

Strategic Plan for Computer Science

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This document presents a vision and a strategic plan for the Iowa State University's Department of Computer Science for the next five years.

This document is organized as follows. Section 1 presents the department's mission. Section 2 presents some historical background which is helpful in setting the context for this document. Sections 3–5 address the three major aspects of the department's mission. In each of these sections, we present the major goals for the department, a plan for achieving the goals, and criteria for measuring success. Section 6 presents the resource needs for accomplishing the goals. Section 7 outlines some barriers to achieving the goals. Section 8 explains how ISU and Iowa would benefit from a strong Computer Science department at ISU. Section 9 offers general recommendations to the department beyond those covered in sections 3–5. Section 10 presents specific recommendations to the university regarding the measures needed to address the crisis faced by department. Appendix A presents the department's perspective on the discipline of Computer Science. Appendix B presents a three-year hiring plan. Appendix C presents recommendations for dealing with the anticipated budget cuts during 2001-2002.

*This strategic plan was drafted by an ad hoc committee consisting of David Fernandez-Baca, Vasant Honavar, Gary T. Leavens, Giora Slutzki, and Johnny Wong with input from the entire Computer Science faculty. This document has been approved by the Computer Science faculty which also voted to forward the plan to the University administration (the Dean of Liberal Arts and Sciences, the Provost, and the President of the University).

1 Mission

Computer Science – the theory, representation, processing, and use of information, is fundamentally transforming every aspect of science, technology, and society. As a result, human endeavor is no longer constrained only by what is physically possible, but by what is computationally realizable. Being an informed citizen in this information age requires the ability to apply computational ways of thinking to design, analysis, experimentation, creative expression, and problem solving. Hence, every modern university, especially one emphasizing Science and Technology like Iowa State does, must have a strong Department of Computer Science.

The Department of Computer Science embraces its mission in research and graduate education (discovery), undergraduate education (learning) and outreach (engagement) in Computer Science.

Research and Graduate Education (Discovery)

Academic research in Computer Science has been, and continues to be critical to our understanding of computation, information, and communication on the one hand and the development of advanced information technologies on the other. Our department pursues its research mission through strong research programs in several key areas of Computer Science including Algorithms, Artificial Intelligence, Computational Complexity, Database Systems, Distributed Systems and Networks, and Software Engineering and Programming Languages. Given the central role of computer science and information technologies enabled by it in our modern society, there is a critical need for training of the next generation researchers and educators in this area. Our graduate curriculum seeks to address this need. The Department offers research-based graduate training leading to M.S. and Ph.D. degrees in Computer Science. It also plays a central role in interdepartmental graduate majors and minors in Bioinformatics and Computational Biology and Information Assurance.

Undergraduate Education (Learning)

With the increasing reliance of our society on advanced information technologies in almost every aspect of our lives, there is a critical national need for preparing the scientific and technological workforce of the twentyfirst century through education in Computer Science. Such education should equip the students not only with a sound knowledge of the foundations of computer science, but also the problem solving and system design skills necessary for designing and building robust, efficient, reliable, scalable, and flexible software systems. Our undergraduate curriculum seeks to address this need. The department has a strong undergraduate program leading to a B.S. in Computer Science.

Outreach (Engagement)

Computer science faculty and students contribute to the community at large in a number of ways including: technology transfer to industry, dissemination of knowledge and expertise to the general population, mentoring of precollege students, knowledge transfer to highschool

teachers, and consulting and advising activities for industrial, government, and non-profit organizations.

The Department of Computer Science is central to Iowa State University's research and educational mission. The constant flow of students and researchers armed with the concepts and techniques from Computer Science courses into virtually every discipline, department, and research center at Iowa State University testifies to the department's pivotal role in the research and education programs across the university. The department offers nationally and internationally recognized research and educational programs in several areas of Computer Science and plays a central role in several interdisciplinary programs such as Bioinformatics and Computational Biology. The constant flow into the department of some of the brightest students, researchers, and faculty from around the world and the high demand for our graduates and their success in leadership positions in both academia and industry bear testimony to the effectiveness of our research and educational programs.

2 Overview

The Department of Computer Science was established at ISU in 1969. The department currently has 18 full-time tenure track faculty, 30 resident Ph.D. students, 70 M.S. students, and approximately 700 undergraduates. The department also bears a fairly heavy service load because many of its undergraduate courses are required by other majors such as Computer Engineering.

Although it offered B.S., M.S., and Ph.D. degrees from the very outset, it was only around 1984 or so that the department began to emphasize graduate education and research. It is worth noting that all of the current faculty were hired since 1983. Fortunately for our department, the academic job market in Computer Science was very tight between 1986 and 1996. During this period, it was not at all uncommon for an open position in Computer Science to attract three or four hundred applications, including many from candidates graduating from the top Computer Science departments. Consequently, our department was able to hire some very strong, mostly young faculty in several key areas including Algorithms, Artificial Intelligence, Computational Complexity, Database Systems, Distributed Systems and Networks, Software Engineering and Programming Languages. In recent years, the escalating demand for training in Computer Science [5] has resulted in unprecedented plans for expansion of Computer Science programs around the country. As a result, the number of available faculty positions far exceeds the production of doctorates. Despite the tough competition, especially in experimental and applied areas of Computer Science, the department has been successful in attracting some very strong young faculty over the past five years.

As the faculty hired during the past 15 years have matured, the Department of Computer Science has made great progress in research and research funding. A number of Computer Science faculty have established well-funded research programs that have gained national and international visibility. The department has become a key participant in major interdisciplinary initiatives at the university such as the establishment of the graduate programs in Bioinformatics and Computational Biology (funded in part by a multi-million dollar training grant from NSF) and Information Assurance.

The department has managed to establish a fairly strong graduate program over the past 15 years. The Computer Science graduate program attracts nearly half of all graduate applications within the college of Liberal Arts and Sciences. It receives one of the largest and strongest pool of applications within the entire university. For example, this year, we received approximately 700 applications and admitted about 70 applicants, of whom approximately 20 were offered teaching or research assistantships. The M.S. degree recipients of our program are highly sought after by industry. Our recent Ph.D. graduates have taken up either academic positions or leadership roles in leading Computing research laboratories in the industry. The department has a strong undergraduate program. The graduates of our program are in high demand in the industry.

However, the enormous progress made by the Department over the past 15 years has not translated into additional resources for the department from the university. For example, as the Computer Science Accreditation Board (CSAB) team that visited our department noted in its report, the budget per student has significantly gone down over the past decade. There has been no increase in support staff. While demand for Computer Science courses has skyrocketed, the number of tenure-track faculty has stayed essentially the same as it was

a decade ago. There has been little institutional support for the instructional laboratory needs, and no plan, to the best of our knowledge, for meeting the physical infrastructure needs (e.g., office and laboratory space) of a growing department.

Due to the large number of undergraduate majors and the demand for Computer Science courses among other graduate majors (e.g., Bioinformatics and Computational Biology), the department bears an inordinately high teaching load relative to the small size of its faculty. This has led to some unavoidable adverse consequences for the students, e.g., inordinately large class sizes; difficulties with getting into the required Computer Science courses; fairly limited range of elective course offerings; and the elimination of the undergraduate minor in Computer Science. Furthermore, the escalating effective teaching load on the department is making it increasingly difficult for the faculty to balance their commitments to research and teaching.

With the current very strong job market for computer scientists, and with the continuing expansion and aggressive hiring by Computer Science departments at other universities, the department is at risk of disintegration unless immediate steps are taken to strengthen it over the next few years. For example, the department has recently lost several faculty members in key areas. Further losses are very likely, and the risk of disintegration is so strong that the word “crisis” does not overstate it. If this crisis is not addressed, it could result in irreversible damage to the University’s goals and certainly prevent ISU from becoming the best land grant university in the United States.

However, given its excellent faculty, strong funding record, and research accomplishments, if the current crisis is addressed through a necessary shift in institutional priorities accompanied by a targeted infusion of resources, the department has the potential to become one of the top Computer Science departments in the country. A necessary step in such a transformation has to do with establishment of a critical mass of faculty in promising research areas in which the department already has nationally and internationally visible research programs. This would enable the department to successfully compete for funding to pursue ambitious multi-investigator projects spanning multiple areas of Computer Science as well as other disciplines. The department would then be in a much stronger position to lead information science and technology related activities at ISU. In the process, it can help bring significant economic benefits to ISU and the state of Iowa.

3 Research and Graduate Education (Discovery)

Goal:

To achieve NRC rankings that place the Computer Science graduate program within the top quartile of all public universities offering doctoral programs in Computer and Information Sciences.

Plan:

- Pursue high impact, high visibility research in areas of national priority in information science and technology.
- Increase annual research expenditure to 2 million dollars within 5 years.
- Increase faculty size to 35 within 5 years with 3–4 new hires each year (see Appendix B: Hiring plan); Hiring should target key experimental and applied areas of computer science including Artificial Intelligence, Distributed Systems and Networks, Information Systems, and Software Systems, while maintaining current strengths (in Algorithms, Bioinformatics and Computational Biology, and Computational Complexity) and responding to emerging opportunities in other areas.
- Nurture research teams that span several areas of computer science to pursue bold new research directions in emerging areas of Information Technology.
- Improve the laboratory infrastructure for research in key experimental and applied areas of Computer Science including Artificial Intelligence, Distributed Systems and Networks, Information Systems, and Software Engineering and Programming Languages.
- Provide a nurturing and supportive environment for the continued professional development of all faculty, especially the junior faculty. More flexible arrangements for funding startup packages are needed so that junior faculty are able to spend the startup funds to best meet the needs of their research program over a 3-4 year period.
- Provide support for grant proposal preparation and better support for grant administration.
- Provide permanent staff to support faculty research computing laboratories. (The current situation in which faculty are expected to install, maintain, and handle security of their research computing laboratories is simply untenable).
- Increase the department's involvement in interdisciplinary research, especially in areas such as Bioinformatics and Computational Biology, Information Assurance, Virtual Reality, Computational Economics, Information Technology for Critical National Infrastructure, etc.

- Increase the production of Ph.D. degrees awarded to around 8 per year in 5 years. This translates to approximately 25 Ph.D. candidates in the graduate program at any given time, and assuming a retention ratio of 1 in 3, approximately 25 new students admitted per year.
- Aggressively recruit and retain the best qualified Ph.D. students. Build on recent progress in diversifying our graduate student body through recruitment efforts targeted at students from Iowa and the midwestern states, Europe (especially Eastern Europe), South America, and Asia.
- Increase the number of graduate assistantships (The number of graduate teaching assistantships offered by the department has significantly gone down over the past 5 years. For example, this year, only 10 teaching assistantships were available to be offered to graduate students admitted for fall 2001. This is nearly half of the number of positions available in previous years when we used to offer 20 or 25 teaching assistantships to first year graduate students).
- Provide the necessary support staff to handle the unusually large number of graduate applications and to deal with graduate student affairs. Continue to improve the infrastructure for handling graduate applications (e.g., by building on recent progress in making application status and other information to applicants through the graduate program web page).
- Periodically review and adjust the graduate curriculum and degree requirements for M.S. and Ph.D. to anticipate and respond to the changing needs of our discipline and to maintain and strengthen the quality of our graduate programs.
- Foster closer integration of research and instruction.
- Free research active faculty to focus their instructional efforts on offering a state-of-the-art curriculum for graduate and undergraduate majors by staffing 100 and 200 level courses with competent instructors.
- Lead the establishment of a Computer and Information Sciences and Engineering (CISE) Research Institute to foster interdisciplinary research in emerging areas of Computer and Information Sciences and Technology [1, 2, 4, 3, 14, 15].
- Build closer ties with industry through visiting positions, internships for Ph.D. students in industrial research laboratories, etc.

How to Measure Success

- National Research Council Rankings.
- Scholarship as evidenced by publication of research monographs, edited collections, of articles in major peer-reviewed conferences and journals.
- The level of Research funding relative to the size and experience of the faculty.

- National and international visibility of the faculty (e.g., leadership in major professional conferences, editorship of journals, participation in grant review panels, invited lectures, etc.)
- Placement of M.S. and Ph.D. graduates.
- External Reviews.
- Quality of incoming graduate students compared with peer institutions.
- Involvement in interdisciplinary collaboration in research and teaching.
- Collaboration or interaction with other institutions and industry.
- Surveys and reports published by professional organizations such as ACM, CRA and federal agencies such as the NSF.
- Review by Industrial Advisory Board.
- Exit and followup surveys of graduates.

4 Undergraduate Education (Learning)

Goal:

To provide the best possible undergraduate education without compromising the research and graduate training missions.

Plan:

- Periodically assess and adjust the number of undergraduate majors in order to ensure the quality of the undergraduate educational experience. We believe that no more than 250 majors (not counting freshmen) is the appropriate size for our undergraduate program given the current tenure track faculty size (18), laboratory and TA resources. This translates to a ratio of number of majors per faculty of 15 which is close to the university average. If we include the freshmen in this calculation, the ratio is significantly higher than the university average.
- Develop state of the art laboratories to support instruction in key areas of experimental computer science (e.g., Artificial Intelligence, Bioinformatics and Computational Biology, Distributed Systems and Networks, Information Systems, Software Engineering and Programming Languages) through continued vigorous efforts at raising funds from ISU, industry, state, and federal sources to support such labs.
- Foster closer integration of teaching and research - including adequate opportunities for undergraduate participation in research.
- Streamline undergraduate advising by setting up web pages with the necessary information and tools for students to design their undergraduate programs.
- Streamline and adjust the undergraduate curriculum so that it continues to be responsive to the training needs in our rapidly changing discipline.
- Facilitate student participation in cooperative training opportunities in industry.
- Ensure reasonable class sizes, especially in courses that involve significant laboratory (programming) component. The enrollment in lecture sections should not exceed 50 and there should be at least one teaching assistant per 25 students [26] to ensure the quality of educational experience for our undergraduates. Because of lack of adequate funds for hiring graduate teaching assistants, our department has come to rely increasingly on undergraduate teaching assistants in many of the undergraduate courses. While the use of undergraduate teaching assistants is reasonable in service courses like ComS 103, it is far from ideal in 200 and 300 level undergraduate courses. Furthermore, increasing reliance on undergraduate TAs has adversely impacted our ability to support graduate students.
- Hire *competent* instructors to teach 100 and 200 level courses for undergraduates. To ensure the quality of instruction in these courses, it is necessary for a tenure track faculty member to serve as a course coordinator (with appropriate reduction in teaching

load) and be involved in designing the courses and supervising instructors. It is necessary to establish *quasi-permanent* instructor positions that can be renewed subject to satisfactory performance, beyond 6 years.

- Until such a time that the department has adequate resources to meet its commitments to research, graduate education, and undergraduate education for its majors, limit service course offerings to those that can be funded entirely by client programs that require their majors to take the respective Computer Science courses.

How to Measure Success

- Outcomes assessment data e.g. exit and followup surveys of graduates.
- Placement of graduates in leading graduate programs or industry.
- Assessment of Employers.
- Accreditation reviews.
- Review by Industrial Advisory Board (see below).

5 Outreach (Engagement)

Goal:

To establish strong, mutually beneficial relationships with industry within and outside the state, schools and colleges within the state, the scientific and professional community, and the society at large.

Plan:

- Host major national and International Conferences in Computer Science and Information Technology at ISU.
- Establish an active industrial advisory board to provide input on research and education programs in Computer Science.
- Have workshops with industry to showcase collaborative research and development opportunities.
- Provide support for internships (e.g., electronic matchmaking).
- Increase participation in Program for Women in Science and Engineering (PWSE), ISU programs for Talented and Gifted K-12 students (CYTAG), etc.
- Increase academic involvement with historically underrepresented groups (e.g., by pursuing cooperative arrangements with historically black colleges and universities).
- Increase involvement in leadership roles in professional and scientific organizations.
- Increase faculty involvement in the broader community (e.g., through participation in advisory boards).

How to Measure Success

- Partnership in Economic Development in the State.
- Assessment of Industrial Advisory Board.
- Technology development (e.g., software, patents, spin-offs).
- Broader impact on the community (e.g., as documented by News articles etc.)

6 Resource Needs

- 15 additional faculty lines over 5 years, with hiring targeted in critical areas such as Artificial Intelligence, Distributed Systems and Networks, Information Systems, and Software Systems while maintaining current strengths in other areas (Algorithms, Bioinformatics and Computational Biology, Computational Complexity).
- New space to house the faculty, graduate students, research labs, seminar rooms and interaction areas, and at least one state-of-the-art lecture hall. (The lack of adequate laboratory and office space, and seminar and meeting rooms is making it difficult to hire and retain faculty, especially in experimental and applied areas of Computer Science).
- At least 3 additional office staff (including 1 person dedicated to grant preparation and grant administration). The average ratio of faculty to office staff in computer science departments in North America is around 3:1 [27].
- 2 additional computer systems support staff to provide adequate support for research and instructional labs. (The current situation where the support for instructional laboratories is barely adequate and support for research laboratories is non-existent is simply untenable).
- 5 additional full-time instructors to cover low-level undergrad courses and courses for non-majors. (It is difficult to meet the university's expectations with regard to undergraduate teaching for majors and nonmajors without significant increase in the number of instructors).
- Provide stable and adequate levels of funding to enable the department to meet the university's expectations in terms of undergraduate instruction. (The current situation wherein the department has to rely on last-minute allocation of "emergency" teaching funds to maintain its course offerings is simply untenable. It is almost impossible to find competent instructors or teaching assistants within a few days prior to the beginning of classes).
- Continuing budget (\$ 300,000 per year) for maintaining state-of-the-art instructional and research facilities. (The current situation in which the Computer Science department is expected to provide instructional laboratories for nearly 4000 university students, in the absence of a stable allocation of funds from the university is simply untenable).
- Funds to support CISE Research Institute (faculty buy-outs, funds to support graduate students and postdoctoral fellows, space, support staff).

7 Barriers to Achieving the Goals

- Lack of adequate institutional commitment to Computer Science. The university's resource commitments to Computer Science have consistently and significantly fallen short of what is needed to meet the department's mission in a major public university with a science and technology emphasis. According to the results of a survey of Computer Science departments around the country published by the Computing Research Association (CRA) [27], the ISU computer science department is well below the national average in terms of key measures of resources such as faculty size, number of secretarial and administrative support staff, physical and laboratory infrastructure, and laboratory support staff.
- Severe resource constraints (e.g., budget cuts) that prevent the department from taking advantage of opportunities to hire in critical areas. For example, the department was prevented from extending offers to some outstanding faculty candidates over the past several years because of lack of funds. This year, we lost the opportunity to hire one of the top people in artificial intelligence.
- Lack of understanding of Computer Science as a major scientific discipline and lack of appreciation of its role in a major public university. This is probably a consequence of the relative youth of the discipline compared to more established sciences such as Physics and Chemistry.
- Difficulties in hiring faculty in critical areas. Given the lack of critical mass in key experimental and applied areas, and lack of a clear mandate for growth in the size of the faculty in Computer Science, the department faces intense competition from its peers in attracting new faculty, especially when the number of open positions in U.S. universities significantly exceeds the production of doctorates in Computer Science.
- Difficulties with retaining faculty in critical areas. All of the current Computer Science faculty were hired during 1983-2000. Between 1986 and 1996, there were relatively few tenure-track academic positions for Computer Scientists, due in part, to the prevailing economic conditions. In contrast, at present, most Computer Science departments are aggressively hiring at all ranks, especially in experimental and applied areas. Consequently, in light of the lack of adequate resources for the department and the perceived lack of university's commitment to Computer Science, the department risks losing some of its most productive faculty to other universities.
- Uncontrolled growth in undergraduate enrollment, without the necessary infusion of resources to meet the instructional needs. Our enrollment has grown more than 50% over the past five years whereas the number of faculty has essentially stayed the same.

8 Benefits to Iowa State University and the State of Iowa

Stronger and larger Computer Science department will benefit education at Iowa State University. With increased faculty resources, the department would be able to offer courses to larger numbers of undergraduate Computer Science majors and larger numbers of Computer Engineering majors. More importantly, the department would also be able to again offer an undergraduate minor in Computer Science. The department would also be able to offer more liberal access to graduate minors. All of these will enhance the the quality and reputation of the department's graduate and undergraduate programs.

Research at Iowa State will benefit from increased research funding, and the ability to leverage strengths in Computer Science into strengths in other high priority areas such as Agriculture (Plant Sciences and Animal Sciences), and Engineering. Computer Science plays a pivotal role in cross-disciplinary research and education in Bioinformatics and Computational Biology, Information Assurance, Computational Sciences and Engineering, etc. A strong Computer Science department will put the university in a strong position to pursue ambitious interdisciplinary initiatives in Information Science and Technology in areas such as Bioinformatics and Computational Biology [22], Digital Government [19, 11], Information Assurance, Human-Computer Interaction [7], and Information Infrastructure [1, 2, 4, 3, 8, 9, 13, 15].

Iowans will benefit from more accessible, state-of-the art educational opportunities for undergraduate and graduate students in Computer Science. Iowa will be able to attract information technology industry as well as other industry that is highly dependent on an information technology base. This is critical to transforming an economy that is almost entirely based on agriculture into one that is more broadly based and hence more robust. This will improve the tax base, help retain highly educated Iowans in Iowa, and improve the quality of life in the state.

9 Recommendations to the Department

- In order to be able to attract research active faculty to take on the Chair's job, create an environment in which the Chair is able to maintain an active research program. For example, establishing the position of an associate chair or at least an assistant to the chair whose primary responsibility would be to deal with day-to-day administration of the department would be extremely helpful. It might also be useful to explore establishing the positions of a Graduate Program Chair to administer all aspects of the graduate program including recruiting, evaluation of applications, graduate curriculum, graduate student affairs; and liaisons with interdepartmental graduate programs such as Bioinformatics and Computational Biology, Information Assurance, etc.; and an Undergraduate Program Chair to administer all aspects of the undergraduate program including advising, undergraduate curriculum, undergraduate affairs, accreditation, and outcomes assessment. Faculty serving in these positions should receive appropriate reductions in other responsibilities (e.g., teaching, service) as necessary.
- Strengthen and empower the major departmental committees by giving them more responsibility and increasing their accountability.
- Improve communication and exchange of information between the university administration and the department (e.g., emerging opportunities, policies, initiatives, and strategies) through both formal as well as informal channels. It is especially important for the department to engage the university on all matters concerning research, education, and outreach involving computer and information science and technology.
- Facilitate better communication between the departmental administration, the faculty, graduate and undergraduate students (e.g., by working with the Graduate Advisory Committee, the Computer Science Club), and the administrative and systems support staff.
- Periodically assess and adjust the department's mission and strategic plan to respond to changes in the discipline as well as emerging opportunities and needs. Hold annual retreats for the faculty to discuss long-term strategic plan, major issues, and implementation of the strategic plan.
- Vigorously pursue all available avenues to educate and inform the University administration, the university community, the State Government, and the broader community about the nature and importance of Computer Science as an academic discipline, and its role in a major university, and the society at large.
- Vigorously pursue the strategic plan.

10 Recommendations to ISU Administration

- Major allocation of funds from the University to help Computer Science department at ISU become one of the top departments in the country. This might involve modifications to the formulae that are used to decide the funding of programs at the university to make them responsive to the demands on the programs or reallocations that are in line with the university's priorities with respect to information science and technology. In the case of Computer Science which has experienced steep growth in demand at the undergraduate and graduate levels, allocation of funds from tuition and other revenues should reflect the current and projected demands on the program.
- Return of a significant fraction of the indirect costs on research grants to the department.
- Entirely new funds from the State have to be sought to ensure that the Computer Science department is able to lead ISU and the state into a future that will be increasingly driven by advances in computing and information science and technology.
- Aggressive fund raising in coordination with the ISU Foundation to finance new initiatives in Computing (new building, CISE Research Institute, etc.).
- Explore long-term strategies and organizational restructuring that may be necessary to adequately fund the the Department of Computer Science at ISU including: the establishment of a School, College, or Faculty of Computing which could serve to better focus current efforts in Computer Science, Computer Engineering, Information Security, Bioinformatics and Computational Biology, Virtual Reality, Management Information Systems. Several major universities have successfully adopted this model to strengthen their programs in Computer Science and related areas [28, 29, 30]. Examples include Carnegie Mellon University, Georgia Tech, Pennsylvania State University, Cornell University, University of Edinburgh (UK), among others.

Appendix A: Computer Science as an Academic Discipline

The emergence of Computer Science as a discipline is perhaps one of the most significant intellectual developments of the twentieth century. Computer science, broadly defined, is the theory and practice of representation, processing, and use of information. The field is still in its infancy, yet encompasses a large and rapidly growing body of knowledge concerning algorithms, information processing, communication, languages, and information systems. It employs both theoretical as well as experimental approaches to advance the state of knowledge in these areas. It offers a powerful paradigm for modeling complex phenomena such as cognition and life, and representing, processing, acquiring, and communicating knowledge that is new in the history of humanity. The power of this paradigm is evident everywhere in our technological society. It has begun to dramatically change our conception of reality.

Almost every aspect of everyday life has been transformed by information technologies enabled by Computer Science. There is a growing realization that information technology is essential for solving critical problems in areas such as fundamental science [12, 14, 15], engineering, education [18, 16], environment, health care [17], economics, commerce [10], and government [11]. The recent explosive growth in computer power and connectivity is reshaping relationships among people and organizations, and transforming the processes of discovery, learning, representing, understanding and communication. As a result of these technological advances, we have unprecedented opportunities for providing rapid and efficient access to enormous amounts of knowledge and information; for studying vastly more complex systems than was hitherto possible; and for advancing in fundamental ways our understanding of information processes in society, nature, and artificial systems. Computer Science plays a central role in facilitating major advances in human capability to generate, model, and represent more complex and cross-disciplinary scientific data from new sources and at enormously varying scales; to transform this information into knowledge by combining and analyzing it in new ways; to deepen our understanding of learning and intelligence in natural and artificial systems; and to collaborate by sharing knowledge and working together [15, 25, 13].

Computer science is transforming several of the basic and applied sciences including biological, physical, and cognitive sciences. The language of algorithms provides to the study of life and mind what calculus provided for the study of physics. Without the language of calculus (which provided the tools for characterizing and quantifying rates of change), it is hard to conceive of classical physics, mechanics, and most branches of engineering. Computer programs embody new theories and dynamic models of cognitive phenomena such as memory and learning, perception, language understanding, and problem solving; physical phenomena such as planetary motion; biological processes such as brain function, gene regulation, reproduction, adaptation, and evolution; and social phenomena such as cooperation, competition, and economic behavior. Due to its central role in entirely new scientific disciplines that are emerging, Computer Science is fundamentally transforming the way we understand ourselves and the world around us.

- A new breed of scientists, armed with the knowledge of computer science and training in biological sciences are making fundamental advances in biological sciences and con-

tributing to the formation of new disciplines such as bioinformatics, and computational biology [22, 23, 17].

- A new breed of scientists, with training in computer science and physical sciences are making fundamental contributions in emerging disciplines such as computational physics, and computational chemistry [15, 17].
- A new breed of technologists trained in computer science as well as the appropriate scientific and engineering disciplines are developing sophisticated new technologies for computer aided design and manufacturing, simulation of complex manufacturing processes, and virtual reality [15, 7, 4].
- A new breed of scientists and technologists trained in computer science and cognitive sciences are making fundamental advances in understanding brains and minds and designing intelligent agents that perceive, reason, learn, choose, communicate, and interact with people as well as complex environments in interesting and useful ways [25, 4].
- Computer Science and information technologies enabled by Computer Science are leading to improved health care through advances in medical informatics, computer-assisted surgery, and computational drug design [15, 17].
- The tools of information technology that were enabled by Computer Science are transforming agriculture and food production through advances in areas such as bioinformatics and precision farming [15, 23].
- The tools of information technology that were enabled by advances in Computer Science are transforming business practices through the emergence of electronic marketplaces, electronic investing, electronic banking, sophisticated software tools for scheduling and workflow and inventory management [15, 3, 10].
- Information technology has become critical to major functions of the government in areas such as national defense, disaster management, and law enforcement [8].
- Information technology is leading to novel approaches to education and training using virtual (simulated) environments for flight training, surgical training, and disaster management [15].
- In the social sciences, entirely new disciplines are emerging as a result of marriage between computer science and social science (e.g., computational organization theory, computational economics) [10].
- In the humanities and the arts, new media and new avenues for creative expression through computer generated or computer assisted music, drawings, paintings, characters (e.g., in movies) and multi-media art have resulted from advances in computer science.

- Our society is on the threshold of an era of intelligent artifacts which is being ushered in, to a large extent, by advances in Computer Science and information technology. Some of the developments around the corner include smart buildings, smart highways, smart appliances, smart artificial organs and prosthetic devices, smart vehicles, intelligent communication networks, and intelligent personal information assistants [4, 3, 15].

As a result, human endeavor is no longer constrained only by what is physically possible, but by what is computationally realizable. Being an informed citizen in this information age requires the ability to apply computational ways of thinking to design, analysis, experimentation, The significance and range of impact of Computer Science and the information technologies enabled by it make it central to the mission of a modern public university.

Appendix B: Hiring Plan for the next 3 years

State of the Computer Science Department

Over the past 15 years, we have managed to recruit and retain several strong faculty. The current faculty provide a strong core around which to further strengthen our research program, increase our external funding, and strengthen our graduate and undergraduate curriculum.

Departmental Needs

Our department is committed to excellence in research and graduate and undergraduate education in Computer Science as well as interdisciplinary programs at ISU such as Bioinformatics and Computational Biology, Information Assurance, and related areas. We immediately need to increase our faculty size in critical areas in order to meet our goals (see strategic plan).

Hiring Plan

The basic approach to hiring is aimed at building critical mass to foster promising research groups built on our current strengths in the following areas: Artificial Intelligence (Data Mining, Intelligent Agents), Distributed Systems and Networks, Software Systems (Software Engineering, Programming Languages, Performance Modelling) and Information Systems (Semi-Structured Databases, Multi-Media Databases, Biological Databases), while maintaining current strengths (in Algorithms, Bioinformatics and Computational Biology, Computational Complexity), and responding to emerging opportunities in other areas. A major objective of the hiring plan is to ensure that each major area of research and education in the department has at least 2 or 3 faculty members to ensure a healthy environment for graduate training and the ability to maintain a stable set of graduate and undergraduate course offerings even when individual faculty members go on faculty development leave. Whenever feasible, we propose to hire new faculty who will strengthen multiple research areas or research groups within the department and across the university. The hiring plan calls for hiring four people (one in each of the four areas) each year for the next three years to meet the current and future needs of the Computer Science Department.

Given the need to build a critical mass of faculty in Artificial Intelligence (in light of current demand for advanced training in the area as well as extensive opportunities for crossdisciplinary collaboration in emerging areas of strength at ISU such as Bioinformatics and Computational Biology and Information Assurance), and the fact that we have hired at least one faculty member in each of the four areas except Artificial Intelligence during the past 2 years, we shall aggressively hire in Artificial Intelligence at the earliest available opportunity. This is especially important since the department has been grossly under staffed (with only 1 faculty member) in Artificial Intelligence for over 10 years.

Appendix C: Surviving the Anticipated Budget Cuts

The Department of Computer Science is not in a position to absorb cuts without major, very likely irreversible, damage to our research, graduate, and undergraduate programs and our role in interdisciplinary initiatives in areas such as Bioinformatics and Computational Biology. If the department is faced with cuts in the next several years, the likely outcome will be the rapid disintegration of the department and significant deterioration of the quality of research and educational programs in Computer Science, resulting in irreparable damage to ISU. (We have lost several faculty in key areas over the past three years, and this is likely to continue unless major steps are taken to address the underlying problems, most of which have to do with lack of institutional support, and the perceived lack of institutional commitment to the department).

If the cuts are short-term (e.g., limited to this fiscal year), the Department can survive the budget cuts provided it is able to reduce its teaching demands while protecting its research and graduate programs. Some measures for dealing with budget cuts in the short term and their possible consequences are as follows:

- Temporary reduction or elimination of a significant fraction of undergraduate service course offering. This would have a corresponding impact on the rest of the university, but it is unavoidable given the resource limitations.
- Introduction of strict limits on enrollment in the courses. In order to ensure adequate quality of educational experience for students in our classes, in light of the anticipated reductions in TA lines and temporary teaching funds, the size of each lecture section should be no more than 50 students, with at least one teaching assistant per 25 students [26]. Limits on enrollment will adversely affect undergraduate majors and non-majors who need Computer Science undergraduate courses as part of their program of study. In many instances, it will prevent students from completing their degree programs within 4 to 5 years.
- Introduction of strict limits on the number of undergraduate majors. Limits on the number of majors will reduce access to the Computer Science undergraduate program for Iowa residents and reduce the tuition revenues for the university.

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