ferreira, Scot Levy, and Patrick M. Widener. Understanding performance interference in next-generation HPC systems. In *Proceedings of the 2016 ACM/IEEE Conference on Supercomputing (SC'16)*, Salt Lake City, UT, November 2016.

[4] Scott Levy, Kurt B. Ferreira, and Patrick G. Bridges. Improving application resilience to memory errors with lightweight compression. In *Proceedings of the 2016 ACM/IEEE Conference on Supercomputing (SC'16)*, Salt Lake City, UT, November 2016.

[5] Oscar H. Mondragón, Patrick G. Bridges, Scott Levy, Kurt B. Ferreira, and Patrick Widener. Scheduling

in-situ analytics in next-generation applications. In *Proceedings of the 16th IEEE/ACM International Symposium on Cluster, Cloud, and Grid Computing (CCGrid'16)*, Cartagena, Colombia, 2016.

Five Other Relevant Publications

[1] Brian Kocoloski, John Lange, Hasan Abbasi, David E. Bernholdt, Terry R. Jones, Jai Dayal, Noah Evans, Michael Lang, Jay Lofstead, Kevin Pedretti, et al. System-level support for composition of applications. In *Proceedings of the 5th International Workshop on Runtime and Operating Systems for Supercomputers*, 2015.

[2] Lei Xia, Zheng Cui, John Lange, Yuan Tang, Peter Dinda, and Patrick G. Bridges. Fast VMM-based overlay networking for bridging the cloud and high performance computing. *Cluster Computing*, 17(1):39–59, 2014.

[3] Zheng Cui, Patrick G. Bridges, John R. Lange, and Peter A. Dinda. Virtual TCP offload: optimizing Ethernet overlay performance on advanced interconnects. In *Proceedings of the 22nd International Symposium on High-performance Parallel and Distributed Computing (HPDC'13)*, pages 49–60. ACM, 2013.

[4] Lei Xia, Zheng Cui, John Lange, Yuabn Tang, Peter Dinda, and Patrick G. Bridges. VNET/P: Bridging the cloud and high performance computing through fast overlay networking. In *Proceedings of the 21st International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC'12)*, June 2012.

[5] Jack Lange, Kevin Pedretti, Peter Dinda, Patrick G. Bridges, Chang Bae, Philip Soltero, and Alexander Merritt. Minimal-overhead virtualization of a large scale supercomputer. In *Proceedings of the 2011 ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments (VEE 2011)*, Newport Beach, CA, March 2011.

Synergistic Activities

Conference and Workshop Leadership: ACM/IEEE International Conference on Supercomputing (SC), Systems Track Co-Chair, 2019; International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC), Travel Grants Chair, 2016-2018; Workshop on Resiliency in High Performance Computing (Resilience), Program Co-chair 2014–2018

Program Committee Member: NSFCloud Workshop on Experimental Support for Cloud Computing, 2014; ACM/IEEE International Conference on Supercomputing (SC), 2010–2014; IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid), 2014–2016; International Conference on Supercomputing (ICS), 2014; International Conference on Parallel Programming (ICPP), 2012, 2006; IEEE International Conference on Computer Communication Networks (ICCCN), 2012, 2014; IEEE International Symposium on Parallel and Distributed Processing with Applications (ISPA), 2012, 2011, 2009, 2006; International Workshop on Extreme Scale Parallel Architectures and Systems (ESPAS), 2012, 2014; Workshop on High-Performance Power-Aware Computing (HPPAC), 2013; International Workshop on Runtime and Operating Systems for Supercomputers (ROSS), 2011–2016; International Workshop on Resiliency in High Performance Computing, 2011–2013; International Workshop on Virtualization Performance: Analysis, Characterization and Tools (VPACT), 2010; International Workshop on System-level Virtualization for High Performance Computing (HPCVirt), 2007–2011; Applied Computing (AC), 2007

Paper Reviewer: IEEE Transactions on Computers, 2010–2012; ACM Transactions on Storage, 2011; IEEE Transactions on Parallel and Distributed Systems, 2011; IEEE Transactions on Software Engineering, 2010–2011

Grant Panelist: U.S. Department of Energy, 2011-2012; National Science Foundation, 2004–2006, 2009–2010

Guest Editor: Operating Systems Review (OSR), 2006, 2008

Project Judge: New Mexico Supercomputing Challenge, 2009, 2010, 2013-2018

Robert Carr

Research Full Professor

A. Areas of Expertise

- Mathematics, Algorithms

B. Interdisciplinary Interests

- Mathematics

C. Current Departmental and University Committees

- N/A

D. Extracurricular Activities Related to Academic Objectives

- N/A

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- N/A

Robert Carr

Address

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1 University of New Mexico
Albuquerque, NM, 87131
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Email: bobcarr@swcp.com

Professional Preparation

1995	Ph.D.	Mathematics,	Carnegie Mellon
1986	M.S.	Mathematics,	Carnegie Mellon
1983	B.S.	Physics and Math,	Carnegie Mellon

Appointments

5/2015	Research Full Professor, Computer Science, University of New Mexico
2000 – 3/2015	Senior Member of Technical Staff, Sandia National Laboratories
1997 – 2000	Limited Term Employee, Sandia National Laboratories
1996 – 1997	Algorithms,Combinatorics,Optimization Postdoctoral, Carnegie Mellon
1995 – 1996	Postdoctoral Fellow, University of Ottawa

Significant Publications

(i) Related to Proposal

1. Finding Low Cost TSP and 2-Matching Solutions using certain Half-integer Subtour Vertices, S. Boyd, R. Carr, *Discrete Optimization*, 8(4), 525–539, 2011.
2. Compacting Cuts: A New Linear Formulation for Minimum Cut, R. Carr, G. Konjevod, G. Little, V. Natarajan, O. Parekh, *ACM Transactions on Algorithms*, 5(3), 2009.
3. On the Held-Karp Relaxation for the ATSP and STSP, R. Carr, S. Vempala, *Math Program Ser A* 100: 569-587, 2004.
4. Randomized Metarounding, R. Carr, S. Vempala, *Random Struct Alg* 20: 343-352, 2002.

5. A New Bound for the 2-Edge Connected Subgraph Problem, R. Carr and R. Ravi, *6th International IPCO Conference*, LNCS Volume 1412, 112-125, 1998.

(i) Other Significant Publications

1. Ramsey theory and integrality gap for the independent set problem, R. Carr, G. Lancia, *Operations Research Letters*, 42(2), 137-139, 2014.
2. Separation Algorithms for STSP Inequalities arising from a new Relaxation, R. Carr, *Math of OR*, 29(1), 80-91, 2004.
3. A 2.1 Approximation Algorithm for a Generalization of the Weighted Edge Dominating Set Problem, R. Carr, G. Konjevod, O. Parekh, F. Toshito, *Journal of Combinatorial Optimization* 5(3), 317-326, 2001.
4. Strengthening the Integrality Gaps for Capacitated Network Design and Covering Problems, R. Carr, L. Fleischer, V. Leung, C. Phillips *Proceedings of SODA* 106-115, 2000.
5. A New Bound for the ratio between the 2-matching Problem and its Linear Programming Relaxation, S. Boyd, R. Carr, *Mathematical Programming A*, Vol 86, 499-514, 1999.

Synergistic Activities

Awards: Franz Edelman Award finalist, team member, "Reducing Security Risks in American Drinking Water Systems," 2008. Employee Recognition Award at Sandia National Labs for being a math resource, 2009.
Expository writing: Polyhedral Combinatorics, R. Carr, G. Konjevod, *Tutorials on Emerging Methodologies and Applications in Operations Research*, H. Greenberg (ed), Kluwer Academic Press, 2004.

Collaborators and Other Affiliations

Current Collaborators: S. Boyd, J. Iglesias, G. Lancia, B. Moseley, O. Parekh, C. Phillips, R. Ravi.
Advisor: Egon Balas, CMU, Sylvia Boyd, U Ottawa.
Student Coauthors: J. Iglesias, G. Konjevod, V. Natarajan, O. Parekh (all from CMU).

Brooke Chenoweth Creel

Lecturer II

A. Areas of Expertise

- Computer Science Education
- Software Development

B. Interdisciplinary Interests

- N/A

C. Current Departmental and University Committees

- Undergraduate Committee
- NCWIT Committee

D. Extracurricular Activities Related to Academic Objectives

- None

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- None

Jedidiah R. Crandall

Professor, Associate Chair, and Graduate Director

A. Areas of Expertise

- Cybersecurity
- Networking
- Privacy
- Internet censorship
- Systems (architecture, OS, *etc.*)

B. Interdisciplinary Interests

- Political science
- Journalism

C. Current Departmental and University Committees

- Graduate Committee, Dept. of Computer Science.
- System Support Group Committee, Dept. of Computer Science.
- Center for Advanced Research Computing Internal Advisory Board member, 2017–present).
- School of Engineering Student Recruitment Committee, 2017–present.

D. Extracurricular Activities Related to Academic Objectives

- Proceedings on Privacy Enhancing Technologies (PoPETs) Editorial Board member, 2017–2019.
- USENIX Workshop on Free and Open Communications on the Internet (FOCI) Steering Committee member, 2014–present.
- Panelist for National Science Foundation panels.

E. Major Awards, Recognitions, etc. from the past five years

- UNM School of Engineering Senior Faculty Research Excellence Award, 2015.

F. Outreach Efforts and Public Service

- New Mexico Supercomputing Challenge Board of Directors member, 2014–present.

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Professional Preparation

Embry-Riddle Aeronautical University, Prescott, AZ, Computer Science, B.S., 2002.

Univ. of California at Davis, Computer Science, Ph.D., 2007.
Thesis title: Capturing and Analyzing Internet Worms.

Appointments

2018–present. The University of New Mexico, Albuquerque, NM. Professor.

2017–present. The University of New Mexico, Albuquerque, NM. Associate Chair.

2013–2018. The University of New Mexico, Albuquerque, NM. Associate Professor.

2007–2013. The University of New Mexico, Albuquerque, NM. Assistant Professor.

Products

(i) Five products related to the proposal.

X. Zhang, J. Knockel, and J.R. Crandall. "ONIS: Inferring TCP/IP-based Trust Relationships Completely Off-Path." *To appear in the Proceedings of the 2018 IEEE INFOCOM conference* (**INFOCOM 2018**).

X. Zhang, J. Knockel, and J.R. Crandall. "High Fidelity Off-Path Round-Trip Time Measurement via TCP/IP Side Channels with Duplicate SYNs" *In the Proceedings of IEEE GLOBECOM* **(GLOBECOM 2016)**

R. Ensafi, P. Winter, A. Mueen, and J.R. Crandall. "Analyzing the Great Firewall of China Over Spance and Time" *Proceedings on Privacy Enhancing Technologies (PoPETs). 1 (1), 61. DOI: 10.1515/popets-2015-0005.* Also presented at **(PETS 2015)**

T. Zhu, D. Phipps, A. Pridgen, J.R. Crandall, and D.S. Wallach. "The Velocity of Censorship: High-Fidelity Detection of Microblog Post Deletions." *In the Proceedings of the 22nd USENIX Security Symposium* (**USENIX Security 2013**).

J.R. Crandall, D. Zinn, M. Byrd, E. Barr, and R. East. "ConceptDoppler: A Weather Tracker for Internet Censorship." *In the Proceedings of the 14th ACM Conference on Computer and Communications Security* (**CCS 2007**).

(i) Five other products.

M. N. Arefi, G. Alexander, H. Rokham, A. Chen, D. Oliveira, X. Wei, M. Faloutsos, and J.R. Crandall. "FAROS: Illuminating In-Memory Injection Attacks via Provenance-based Whole System Dynamic Information Flow Tracking." *In the Proceedings of the IEEE/IFIP International Conference on Dependable Systems and Networks* (**DSN 2018**).

M. Zamani, J. Saia, and J.R. Crandall. "TorBricks: Blocking-Resistant Tor Bridge Distribution" *To appear at the 19th International Symposium on Stabilization, Safety, and Security of Distributed Systems.* **(SSS 2017)**

X. Zhang, J. Knockel, and J.R. Crandall. "Original SYN: Finding Machines Hidden Behind Firewalls." *In the Proceedings of the 2015 IEEE INFOCOM conference* (**INFOCOM 2015**).

R. Ensafi, M. Jacobi, and J.R. Crandall. "Students Who Don't Understand Information Flow Should be Eaten: An Experience Paper." *In the Proceedings of the 5th USENIX Workshop on Cyber Security Experimentation and Test* (**CSET 2012**).

R. Ensafi, J.C. Park, D. Kapur, and J.R. Crandall. "Idle Port Scanning and Non-interference Analysis of Network Protocol Stacks Using Model Checking." *In the Proceedings of the 19th USENIX Security Symposium* (**USENIX Security 2010**).

Synergistic Activities

Co-chair of USENIX Free and Open Communications on the Internet (FOCI) 2013 and 2014 and currently on the **FOCI Steering Committee**, Publicity Chair for Passive and Active Measurements (PAM) 2014, **Editorial Board Member for PoPETS** (Proceedings on Privacy Enhancing Technologies) 2017 through 2019.

Honors and awards: **NSF CAREER award (2009)**, UNM CS dept. Qforma Lectureship (2010 and 2011), UNM Graduate Student Association Faculty Mentor Award (2012), **UNM School of Engineering Senior Faculty Research Excellence Award (2015)**.

Have supervised many Research Experiences for Undergraduates (REU) students, many of whom are now in graduate school. Have supervised two Ronald E. McNair program students, both currently in graduate school.

Active in outreach to high schools in New Mexico, and currently serve on the **New Mexico Supercomputing Challenge Board of Directors**.

Trilce Estrada

Assistant Professor

A. Areas of Expertise

- Distributed Machine Learning, Data Representations for Scalable Data Analytics, Big Data, Stream Analysis

B. Interdisciplinary Interests

- In-Situ Analysis of Sicnetific Simulations
- Natural Language Processing for Biomedical Applications
- Biomedical Image Processing

C. Current Departmental and University Committees

- Search committee for the hiring cycle 2019, Department of Biology
- Search committee for the hiring cycle 2017 and 2018, Department of Computer Science

D. Extracurricular Activities Related to Acadmic Objectives

- Chair of Mentor Protege Program (SC 19), International Conference for High Performance Computing, Networking, Storage and Analysis 2019
- Chair of IPDPS PhD Forum and Student Program, IEEE International Parallel & Distributed Processing Symposium 2015, 2016, 2017, 2018
- Applications Area Chair of Birds of a Feather (SC 16), International Conference for High Performance Computing, Networking, Storage and Analysis 2015
- Vice-chair of Workshops (SC 15), International Conference for High Performance Computing, Networking, Storage and Analysis 2015
- Eight times NSF panelist: SE2, SBIR, SPX, CRII (2014 - 2018)
- Big Data Aspect Chair of the NSF-TCPP curriculum revision committee, 2017-present
- NSF Software Infrastructure for Heterogeneous Computing Committee, 2016-2017
- Program committee: Conference for High Performance Computing, Networking, Storage and Analysis (SC): Workshops 2019, Birds of a Feather 2014, 2018, Doctoral Showcase 2014. IEEE/ACM Intl. Symposium on Cluster, Cloud and Grid Computing (CCGrid) 2017, 2018. IEEE International Parallel & Distributed Processing Symposium (IPDPS) 2017, 2019. IEEE Cluster Conference 2014, 2017, 2018. NSF/TCPP Workshop on Parallel and Distributed Computing Education (EduPar), 2018. Workshop on Education for High-Performance Computing (EduHPC), 2018. International Conference on High Performance Computing and Communications (HPCC) 2012, 2017. Machine Learning in HPC Environments, Supercomputing Workshop, 2016, 2018. High Performance Computing for Big Data Computational Biology Workshop (HPC-BCB) 2015. Grace Hopper Celebration of Women in Computing 2015

E. Major Awards, Recognitions, etc. from the past five years

- NSF CAREER Award: 1453430. CAREER: Enabling distributed and in-situ analysis for multi-dimensional structured data. 2015-2020
- 1st. place at the IEEE International Scalable Computing Challenge, co-located with IEEE/ACM CCGrid, 2015

F. Outreach Efforts and Public Service

- Faculty advisor for the CSGSA and Women in Computing organizations in the CS department. 2016 - present
- Department of Computer Science outreach committee, 2014 - present
- Speaker at the March for Science, Santa Fe, 2017
- Wings for Life tutor, Albuquerque (2017)
- SOE Global Initiatives Delegation 2015
- Judge for the middle round of the New Mexico Supercomputing Challenge (2013-2015)
- UNM representative at the Day of Science, Explora Museum (2014, 2016)

TRILCE ESTRADA-PIEDRA

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Department of Computer Science
Alburquerque, NM 87131

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PROFESSIONAL PREPARATION

Universidad de Guadalajara, México, Computer Systems, BS., 2001

Instituto Nacional de Astrofísica Óptica y Electrónica, México, Computer Science, MS., 2004

University of Delaware, Newark, DE, USA, Computer Science, PhD, 2012

University of Delaware, Newark, DE, USA, Computer Science, Postdoctoral Researcher, 2012-2013

APPOINTMENTS

Academic positions:

2013-	Assistant Professor, Department of Computer Science, University of New Mexico, Albuquerque, NM
2012-2013	Postdoctoral Researcher, Department of Comp. & Info. Sciences, University of Delaware, Newark, DE
2007-2012	Research Assistant, Department of Comp. & Info. Sciences, University of Delaware, Newark, DE

Industry positions:

2010-2010	Summer Intern at IBM T.J. Watson Research Center, Hawthorne, NY
2005-2006	Software Developer at INAOE Vision Lab, PUE, Mexico
2001-2002	Software Developer at General Hospital of Guadalajara, JAL, Mexico

PRODUCTS

Relevant products:

1. X. Chen, Q. Guan, L. Lo, S. Su, Z. Ren, J. Ahrens, **T. Estrada**. In Situ TensorView: In Situ Visualization of Convolutional Neural Networks. In Proc. of IEEE International Conference on Big Data, 2018
2. **T. Estrada**, J. Benson, H. Carrillo-Cabada, A. Razavi, M. Cuendet, H. Weinstein, E. Deelman, M. Taufer. Graphic Encoding of Macromolecules for Efficient High-Throughput Analysis. In Proc. of 9th ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM BCB), 2018
3. X. Chen, M. Peterson, J. Benson, M. Taufer, and **T. Estrada**: KeyBin2: Distributed Clustering for Scalable and In-Situ Analysis. In Proc. of 47th International Conference on Parallel Processing. (ICPP), 2018

4. X. Chen, J. R. Benson, T**. Estrada**; Keybin: Key-based Binning for Distributed Clustering. In Proc. of the IEEE Cluster Conference, Honolulu, HI, 2017.
5. J. R. Benson, **T. Estrada**, A. Rosenberg, M. Taufer; Scheduling Matters: Area-oriented Heuristics for Resource Management. In Proc. of the 28th International Symposium on Computer Architecture and High Performance Computing, Los Angeles, CA, 2016.

Other significant products:

6. J. Benson, H. A. Carrillo-Cabada, J. Wigdahl, S. Nemeth, J. Maynard, G. Zamora, S. Barriga, **T. Estrada**, P. Soliz, Transfer Learning for Diabetic Retinopathy. The International Society for Optics and Photonics (SPIE) 10574: Medical Imaging 2018: Image Processing, 105741Z, 2 March, 2018.
7. M. Perez-Arriaga, S. Abad-Mota, **T. Estrada**, Construction of Semantic Data Models. To appear in Communications in Computer and Information Science (CCIS), 2018.
8. B. Zhang, **T. Estrada**, P. Cicotti, P. Balaji, and M. Taufer. Enabling Scalable and Accurate Clustering of Distributed Ligand Geometries on Supercomputers. Journal of Parallel Computing (ParCo), 63: 38-60, 2017
9. T.R. Balasubramanian, **T. Estrada**; Crowdlearning: A Framework for Collaborative and Personalized Learning. In Proceedings of The 46th Annual Frontiers in Education (FIE) Conference, Erie, PA, 2016.
10. B. Zhang, **T. Estrada**, P. Cicotti, P. Balaji, and M. Taufer. Accurate Scoring of Drug Conformations at the Extreme Scale. In Proc. of 8th IEEE International Scalable Computing Challenge - Co-located with IEEE/ACM CCGrid, (1st Place), 2015

SYNERGISTIC ACTIVITIES (SELECTED)

1. Chair of the Mentor Protégé Program (SC 19). International Conference for High Performance Computing, Networking, Storage and Analysis 2019 - Assemble a program committee, oversee submission, review and select participants, organize panels and tutorials at SC 2019.
2. Chair of the IPDPS PhD Forum and Student Program, IEEE International Parallel & Distributed Processing Symposium 2015, 2016, 2017, 2018 - Participate in steering committee meetings, oversee application and selection process, secure funds for student grants, and execute a 3-day student mentoring program at IPDPS for two years in a row.
3. Applications Area Chair of Birds of a Feather (SC 16), International Conference for High Performance Computing, Networking, Storage and Analysis 2015 - Assemble a program committee, oversee submission, review, and selection of BoF submissions at SC 2016.
4. Vice-chair of Workshops (SC 15), International Conference for High Performance Computing, Networking, Storage and Analysis 2015 - Oversee the submission, review, selection, general logistics, and execution of 41 workshops at SC 2015.
5. Big Data Aspect Chair of the NSF-TCPP curriculum revision committee, 2017-present. Led a team of interdisciplinary researchers from industry and academia to revise the TCPP curriculum guidelines to include Big Data aspects. Work in collaboration with the other aspect leads (Energy, Distributed Systems, Exemplars) and Area chairs (Programming, Algorithms, Architecture).

George Matthew Fricke

Research Assistant Professor

A. Areas of Expertise

- Complex Systems
- Swarm Robotics
- Machine Learning
- High-performance Computing
- Computational biology emphasizing immunology and phylogenetics

B. Interdisciplinary Interests

- Funded by the NASA Astrobiology Institute to work with molecular chemists and biologists to develop complex systems and machine learning tools for the detection of extraterrestrial life.
- Funded by the Center for Advanced Research Computing to implement high-performance software for a variety of interdisciplinary tasks. Current projects include machine-learning applied to identification of tree species from high-altitude surveys, analysis of functional and structural magnetic resonance images to identify impaired decision making following traumatic brain injury, phylogenetic identification of tuberculosis genes that confer immunization resistance, and quantum-dynamic modelling of photo-electric materials.
- In colaboration with the Department of Earth and Planetary sciences, development of autonomous surveying for drone swarms in support of gas sampling during eruption at the Manam Motu and Rabaul volcanos.

C. Current Departmental and University Committees

- None

D. Extracurricular Activities Related to Acadmic Objectives

- Workshop Organizer, Robotics Science and Systems Conference, Workshop Hackathon: Become a swarm programmer overnight. MIT, 2017
- Program Committee for the Distributed Autonomous Robotic Systems (DARS) conference, 2018
- Reviewer for Swarm Intelligence, Automatica, Journal of Theoretical Biology, IEEE Robotics and Automation Letters, DARS: Distributed Autonomous Robotic Systems, IROS: IEEE/RSJ Intl. Conference on Intelligent Robots and Systems, Alife: Conference on the Synthesis and Simulation of Living Systems, BDA: Biological Distributed Algorithms, ICRA: International Conference on Robotics and Autonomy, ISRR: International Symposium on Robotics Research, and the Philosophical Transactions of the Royal Society B (Biology).

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- TEDx talk on autonomous resource collection by robot swarms on Mars.
- Gave talks on robotics to multiple chapters of the "Girls who code" grade-school computer science club.
- Taught a class at the Supercomputing challenge on data-analysis for high-school teams.

- Judge, Senior Mathematics, Senior Computer Science, Annual Central NM Regional Science & Engineering Research Challenge.
- Instructor, UNM Computer Science Middle School Outreach over multiple spring breaks.
- Software Lead for NASA Swarmathons I and II and Technical Lead for Swarmathons III and IV. NASA Swarmathon is an annual swarm robotics programming challenge designed teach undergraduate students from minority-serving institutions about swarm robotics. Swarmathon students have built 100 robots and we have engaged over 1000 undergraduates from 44 Minority Serving Institutions. Students participate in a year long course culminating in a competition. This program is held in collaboration with the NASA John F. Kennedy Space Center.

George Matthew Fricke
Research Assistant Professor
Computer Science
University of New Mexico
1 University of New Mexico, Albuquerque, NM 87131-0001
mfricke @unm.edu, (505) 277-2048

(a) Professional Preparation

Undergraduate Institutions			
Appalachian State University	Boone, NC	Anthropology	B.A., 1996
University of New Mexico	Albuquerque, NM	Mathematics	B.S., 2012
Graduate Institutions			
University of New Mexico	Albuquerque, NM	Computer Science	M.S., 2003
University of New Mexico	Albuquerque, NM	Computer Science	Ph.D., 2017
Postdoctoral Institutions			
University of New Mexico	Albuquerque, NM	Computer Science	Postdoc, 2017

(b) Appointments

UNM	Albuquerque, NM	Dept. of Computer Science	Research Assistant Professor, 2018
UNM		Center for Advanced Research Computing	Applications Scientist, 2018

(c) Products

Most Relevant

Tasnim, H., G. M. Fricke, J. R. Byrum, J. O. Sotiris, J. L. Cannon, and M. E. Moses (2018). Quantitative Measurement of Naïve T cell Association with Dendritic Cells, FRCs, and Blood Vessels in Lymph Nodes. *Frontiers in immunology* 9.

Mrass, P., Oruganti, S. R., Fricke, G. M., Tafoya, J. O., Byrum, J. R., Yang, L., Hamilton, S. L., Miller, M. J., Moses, M. E. and Cannon, J. L. (2017). ROCK regulates the intermittent mode of interstitial T cell migration in inflamed lungs. *Nature communications*, 8(1), p.1010. Nature Publishing Group.

Fricke, G. M., Letendre, K. A., Moses, M. E. and Cannon, J. L. (2016). Persistence and adaptation in immunity: T cells balance the extent and thoroughness of search. *PLoS computational biology*, 12(3), p.e1004818. Public Library of Science.

Fricke, G. M., and J. L. Thomas (2006). Receptor aggregation by intermembrane interactions: A Monte Carlo study *Biophysical Chemistry* Volume 119, Issue 2, 20; Pages 205-211.

Additional

Fricke, G. M., Hecker, J. P., Cannon, J. L. and Moses, M. E. (2016). Immune-inspired search strategies for robot swarms. *Robotica*, 34(8), pp.1791-1810. Cambridge University Press.

Fricke, G. M., Hecker, J. P., Griego, A. D., Tran, L.T. and Moses, M. E. (2016). A distributed deterministic spiral search algorithm for swarms. In *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, (pp. 4430-4436). IEEE.

Fricke, G. M., Black, S. R., Hecker, J. P., Cannon, J. L. and Moses, M. E. (2015). Distinguishing adaptive search from random search in robots and t cells. In *Proceedings of Genetic and Evolutionary Computation (GECCO)* (pp. 105-112). ACM.

Melanie Moses, Tatiana Flanagan, Kenneth Letendre, and Matthew Fricke (2013). Ant colonies as a model of human computation. In Pietro Michelucci, editor, Handbook of Human Computation, pages 25–39. New York: Springer.

Fricke, G. M., Asperti-Boursin, F., Hecker, J. P., Cannon, J. L. and Moses, M. E. (2013). From Microbiology to Microcontrollers: Robot Search Patterns Inspired by T Cell Movement. *Proceedings of Advances in Artificial Life (ECAL)* (pp. 1009-1016). The MIT Press.

Flanagan, T. P., Letendre, K. L., Burnside, W. R., Fricke, G. M. and Moses, M. E. (2012). Quantifying the effect of colony size and food distribution on harvester ant foraging. *PLoS one*, 7(7), p.e39427. Public Library of Science.

Flanagan, T.P., Letendre, K., Burnside, W., Fricke, G. M. and Moses, M., (2011), April. How ants turn information into food: A case study in distributed search. In *Proceedings of Artificial Life* (ALIFE), (pp. 178-185). IEEE.

(d) Synergistic Activities

Center for Advanced Research Computing (2000 and 2018 – present, http://carc.unm.edu). My work at the center focuses on adaptation of scientific projects in chemistry, physics, biology and machine learning to a high performance computing environment. This allows very large projects to be deployed across thousands of computational nodes, including specialised large memory and GPU nodes.

NASA Swarmathon (2015 – present, http://NasaSwarmathon.com) Software Lead (Swarmathon I & II) and Techical Lead (Swarmathon III)**,** and workshop organiser for a swarm robotics programming challenge designed to develop algorithms for search and resource collection on the Moon and Mars, funded by NASA's Minority University Research and Education Program. The algorithms developed by Swarmathon participants support NASA's Journey to Mars in which robots will collect resources to support human settlements. The Swarmathon has built 100 robots and engaged over 1000 undergraduates from 44 Minority Serving Institutions, with 300 students traveling to Kennedy Space Center to watch their robots compete in collaborative 'swarms' that autonomously collect resources. Each year we have run

1) an REU program in which a total of 18 undergrads spend 10-12 weeks as research interns in the Moses lab or in the labs of partner Swarmathon schools and

2) the Swarmathon Workshop & Hackathon at the Robotics Science and Systems Conference (U. Michigan in 2016 and MIT in 2017) for 30 undergraduates from MSIs, culminating with an overnight robotics hackathon. 80% of participants (most 1st generation college students) indicated a desire to go to graduate school; over 60% wanted to pursue a PhD in robotics.

Swarmathon press coverage includes newspaper articles and radio/TV shows including on NPR, BBC, *Nature Knows Best* and local news programs in New Mexico and in the home towns of Swarmathon teams. http://swarms.cs.unm.edu/press.html.

Thomas P. Hayes

Associate Professor

A. Areas of Expertise

- Theory of Computation
- Randomized Algorithms
- Machine Learning
- Distributed Computing
- Markov Chains and Phase Transitions

B. Interdisciplinary Interests

- Statistical Physics
- Discrete Mathematics
- Probability Theory

C. Current Departmental and University Committees

- CS Admissions & Orientation Committee
- CS Graduate Committee
- CS Teaching Assignment Coordinator

D. Extracurricular Activities Related to Academic Objectives

- Program Committee member: ACM-SIAM Symposium on Discrete Algorithms (SODA 2017 and 2019)
- NSF Algorithmic Foundations Program Review Panel, April 2015

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- Desert Willow Math Club for 2-5th and 6-8th graders.

THOMAS P. HAYES

Professional Preparation

Michigan State University	Mathematics	B.A. 1993
University of Chicago	Mathematics	Masters 1994
University of Chicago	Computer Science	Ph.D. 2003
Toyota Technological Institute at Chicago	Computer Science	2003–2004
University of California at Berkeley	Computer Science	2004–2006
Toyota Technological Institute at Chicago	Computer Science	2006–2008

Appointment

University of New Mexico, Dept. of Computer Science: Assoc. Professor, 2015–present

University of New Mexico, Dept. of Computer Science: Asst. Professor, 2008–2015

Selected Publications

Note: articles in Theoretical Computer Science almost always use alphabetical author order.

1 V. Dani, T.P. Hayes, M. Movahedi, J. Saia, and M. Young. "Interactive Communication with Unknown Noise Rate." *Information and Computation***261** (special issue for ICALP 2015) (2018) 464–486.

2 C. Efthymiou, T.P. Hayes, D. Stefankovic, E. Vigoda, and Y. Yin. "Convergence of MCMC and Loopy BP in the Tree Uniqueness Region for the Hard-Core Model." To appear in *SIAM J. Computing* (special issue). Extended abstract appeared in FOCS 2016.

3 V. Dani, T.P. Hayes, C. Moore, and A. Russell, "Codes, lower bounds, and phase transitions in the symmetric rendezvous problem," *Random Structures & Algorithms* **49 (4)**, 742–765 (2016).

4 T. P. Hayes, J. C. Vera and E. Vigoda. "Randomly Coloring Planar Graphs with Fewer Colors Than the Maximum Degree." *Random Structures & Algorithms.* **47(4)** (2015) 731–759.

5 T. P. Hayes. "Local Uniformity Properties for Glauber Dynamics on Graph Colorings." *Random Structures & Algorithms* **43(2)** (2013) 139–180.

6 Y.J. Chang, V. Dani, T. P. Hayes, Q. He, W. Li, and S. Pettie. "The Energy Complexity of Broadcast." 2018. In: *Proceedings of the 2018 ACM Symposium on Principles of Distributed Computing* (PODC 2018) 95–104. arXiv:1710.01800 [cs.DC]

7 A. Aggarwal*, V. Dani, T. Hayes, and J. Saia. "Sending a Message with Unknown Noise." 2018. In: Proceedings of the 19th International Conference on Distributed Computing and Networking (ICDCN 2018) 8–17.

8 C. Efthymiou, T. P. Hayes, D. Štefankovič, and E. Vigoda. "Sampling Random Colorings of Sparse Random Graphs." In: *Proceedings of the twenty-ninth annual ACM-SIAM Symposium on Discrete Algorithms* (SODA 2018) 1759–1771. arXiv:1707.03796 [cs.DM, math.CO]

9 V. Dani, J. Diaz, T. P. Hayes, and C. Moore. "The Power of Choice for Random Satisfiability." *Approximation, Randomization, and Combinatorial Optimization. Algorithms and Techniques* (RANDOM 2013), 484–496.

Recent Research Collaborators:
Yi-Jun Chang, University of MIchigan
Varsha Dani, University of New Mexico
Josep Diaz, UPC Barcelona
Martin Dyer, University of Leeds
Charilaos Efthymiou, Georgia Institute of Technology
Alan Frieze, Carnegie Mellon University
Josh Grochow, Santa Fe Institute
Shuang Luan, University of New Mexico
Mahnush Mohavedi, University of New Mexico
Cristopher Moore, Santa Fe Institute
Seth Pettie, University of Michigan
Alexander Russell, University of Connecticut
Navin Rustagi, Univerity of New Mexico
Jared Saia, University of New Mexico
Daniel Stefankovic, University of Rochester
Amitabh Trehan, University of Victoria
Juan Vera, University of Waterloo
Eric Vigoda, Georgia Institute of Technology
Yitong Yin, Nanjing University
Maxwell Young, Drexel University

Graduate Advisors and Postdoctoral Sponsors

László Babai, University of Chicago, Ph.D. advisor
Eric Vigoda, Georgia Institute of Technology, Ph.D. advisor
Alistair Sinclair, University of California at Berkeley, postdoctoral sponsor
David McAllester, Toyota Technological Institute, postdoctoral sponsor

Thesis Advisor (5):

Abhinav Aggarwal, current Ph.D. student, University of New Mexico. (co-advised with Prof. Jared Saia)
Michael Janes, former Ph.D. student, University of New Mexico. Currently a software developer at Ansys, Inc, Pittsburgh.
Tanya Jeffries, M.S. 2016, University of New Mexico. Currently Ph.D. student at U. of Arizona, Tucson.
Vanessa Job, current Ph.D. student, University of New Mexico.
Vamsi Potluru, Ph.D. 2014, University of New Mexico. Currently a postdoc at Rutgers Discovery Informatics Institute.

Bruna D. Jacobson

Research Assistant Professor

A. Areas of Expertise

- Theoretical/Computational Molecular Biophysics, Monte Carlo and Rule-based Modeling, Data-driven Multiscale Modeling of Biological Systems, Phase Transitions in Soft Condensed Matter Systems

B. Interdisciplinary Interests

- Affiliate Member in The New Mexico Spatiotemporal Modeling Center (STMC) at the UNM Medical School
- Study of biomolecular systems (such as molecular motors and allergens) via robotic-inspired and physics-based methods.

C. Current Departmental and University Committees

- None

D. Extracurricular Activities Related to Academic Objectives

- Invited talks: Tulane University (2017), Center for Biomedical Engineering at UNM (2016), University of Vermont Medical School (2015), Spatiotemporal Modeling Center, UNM Medical School (2015)
- Local organizing committee member of Electronic Structure 2016 in June 2016 at the University of New Mexico, Albuquerque, NM.
- Co-organizer of the Workshop on Robotics Methods for Structural and Dynamic Modeling of Molecular Systems in Robotic Science and Systems Conference (July 2014), Berkeley, CA.

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- Participated in the Discover STEM Day at the National Museum of Nuclear Science and History (2018)
- Presented a Teen Science Café at Explora Children's Museum in Albuquerque NM (2017)
- Science Communicator at Explora Children's Museum, Albuquerque NM

Bruna Jacobson
Research Assistant Professor
Department of Computer Science
University of New Mexico
1 University of New Mexico, Albuquerque, NM 87131-0001
bjacobson@unm.edu

(a) Professional Preparation

Federal University of Rio G. do Norte	Natal, Brazil	Physics	BS, 2004
Federal University of Rio G. do Norte	Natal, Brazil	Physics	MS, 2005
University of Southern California	Los Angeles, CA	Physics	PhD, 2012
University of New Mexico	Albuquerque, NM	Physics	2012 - 2014
University of New Mexico	Albuquerque, NM	Computer Science	2014 - 2017

(b) Appointments

2017 - Present Research Assistant Professor, Computer Science Department, University of New Mexico

(c) Products

1. B. Jacobson, David, J.C.L., Malone, M.C., Manavi, K., Atlas, S.R. and Tapia, L., (2017). "Geometric Sampling Framework for Exploring Molecular Walker Energetics and Dynamics." In *Proceedings of the 8th ACM International Conference on Bioinformatics, Computational Biology, and Health Informatics* (pp. 704-709). ACM.
2. Mahajan, A., Youssef, L.A., Cleyrat, C., Grattan, R., Lucero, S.R., Mattison, C.P., Erasmus, M.F., Jacobson, B., Tapia, L., Hlavacek, W.S. and Schuyler, M., (2017). "Allergen Valency, Dose, and FcεRI Occupancy Set Thresholds for Secretory Responses to Pen a 1 and Motivate Design of Hypoallergens." *The Journal of Immunology*, *198*(3), pp.1034-1046.
3. B. P. W. de Oliveira (B. Jacobson), E. L. Albuquerque, M. S. Vasconcelos, "Electronic density of states in sequence dependent DNA molecules", Surface Science 600 (18), 3770 (2006).
4. R. G. Sarmento, E. L. Albuquerque, P. D. Sesion Jr., U. L. Fulco, B. P. W. de Oliveira (B. D. Jacobson), "Electronic transport in double-strand poly(dG)-poly(dC) DNA segments", Physics Letters A 373 (16), 1486 (2009).
5. Adamson, T., Baxter, J. , Manavi, K., Suknot, A., Jacobson, B., Kelley, P. and Tapia, L. (2014): "Molecular Tetris: Crowdsourcing Molecular Docking Using Path-Planning and Haptic Devices," In Proceedings of the ACM SIGGRAPH Motion in Games (MIG), pp. 133-138, Los Angeles, CA.
6. Hoard, B., Jacobson, B., Manavi, K. and Tapia, L. (2016): "Extending Rule-Based Methods to Model Molecular Geometry," BMC Systems Biology Journal, 10(2), pp. 121-138.
7. Manavi, K., Jacobson, B., Hoard, B., and Tapia, L. (2016): "Influence of Model Resolution on Geometric Simulations of Antibody Aggregation," Robotica Journal Special Issue on Robotics Methods for Structural and Dynamics Modeling of Molecular Systems, 34(8), pp. 1754-1776.

8. T. Adamson, J. Baxter, K. Manavi, B. Jacobson and L. Tapia, "Crowdsourced Molecular Docking Using Path-Planning and Haptic Devices", In *Proc. RSS Workshop on Robotics Methods for Structural and Dynamic Modeling of Molecular Systems (RMMS)*, Berkeley, CA, USA, July 2014.
9. B. P. W. de Oliveira (B. Jacobson), S. Haas, "Electron-phonon bound states and impurity band formation in quantum wells", Physical Review B 79, 155102 (2009).
10. J. Santos, B. P. W. de Oliveira (B. D. Jacobson), O. R. Nelson, "Impedance of rigid bodies in one-dimensional elastic collisions", Rev. Bras. Ens. Fis. 34, 1305 (2012).

(d) Synergistic Activities

- Science Communicator Fellow at Explora Museum, 2017.
- Co-Organizer of the *Workshop on Robotics Methods for Structural and Dynamic Modeling of Molecular Systems* at the Robotics Science and Systems Conference, Berkeley, CA, 2014.
- Co-Organizer of the First, Second, and Third Annual Conference for Undergraduate Women in Physics at the University of Southern California, 2006, 2007, 2008.

Deepak Kapur

Distinguished Professor of COmputer Science

A. Areas of Expertise

- Fornal Methods, Program Analysis, Automated Reasoning, Tern Rewriting, Unification, Symbolic Computation, Resultants, Groebner basis Computation, Polynomial Equation Solving, Geometric and Algebraic Reasoning, Social Aspects of Computing.

B. Interdisciplinary Interests

- Applications of Logic and Algebra to Program Analysis.
- Applications of Term Rewriting to developing Constructive Method in Computational Algebra.

C. Current Departmental and University Committees

- Chair of Tenure and Promotion Committee
- Broadening Participation of Underrepresented Groups in Computing
- Chair, Task Force on Increasing Female Enrollments in Computer Science

D. Extracurricular Activities Related to Academic Objectives

- Liaison and UNM Representative to National Conference of Women in Information Technology (NCWIT).
- Board Member, *United Nations University – Computing and Society (UNU-CS), Macau.*
- Board Member, *United Nations University – International Institute for Software Technology (UNU-IIST), Macau.*
- Member, External Advisory Board, Department of Computer Science, New Mexico State University.
- External Reviewer, Computation, Computer, Information and Mathematics (CCIM), Sandia National Labs., 2001, 2002, 2003, 2004.
- Site Reviewer, Science Foundation, Ireland, 2006.
- Member of the Editorial Board, *LIPIcs: Leibniz International Proceedings in Informatics,* 2010–2018.
- Editor-in-Chief, *Journal of Automated Reasoning* (the premier journal in automated theorem proving), 1993–2007.
- Member, Editorial Board, *Journal of Symbolic Computation* (the premier journal in symbolic computation), 2008 onwards.
- Member, Editorial Board, *Journal of Automated Reasoning* (the premier journal in automated theorem proving), 2007 onwards.
- Editor, *Applicable Algebra in Engineering, Communication and Computer Science.*
- Editor, *Journal of Systems Science and Complexity.*
- Program Committee Co-Chair, *Theoretical Aspects of Computing - ICTAC 2017*, 14th International Colloquium, Hanoi, Vietnam, October 23-27, 2017.
- Program Committee Co-Chair, *Dependable Software Engineering: Theories, Tools, and Applications,* Second International Symposium (SETTA 2016), Beijing, China.
- Member Steering Committee, *Dependable Software Engineering: Theories, Tools, and Applications,*

- Program Committee Co-Chair, *Automated Reasoning-7th International Joint Conference IJCAR 2014,* Held as part of the Vienna Summer of Logic, VSL 2014, Vienna, Austria, July 19-22, 2014.
- Chair, *Ninth Asian Symposium on Computer Mathematics (ASCM),* Singapore, Dec. 2007.
- Chair, Organizing Committee, *International Joint Conference on Automated Reasoning (IJCAR).*
- Member, Organizing Committee, *International Conference on Automated Deduction (CADE).*
- Invited Speaker, *The First National Formal Methods and Applications Conf.,* Beijing, Nov. 2016.
- Invited Speaker, *2014 Conference on Software Analysis and Verification,* Beijing, Dec. 2014.
- Invited Speaker, *Automated Deduction in Geometry, ADG 2014,* Coimbra, Portugal, July 2014.
- Invited Speaker, *Workshop on Differential Algebra and Related Topics,* Institute of Studies in Fundamental Sciences (IPM), Tehran, Iran, June 2014.
- Invited Speaker, *EACA 2014,* Barcelona, Spain, June 2014.
- Invited Speaker, *Workshop affiliated with MACIS,* Beihang University, Beijing, Dec. 2013.
- Invited Speaker, *Workshop on Analysis and Verification of Dependable Cyber Physical Software*, Changsha, Nov. 2013.
- Invited Speaker, *International Seminar on Verification, Automated Debugging, and Symbolic Computation*, Beijing, Oct. 23-25, 2013.
- Invited Speaker, *Sino-German workshop on Probabilistic Systens,* Beijing, Sep. 24-27, 2013.
- Invited Speaker, *International Seminar on Verification, Automated Debugging, and Symbolic Computation*, Beijing, Oct. 10-12, 2012.
- Member, Program Committee of *International Joint Conference on Automated Reasoning (IJCAR)*, Coimbra, 2016
- Member, Program Committee of the *International Symposium on Symbolic and Algebraic Computation (ISSAC)*, 2016.
- Member, Program Committee of the *25th International Conference on Automated Deduction (CADE)*, August 2015, Berlin.
- Member, Program Committee, *Verification Workshop (Verify'10)*, Vienna, July 2014.
- Member, Program Committee, *8th International Conference on Artificial Intelligence and Symbolic Computation (AISC),*, Sevilla, Spain, Dec 2014.
- Member, Program Committee, *8th International Conference on Language and Automata Theory and Applications (LATA 2014)*, Madrid, Spain, March 2014.
- Member, Program Committee, *10th International Conference on Distributed Computing and Internet Technology (ICDCIT),* Bhubaneswar, India, Feb. 2014.
- Member, Program Committee, *8th International Conference on Language and Automata Theory and Applications (LATA 2012)*, Bilbao, Spain, March 2013.
- Member, Program Committee of the *5th International Joint Conference on Automated Reasoning (IJCAR)*, Manchester, August, 2012.
- Member, Program Committee of the *23th International Conference on Rewriting Techniques and Applications (RTA),* Nagoya, 2012.
- Member, Program Committee, *18th International Conference on Logic for Programming, AI and Reasoning (LPAR),* Venezuela, March 2012.
- Member, Program Committee of the *22th International Conference on Automated Deduction (CADE)*, 2011.
- Member, Program Committee of the *CICM, 2011.*

E. Major Awards, Recognitions, etc. from the past five years

- *Herbrand Award,* 2009. This is the highest award in the field of automated reasoning and deduction. The citation is reproduced from `http://www.cadeinc.org/HerbrandAward.html`:
  Herbrand Award for Distinguished Contributions to Automated Reasoning presented to Deepak Kapur in recognition of of his seminal contributions to several areas of automated deduction including inductive theorem proving, geometry theorem proving, term rewriting, unification theory, integration and combination of decision procedures, lemma and loop invariant generation, as well as his work in computer algebra, which helped to bridge the gap between the two areas.
- Visiting Professorship for Senior International Scientists, the Chinese Academy of Sciences, 2013-2014.
- *Senior Faculty Research Excellence Award,* School of Engineering, the University of New Mexico, May 2010.
- *Excellence in Research Award,* the University at Albany, SUNY, 1998.
  `http://www.albany.edu/feature98/excellence_awards/kapur.html`.
- Distinguished Paper Award, International Conference on Software Engg. (ICSE 2012), Zurich.

F. Outreach Efforts and Public Service

- N/A

Deepak Kapur
Department of Computer Science
University of New Mexico
Albuquerque, NM 87131
Tel.: (505)-277-1581, email: kapur@cs.unm.edu

Education

Indian Institute of Technology (IIT), Kanpur, India, Electrical Engineering, B. Tech., 1971
Indian Institute of Technology (IIT), Kanpur, India, Computer Science, M. Tech., 1973
Massachusetts Institute of Technology (MIT), Cambridge, MA., Computer Science, Ph.D., 1980.

Employment

August 2007: Distinguished Professor, Department of Computer Science, University of New Mexico, Albuquerque, NM.
Jan. 1999–June 2006: Chair, Department of Computer Science, University of New Mexico, Albuquerque, NM.
1988–1998: Professor of Computer Science, State University of New York, Albany, NY.
1980–1987: Research Staff, Computer Science, G.E. R&D Center, Schenectady, New York.

Research Interests

Programming Languages. Formal Methods. Symbolic Computation. Elimination Methods. Multivariate Resultants. Geometric Reasoning. Automated Reasoning. Term Rewriting. Decision Procedures. Program Analysis.

Selected Publications

1. D. Kapur, D. Lu, M. B. Monagan, Y. Sun, D. Wang, "An efficient algorithm for computing parametric multivariate GCD," Proc. *Intl. Symp. on Symbolic and Algebraic Computation (ISSAC)*, 239-246, NY, 2018

2. D. Kapur, "Comprehensive Gröbner basis Theory for a Parametric Polynomial Ideal and the associated Completion Algorithm," *J. of Systems Science and Complexity,* Vol. 30(1), 30^{th} Anniversary Special Issues, 2017.

3. D. Kapur, "Nonlinear Polynomials, Interpolants and Invariant Generation for System Analysis," Proc. *Second Intl. Workshop on Satisfiability, Checking and Symbolic Computation,* Kaiserslautern, July 2017.

4. T.V. Nguyen, W. Weimer, D. Kapur, and S. Forrest, "Connecting Program Synthesis and Reachability: Automatic Program Repair using Test-Input Generation," Proc. 23^{rd} *Intl. Conf. on Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, 301-318, Sweden, 2017.

5. *Ting Gan, Liyun Dai,* Bican Xia, Naijun Zhan, Deepak Kapur, and *Mingshuai Chen*, "Interpolant Synthesis for Quadratic Polynomial Inequalities and Combination with EUF." Proc. *Intl. Joint Conf. on Automated Reasoning– IJCAR 2016,* Springer LNCS 9706, 195-212, 195-212.

6. S. Falke and D. Kapur, "When is a formula a loop invariant?" *Logic, Rewriting and Concurrency – Festschrift for José Meseguer*, LNCS 9200, Springer, Sept. 2015, 264-286.

7. D. Kapur and Y. Yang, "An algorithm to check whether a basis of a parametric polynomial system is a comprehensive Gröbner basis and the associated completion algorithm," Proc. *Intl. Symp. on Symbolic and Algebraic Computation (ISSAC)* Bristol, July 2015.

8. D. Kapur, "A Quantifier Elimination based Heuristic for Automatically Generating Inductive Assertions for Programs," J. of *Systems Science and Complexity,* Vol. 19, No. 3, 2006, 307-330.

9. D. Kapur, Y. Sun, and D. Wang, "An Efficient Algorithm for Computing Comprehensive Gröbner System for a Parametric Polynomial System, " *J. of Symbolic Computation,* 49, 2013, 27-44.

10. D. Kapur, Y. Sun, and D. Wang, "An Efficient Method for Computing Comprehensive Gröbner bases," *J. of Symbolic Computation,* 52, May 2013, 124-142.

Publications: Books: 7; Journal and Book Chapters: 69; Conference Proceedings: 166.

Synergistic Activities

- *Herbrand Award,* 2009. This is the highest award in the field of automated reasoning and deduction. The citation is reproduced from `http://www.cadeinc.org/HerbrandAward.html`:

- Editor-in-Chief, *Journal of Automated Reasoning*, 1993-2007.
  Member of the Editorial Board, *LIPIcs: Leibniz International Proceedings in Informatics,* 2010 onwards.
  Editor, *Journal of Symbolic Computation*, *Journal of Automated Reasoning, Journal of Constraints*, *Journal of Applicable Algebra in Engineering, Communication and Computer Science*.

- Guest Editor and Chair, *Logic, Mathematics, and Computer Science: Interactions,* Symposium in honor of Bruno Buchberger's 60th Birthday, RISC-Linz, Hagenberg, Austria, Oct. 22-24, 2002.

- Guest co-Editor, a special issue of *J. of Symbolic Computation* devoted to *Intl. Conference on Mathematics Mechanization,* to honor Wu Wen-Tsun on his 90th birthday, 2009.

- Invited Speaker, *Workshop on Differential Algebra and Related Topics,* Institute of Studies in Fundamental Sciences (IPM), Tehran, Iran, June 2014. Invited Speaker, *Automated Deduction in Geometry,* Coimbra, 2014.
  Invited Speaker, *Conference Encuentros de Algebra Computational y Aplicaciones (EACA),* Barcelona, 2014.
  Keynote Speaker, *Federated Logic Conference, 2010*, Edinburgh, July 2010.
  Keynote Speaker, *Intl. Conference on Mathematics Mechanization* to honor Prof. Wen-Tsun Wu's 90^{th} Birthday, 2009, Beijing, China.
  Invited Speaker, *WING 2007*, 1st International Workshop on Invariant Generation, 25-26 June 2007, Hagenberg, Austria.
  Invited Speaker, *Calculemus 2006 Symposium,* Genova, Italy, July 2006.
  Keynote Speaker, *10th International IMACS Conference on Applications of Algebra (ACA 2004),* Lamar, TX, July 2004.
  Invited Speaker, *Mathematics, Algorithms and Proofs, 2006 (MAP 2006)*,Spain, Jan. 2006.
  Keynote Speaker, *6th Asian Symp. on Computer Math (ASCM),* Beijing, China, Oct. 2003.
  Invited Speaker, a special session on *Automated Reasoning in Mathematics and Logic,* AMS, Georgia Tech University, Atlanta, March 2002.

- Chair, *Theoretical Aspects of Computing-ICTAC 2017-*14^{th} *Inter. Coll.* Hanoi, October 2017.
  Chair, *Dependable Software Engineering: Theories, Tools, and Applications,* Second International Symposium (SETTA 2016).
  Chair, *Intl. Conference on Automated Reasoning (IJCAR), 2014*, a part of *Federated Logic Conference*.
  Chair, *8th Asian Symposium on Computer Mathematics (ASCM)*, 2007.
  Chair, *11th International Conference on Automated Deduction*, 1992.
  Member, Program Committee, *International Symposium on Symbolic and Algebraic Computation,* 2016.
  Member, Program Committees of the *International Conferences on Automated Deduction (CADE)*, 1988, 1990, 1997, 1998, 1999, 2000, 2002, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017,2019.
  Member, Program Committees of *Intl. Joint Confs. on Automated Reasoning (IJCAR)*, 2001, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018.
  Member, Program Committee, *Automated Deduction in Geometry,* 2000, 2002, 2004, 2006, and 2008, 2010, 2016.
  Member, Program Committee, *Asian Symp. on Computer Mathematics (ASCM),* 2000, 2001, 2003, 2009, 2011, 2015.
  Member, Program Committee, *Calculemus*, 2000, 2006, 2007, 2008, 2011.

Marina Kogan

Assistant Professor

Areas of Expertise

- Human-computer interaction
- Social computing
- Crisis informatics
- Network science
- Human-centered data science

A. Interdisciplinary Interests
   - Network Science
   - Complex Adaptive Systems
   - Public self-organization and coordination in natural disaster
   - Online coordination in political crises
   - Sociotechnical systems
   - Collaborate with faculty in political science, economics, and civil engineering

B. Current Departmental and University Committees
   - 2018/2019 Computer Science Department Hiring Committee
   - Strategic Planning for Retaining Women in Computing committee, a joint effort between the University of New Mexico Computer Science Department and the National Center for Women & Information Technology

C. Extracurricular Activities Related to Academic Objectives
   - Organizing Committee, ACM Group (2017)
   - Program Committee, International Conference on Weblogs and Social Media (2018)
   - Program Committee, European Conference on Computer Supported Cooperative Work (2018)
   - Program Committee, Web and Society track, The Web Conference (2019)
   - Program Committee, Interaction Beyond the Individual subcommittee, ACM CHI (2019)
   - Co-developed a workshop on Human-Centered Data Science (HCDS), submitted to the ACM Conference on Human Factor in Computing (CHI) 2019. The workshop focuses on scoping out the intellectual boundaries of HCDS and defining methodological best practices for this nascent subfield.

D. Major Awards, Recognitions, etc from the past five years
   - NSF Data Science Workshop (August 2015)
   - CRA-W Grad Cohort (2014)
   - NSF GK-12 Fellowship (2012 – 2014)

E. Outreach Efforts and Public Service
   - Judge at the 14th Annual Computer Science Student Conference (April 2018)

Marina Kogan, PhD

Computer Science
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Albuquerque, NM 87131-0001

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Fax: 505-277-6927
Email: mkogan@unm.edu

Professional Preparation

City University of New York (New York, NY), B.S. in Computer Science, 2005

City University of New York (New York, NY), B.A. in Sociology & Anthropology, 2005

University of Illinois (Urbana-Champaign, IL), M.A. in Sociology, 2010

University of Colorado (Boulder, CO), M.S. in Computer Science, 2014

University of Colorado (Boulder, CO), Ph.D. in Computer Science, 2017

Thesis: Emergent Forms of Online Sociality in Disasters Arising from Natural Hazards
Advisor: Leysia Palen

Research interests: Human-computer interaction, computer-supported cooperative work, crisis informatics, complex systems, network science, human-centered data science

Appointments

Assistant Professor, Department of Computer Science, University of New Mexico, 2018- Present

Selected publications

1. Stowe, K., M. Palmer, L. Palen, K. M. Anderson, J. Anderson, **M. Kogan**, R. Morss, J. Demuth & H. Lazrus. Developing and Evaluating Annotation Procedures for Twitter Data during Hazard Events. To appear at Joint Workshop on Linguistic Annotation, Multiword Expressions and Constructions at the International Conference on Computational Linguistics (COLING 2018).
2. **Kogan, M** & Palen, L. Conversations in the Eye of the Storm: At-Scale Features of Conversational Structure in a High-Tempo, High-Stakes Microblogging Environment. *Proc of CHI*, 2018.
3. Anderson, J., **Kogan, M.**, Bica, M., Palen, L., Anderson, K., Morss, R., Demuth, J., Lazrus, H., Wilhelmi, O., & Henderson, J. Far Far Away in Far Rockaway: Responses to Risks and Impacts during Hurricane Sandy through First-Person Social Media Narratives. *Proc of* International Conference on Information Systems for Crisis Response And Management, 2016**.**
4. **Kogan, M**., Anderson, J., Palen, L., Anderson, K., & Soden, R. Finding the Way to OSM Mapping Practices: Bounding Large Crisis Datasets for Qualitative Investigation. *Proc of* ACM Conference on Human Factors in Computing Systems (CHI), 2016.
5. **Kogan, M**., Palen, L. & Anderson, K.. Tweet Local, Retweet Global: Retweeting by the Geographically-Vulnerable during Hurricane Sandy. *Proc of* ACM Conference on Computer-Supported Cooperative Work and Social Computing, 2015.

Other significant publications

1. Demuth, J.L, R.E. Morss, L. Palen, K.M. Anderson, J. Anderson, **M. Kogan**, K. Stowe, M. Bica, H. Lazrus, O. Wilhelmi, J. Henderson (2018): "Sometimes da #beachlife ain't always da wave": Understanding People's Evolving Hurricane Risk Communication, Risk Assessments, and Responses Using Twitter Narratives. Weather, Climate, and Society, 10(3), 537-560.
2. Morss, R., Demuth, J., Lazrus, H., Palen, L, Barton, M., Davis, C., Snyder, C., Wilhelmi, O., Anderson, K., Ahijevych, D., Anderson, J., Bica, M., Fossell, K., Henderson, J., **Kogan, M**., Stowe, K., Watts, J (2017). Hazardous Weather Prediction and Communication in the Modern Information Environment. Bulletin of the American Meteorological Society, 98 (12), 2653-2674.
3. **Kogan, M**. Digital Traces of Online Self-Organizing and Problem Solving in Disaster. In GROUP'2016 Doctoral Consortium papers. ACM
4. Anderson, J., Soden, R., Anderson, K., **Kogan, M**., & Palen, L. EPIC-OSM: A Software Framework for OpenStreetMap Data Analytics. Proc of HICSS, 2016.
5. Clauset, A., **Kogan, M**., Redner, S. Safe leads and lead changes in competitive team sports. Phys. Rev. E 91:6, 2015.

Synergistic activities

1. Developed and taught a new curriculum for Social and Ethical Issues in Computing (CS293) that emphasizes social and cultural implications of current and future technological developments, such as algorithmic bias, online filter bubbles, and privacy issues associated with the user-data-as-product funding model for many social media platforms.
2. Developed and taught a new curriculum for Social Computing (CS491/591), which focuses on sociotechnical systems, such as social media platforms, specifically addressing the types of insights that can be gleaned from the social media data and the corresponding methods of analysis.
3. Co-developed a workshop on Human-Centered Data Science (HCDS), submitted to the ACM Conference on Human Factor in Computing (CHI) 2019. The workshop focuses on scoping out the intellectual boundaries of HCDS and defining methodological best practices for this nascent subfield.
4. Service to professional organizations: Organizing Committee, ACM International Conference on Supporting Group Work (2017); Program Committee, International Conference on Weblogs and Social Media (2018), Program Committee, European Conference on Computer Supported Cooperative Work (2018), Program Committee, Web and Society track, The Web Conference (2019); Program Committee, Interaction Beyond the Individual subcommittee, ACM CHI (2019).
5. Member of the Strategic Planning for Retaining Women in Computing committee, a joint effort between the University of New Mexico Computer Science Department and the National Center for Women & Information Technology (2018-present).

Matthew Lakin

Assistant Professor

A. Areas of Expertise
    - Molecular computing, DNA nanotechnology, synthetic biology, domain-specific languages, semantics, formal methods

B. Interdisciplinary Interests
    - Design and analysis of biomolecular circuits and biological systems
    - Experimental implementation of biomolecular circuits
    - Biomedical diagnostics and pathogen detection

C. Current Departmental and University Committees
    - CS Dept faculty hiring committee
    - CS Dept graduate committee

D. Extracurricular Activities Related to Academic Objectives
    - Program Committee member for 24th International Conference on DNA Computing and Molecular Programming.
    - Program Committee member for 10th International Workshop on Biodesign Automation.
    - Panel and ad hoc reviewer for National Science Foundation
    - Peer reviewer for Journal of the Royal Society Interface, ACS Synthetic Biology, Nucleic Acids Research.
    - Organizing committee member, International Conference on Engineering Synthetic Cells and Organelles, Santa Fe, NM, May 2020.

E. Major Awards, Recognitions, etc from the past five years
    - N/A

F. Outreach Efforts and Public Service
    - Poster session judge at student-run UNM STEM Research Symposium

Matthew R. Lakin

Assistant Professor
Department of Computer Science
Center for Biomedical Engineering
University of New Mexico
Albuquerque, NM 87131
(505) 277-3351; mlakin@cs.unm.edu

Professional Preparation

University of Cambridge	Cambridge, UK	Computer Science	B.A. (Hons), 2005
University of Cambridge	Cambridge, UK	Computer Science	Ph.D., 2010
Microsoft Research	Cambridge, UK	Computational Science	Postdoc, 2009–2011
University of New Mexico	Albuquerque, NM	Computer Science	Postdoc, 2011–2015

Appointments & Affiliations

2017–	Assistant Professor, Department of Computer Science, University of New Mexico
2014–	Member, Center for Biomedical Engineering, University of New Mexico
2015–2017	Research Assistant Professor, Department of Chemical & Biological Engineering, University of New Mexico
2015–2017	Research Assistant Professor, Department of Computer Science, University of New Mexico
2013–2015	Postdoctoral Fellow, New Mexico Cancer Nanoscience and Microsystems Training Center
2011–2015	Postdoctoral Scholar, Department of Computer Science, University of New Mexico
2009–2011	Postdoctoral Researcher, Microsoft Research, Cambridge

Products

Five Publications Related to Proposed Work

1. Aurora Fabry-Wood, Madalyn Elise Fetrow, Carl W. Brown, III, Nicholas A Baker, Nadiezda Fernandez Oropeza, Andrew P. Shreve, Gabriel A. Montaño, Darko Stefanovic, Matthew R. Lakin and Steven W. Graves, 2017. "A microsphere-supported lipid bilayer platform for DNA reactions on a fluid surface." *ACS Applied Materials and Interfaces*, vol. 9, no. 35, pages 30185–30195.
`doi:10.1021/acsami.7b11046`

2. Carl W. Brown, III, Matthew R. Lakin, Eli K. Horwitz, Hannah E. West, Darko Stefanovic, and Steven W. Graves, 2014. "Signal propagation in multi-layer DNAzyme cascades using structured chimeric substrates." *Angewandte Chemie International Edition*, vol. 53, no. 28, pages 7183–7187.
`doi:10.1002/anie.201402691`

3. Matthew R. Lakin, Carl W. Brown, III, Eli K. Horwitz, M. Leigh Fanning, Hannah E. West, Darko Stefanovic, and Steven W. Graves, 2014. "Biophysically inspired rational design of structured chimeric substrates for DNAzyme cascade engineering." *PLoS ONE*, vol. 9, no. 10, e110986.
`doi:10.1371/journal.pone.0110986`

4. Carl W. Brown, III, Matthew R. Lakin, Aurora Fabry-Wood, Eli K. Horwitz, Nicholas A. Baker, Darko Stefanovic, and Steven W. Graves, 2015. "A unified sensor architecture for isothermal detection of double-stranded DNA, small molecules, and oligonucleotides." *ChemBioChem*, vol. 16, no. 5, pages 725–730.
`doi:10.1002/cbic.201402615`

5. Matthew R. Lakin and Darko Stefanovic, 2016. "Supervised learning in adaptive DNA strand displacement networks." *ACS Synthetic Biology*, vol. 5, no. 8, pages 885–897.
`doi:10.1021/acssynbio.6b00009`

Five Other Publications

1. Matthew R. Lakin, Milan N. Stojanovic, and Darko Stefanovic, 2017. "Implementing Molecular Logic Gates, Circuits, and Cascades Using DNAzymes." In A. Adamatzky (ed.), *Advances in Unconventional Computing Volume 2: Prototypes, Models and Algorithms*, Emergence, Complexity and Computation, volume 23, chapter 1, pages 1–28. Springer International Publishing.
doi:10.1007/978-3-319-33921-4_1

2. Carl W. Brown, III, Matthew R. Lakin, Darko Stefanovic, and Steven W. Graves, 2014. "Catalytic molecular logic devices by DNAzyme displacement." *ChemBioChem*, vol. 15, no. 7, pages 950–954.
doi:10.1002/cbic.201400047

3. Matthew R. Lakin, Simon Youssef, Filippo Polo, Stephen Emmott, and Andrew Phillips, 2011. "Visual DSD: a tool for design and analysis of DNA strand displacement circuits." *Bioinformatics*, vol. 27, no. 22, pages 3211–3213.
doi:10.1093/bioinformatics/btr543

4. Matthew R. Lakin, David Parker, Luca Cardelli, Marta Kwiatkowska, and Andrew Phillips, 2012. "Design and analysis of DNA strand displacement devices using probabilistic model checking." *Journal of the Royal Society Interface*, vol. 9, no. 72, pages 1470–1485.
doi:10.1098/rsif.2011.0800

5. Rasmus L. Petersen, Matthew R. Lakin, and Andrew Phillips, 2016. "A strand graph semantics for DNA-based computation." *Theoretical Computer Science*, vol. 632, pages 43–73.
doi:10.1016/j.tcs.2015.07.041

Synergistic Activities

1. Invited peer reviewer for the Proceedings of the National Academy of Sciences of the USA, Nature Communications, ACS Synthetic Biology, Nucleic Acids Research, ACS Nano, Journal of the Royal Society Interface, Theoretical Computer Science, Natural Computing, BioSystems, and various conferences, including the International Conference on DNA Computing and Molecular Programming and the IEEE International Symposium on Logic in Computer Science.

2. Program committee member, 9th International Workshop on Bio-Design Automation (IWBDA 2017).

3. Program committee member, 24th International Conference on DNA Computing and Molecular Programming (DNA24).

4. Session chair, Workshop on Computing with Biomolecules: From Network Motifs to Complex and Adaptive Systems, a satellite workshop of ALife 2014 conference (2014).

5. Program committee member, 1st and 2nd International Workshops on Verification of Engineered Molecular Devices and Programs (2014, 2015).

Shuang (Sean) Luan

Professor

A. Areas of Expertise

- Computational Geometry, Computer Algorithms

B. Interdisciplinary Interests

- Medical Physics
- Medical Informatics
- Biomedical Engineering

C. Current Departmental and University Committees

- None. (Currently on sabbatical leave.)

D. Extracurricular Activities Related to Acadmic Objectives

- Committee of the 12th Annual International Computing and CombinatoricsConference (COCOON'06), the 3rd and 5th Annual International Frontiers of Algorithmic Workshop (FAW), and one of the two organizers of the 1st New Mexico Workshop on Monte Carlo for Particle Therapy Treatment Planning. Frequent panelist for National Science Foundation Review Panels.
- Reviewer for the following journals and conferences: ACM Journal of Experimental Algorithms, International Journal of Computational Geometry and Applications, Journal of Combinatorial Optimization, Medical Physics, Physics in Medicine and Biology, Radiation Oncology, Radiotherapy and Oncology, Technology in Cancer Research and Treatment, International Computing and Combinatorics Conference (COCOON), Symposium on Discrete Algorithms (SODA).

E. Major Awards, Recognitions, etc. from the past five years

- UNM STC Creative Award 2018, 2017, 2015, 2014
- UNM Faculty of Color Research Award 2013

F. Outreach Efforts and Public Service

- Fund Raising Chair for the 2018 Asian American Engineer of the Year Award (AAEOY)

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Shuang Luan	Tenured Full Professor of Computer Science with a Joint Position in Radiology
eRA COMMONS USER NAME (credential, e.g., agency login) luan1582	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	MM/YY	FIELD OF STUDY
Harbin Institute of Technology, China	BS	07/98	Computer Science and Engineering
University of Notre Dame, Indiana, US	MS	05/02	Computer Science and Engineering
University of Notre Dame, Indiana, US	PhD	05/04	Computer Science

A. Personal Statement

I have the expertise, leadership and motivation to successfully carry out the proposed research.

I have been the PI or co-Investigator on several previous NSF- and NIH-funded grants. One of my biggest contributions to the project will come from my expertise and background in the interface between computer science and radiation therapy. Throughout the years, I have been successfully using advanced computing techniques (such as computational geometry, graph algorithms, numeral optimization, high performance computing, image processing, medical embedded systems, etc.) to tackle many critical problems in radiation therapy and radiosurgery. Ten US patents in the area of radiation therapy have been issued or filed based on my research. Three of my patents related intensity-modulated radiation therapy (IMRT) have been commercially licensed by Varian, two by Elekta and one by Accuray. I also co-authored the paper “Arc-modulated Radiation Therapy (AMRT): a single-arc form of Intensity-Modulated Arc Therapy”, which is a runner up of prestigious *Physics in Medicine and Biology Paper of the Year Award* in 2008.

B. Positions and Honors

Positions and Employment

July 2004 - present — University of New Mexico, Albuquerque, NM 87131
Current Position: Tenured Full Professor of Computer Sicence with a joint position in Radiology

Other Experience and Professional Memberships

2003 --- present Member, American Association of Physicists in Medicine (AAPM).

2002 August --- October, 2003 January --- May, 2004 June --- July: Consultant, University of Maryland Radiation Oncology Department.

2005, 2006, 2007 June --- July: Visiting Assistant Professor, University of Maryland Radiation Oncology.

2008 July, 2009 August: Visiting Assistant Professor, University of California San Francisco Radiation Oncology Department.

2009 June --- July: Guest Scientist, DKFZ (German Cancer Research Center) Medical Physics Department, Heidelberg, Germany.

2011 Sept --- Oct: Guest Scientist, Heidelberg Ion Therapy Center (HIT), Heidelberg, Germany.

Honors

2002-2003: Center for Applied Mathematics (CAM) Fellow, University of Notre Dame.

2009: Qforma Endowed Lecturer, University of New Mexico Department of Computer Science.

Laureate in the 2011 Computer World Honors Program for Arc-modulated Radiation Therapy.

2012, 2014, 2016, 2017, 2018 University of New Mexico Science and Technology Center Innovation Award

C. Contribution to Science

C.1 Radiation Therapy Treatment Planning: I have pioneered the use of graph algorithms in combination with other more traditional optimization techniques such as numerical optimization for solving radiation therapy and radiosurgery

planning problems. I have successfully tackled an array of medical problems using this hybrid technique where graph algorithms and geometric techniques are used to quickly find a high quality initial solution, which is then fine-tuned by numerical techniques. Some of the successful examples are: the static leaf sequencing in step-and-shoot intensity-modulated radiation therapy, dynamic Gamma Knife radiosurgery and dynamic photon painting radiosurgery, single arc intensity-modulated radiation therapy, high dose rate prostate brachytherapy and so on. Our solutions have significantly improved the current state of the art. A large part of our success can be attributed to the application of a variety of algorithmic techniques, such as: (constrained) shortest path, arrangement traversals, maximum flow, bipartite matching, minimum cost flows, randomization, approximation algorithms, etc. The research has also resulted in 10 patents and 6 commercial licensing agreements. I have a significant publication record in this area, and below I will list some of my most important publications. I served as the primary investigator or co-investigator in all these studies.

1. Riofrio D, Zhou J, Ma L, **Luan S**. Particle Swarm Optimization for Radiation Therapy Planning. *ACM Conference on Bioinformatics, Computational Biology, Biomedical Informatics (ACM BCB 2015)*.
2. Riofrio D, **Luan S**, Zhou J, Ma L. Inverse Planning of Gamma Knife Radiosurgery Using Natural Physical Models. *The 56th Annual Meeting of American Association of Physicists in Medicine (AAPM)*, 2014. Oral Presentation.
3. Chen Z, **Luan S**, Riofrio D, Ma L. A study on the focusing power of dynamic photon painting. *The 52nd Annual Meeting of American Association of Physicists in Medicine (AAPM)*, 2010. (John R. Cameron Young Investigator Competition Finalist, 12 out of 198 submissions.)
4. Keyes R, Romano C, Arnold D, and **Luan S**. Cloud computing as a Monte Carlo cluster for radiation therapy. In The XVth International Conference on the Use of Computers in Radiation Therapy (ICCR), 2010.
5. **Luan S**, Swanson N, and Ma L. Dynamic Gamma Knife Radiosurgery, *Physics in Medicine and Biology*, 54 (2009), 1579-1591.
6. Wang C, **Luan S**, Tang G, Chen D, Earl M, Yu C. Arc-modulated Radiation Therapy (AMRT): a single-arc form of Intensity-Modulated Arc Therapy. *Physics in Medicine and Biology*. Vol 53, No. 22, Nov. 2008, pages 6291-6304. Runner up of the Roberts Prize, *Physics in Medicine and Biology Paper of the Year Award*.
7. **Luan S**, Wang C, Cao D, Chen D, Shepard D, and Yu C. Leaf-sequencing for intensity-modulated arc therapy using graph algorithms, *Medical Physics*, Vol 35, No. 1, 2008, 61-69.
8. **Luan S**, C. Wang, Chen D, Hu X, Naqvi S, Wu X, and Yu C. An improved MLC segmentation algorithm and software for step-and-shoot IMRT delivery without tongue-and-groove error. *Medical Physics*, Vol 33, No. 5, 2006 pages 1199-1212.
9. **Luan S**, Wang C, Chen D, Hu X, Naqvi S, Lee C, and Yu C. A new MLC segmentation algorithm/software for step-and-shoot IMRT delivery. *Medical Physics*, Vol. 31, No. 4, April 2004, page 695-707.

C.2 Diabetic Foot Diagnosis: Diabetes is an incurable metabolic disease and afflicts an estimated over 400 million people worldwide. People with diabetes are at the risk of a wide range of devastating complications including diabetic peripheral neuropathy (DPN), which is commonly referred to as the “diabetic foot” and most often affects the lower extremities (i.e., leg and foot) and can lead to amputations. Studies revealed that traditional tests for detecting diabetic foot may miss the diagnosis in as many as 61% of patients. We have developed a new diagnostic system based on thermal imaging a novel thermal regulation model. Our new computer-aided diagnosis system can successfully diagnose over 93% of DPN subjects with a false positive rate of only 6%. Below are some of the important publications in this area. I served as the principal investigator of these studies.

1. Chekh V, Soliz P, Burge M, and **Luan S**. A Physiological Thermal Regulation Model with Application to the Diagnosis of Diabetic Peripheral Neuropathy. In *Proceedings of ACM BCB, Boston, Massachusetts, USA, August 2017.* DOI: 10.1145/3107411.3107512
2. Iven G, Chekh V, **Luan S**, Mueen A, Soliz P, Xu W and Burge M. Non-contact Sensation Screening of Diabetic Foot using Low Cost Infrared Sensors. *IEEE Computer Based Medical Systems (CBMS’2014)*.
3. Chekh V, Soliz P, **Luan S**, McGrew E, Barriga S, Burge M, and Luan S. Computer Aided Diagnosis of Diabetic Peripheral Neuropathy. *SPIE Medical Imaging 2014.*
4. Chekh V, **Luan S**, Burge M, Carranza C, Soliz P, Barriga S, and McGrew E. Quantitative Early Detection of Diabetic Foot. *ACM Conference on Bioinformatics, Computational Biology, Biomedical Informatics (ACM BCB 2013).*

C.3 LET Measurement: The last decades have seen dramatic advances in heavy charged particle beams for cancer therapy. Research has shown that heavy ions are more effective in cell killing because they create denser ionization events along the particle track, which causes more irreparable damage to the DNA. The physics quantity that is a good surrogate for such biological damage is the LET, the mean locally imparted energy to the medium by a particle. Unfortunately, incorporating LET in clinical use is still extremely challenging. This is mainly due to the lack of an instrument for experimental measurement and verification of LET distributions. We have developed a novel method for measuring LET using a dual ion chamber methodology. Our experiments performed at the Heidelberg Ion Therapy Center have shown that our new method can extract LET values under proton, carbon ion, and oxygen ion beams with an average error of about 3%. The following is our earlier publication on the methodology, and our most recent result will be submitted to Physics in Medicine and Biology. I served as the principal investigator of this research effort.

1. Tegami S, Bello SD, **Luan S**, Mairani A, Parodi K, Holzscheiter M. LET Monitoring using Liquid Ionization Chambers. *International Journal of Medical Physics, Clinical Engineering and Radiation Oncology. 2017 6(2)*
2. Bello S, **Luan S**, Holzscheiter M. A method for measuring LET of hadron beams. The 60th Annual Meeting of American Association of Physicists in Medicine (AAPM), 2018. Oral Presentation

C.4 Simulating Diffusion Limited Reactions for Calculating DNA Damages: I have also developed fast and efficient geometric algorithm for simulating diffusion limited reactions for calculating DNA damages. In these research, we have applied advanced algorithmic techniques such as kinetic data structures, hashing, Kd-trees, directed acyclic graph for point locations, etc and significantly improved the current state-of-the-art.

1. Karamitrosa M, **Luan S**, Bernald M, Allisone J, Baldacchinof G, Davidkovah M, Francisi Z, W. Friedlandj, V. Ivantchenkok,e, A. Ivantchenkoe, A. Manterol, P. Nieminemm, G. Santinm, H. N. Trann, V. Stepana,h, S. Incerti. "Diffusion-controlled reactions modelling in Geant4-DNA", Journal of Computational Physics, 274, 841–882 (2014)
2. Bloom S, **Luan S**, Karamitros M, and Incerti S. Geometric Algorithms for Simulating Diffusion-Limited Reactions. *Symposium of the Theory of Modeling and Simulations (TMS'14)*

D. Additional Information

Completed Research Support

- NIH NCI 1R21CA197325-01, "An LET Dosimeter". Sept 1, 2015 – Aug 31, 2018. Role: PI.
- NSF CBET-0853157: "Computer-Aided Treatment Planning for Antiproton Therapy", $375,000, Aug 1, 2009 - July 31, 2012. Role PI.
- NSF CBET-0755054, "Computer-Aided Dynamic Gamma Knife Radiosurgery Treatment Planning", Feb 15, 2008 - Jan 31, 2011. Single PI.
- NCI R01CA117997, "4 Dimensional IMAT Planning using Graph Algorithms". June 1, 2007 - April 30, 2011. Role: Co-Investigator.

Patents

- US Patent 7.283,611 B1: Segmentation Algorithmic Approach to Step and-Shoot Intensity Modulated Radiation Therapy.
- US Patent: 7,466,797: Error control in Algorithmic Approach to Step-and-Shoot Intensity Modulated Radiation Therapy.
- US Patent 8,014,494: Single Arc Dose Painting for Precision Radiation Therapy.
- US Patents 8654,923 and 9,630,023 B2: System and Methods for using a Dynamic Scheme for Radiosurgery.
- US Patent 8,835,877, 9387348, and 9,561,389: System and Methods for Photon based Radiotherapy and Radiosurgery Delivery.
- PCT 20130054670: System and Methods for Performing Medical Physics Calculation.
- PCT 20160070709: Online Review Using Multiple Sources.
- U.S. Patent Application No.: 15/304,306: Optimization methods for radiation therapy planning. (Allowed on Aug 22, 2017)

Jedidiah McClurg

Assistant Professor

A. Areas of Expertise

- Programming languages, program synthesis and verification, software-defined networking (SDN)

B. Interdisciplinary Interests

- Currently teaching cross-listed course ECE 440 (Computer Networking)
- Using formal methods to solve problems in various domains

C. Current Departmental and University Committees

- N/A

D. Extracurricular Activities Related to Acadmic Objectives

- Artifact Evaluation Committee (AEC) member: POPL 2018, POPL 2016
- Conference reviewer: POPL 2019, ATVA 2018, ESOP 2017, TACAS 2016, CAV 2014, ASE 2014
- Journal reviewer: IEEE Transactions on Networking (ToN) 2017

E. Major Awards, Recognitions, etc. from the past five years

- CU Boulder Outstanding Research Award, 2017
- ARCS Scholarship, 2017
- CU Boulder Outstanding TA Award, 2013

F. Outreach Efforts and Public Service

- N/A

Dr. Jedidiah McClurg

Dept. of Computer Science, Univ. of New Mexico, e-mail: jrmcclurg@unm.edu, tel: +1-(312)-833-0724

(a) Professional Preparation

University of Iowa, Iowa City, IA; Electrical & Computer Engineering; B.S.E., 2009
Northwestern University, Evanston, IL; Computer Science; M.S., 2013
University of Colorado Boulder, Boulder, CO; Computer Science; Ph.D., 2018

(b) Appointments

2018–present: **Assistant Professor**, University of New Mexico, Computer Science, Albuquerque, NM
2014: **Research Intern**, Microsoft Research, RiSE Group, Redmond, WA
2013: **Graduate Intern**, Rockwell Collins, Advanced Technology Center, Cedar Rapids, IA
2011: **Graduate Intern**, Rockwell Collins, Advanced Technology Center, Cedar Rapids, IA
2009–2010: **Graduate Co-op**, Rockwell Collins, SATCOM, Cedar Rapids, IA
2008: **Graduate Co-op**, Rockwell Collins, Panels, Cedar Rapids, IA
2004: **Technical Intern**, Rockwell Collins, Advanced Technology Center, Cedar Rapids, IA
2002: **Technical Intern**, aJile Systems, Cedar Rapids, IA

(c) Publications

(c).(i) Publications Most Closely Related to Proposed Project

[1] Jedidiah McClurg, Hossein Hojjat, and Pavol Cerny. "Synchronization Synthesis for Network Programs". In *CAV* (2017).

[2] Pavol Cerny, Nate Foster, Nilesh Jagnik, and Jedidiah McClurg. "Optimal Consistent Network Updates in Polynomial Time". In *DISC* (2016).

[3] Hossein Hojjat, Philipp Ruemmer, Jedidiah McClurg, Pavol Cerny, and Nate Foster. "Optimizing Horn Solvers for Network Repair". In *FMCAD* (2016).

[4] Jedidiah McClurg, Hossein Hojjat, Nate Foster, and Pavol Cerny. "Event-driven Network Programming". In *PLDI* (2016).

[5] Jedidiah McClurg, Hossein Hojjat, Pavol Cerny, and Nate Foster. "Efficient Synthesis of Network Updates". In *PLDI* (2015).

(c).(ii) Other Significant Publications

[6] Hossein Hojjat, Jedidiah McClurg, Pavol Cerny, and Nate Foster. "Network Updates for the Impatient: Eliminating Unnecessary Waits". In *PLVNET* (2015).

[7] J. Protzenko, S. Burckhardt, M. Moskal, and Jedidiah McClurg. "Implementing Real-time Collaboration in TouchDevelop using AST Merges". In *MobileDeLi* (2015).

[8] Vaibhav Rastogi, Zhengyang Qu, Jedidiah McClurg, Yinzhi Cao, and Yan Chen. "Uranine: Real-time Privacy Leakage Monitoring without System Modification for Android". In *SecureComm* (2015).

[9] David S Hardin, Jennifer A Davis, David A Greve, and Jedidiah R McClurg. "Development of a Translator from LLVM to ACL2". In *ACL2* (2014).

[10] Jennifer Davis, David Hardin, and Jedidiah McClurg. "Creating Formally Verified Components for Layered Assurance with an LLVM-to-ACL2 Translator". In *LAW* (2013).

(d) Synergistic Activities

1. **Conference Service:** (i) Served as an Artifact Evaluation Committee (AEC) member for POPL 2018 and POPL 2016. (ii) Served as a reviewer for POPL 2019, ATVA 2018, IEEE Transactions on Networking (ToN) 2017, ESOP 2017, TACAS 2016, CAV 2014, and ASE 2014.
2. **Community Service:** (i) Served as a science fair judge at Lincoln Park High School in Chicago, 2011.
3. **Mentoring and Advising:** (i) Informally supervised an undergraduate Engineering student on a research project in Fall 2016, which resulted in an early version of some networking-related code which will be used in this project. (ii) Informally supervised masters student Nilesh Jagnik (current position: Software Engineer at Google) on a research project which examined optimal network updates—this resulted in a DISC 2016 paper. (iii) Tutored several undergraduates at University of Iowa (Introduction to Real Analysis, etc.). Worked as a tutor for SAT/ACT preparation.
4. **Teaching:** (i) Instructor for the Computer Networking course (about 50 undergraduate/graduate students) at University of New Mexico this Fall. (ii) Received an Outstanding Teaching Assistant Award from the CU Boulder Computer Science Dept., Fall 2013. (iii) Since 2007, has served as an undergraduate/graduate teaching assistant 8 times, in course areas such as Introduction to Computer Programming, Digital Logic Design, and Programming Languages.

Melanie E. Moses

Professor

1. Areas of Expertise

   - Complex adaptive systems
   - Biologically-inspired computation
   - Swarm robotics
   - Computational immunology

2. Interdisciplinary Interests

   - Secondary appointment in UNM Biology
   - External Faculty of the Santa Fe Institute
   - Member, IEEE Task Force on Artificial Life and Complex Adaptive Systems 2017-present
   - Member, Scientific Review Committee, University of Maryland National Socio-Environmental Synthesis Center (SESYNC) 2014-2018
   - Participant in UNM Spatio-Temporal Modelling Center (STMC) and the Center for Evolutionary and Theoretical Immunology (CETI) leading seminars and an active research program with over 20 publications with Biology and Biomedical faculty, and serving on Ph.D. committees.

3. Current Departmental and University Committees

   - 2017-present, Co-PI, ADVANCE at UNM, NSF program to create sustainable changes in the UNM climate, contributing to increased success of women and minority faculty
   - 2017-present, Member, School of Engineering Committee on Visibility and Reputation
   - 2018 Chair, CS Department Faculty Search Committee

4. Extracurricular Activities Related to Academic Objectives

   - 2017-present, Steering Committee for the CRA Underrepresented Minority Graduate Cohort, annual 2 day workshops for 100 students
   - Co-organizer, Santa Fe Institute Working Group, *Liquid Brains, Solid Brains*, December 2017
   - Organizer, *Swarmathon RSS Workshop and Hackathon* with talks by top swarm robotics researchers, mentoring and an overnight Hackathon for 25-30 undergraduates, Cambridge, MA July, 2017; Ann Arbor, MI July 2016.
   - Co-organizer, Santa Fe Institute Working Group, *Evolution & Restraint of Complex Systems*, December 2016
   - Co-organizer, Santa Fe Institute Working Group, *Motility in the Immune System* July, 2015
   - Co-Organizer, *Robot Guru ICRA Workshop* a full day broadening participation in computing workshop Seattle WA; May, 2015
   - Co-director, UNM Program in Interdisciplinary Biological and Biomedical Science (PiBBs). NIH and HHMI funded interdisciplinary graduate training program for 20 students who produced over 100 publications in interdisciplinary biology. 2013-2015.
   - Program Committee BDA 2017, 2018; DARS 2016, 2018, ALIFE 2017, ANTS 2016
   - Reviewer for AIS 2014, ALIFE 2014, IEEE IROS 2013-2017, IEEE ICRA 2015, First Intl Symposium on Multi-Robot and Multi-Agent Systems, 2017.

- Invited Presentations: UC San Diego Bioinformatics Program (2018), Gordon Research Conference U. of New England (2018), BIRS Workshop: Quantitative Analysis of Immune Cell Migration (2018), Swarms from Biology to Robots and Back Workshop at IEEE ICRA (2018), Conference on Collective Behavior, Intl. Centre for Theoretical Physics (2018), Keynote at the UNM Research Administrators Symposium (2017), Keynote at the Evolution, Development and Complexity Satellite at the Conference of Complex Systems (2017), Complex Systems Summer School, Santa Fe Institute (2017), Symbolic Systems Program 30th Anniversary, Stanford (2017), University of Florida joint Biology and Mechanical Engineering Seminar (2017), Frontiers of Ecological Theory Integration Workshop Santa Fe Institute (2016), Keynote, Biological Distributed Algorithms (BDA) Workshop (2016), Keynote, ACM Richard Tapia Celebration of Diversity in Computing (2016), HHMI Summer Research Program Harvey Mudd College (2016), Department of Computer and Software Engineering, Polytechnique Montreal (2016), Women in STEM Conference of the US Delegation to the Howard University Republic of South Africa Project (2015), Kennedy Space Center Engineering Academy (2015).

5. Major Awards, Recognitions, etc. from the past five years

   - 2018 Finalist, Airbus Global Engineering Deans Council Diversity Award
   - 2017 Africana Studies Ambassador Award for Computer Science Education for Students of Color
   - 2016 School of Engineering Harrison Award for Service
   - 2013 School of Engineering Teaching Award for new faculty
   - 2012 School of Engineering Research Award for new faculty

6. Outreach Efforts and Public Service

   - 2015 to present, Principle Investigator, NASA Swarmathon a swarm robotics programming challenge designed to revolutionize space exploration, funded by NASA's Minority University Research and Education Program. The Swarmathon has built 100 robots and engaged over 1000 undergraduates from 44 Minority Serving Institutions participating in a year long course and competition for autonomous collective robotics.
   - 2015 to Present, Principle Investigator, NM CSforAll, a program to increase the number and diversity of Computer Science students in New Mexico. NM CSforAll has provided professional development for 60 high school teachers who have taught 1100 high school students in introductory programming, computational thinking and scientific modeling. 400 students have taken NM CSforAll as the first CS course to meet a UNM Natural Science core graduation requirement.

Melanie E. Moses
Department of Computer Science
University of New Mexico, Albuquerque, NM 87131-0001
melaniem@unm.edu, (505) 277-3112
moseslab.cs.unm.edu

(a) Professional Preparation

Stanford University	Palo Alto	Symbolic Systems	B.S. 1993
University of New Mexico	Albuquerque	Biology	Ph.D. 2005
University of New Mexico	Albuquerque	Biology & Computer Science	Postdoc 2006

(b) Appointments

University of New Mexico	Professor, Department of Computer Science	7/2018 to present
University of New Mexico	Associate Professor, Department of Computer Science	7/2013 to 6/2018
UCLA	Visiting Associate Professor	1/2014 to 6/2014
Universitat Pompeu Fabra	Visiting Associate Professor	7/2013 to 12/2013
Santa Fe Institute	External Faculty	7/2012 to present
University of New Mexico	Assistant Professor, Department of Computer Science	1/2007 to 6/2013
University of New Mexico	Joint Appointment - Department of Biology	8/2010 to present

(c) Publications (5 most relevant)

* indicates Student advisees

*Lu, Q., J. P. *Hecker, and M. E. Moses (2018) "Multiple-place swarm foraging with dynamic depots," *Autonomous Robots* 42(4): 909-926.

*Lu, Q, J.P. *Hecker, *T. P. Flanagan, M. E. Moses (2016) Multiple-Place Foraging Algorithm: A Distributed Foraging Model for Evolutionary Swarm Robotics. *Proceedings of the 2016 IEEE/RSJ International Conference on Intelligent Robots and Systems* 3815-3821.

*Fricke, G.M., *Hecker, J.P., Cannon, J.L. and Moses, M.E. (2016). Immune-inspired search strategies for robot swarms. *Robotica* 34(8):1791-1810.

*Fricke, G. M., *K. A. Letendre, M. E. Moses, and J. L. Cannon (2016). "Persistence and adaptation in immunity: T cells balance the extent and thoroughness of search." *PLoS Computational Biology* 10.1371.

*Hecker, J. P., and M. E. Moses. (2015). "Beyond pheromones: evolving error-tolerant, flexible, and scalable ant-inspired robot swarms." *Swarm Intelligence* 9(1): 43-70.

Publications (5 additional)

Mrass, P., S. Oruganti, *G. M. Fricke, *J. Tafoya, J. Byrum, L.Yang, S. Hamilton, M. Miller, M. Moses, and J. Cannon. ROCK regulates the intermittent mode of interstitial T cell migration in inflamed lungs. *Nature Communications 8(1):1010*, 2017.

*Flanagan, T. P, *K. Letendre, *W. Burnside, *M. Fricke & M. E. Moses. (2011). How ants turn information into food. *Proc. of the 2011 IEEE Conf on Artificial Life*: 178-185. **Best Paper Award.**

DeLong, J.P., J.G. Okie, M.E. Moses, R.M. Sibly, and J.H. Brown. (2010). Shifts in metabolic scaling, production, and efficiency across major evolutionary transitions of life. *Proceedings of the National Academy of Sciences* 107(29): 12941-12945.

Banavar, J.R., M.E. Moses, J.H. Brown, J. Damuth, A. Rinaldo, R.M. Sibly and A. Maritan. (2010). A general basis for quarter power scaling in biology." *Proceedings of the National Academy of Sciences* 107(36): 15816-158120.

H. Samaniego* and M. E. Moses, "Cities as organisms: Allometric scaling of urban road networks," *Journal of Transport and Land use*, vol. 1, no. 1, 2008.

(d) Synergistic Activities

[1] **PI, NASA Swarmathon** (2015 – present, http://NasaSwarmathon.com) a swarm robotics programming challenge designed to revolutionize space exploration, funded by NASA's Minority University Research and Education Program. The Swarmathon has built 100 robots and **engaged over 1000 undergraduates from 44 Minority Serving Institutions**. After a year of coursework and development, students travel to Kennedy Space Center to have their robots compete in collaborative 'swarms' that autonomously find and collect resources. Each year the Swarmathon Workshop has been held at the Robotics Science and Systems Conference (U. Michigan and MIT) for 30 undergraduates from MSIs, culminating with an overnight robotics hackathon. 80% of students subsequently express a desire to go to graduate school, primarily in robotics. We have supported 19 summer research REU students at UNM and partner Swarmathon schools coordinated through the CRA-W DREU program. Undergraduates have mentored hundreds of high school students in a parallel simulated Swarmathon competition. The algorithms developed in this competition support NASA's Journey to Mars in which robots will collect resources to support human settlements. For press coverage see http://swarms.cs.unm.edu/press.html.

[2] **PI, NM-CSforAll** (2015 – present, http://cs4all.cs.unm.edu/) originated as an NSF program to increase the number and diversity of Computer Science students in New Mexico. **NM-CSforAll has provided professional development for 60 high school teachers who have taught 1100 high school students** in introductory programming, computational thinking and scientific modeling. High school students earn UNM dual credit, and the course is now the first Computer Science course to meet a UNM graduation requirement as a Natural Science core course.

[3] **Education and Research Leadership:**

Co-PI, ADVANCE at UNM (2017-present) NSF program to create sustainable changes in the UNM climate to increase success of women and minority faculty.

Chair, Research Excellence Working Group of the OVPR Research Strategic Planning Committee (2016). The Research Excellence report is available at http://research.unm.edu/strategic-plan.

Member, Provost's Committee on Redesigning the University, task force on academic structure and organization for interdisciplinary research and education (2018 – present)

Co-director UNM Program in Interdisciplinary Biological & Biomedical Science (**PIBBS,** 2013- 2015) and Advisory Board member (2011-2015)(http://biology.unm.edu/PIBBS/Index.html). PIBBS funded fellowships for 35 Ph.D. trainees from 7 different departments (Anthropology, Biology, Chemistry, Computer Science, Electrical and Computer Engineering, Mathematics & Statistics, and Physics & Astronomy). These 35 fellows produced >130 publications in journals with an average impact factor of 6.6 (6 times the average in science). Students are mentored by collaborative teams of faculty and earn a graduate certificate in Interdisciplinary Biology. PIBBS fellows developed and collaboratively co-taught undergraduate courses in interdisciplinary topics with a PIBBS student from another discipline, mentored by PIBBS faculty.

Co-PI & Computer Science Faculty Advisor for the UNM STEP Program (2011 – 2016) which funded summer internships for 70 undergraduates each year and quarterly mentoring family meetings to increase student retention.

Co-Chair of the Gordon Research Conference on the Metabolic Basis of Ecology (2010-2012, 2008-2010 Co-Vice Chair), a week-long conference with 100 attendees, 20 speakers and 40 graduate students.

Co-organizer of SFI working groups (2015-2017) Motility in the Immune System; Evolution & Restraint of Complex Systems; and Liquid Brains, Solid Brains.

Member, Scientific Review Committee, University of Maryland National Socio-Environmental Synthesis Center (SESYNC, 2015 – present).

Member, IEEE Task Force on Artificial Life and Complex Adaptive Systems (2017-present).

Program committee member: Biological Distributed Algorithms (BDA) Workshop 2017, 2018; Intl. Symposium on Distributed Autonomous Robotic Systems (DARS) 2016, 2018; IEEE Symposium on Artificial Life (ALIFE) 2014, 2017; International Conference on Swarm Intelligence (ANTS 2016); Artificial Immune Systems Workshop (AIS 2014).

Member, Steering Committee for the Computing Research Association Underrepresented Minority Graduate Cohort, which runs workshops to increase underrepresented groups in computing research: 2017-present.

Abdullah A. Mueen

Assistant Professor of Computer Science

A. Areas of Expertise

- Data Mining
- Social Networks
- Databases

B. Interdisciplinary Interests

- Seismic Signal Discovery
- Material Discovery

C. Current Departmental and University Committees

- Graduate Committee

D. Extracurricular Activities Related to Academic Objectives

- Academic Adviser of UNM Cricket Club (a student organization)
- Language Proficiency Tester

E. Major Awards, Recognitions, etc. from the past five years

- None

F. Outreach Efforts and Public Service

- Voluntary Support in Elementary Classrooms

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Work email: mueen@cs.unm.edu

Professional Preparation

Bangladesh Univ of Eng Technology, Dhaka, Bangladesh	Computer Science & Eng.	B.Sc.,	2006
University of California - Riverside, Riverside, California	Computer Science	Ph.D.,	2012

Appointments

09/2013 – Present:	Assistant Professor of Computer Science, University of New Mexico
2013:	Scientist, Cloud and Information Services Lab, Microsoft Corporations
2012:	Program Manager, Online Services Division (Bing), Microsoft Corporations

Products

Five Products Most Closely Related to the Proposed Project:

1. Searching and Mining Trillions of Time Series Subsequences under Dynamic Time Warping. Thanawin Rakthanmanon, BIlson Campana, **Abdullah Mueen**, Gustavo Batista, M. Brandon Westover, Qiang Zhu, Jesin Zakaria, Eamonn Keogh, *In the Proceedings* of ACM SIGKDD 2012. pp. 262-270. **Best Paper Award.**
2. AWarp: Fast Warping Distance for Sparse Time Series. **Abdullah Mueen**, Nikan Chavoshi, Noor Abu-El-Rub, Hossein Hamooni, Amanda J. Minnich, *In the Proceedings of IEEE* ICDM 2016: 350-359.
3. Experimental comparison of representation methods and distance measures for time series data. Xiaoyue Wang, **Abdullah Mueen**, Hui Ding, Goce Trajcevski, Peter Scheuermann, Eamonn J. Keogh, Data Mining Knowledge Discovery 26(2): 275-309 (2013), DMKD 2013**.**
4. Accelerating Dynamic Time Warping Subsequence Search with GPUs and FPGAs. Doruk Sart, **Abdullah Mueen**, Walid Najjar, Vit Niennattrakul, Eamonn Keogh, In the Proceedings of IEEE ICDM 2010. pp. 1001-1006.
5. Enumeration of Time Series Motifs of All Lengths. **Abdullah Mueen,** In the Proceedings of IEEE International Conference on Data Mining, ICDM 2013. Pp. 547-556.

Five Other Significant Products:

1. Matrix Profile I: All Pairs Similarity Joins for Time Series: A Unifying View that Includes Motifs, Discords and Shapelets. Chin-Chia Michael Yeh, Yan Zhu, Liudmila Ulanova, Nurjahan Begum, Yifei Ding, Hoang Anh Dau, Diego Furtado Silva, **Abdullah Mueen**, Eamonn Keogh, In the Proceedings of IEEE ICDM 2016: 1317-1322
2. Fast Approximate Correlation for Massive Time-Series Data. **Abdullah Mueen**, Suman Nath, Jie Liu, In the Proceedings of ACM SIGMOD 2010. pp. 171-182.
3. Exact Discovery of Time Series Motifs. **Abdullah Mueen**, Eamonn Keogh, Qiang Zhu, Sydney Cash, Brandon Westover, In the Proceedings of SIAM International Conference on Data Mining, pp. 473-484, SDM 2009.

4. Online Discovery and Maintenance of Time Series Motif. **Abdullah Mueen**, Eamonn Keogh, In the Proceedings of ACM SIGKDD 2010. pp. 1089-1098.
5. Clustering Time series using Unsupervised-Shapelets. Jesin Zakaria, **Abdullah Mueen**, Eamonn Keogh, In the Proceedings of IEEE International Conference on Data Mining, pp. 785-794, ICDM 2012.

Synergistic Activities

- Patents — three issued patents with HP Labs and Microsoft Corporation; three patent applications filed on: review analytics to identify fraudulent reviews, bot discovery, and high-speed dictionary matching with streaming time series. The three patent applications are synergistic to the proposed work.
- Journal review — Reviewed articles for several journals, including Data Mining and Knowledge Discovery (DMKD), Knowledge and Information Systems (KAIS), and IEEE Transactions on Knowledge and Data Engineering (TKDE).
- Service to the scientific and engineering community — Served on the Program Committees of the: ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD 2012, 2015), IEEE International Conference on Data Mining (ICDM 2013-15), SIAM International Conference on Data Mining (SDM 2013-15) and ACM Conference on Information and Knowledge Management (CIKM 2013-15); Arrange the annual Workshop on Mining and Learning from Time Series (MiLeTS) in KDD; Maintain the DeBot archive of Twitter bots and provide an API for on-demand bot detection for specific topics and keywords.
- Conference tutorial presentations — Presented several tutorials in top conferences: ICDM (2014), SDM (2015), KDD (2016), CIKM (2016) and DSAA (2016).
- Professional awards — Awarded runner-up for the doctoral dissertation award in the Knowledge Discovery and Data Mining (KDD) conference, the premiere conference in data mining (2012); Won the best research paper award in KDD (2012).

Gruia-Catalin Roman
Professor

A. Areas of Expertise

- Software engineering, middleware, mobile computing, distributed and concurrent algorithms, personalized applications in the Internet of Things, space software for nanosat swarms

B. Interdisciplinary Interests

- My research collaboration with UT Austin in the area of the Internet of Things has significant social implications
- While serving as Dean of Engineering, I pursued a wide range of interdisciplinary initiatives across the School and the University

C. Current Departmental and University Committees

- Computer Science Promotion and Tenure committee

D. Extracurricular Activities Related to Academic Objectives

- Software engineering consultant and technical advisor for AFRL
- 2010 - General Chair, *International Symposium on the Foundations of Software Engineering* FSE-18), Santa Fe, New Mexico.
- 2005 - General Chair, *International Conference on Software Engineering* (ICSE05), Saint Louis, Missouri.
- 2002-04 - Member of the editorial board for ACM Transactions on Software Engineering and Methodology.
- 2003 - Vice Chair for Agents and Mobile Code, *23rd International Conference on Distributed Computing Systems (ICDCS)*.
- 2002 - Guest Editor (with A. L. Murphy), *Special* Issue *on Software Engineering for Mobility*, Automated Software Engineering 9, No. 2, Kluwer Academic Publishers, April 2002.
- 2001 - Co-Chair (with G. P. Picco), Workshop *on Software Engineering and Mobility*, organized in conjunction with *International Conference on Software Engineering* (ICSE01).
- 2000 - Program Co-Chair (with A. Porto), *International Conference on Coordination Models and Languages (Coordination 2000)*.

E. Major Awards, Recognitions, etc. from the past five years

- Recognition for past service as General Chair on the occasion of the 40th anniversary of the International Conference on Software Engineering (2018)

F. Outreach Efforts and Public Service

- Most of my outreach activities have taken place during my service as Dean of Engineering

GRUIA-CATALIN ROMAN

Professor
Department of Computer Science • University of New Mexico

Professional Preparation

University of Pennsylvania (Philadelphia, PA), BS in Computer Science and Engineering, December 1973
University of Pennsylvania (Philadelphia, PA), MS in Computer and Information Sciences, May 1974
University of Pennsylvania (Philadelphia, PA), PhD in Computer Science and Engineering, May 1976

Appointments

Professor. 2011-present, Dept. of Computer Science, *University of New Mexico*, Albuquerque, NM.
Professor. 2011-2014, Dean of Engineering, *University of New Mexico*, Albuquerque, NM.
Professor. 1990-2011, Dept. of Computer Science, *Washington University*, St. Louis, MO.
2004-2011 Harold B. and Adelaide G. Welge Professor of Computer Science
Associate Professor. 1981-1990, Dept. of Computer Science, *Washington University*, St. Louis, MO.
Assistant Professor. 1976-1981, Dept. of Computer Science, *Washington University*, St. Louis, MO.

Academic Activities

Scholarly Research. Dr. Roman published nearly 200 publications with an overall citation count that exceeds 3000 (Google Scholar), including numerous papers having citation counts in excess of 100. In the broadest sense, his work can be characterized as being concerned with the design of software instruments that enable rapid development of dependable software, particularly in novel settings such as the mobile and wireless domains. His research style has been one that focused on innovation and creative thinking. He graduated 19 students with doctoral degrees, many of them pursuing successful research and academic careers of their own.

Outreach Activities. Dr. Roman has been instrumental in a major expansion of the outreach program at University of New Mexico. He created the new position of outreach coordinator, engaged with high school students and counselors, greatly expanded an internship program specifically designed to increase retention, and is engaging students with industry and research laboratories through a new initiative, the Software Engineering Clinic. As dean, he identified student success as a top strategic priority for the School of Engineering and adopted a life-cycle perspective on how to achieve it. This included reaching out to middle school and high school students, redesigning the admission processes, formulating new math preparation strategies designed to increase the graduation rate among the most vulnerable students with interest in engineering, and a lot more.

Advising and Teaching. Dr. Roman has a real passion for graduate education, which led him to supervise a relatively large group of doctoral students on topics that are innovative and of social importance. His focus on training the next generation of faculty and researchers was explicit and led to many of his doctoral students entering academia. His research on mobile computing led to the development of a rigorous class that addresses topics like mobile algorithms, middleware for mobility, and formal models of mobility. Finally, he was among the first to introduce software engineering into the university curriculum and was able to maintain such classes relevant and fresh by testing them in industrial settings as well.

Representative Publications

Picco, G. P., Julien, C., Murphy, A. L., Musolesi, M., and Roman, G.-C., "Software Engineering for Mobility: Reflecting on the Past, Peering into the Future." (Invited Paper), *36th International Conference on Software Engineering*, *Future of Software Engineering Track*, Hyderabad, India, May 2014.

Murphy, A. L., Picco, G. P., and Roman, G.-C., "LIME: A Coordination Middleware Supporting Mobility of Hosts and Agents," *ACM Transactions on Software Engineering and Methodology* 15, No. 3, July 2006, pp. 279-328.

Roman, G.-C., and McCann, P. J., "A Notation and Logic for Mobile Computing," *Formal Methods in System Design* 20, No. 1, 2002, pp. 47-68.

Huang, Q., Bhattacharya, S., Lu, C., and Roman, G.-C., "FAR: Face-Aware Routing for Mobicast in large-Scale Sensor Networks," *ACM Transactions on Sensor Networks* 1, No. 2, November 2005, pp. 240-271.

Murphy, A. L., Roman, G.-C., and Varghese, G., "Tracking Mobile Units for Dependable Message Delivery," *IEEE Transactions on Software Engineering* 28, No. 5, May 2002, pp. 433-448.

Fok, C.-L., Roman, G.-C., and Lu, C., "Agilla: A Mobile Agent Middleware for Self-Adaptive Wireless Sensor Networks," *ACM Transactions on Autonomous and Adaptive Systems* 4, No. 3, July 2009, pp. 16:1-16:26.

Hackmann, G., Fok, C.-L., Roman, G.-C., and Lu, C., " Agimone: Middleware Support for Seamless Integration of Sensor and IP Networks," *Proceedings of the 2nd International Conference on Distributed Computing in Sensor Networks (DCOSS 2006)*, Gibbons, P. B., Abdelzaher, T., Aspnes, J., and Rao, R., (editors), Lecture Notes in Computer Science 4026, Springer, San Francisco, USA, June 2006, pp. 101-118.

Handorean, R., Sen, R., Hackmann, G., and Roman, G.-C., "Supporting Predictable Service Provision in MANETs via Context Aware Session Management," *International Journal of Web Services Research* 3, No. 3, July-September 2006, pp. 1-26.

Julien, C., and Roman, G.-C., "EgoSpaces: Facilitating Rapid Development of Context-Aware Mobile Applications," *IEEE Transactions on Software Engineering* 32, No. 5, May 2006, pp. 281-298.

Chipara, O., Lu, C., Stankovic, J., and Roman, G.-C., "Dynamic Conflict-free Transmission Scheduling for Sensor Network Queries," *IEEE Transactions on Mobile Computing* 10, Nr. 5, May 2011, pp. 734-748.

Recent Professional Activities:

2010 - General Chair, International Symposium on the Foundations of Software Engineering FSE-18), Santa Fe, New Mexico.

2005 - General Chair, International Conference on Software Engineering (ICSE05), Saint Louis, Missouri.

2002-04 - Member of the editorial board for ACM Transactions on Software Engineering and Methodology.

2003 - Vice Chair for Agents and Mobile Code, 23rd International Conference on Distributed Computing Systems (ICDCS).

2002 - Guest Editor (with A. L. Murphy), Special Issue on Software Engineering for Mobility, Automated Software Engineering 9, No. 2, Kluwer Academic Publishers, April 2002.

2001 - Co-Chair (with G. P. Picco), Workshop on Software Engineering and Mobility, organized in conjunction with International Conference on Software Engineering (ICSE01).

2000 - Program Co-Chair (with A. Porto), International Conference on Coordination Models and Languages (Coordination 2000).

Doctoral Dissertations (first appointment):

2010 - O. Chipara (Co-Advisor with C. Lu), Postdoc U. of California, San Diego 2010 - C.-L. Fok, Postdoc U. of Texas, Austin

2008 - R. Sen, Advisory Forensic Services, PricewaterhouseCoopers LLP, New York, New York 2008 - S. Bhattacharya, Intel India System Research Center, Bangalore, India

2006 - J. Payton, U. of North Carolina, Charlotte, North Carolina

2005 - R. Handorean, Qualcomm, Boulder, Colorado

2004 - C. Julien, U. of Texas at Austin, Austin, Texas

2003 - Q. Huang (Co-Advisor with C. Lu), Palo Alto Research Center, Palo Alto, California 2002

2003 - M. E. Tudoreanu (Co-advisor with E. Kramer), U. of Arkansas, Little Rock, Arkansas 2000

2003 - D.R. Hart, U. of Alabama, Huntsville, Alabama.

2000 - A.L. Murphy, U. of Rochester, Rochester, New York.

Jared Saia

Full Professor

1. Areas of Expertise

    - Theory and Algorithms, Probability, Distributed and Randomized, Algorithms, Graph Theory, and Spectral Methods, Distributed Algorithms

2. Interdisciplinary Interests

    - Interest in game theory and computational economics, particularly with respect to blockchains and cryptocurrencies

3. Departmental and University Committees

    - Tenure and Promotion (Departmental)
    - Faculty Job Search

4. Extracurricular Activities Related to Academic Objectives

    - Program committee for Symposium on Theory of Computing (STOC), 2017; Symposium on Discrete Algorithms (SODA), 2012; Symposium on Parallel Algorithms and Architecture (SPAA), 2010; International Parallel and Distributed Processing Symposium (IPDPS), 2014, 2007, 2009; Principles of Distributed Computing (PODC), 2015, 2011, 2005, 2006; ACM/SIGMOBILE International Workshop on Foundations of Mobile Computing (DIALM-POMC), 2004.
    - Workshops Organized: Co-chair, First Annual Workshop on Competitive Economics of Cybersecurity (CEC), Sandia Labs, 2018; Co-chair, 10th ACM International Workshop on Foundations of

Mobile Computing (FOMC), 2014; Workshop on Analysis of Dynamic Networks(ADN), 2009; International Conference on Data Mining (ICDM): Workshop on Analysis of Dynamic Networks (ADN), 2008.

- Invited talks at: Shenzhen Blockchain Workshop, Shenzhen China, Security Group, Cornell University, Bertinoro Workshop on Algorithms and Data Structures, Neural Information Processing Systems (NIPS), University of Maryland, University of Southern California, Microsoft Research Labs, University of Barcelona, University of Rome Sapienza, Rutgers, Santa Fe Institute, University of Tel Aviv, Dartmouth, University of Georgia, University of Victoria, University of Illinois at Chicago, Sandia Labs, Los Alamos Labs, and IBM Labs.
- Research covered in the popular press: "Social Networking Software Tracks Zebras and Consumers", in ACM Technical News, washingtonpost.com, Newswise Website, FOREX Trading, Healthcare Industry Today, and Ecademy Daily News, 9/6/07 - 9/10/07; "Professor Fights a Mathematical Battle to Keep the Virtual World Running Smoothly", ACM Technical News, 2/26/07 and UNM Today, 2/27/07; "Professor Goes to War", front page article in University of New Mexico Daily Lobo, 3/2/07
- Served as reviewer for the following conferences and Jounals: Foundations of Computer Science (FOCS), Principles of Distributed Computing(PODC), Symposium on Discrete Algorithms(SODA), International Colloquium on Automata, Languages and Programming(ICALP),Symposium on Parallel Algorithms (SPAA), Symposium on Distributed Computing(DISC), Joint Conference of the IEEE Computer and Communications Societies (InfoComm), Journal of Experimental Algorithms(JEA), Journal of Algorithms(JOA), Journal of Computing(JOC), Journal of Distributed Computing (JODC), Journal of Networking (JON), and IEEE Transactions on Computing.

5. Major Awards, Recognitions, etc from the past five years

   - Best Paper Award, International Conference on Distributed Computing and Networking (ICDCN), 2014.
   - School of Engineering Senior Research Excellence Award

6. Outreach Efforts and Public Service

- Chair of Bi-Annual Workshop on Competitive Economics of Cybersecurity (CEC), Sandia Labs. This is a workshop jointly funded by Sandia labs and a NSF grant. There are about 20 speakers, a keynote, a panel and a student lightening talk session.
- Author of distributed computing research blog, Machinations, which covers major conferences and workshops, reviews of important papers, student and career advice, etc.

Jared Saia

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Albuquerque, NM 87131-1386

Professional Preparation

Stanford University, Computer Science, B.S. 1993
University of Washington, Computer Science, Ph.D. 2002

Appointments

2013-present, Full Professor, Computer Science, *University of New Mexico*
2010-2013, Associate Professor, Computer Science, *University of New Mexico*
2002-2009, Assistant Professor, Computer Science, *University of New Mexico*
1993-1994, Researcher, *Advanced Telephony Research Labs in Nara, Japan*

Selected Publications

The following list is out of about 90 publications, with total citations numbering over 2,500 with an h-index of 24. In theory conferences and journals, author name order is alphabetical.

Publications Related to Proposed Research

- Varsha Dani, Mahnush Movahedi, Yamel Rodriguez and Jared Saia, "Scalable Mechanisms for Rational Secret Sharing," *Principles of Distributed Computing (PODC)*, 2011.
- Valerie King and Jared Saia, "Byzantine Agreement in Polynomial Expected Time," *Symposium on Theory of Computing (STOC)*, 2013. **Invited to special issue of the Journal of the ACM, 2016**.
- Varsha Dani, Valerie King, Mahnush Movahedi and Jared Saia, "Quorums Quicken Queries: Efficient Asynchronous Secure Multiparty Computation," *International Conference on Distributed Computing and Networking (ICDCN)*, 2014. **Best Paper Award, Distributed Computing Track**.
- Seth Gilbert, Valerie King, Jared Saia and Maxwell Young. "Resource-Competitive Analysis: A New Perspective on Attack-Resistant Distributed Computing," *ACM International Workshop on Foundations of Mobile Computing (FOMC)*, 2012.
- Seth Gilbert, Valerie King, Seth Pettie, Ely Porat, Jared Saia and Maxwell Young, "(Near) Optimal Resource-Competitive Broadcast with Jamming," *ACM Symposium on Parallelism in Algorithms and Architectures (SPAA)*, 2014.

Other Publications

- Varsha Dani, Tom Hayes, Mahnush Mohavedi, Jared Saia and Maxwell Young, "Interactive Communication with Unknown Noise Rate" International Colloquium on Automata, Languages, and Programming (ICALP) 2015. Invited to special issue of "Information and Computation" devoted to selected papers from ICALP.
- Valerie King, Jared Saia and Maxwell Young, "Conflict on a Communication Channel" *Principles of Distributed Computing (PODC)*, 2011.
- Valerie King and Jared Saia, "Breaking the $O(n^2)$ Bit Barrier: Scalable Byzantine agreement with an Adaptive Adversary", in *Principles of Distributed Computing (PODC)*, 2010. **Best Paper Award at PODC 2010 ($1,000). Invited to special issue of Journal of the ACM.**
- Valerie King and Jared Saia, "Faster Agreement Via a Spectral Method for Detecting Malicious Behavior", *Symposium on Discrete Algorithms (SODA)*, 2014.

- Bruce Kapron, David Kempe, Valerie King, Jared Saia and Vishal Sanwalani, "Fast asynchronous Byzantine agreement and leader election with full information," *ACM Transactions on Algorithms(TALG)* 6(4): 1-28 (2010). **Invited issue of best papers from SODA 2008**.

Service and Synergistic Activities

- Program committee for: Symposium on Theory of Computing (STOC), 2017; Symposium on Discrete Algorithms (SODA), 2012; International Conference on Automata, Languages and Complexity (ICALP), 2014; Principles of Distributed Computing (PODC), 2005, 2006, 2010, 2014; International Conference on Distributed Computing Systems (ICDCS), 2012, 2011; Symposium on Parallel Algorithms and Architecture (SPAA), 2010; International Parallel and Distributed Processing Symposium (IPDPS), 2007, 2009, 2010; ACM Workshop on Foundations of Mobile Computing (FOMC), 2004.

- Workshops organized: ACM Workshop on Foundations of Mobile Computing (FOMC), 2014; SIAM International Conference on Data Mining (SDM): Workshop on Analysis of Dynamic Networks(ADN), 2009; International Conference on Data Mining (ICDM): Workshop on Analysis of Dynamic Networks (ADN), 2008

- Invited talks at: Osaka University Computer Science Department '16, Aarhus University Computer Science Department '15, 41st International Conference on Current Trends in Theory and Practice of Computer Science (SOFSEM) in Czech Republic '15, Bertinoro Workshop on Algorithms and Data Structures ('10,'11,'15, '17), Neural Information Processing Systems (NIPS), University of Maryland, University of Southern California, Microsoft Research Labs, University of Barcelona, University of Rome Sapienza, Rutgers, Santa Fe Institute, University of Tel Aviv, Dartmouth, University of Georgia, University of Victoria, University of Illinois at Chicago, Sandia Labs, Los Alamos Labs, and IBM Labs.

- Research covered in the popular press: *Social Networking Software Tracks Zebras and Consumers*, in ACM Technical News, washingtonpost.com, Newswise Website, FOREX Trading, Healthcare Industry Today, and Ecademy Daily News, 9/6/07 - 9/10/07; *Professor Fights a Mathematical Battle to Keep the Virtual World Running Smoothly*, ACM Technical News, 2/26/07 and UNM Today, 2/27/07; *Professor Goes to War*, front page article in University of New Mexico Daily Lobo, 3/2/07

- Author of distributed computing research blog, *Machinations*, which covers major conferences and workshops, reviews of important papers, student and career advice. 35,000 unique page views since inception.

Darko Stefanovic
Professor and Chair
A. Areas of Expertise

- Programming Languages, Compilers, Run-Time Systems, Memory Management, DNA Computing, Molecular Robotics, Scientific Modeling

B. Interdisciplinary Interests

- Faculty Member, UNM Center for Biomedical Engineering (CBME)
- Faculty Member, UNM graduate program in Nanoscience and Microsystems Engineering (NSME)
- Research in collaboration with Prof. Graves, UNM Dept. of Chemical and Nuclear Engineering, and faculty in Chemistry, Physics, Medicine, Biochemistry at several universities in the US, Italy, and Australia

C. Current Departmental and University Committees

- Graduate Committee (departmental)
- Undergraduate honors thesis committee (departmental)

D. Extracurricular Activities Related to Academic Objectives

- Invited talks at symposia: 2nd International Conference in Code Biology, Jena (2015); University of Vienna Theoretical Bioinformatics Institute 30th TBI Winterseminar, Bled (2015); Dagstuhl Seminar 14452: Algorithmic Cheminformatics (2014); Molecular Robotics Workshop, Radcliffe Institute for Advanced Study at Harvard University (2014); Defence Futures and Emerging Capability/Technology Symposium, Defence Science and Techonology Organisation, Australian Government Department of Defence, Melbourne (2013); Computability in Europe, Special session: Computation in Nature, Milano (2013)
- Other invited talks: University of Trento (2015); University of Udine (2015); University of Queensland (2013); University of the Sunshine Coast (2013); Australian National University (2013); Aarhus University (2012)
- Program committee co-chair, 18th International Conference on DNA Computing and Molecular Programming, 2012, Aarhus.
- Co-organizer, Computing with Biomolecules Workshop at ALIFE 2014, New York. In charge of student travel awards.
- Special issue editor, *Natural Computing* (Springer), 2012–2013.
- Editorial board member, International Journal of Parallel, Emergent and Distributed Systems, 2015–present.

- Program Committee: DNA Computing and Molecular Programming (2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018)
- Program Committee: Unconventional Computing (2009, 2010)
- Program Committee: International Workshop on Bio-design Automation (2013, 2014, 2015, 2016)
- Program Committee: ACM International Conference on Nanoscale Computing and Communication (2016, 2017, 2018)
- Program Committee: Theory and Practice of Natural Computing (2014)
- Program Committee: IEEE International Conference on Evolvable Systems (2014)
- Reviewer, panelist, and site visit panelist for NSF, Army Research Office, DFF (Danish Councils for Independent Research (Danish Agency for Science, Technology and Innovation)), FWF (Austrian Science Fund)
- Reviewer for journals: ACM Transactions on Computer Systems; ACM Transactions on Architecture and Compiler Optimizations; IEEE Transactions on Parallel and Distributed Systems; IEEE Transactions on Computers; IEEE Transactions on NanoBioscience; Journal of the American Chemical Society; Nucleic Acids Research; BioSystems; Nano Letters; Science; Theoretical Computer Science; Journal of the Royal Society Interface; Nature Nanotechnology; International Journal of Computer Mathematics; PLoS Computational Biology; Journal of Computational and Theoretical Nanoscience; International Journal of Unconventional Computation; Nature Reviews Genetics; Higher-Order and Symbolic Computation; Journal of Systems and Software; Physica D: Nonlinear Phenomena; Chemistry & Biology; Natural Computing; BMC Bioinformatics; Journal of Cheminformatics; Proceedings of the National Academy of Sciences; Analytical Chemistry; Journal of Physical Chemistry; Nanoscale; Nature Communications; Chemical Science; Nature Chemistry; Chemical Communications; ACS Synthetic Biology; Journal of Chemical Information and Modeling; IEEE Transactions on Dependable and Secure Computing; Molecules; MATCH Communications in Mathematical and in Computer Chemistry; Algorithms for Molecular Biology; ChemPhysChem; ChemBioChem; Angewandte Chemie; Computer Science and Information Systems; ACS Nano; Small; Scientific Reports; Science Advances; Sensors and Actuators B: Chemical.
- Reviewer for conferences: Architectural Support for Programming Languages and Operating Systems (ASPLOS); Object-Oriented Programming Systems, Languages, and Applications (OOPSLA); Programming Language Design and Implementation (PLDI); Parallel Architectures and

Compilation Techniques (PACT); International Conference on Supercomputing (ICS); European Compiler Construction Conference; High Performance Computer Architectures (HPCA); International Symposium on Computer Architecture (ISCA); International Symposium on Performance Analysis of Systems and Software; International Symposium on Microarchitecture (MICRO); Workshop on Hot Topics in Operating Systems (HotOS); International Meeting on DNA Computing.

E. Major Awards, Recognitions, etc from the past five years

- IEEE Senior Member, 2012
- ACM Distinguished Scientist Member, 2016
- UNM School of Engineering Senior Faculty Research Excellence Award, 2014
- ACM SIGPLAN Most Influential Paper Award, for OOPSLA 2006 paper "The DaCapo benchmarks: Java benchmarking development and analysis", 2016.

F. Outreach Efforts and Public Service

- Most outreach and public service over that past three years has been in the context of Department Chair activities.
- SY Jackson Elementary School Science Fair (reviewer)
- NCWIT Learning Circle

Darko Stefanovic

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June 2018

Professional Preparation

University of Belgrade	Elec. Eng. and Comp. Sci.	Dipl.Ing., 1989
University of Massachusetts Amherst	Computer Science	M.S., 1994
University of Massachusetts Amherst	Computer Science	Ph.D., 1999
Princeton University	Electrical Engineering	postdoc, 1998–2000

Appointments & Affiliations

2016–	Department Chair, Computer Science, University of New Mexico
2015–	Professor, Computer Science, University of New Mexico
2015–2016	Interim Department Chair, Computer Science, University of New Mexico
2006–2015	Associate Professor, Computer Science, University of New Mexico
2010	Interim Associate Chair, Computer Science, University of New Mexico
2009–	Faculty Member, Center for Biomedical Engineering, University of New Mexico
2005–	Faculty Member, Nanoscience and Microsystems Engineering, University of New Mexico
2004–2007	Regents' Lecturer, University of New Mexico
2000–2006	Assistant Professor, Computer Science, University of New Mexico
1998–2000	Postdoctoral Research Associate, Elecrical Engineering, Princeton University
1992–1993	Visiting Scholar, Computer Science, Carnegie Mellon University
1985	System Analyst, Burroughs Corporation, Milano, Italy

Products

Five Publications Most Closely Related to the Proposed Project

1. A. Fabry-Wood, M. E. Fetrow, C. W. Brown, III, N. A. Baker, N. Fernandez Oropeza, A. P. Shreve, G. A. Montaño, D. Stefanovic, M. R. Lakin, S. W. Graves, "A Microsphere-Supported Lipid Bilayer Platform for DNA Reactions on a Fluid Surface", *ACS Applied Materials & Interfaces*, 9 (35), 30185–30195 (2017).

2. M. R. Lakin and D. Stefanovic, "Supervised learning in adaptive DNA strand displacement networks", *ACS Synthetic Biology*, 5(8), 885–897 (2016).

3. M. R. Lakin, D. Stefanovic, and A. Phillips, "Modular Verification of Chemical Reaction Network Encodings via Serializability Analysis", *Theoretical Computer Science*, 632, 21–42 (2016).

4. D. Mohr and D. Stefanovic, "Stella: A Python-based Domain-Specific Language for Simulations", *ACM Symposium on Applied Computing*, Pisa, Italy, April 2016.

5. C. W. Brown, III, M. R. Lakin, E. K. Horwitz, M. L. Fanning, H. E. West, D. Stefanovic, and S. W. Graves, "Signal Propagation in Multi-Layer DNAzyme Cascades using Structured Chimeric Substrates", *Angewandte Chemie International Edition*, 53(28), 7183–7187 (2014).

Five Other Significant Publications

1. O. Semenov, M. J. Olah, and D. Stefanovic, "Mechanism of Diffusive Transport in Molecular Spider Models", *Physical Review E*, 83, 021117 (2011).

2. R. Pei, E. Matamoros, M. Liu, D. Stefanovic, and M. N. Stojanovic, "Training a molecular automaton to play a game", *Nature Nanotechnology*, 5, 773–777 (2010).

3. R. Pei, S. K. Taylor, D. Stefanovic, S. Rudchenko, T. E. Mitchell, and M. N. Stojanovic, "Behavior of Polycatalytic Assemblies in a Substrate-Displaying Matrix", *Journal of the American Chemical Society*, 128(39), 12693–12699 (2006).

4. M. N. Stojanovic and D. Stefanovic, "A Deoxyribozyme-Based Molecular Automaton", *Nature Biotechnology*, 21, 1069–1074 (2003).

5. M. N. Stojanovic, T. E. Mitchell, and D. Stefanovic, "Deoxyribozyme-Based Logic Gates", *Journal of the American Chemical Society*, 124(14), 3555–3561 (2002).

Synergistic Activities

1. Reviewer for: ACM Transactions on Architecture and Compiler Optimizations; ACM Transactions on Computer Systems; ACS Nano; ACS Synthetic Biology; Algorithms for Molecular Biology; Analytical Chemistry; Angewandte Chemie; BMC Bioinformatics; BioSystems; ChemBioChem; ChemPhysChem; Chemical Communications; Chemical Science; Chemistry & Biology; Computer Science and Information Systems; Higher-Order and Symbolic Computation; IEEE Transactions on Computers; IEEE Transactions on Dependable and Secure Computing; IEEE Transactions on NanoBioscience; IEEE Transactions on Parallel and Distributed Systems; International Journal of Computer Mathematics; International Journal of Unconventional Computation; Journal of Chemical Information and Modeling; Journal of Cheminformatics; Journal of Computational and Theoretical Nanoscience; Journal of Physical Chemistry; Journal of Systems and Software; Journal of the American Chemical Society; Journal of the Royal Society Interface; MATCH Communications in Mathematical and in Computer Chemistry; Molecules; Nano Letters; Nanoscale; Natural Computing; Nature Chemistry; Nature Communications; Nature Nanotechnology; Nature Reviews Genetics; Nucleic Acids Research; PLoS Computational Biology; Physica D: Nonlinear Phenomena; Proceedings of the National Academy of Sciences; Science; Scientific Reports; Small; Theoretical Computer Science.

2. Program committee co-chair, 18th International Conference on DNA Computing and Molecular Programming, Aarhus, Denmark, 2012.

3. Participated (2003–2008) in the development of the DaCapo benchmark suite for memory management and other performance studies of Java virtual machine implementations. `http://dacapobench.org`

4. Participated (2001–2006) in the design and implementation of JikesRVM, an open-source virtual machine for Java applications, in particular in its port to the 64-bit PowerPC architecture. `http://jikesrvm.org`

5. Participated (1991–1997) in the design and implementation of UMass Garbage Collector Toolkit, a language-independent set of tools for building flexible memory managers, made available to researchers in academia and industry

Lydia Tapia

Associate Professor

A. Areas of Expertise

- motion planning
- robotics
- artificial intelligence
- machine learning
- computational biology
- virtual reality

B. Interdisciplinary Interests

- molecular docking
- protein folding
- antibody assembly
- molecular computing
- control theory

C. Current Departmental and University Committees

- **CS Department Chair/Faculty Search Committee, Member**, 2015-2017, 2018-2019.
- **CS Department Promotion and Tenure Committee, Member**, 2018-2019.
- **CS Department NCWIT-funded Committee for Increasing Enrollment of Women in CS at UNM, Member**, 2018-2019.
- **CS Department Awards Committee, Chair**, 2012-present.
  Chair of committee to select students for departmental awards and to help with applications for national student awards.
- **UNM Regent's Scholar, Mentor**, 2014-present.
  Advisor for students in the UNM Regent's Scholar Program, the top scholarship program at UNM.

D. Extracurricular Activities Related to Academic Objectives

- **IEEE Robotics and Automation Society Technical Committee on Algorithms for Planning and Control of Robot Motion**, Co-Chair, 2015-2018.
- **Third Machine Learning in Planning and Control of Robot Motion Workshop**, Organizer, 2018.
  Co-organized the Third Machine Learning in Planning and Control (MLPC) of Robot Motion Workshop at the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems Conference (IROS) in Brisbane, Australia, May 2018.
- **Robotics Science and Systems Conference (RSS) Organizing Committee Member**, Co-Chair of Workshops at RSS 2016.
- **Robotica Special Issue on Robotics Methods for Structural and Dynamic Modeling of Molecular Systems**, Guest Editor, 2016.
  Lead Guest Editor for the special issue that published papers integrating concepts from molecular modeling and robotics. Special issue published in May 2016.

- **Machine Learning in Planning and Control of Robot Motion Workshop**, Organizer, 2015.
  Co-organized the Second Machine Learning in Planning and Control (MLPC) of Robot Motion Workshop at the 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems Conference (IROS) in Hamburg, Germany, Sept 2015.
- **Machine Learning in Planning and Control of Robot Motion Workshop**, Lead Organizer, 2014.
  Lead organizer for the "Machine Learning in Planning and Control (MLPC) of Robot Motion" Workshop at the 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems Conference (IROS) in Chicago, IL, Sept 2014.
- **Workshop on Robotics Methods for Structural and Dynamic Modeling of Molecular Systems**, Lead Organizer, 2014.
  Lead organizer for the "Workshop on Robotics Methods for Structural and Dynamic Modeling of Molecular Systems" (RMMS) at the 2014 Robotics Science and Systems Conference (RSS) in Berkeley, CA, July 2014.
- **IEEE International Conference on Intelligent Robots and Systems (IROS) Conference**, Associate Editor, 2012-2014, 2016.
-

E. Major Awards, Recognitions, etc. from the past five years

- Best Paper in Service Robotics, IEEE International Conference on Robotics and Automation (ICRA), 2018
- Computing Research Association Borg Early Career Award, 2017
- National Science Foundation CAREER Award, 2016
- Denice Denton Emerging Leader Award, Anita Borg Institute for Women and Technology, 2015
- Senior Member, The Institute of Electrical and Electronics Engineers (IEEE), 2015

F. Outreach Efforts and Public Service

- **Becoming a Robot Guru 3: Integrating Science, Engineering and Creativity Workshop**, Lead Organizer, 2018.
  Lead organizer for a broadening participation in computing workshop at the 2018 WAFR Conference in Merida Mexico. Awarded budget of $35,000 from Google to fund the workshop.
- **Grace Hopper Celebration of Women in Computing Conference**, Invited Speaker 2018.
  Invited speaker for Computing Research Association Session Track in Houston, TX, Sept, 2018.
- **Becoming a Robot Guru 2: Integrating Science, Engineering and Creativity Workshop**, Lead Organizer, 2016.
  Lead organizer for a broadening participation in computing workshop at the 2016 Robotics: Science and Systems Conference (RSS) in Ann Arbor, MI, June 2016. Awarded budget of $20,000 from the Computing Research Association Committee on the Status of Women in Research and the Coalition to Diversify Computing to fund student travel awards to the workshop.
- **Denice Denton Emerging Leaders Workshop Steering Committee Member**, professional development workshop in 2016.
- **Becoming a Robot Guru: Integrating Science, Engineering and Creativity Workshop**, Lead Organizer, 2015.
  Lead organizer for a broadening participation in computing workshop at the 2014 IEEE International Conference on Robotics and Automation Conference (ICRA) in Seattle, WA, May 2015. Awarded budget of $21,000 from the Computing Research Association Committee on the Status of Women in Research and the Coalition to Diversify Computing to fund student travel awards to the workshop.

- **IEEE International Conference on Robotics and Automation (ICRA) Organizing Committee Member**, Chair of the Student Activities at ICRA 2015.
- **Computing Research Association URMD Graduate Cohort**, Steering Committee, 2018 & 2019.
  Aiding in development of professional development conference for new underrepresented minority and disabled graduate students held in 2018 and planned in 2019.
- **Computing Research Association Graduate Cohort**, Invited Speaker, 2016 & 2018 & 2019.
  Invited speaker at professional development conference for new graduate students at 2016 and 2018 conferences.
- **Computing Research Association Undergraduate Research Award**, Selection Committee Member, 2014 & 2015.
  Evaluated undergraduate research applications for the 2014 & 2015 Computing Research Association (CRA) Undergraduate Research Awards.
- **Congressional Science, Technology, Engineering and Math (STEM) Academic Competition, the "House Student App Challenge"**, Judge, 2014.
  Assisted Congressman Ben Luján with evaluating entries to the 2014 House Student App Challenge.
- **Engaging Undergraduates in Research**, Invited Speaker, 2014.
  Invited speaker at the Computing Research Association Education Committee (CRA-E) Engaging Undergraduates in Research Workshop held in Los Angeles, California, November 2014.

Lydia Tapia

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(a) PROFESSIONAL PREPARATION

Tulane University	New Orleans LA	Computer Science	B.S., 1998
Texas A&M University	College Station TX	Computer Science	Ph.D., 2009
University of Texas, Austin	Austin TX	Computational Chemistry	Postdoc, 2009-2011

(b) APPOINTMENTS

2017 - present	Associate Professor, Computer Science, University of New Mexico
2011 - 2017	Assistant Professor, Computer Science, University of New Mexico
2009 – 2011	Computing Innovation Post-Doctoral Fellow, University of Texas at Austin
1998 – 1999	Technical Research Staff, Sandia National Laboratories

(c) PUBLICATIONS

(i) Five Products Most Closely Related to the Proposed Project

1. Tapia, L. "Workshops to Diversify the Next Generation of Roboticists." *IEEE Robotics & Automation Magazine* 25, no. 3 (2018).
2. Tapia, L. "Hispanics and Native Americans in Computer Science: Patterns, Pressures, and Programs." Invited Talk at the *National Academies of Sciences* Roundtable on Post-Secondary Data Science Education, Atlanta, GA, Sept 2018..
3. Mahajan, A., Youssef, L. A., Cleyrat, C., Grattan, R., Lucero, S. R., Mattison, C. P., Erasmus, M. F., Jacobson, B., Tapia, L., Hlavacek, W. S., Schuyler, M., and Wilson, B. S. "Allergen Valency, Dose, and FcεRI Occupancy Set Thresholds for Secretory Responses to Pen a 1 and Motivate Design of Hypoallergens." *The Journal of Immunology* 198, no. 3 (2017): 1034-46
4. Chiang, H-T, Malone, N., Lesser, K., Oishi, M., and Tapia, L. (2015): "Aggressive Moving Obstacle Avoidance Using a Stochastic Reachable Set Based Potential Field", In H. Akin et al., editors, Algorithmic Foundations of Robotics XI, pp. 73-90, Zeist, Springer, 2015.
5. Malone, N., Chiang, H-T, Lesser, K., Oishi, M., and Tapia, L. " Hybrid Dynamic Moving Obstacle Avoidance Using a Stochastic Reachable Set-Based Potential Field." *IEEE Transactions on Robotics* 33, no. 5 (2017): 1124-1138.

(ii) Five Other Significant Products

1. Tapia, L., Tang, X., Thomas, S., and Amato, N. M. "Kinetics Analysis Methods for Approximate Folding Landscapes." *Bioinformatics* 23, no. 13 (2007): i539-48.
2. Thomas, S., Tang, X., Tapia, L., and Amato, N. M. "Simulating Protein Motions with Rigidity Analysis." *Journal of Computational Biology* 14, no. 6 (2007): 839-55.
3. Manavi, K., Jacobson, B., Hoard, B., and Tapia, L. "Influence of Model Resolution on Geometric Simulations of Antibody Aggregation." *Robotica* 34, no. 8 (2016): 1754-76.
4. Hoard, B., Jacobson, B., Manavi, K., and Tapia, L. "Extending Rule-based Methods to Model Molecular Geometry and 3D Model Resolution." *BMC Systems Biology* 10, no. 2 (2016): 48.
5. Tang, X., Thomas, S., Tapia, L., Giedroc, D. P., and Amato, N. M. "Simulating RNA Folding Kinetics on Approximated Energy Landscapes." *Journal of Molecular Biology* 381, no. 4 (2008): 1055-67.

(d) SYNERGISTIC ACTIVITIES

- **Service to the Scientific Community**. Co-Chair for the Workshop on the Algorithmic Foundations of Robotics (WAFR) 2018, Associate Editor, IEEE Robotics and Automation Letters (RA-L) Journal, 2015-2018, IEEE Robotics and Automation Society Technical Committee on Algorithms for Planning and Control of Robot Motion}, Co-Chair, 2015-2019.
- **Outreach Activities**. Lead organizer for the Becoming a Robot Guru Workshops, broadening participation in computing workshops at the 2016 Robotics: Science and Systems Conference (RSS) in Ann Arbor, MI and 2014 IEEE International Conference on Robotics and Automation Conference (ICRA) in Seattle, WA.
- **Mentoring and Broadening Participation**. Have advised fourteen and co-advised thirteen undergraduate students doing undergraduate research, seven of these students are currently enrolled in/have graduated from graduate school. Three students have received awards from the Computing Research Association Outstanding Undergraduate Researcher Award competition: Honorable Mention in 2011 (co-advisor), Honorable Mention in 2013 (advisor), and Finalist (3rd place) in 2014 (advisor).

Marie Vasek

Assistant Professor

A. Areas of Expertise

- Cybersecurity, Cybercrime measurement, Cryptocurrencies, Security economics

B. Interdisciplinary Interests

- Research in collaboration with economists at the University of Tel Aviv
- Present work at economics conferences
- Program committee member of interdisciplinary conference: Workshop on Economics of Information Security
- Reviewer for numerous non-CS journals including the interdisciplinary Journal of Cybersecurity and Journal of Difference Equations and Applications

C. Current Departmental and University Committees

- Undergraduate Curriculum Committee

D. Extracurricular Activities Related to Academic Objectives

- Program Committee Member: Financial Cryptography and Data Security 2019, Workshop on the Economics of Information Security 2018, World Wide Web Conference (Security and Privacy Track) 2017
- Journal Reviewer: Computers & Security, ACM Transactions on Privacy and Security, Journal of Cybersecurity, Ledger, Journal of Difference Equations and Applications
- Grant Review Panelist: National Science Foundation 2018
- External Reviewer: International Conference On Information Systems 2018, Workshop on Bitcoin Research 2017, Financial Cryptography and Data Security 2016, Usenix Security 2015 (among others)
- Invited talks/colloquia: University of Innsbruck, Emory University, University of New Mexico, Wellesley College, University of Trento, University of Cambridge
- Panelist: CRESSE conference, FTC workshop on Decrypting Cryptocurrency Scams
- Research covered in the popular press: Buzzfeed, New Scientist, and Coindesk (among others)

E. Major Awards, Recognitions, etc. from the past five years

- Google Anita Borg Memorial Scholarship 2016

F. Outreach Efforts and Public Service

- Co-Director of StopBadware, an anti-malware organization aimed at helping webmasters and Internet infrastructure operators at understanding and remediating malware infections.

Biographical Sketch

Dr. Marie J. Vasek

Dept. of Computer Science, Univ. of New Mexico, Albuquerque, NM 87131
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https://www.cs.unm.edu/~vasek/

(a) Professional Preparation

Wellesley College, Wellesley, MA; Computer Science; B.A., 2012.
Southern Methodist University, Dallas, TX; Computer Science; M.S., 2015.
The University of Tulsa, Tulsa, OK; Computer Science; Ph.D., 2017.

(b) Appointments

8/2017–present: **Assistant Professor of Computer Science**, University of New Mexico, Albuquerque, NM.

(c) Products

(i) **Related to cryptocurrency fraud measurement**

1. A. Feder, N. Gandal, JT Hamrick, T. Moore, and **M. Vasek**. "The Rise and Fall of Cryptocurrencies". In *Workshop on the Economics of Information Security*, June 2018.
2. **M. Vasek** and T. Moore. "Analyzing the Bitcoin Ponzi Scheme Ecosystem". In *Workshop on Bitcoin and Blockchain Research*, March 2018.
3. **M. Vasek**, J. Bonneau, R. Castellucci, C. Keith, and T. Moore. "The Bitcoin Brain Drain: Examining the Use and Abuse of Bitcoin Brain Wallets." In *Financial Cryptography and Data Security*, February 2016.
4. **M. Vasek** and T. Moore. "There's No Free Lunch, Even Using Bitcoin: Tracking the Popularity and Profits of Virtual Currency Scams." In *Financial Cryptography and Data Security*, volume 8975 of *Lecture Notes in Computer Science*, pages 44–61. Springer, January 2015.
5. **M. Vasek**, M. Thornton, and T. Moore. "Empirical Analysis of Denial-of-Service Attacks in the Bitcoin Ecosystem." In *1st Workshop on Bitcoin Research*, volume 8438 of *Lecture Notes in Computer Science*, pages 57–71. Springer, March 2014.

(ii) **Other products**

1. **M. Vasek**, M. Weeden, and T. Moore. "Measuring the Impact of Sharing Abuse Data with Web Hosting Providers." In *ACM Workshop on Information Sharing and Collaborative Security*, pages 71–80. ACM, October 2016.
2. **M. Vasek**, J. Wadleigh, and T. Moore. "Hacking is not Random: A Case-Control Study of Webserver-Compromise Risk." In *IEEE Transactions on Dependable and Secure Computing*, 13(2):206-219, 2016.
3. **M. Vasek** and T. Moore. "Identifying Risk Factors for Webserver Compromise." In *Financial Cryptography and Data Security*, volume 8437 of *Lecture Notes in Computer Science*, pages 326–345. Springer, March 2014.
4. B. Johnson, A. Laska, J. Grossklags, **M. Vasek**, and T. Moore. "Game-Theoretic Analysis of DDoS Attacks Against Bitcoin Mining Pools." In *1st Workshop on Bitcoin Research*, volume 8438 of *Lecture Notes in Computer Science*, pages 72–86. Springer, March 2014.

5. **M. Vasek** and T. Moore. “Do Malware Reports Expedite Cleanup? An Experimental Study." In *5th USENIX Workshop on Cyber Security Experimentation and Test (CSET)*, August 2012.

(d) Synergistic Activities

- Dr. Vasek co-directs StopBadware, an anti-malware nonprofit organization which has helped more than 200,000 non-technical webmasters clean up their websites, aided more than 60 Internet operators in cleaning up their network, and shared malware data with numerous researchers.
- Dr. Vasek has participated in the public policy discourse around cryptocurrencies as an invited speaker at the FTC’s workshop on Decrypting Cryptocurrency Scams and the Virginia Tech conference on Understanding the Dark Web and Its Implications for Policy.
- Dr. Vasek has developed a hands-on cybersecurity class that addresses technical as well as economic issues with entire content publicly available.
- Dr. Vasek has served as a program committee member for the Workshop on the Economics of Information Security, WWW Security and Privacy track, and the upcoming Financial Cryptography conference. She has also served as a journal reviewer for the ACM Transactions on Privacy and Security and Computers & Security.

Lance R. Williams

Associate Professor

A. Areas of Expertise

- Digital Image Processing
- Computer Vision
- Functional Programming
- Artificial Life

B. Interdisciplinary Interests

- Neuroscience
- Human Vision
- Evolutionary Biology
- Cellular Biology
- Applied Mathematics

C. Current Departmental and University Committees

- Chair, Undergraduate Committee, Dept. of Computer Science, Univ. of New Mexico
- Deans Academic Advisory Council, School of Engineering, Univ. of New Mexico

D. Extracurricular Activities Related to Academic Objectives

- *16th Intl. Conf. on the Synthesis and Simulation of Living Systems (ALIFE '18)*, Program Committee
- *European Conf. on Artificial Life (ECAL '17)*, Program Committee
- *15th Intl. Conf. on the Synthesis and Simulation of Living Systems (ALIFE '16)*, Program Committee
- *European Conf. on Artificial Life (ECAL '15),* Program Committee

E. Major Awards, Recognitions, etc. from the past five years

- Wilkes Award for Best Paper, *The Computer Journal*, British Computer Society, 2015

F. Outreach Efforts and Public Service

- Invited talk, *Programs as Polypeptides*, Microsoft Research, Cambridge, England, 2015
- Invited talk, *Programs as Polypeptides*, University of York, York, England, 2015
- Invited talk, *Programs as Polypeptides*, Dublin City University, Dublin, Ireland, 2015
- Invited talk, *Programs as Polypeptides*, National University of Ireland, Maynooth, Ireland 2015
- Invited talk, *Self-Replicating Distributed Virtual Machines*, Dept. of Cognitive Science, Hampshire College, Amherst, Massachusetts, 2015

LANCE WILLIAMS
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Education:
Ph.D. Computer Science, University of Massachusetts Amherst, 1994
M.S. Computer and Information Science, University of Massachusetts Amherst, 1988
B.S. with Honors in Computer Science, Pennsylvania State University, 1985

Academic Experience:
University of New Mexico (UNM), Associate Professor of Computer Science, 1997–present.
Weizmann Institute for Science, Dept. of Applied Mathematics, Rehovot, Israel. Visiting Scientist, May 1996.
Smith College, Dept. of Computer Science, Northampton, Mass., Adjunct Faculty, 1988–1990.

Non-Academic Experience:
NEC Research Institute, 1993–1999. Princeton, NJ. Post-doctoral Scientist, 1993–1997; Visiting Scientist, Summers 1998, 1999.

Honors and Awards:
Junior Faculty Teaching Excellence Award, UNM School of Engineering, 2003.
Wilkes Award for Best Paper of Year, *The Computer Journal*, British Computer Society, 2014.

Recent Service Activities:
Chair, Undergraduate Committee, Dept. of Computer Science, Univ. of New Mexico, 2008–present.
Member, Popejoy Dissertation Award Selection Committee, Dept. of Computer Science, Univ. of New Mexico, 2018.
Member, Selection Committee, School of Engineering (SOE) Scholarships, School of Engineering, Univ. of New Mexico, 2017.
Chair, Undergraduate Lecturer Hiring Committee, Dept. of Computer Science, Univ. of New Mexico, 2012, 2017.
Self-study author for Bachelor degree accreditation by Accreditation Board for Engineering and Technology (ABET), Dept. of Computer Science, Univ. of New Mexico, 2011, 2017.
Faculty Advisor, ACM Student Chapter, Dept. of Computer Science, Univ. of New Mexico, 2016–present.
Member, Dean's Academic Advisory Council, School of Engineering, Univ. of New Mexico, 2012–present.

Courses Taught:
CS 293 Ethics and Social Impact of Computing
CS 357 Declarative Programming
CS 422/522 Digital Image Processing
CS 456/556 Advanced Declarative Programming
CS 530 Geometric and Probabilistic Methods in Computer Science
CS 491/591 Self-replicating Machines

Selected Publications:

Zhang, X. and L.R. Williams (2019), Euclidean Invariant Recognition of 2D Shapes Using Histograms of Magnitudes of Local Fourier-Mellin Descriptors, *Winter Conference on Applications of Computer Vision (WACV '19)*, Hilton Waikoloa Village, Hawaii.

Jensen, L.A. and L.R. Williams (2018), An FPGA Implementation of a Distributed Virtual Machine, *Unconventional and Natural Computation (UCNC '18)*, Fountainbleu, France.

Williams, L.R. (2016). Programs as Polypeptides, *Artificial Life*, 22(4), 451-482.

Williams, L.R. (2016). A Self-Replicating System of Ribosome and Replisome Factories, *15th Intl. Conf. on the Synthesis and Simulation of Living Systems (ALIFE '16)*, Cancun, Mexico.

Williams, L.R. (2014). Self-Replicating Distributed Virtual Machines, *14th Intl. Conf. on the Synthesis and Simulation of Living Systems (ALIFE '14)*, New York, NY.

Williams, L.R. (2013). Evolution of Tail-Call Optimization in a Population of Self-Hosting Compilers, *European Conf. on Artificial Life (ECAL '13)*, Taormina, Sicily.

Williams, L.R. (2012). Robust Evaluation of Expressions by Distributed Virtual Machines, *Unconventional and Natural Computation (UCNC '12)*, Orleans, France.

Ackley, D.H., Cannon, D.C. and L.R. Williams (2012). A Movable Architecture for Robust Spatial Computing, *The Computer Journal*, 56(12), 1450-1468.

Abbott, R.G. and Williams, L.R. (2009). Multiple Target Tracking with Lazy Background Subtraction and Connected Components Analysis. *Machine Vision and Applications*, 20(2), 93-101.

Zhang, J., Steinberg, S.L., Wilson, B. S, Oliver, J. M., and Williams, L. R. (2008). Markov Random Field Modeling of the Distribution of Proteins on Cell Membranes. *Bulletin of Mathematical Biology*, 70(1), 297-321.

Recent Professional Development Activities:

16th Intl. Conf. on the Synthesis and Simulation of Living Systems (ALIFE '18), Program Committee
European Conf. on Artificial Life (ECAL '17), Program Committee
15th Intl. Conf. on the Synthesis and Simulation of Living Systems (ALIFE '16), Program Committee
Invited talk, *Programs as Polypeptides*, Microsoft Research, Cambridge, England, 2015.
Invited talk, *Programs as Polypeptides*, University of York, York, England, 2015.
Invited talk, *Programs as Polypeptides*, Dublin City University, Dublin, Ireland, 2015.
Invited talk, *Programs as Polypeptides*, National University of Ireland, Maynooth, Ireland 2015.
European Conf. on Artificial Life (ECAL '15), Program Committee
Invited talk, *Self-Replicating Distributed Virtual Machines*, Dept. of Cognitive Science, Hampshire College, Amherst, Massachusetts, 2015.