

**UNIVERSITY OF MASSACHUSETTS AMHERST  
OFFICE OF THE SECRETARY  
THE FACULTY SENATE**

**PROGRAM PROPOSAL SIGNATURES SHEET (FINAL APPLICATION)**

**PROGRAM TITLE:** Bachelor of Arts in Computer Science

**PLEASE CHECK:** GRADUATE []      UNDERGRADUATE []

**DEPARTMENT:** Computer Science

**HEAD/CHAIR:** Prof Andrew G. Barto

**SCHOOL OR COLLEGE:** College of Natural Sciences

**DEAN:** Steve Goodwin

**Submission Date:** 30 October 2009

**Proposed Starting Date:** 1 September 2010

**Degree to be awarded:** Bachelor of Arts

**Appropriate time required for completion:** Four years

**I. PROPOSAL DEVELOPMENT**

**Provide a brief overview of the process for developing the proposed program, including any use of outside consultants or assistance provided by prospective professional accreditation groups.**

Beginning in the fall of 2005, the Computer Science department undertook a comprehensive review of its undergraduate offerings. Since our last such review in 1995 (when the web, for example, was largely a tool for academic research), the field had changed considerably and necessitated a number of changes to our course offerings. We were and are also concerned about the limited population of undergraduate students we attract, and the difficulty of combining undergraduate study in computer science with other areas. As a result of this review, we have already carried out several initiatives:

- A new program of about 20 upper-division courses at the 300 and 400 levels, all reflecting active research activities within the department. Many of these courses are based on courses previously offered at the 500 level, to final-year students. Our goal in this change is to bring exciting, cutting edge aspects of the discipline within reach of our students at an earlier stage of their undergraduate careers.
- A revision of the core lower-division courses for majors including new courses in computer systems principles, programming methodology and reasoning under uncertainty, targeted to prepare for the upper-division courses. Several of these courses are novel within our discipline, and reflect our projections of how computer science will be applied in the future.
- A revision of the BS requirements to reflect these curriculum changes, with fewer specific courses required for all majors and more upper-level courses as part of defined concentrations within the major, giving students simultaneously more flexibility and more guidance. The goal in making our BS more flexible and agile with respect to trends in the discipline is to attract more majors and to prepare them for a wider range of computing industry careers and graduate programs. This revision received final approval by the Faculty Senate in the spring of 2009.
- A coherent set of options for students with varying levels of commitment to computer science, ranging from service courses for non-majors and introductory courses for majors, through a revised minor (requiring five courses rather than nine), all the way to the BS degree.

Towards this last goal we propose a new degree program, a BA in Computer Science, to serve students who seek to combine computer science with intellectual strength in a second discipline, but not in the traditional combination of a BS in computer science with a minor in another field. The BA is not simply a lighter version of the BS – it requires fewer technical courses, but includes a four-course concentration in some other field, related to the theory or practice of computer science.

During this review process, the department underwent its periodic AQAD review, where a panel of distinguished visitors considered all aspects of our academic and research programs. We presented them with a slightly different version of this BA proposal as part of their review of our undergraduate program. Their specific comment on the BA was as follows:

"Being able to offer both the BS and the BA degrees is great for the students. It is important to be able to do this without extra teaching burden on the faculty so the department can preserve the strong research environment."

Their overall recommendation regarding the undergraduate program revisions was also highly supportive:

"The review committee strongly endorses the plan to make the undergraduate program more flexible and more problem- and idea-oriented. There is a critical national shortage in the workforce in computing. Attractive jobs are widely available. Starting computer science salaries are high compared to other technical degrees. The current ebb in CS enrollment is causing a national shortage of computing professionals. The more flexible curriculum will help in attracting a more diverse group of students. We advise the university not to overreact to the current lower enrollment because CS enrollments are cyclical."

## II. PURPOSE AND GOALS

### A. Describe the program's purpose and the particular knowledge and skills to be acquired by program graduates.

The BA in computer science will graduate computing professionals who have the necessary depth of expertise in computer science to have lifelong careers in the field, and who, at the same time, have sufficient exposure to a second discipline to be able to interact with professionals in that field in a knowledgeable manner, so as to apply advanced computer science techniques to problems in that second area. The skills to be acquired will include essentials of computer programming, elements of software engineering, theory of computation as applied to large problems and/or problems in which there is uncertainty, and upper division electives in a wide variety of computer science subdisciplines, such as networking, databases, programming languages, artificial intelligence, robotics, computer vision, graphics, computing theory, software engineering, and so on. Students in the BA will also engage in a four-course concentration in a second field, as approved by the department, to obtain depth of knowledge in that area. Three semesters of mathematics, including two semesters of calculus (possibly at the level appropriate for business or the life sciences) will be required. Under current college requirements (which could change with Computer Science's move to CNS), the BA will also require four semesters of foreign language (or equivalent) and two courses in the humanities in addition to General Education.

### B. Describe the goals you hope to achieve within five years and specify the measures which would be used to determine the successful achievement of those goals.

#### Background

The Computer Science Department at UMass Amherst is uniquely positioned as the only highly ranked CS program (top 20 nationally) in a Massachusetts public university. The undergraduates in our current BS degree program have access to exciting research opportunities, state-of-the-art equipment, and a faculty comparable with other top-ranked computer science departments in the nation. In their upper-level courses, our undergraduates are exposed to ideas on the leading edge of computer science. The current program works well for students who have chosen to dedicate themselves to computer science, but less well for a variety of other highly capable students whose interests extend beyond pure computer science.

#### The Problem

As we move into the 21<sup>st</sup> century, we believe it is important for the field of Computer Science to attract and encourage a student population that is more diverse in its interests and future directions. One of our goals is to support students who want to combine an interest in computer science with other interests throughout the sciences and humanities. Computer technologies have had a profound impact on research in every field of science, on communications, on business, on health care, on education, on the military, and on the media. Computer scientists have had a hand in all of these transformative technologies, and future generations will continue to pursue innovations in all of these areas and more.

Our existing BS program offers the exciting research activities and expertise of our faculty to a relatively select group of undergraduate majors, primarily late in their careers. But our mission should be to provide a fine computer science education to a wide variety of students, producing more graduates who will benefit the state and the nation.

Students today view computers as essential elements for modern life whether they choose to study computer science or not. It is time for us to stop treating computer science as a field that is separate from the rest of the world. Both that world and the workplace need more students who know about computing *and* something else at the same time.

Unfortunately, our demanding BS degree requirements do not afford our majors many opportunities for exploration outside Computer Science. Strong math and science requirements for the BS leave limited room for Computer Science electives, let alone courses in other departments. Many of our best students are double majors, but a double major including Computer Science is extremely demanding. Of those who try, most have found it difficult to finish in four years.

An anecdote may help illustrate our point. Marisa Pacifico entered UMass Amherst as an undeclared pre-major, interested in business, in the fall of 2005. In her first year she took CMPSCI 121, liked it, and asked about a double major in business and CS. She was told that it would be difficult, requiring at least ten very busy semesters to complete. It was difficult, but she has persevered and is on track to complete both majors in the spring of 2010. She is active in our CS women students group and is now finding unexpected connections between her computer forensics course and her work in accounting. We believe there are many more Marisas out there, and that we are losing some of them who are not prepared to combine our existing BS degree with work in another field, either as a concentration or as a double major.

#### Goals

Given where we are, our primary goal in creating this program is to increase the number and diversity of computer science majors without significantly decreasing the number of majors in the existing BS program. Our target five years out is

to be granting 20 to 40 BA's per year, with a steady state of approximately 120 students in the BA program in addition to the 290 currently in the BS. The numbers of students enrolled and graduating are clear measures of the program's success. Because we want the new program to draw from new sources, rather than taking students from the BS program, we will track the number of students who switch programs through our annual exit interviews with seniors.

In addition, we seek to increase the percentage of students from groups underrepresented among computer science majors. While the ongoing changes to the BS are meant to address this, we anticipate that the BA will be even more attractive to such students. Thus, our goal is to reach the level of 20% women and minorities in the BA, which is about four times the current percentage in the BS program.

Another goal in creating the BA program is to encourage more students to double-major in disciplines that are more diverse than the present double majors. Currently we count roughly 30% of our BS students as double majors, based on actual advising information (although, according to the University's OIR report, it is only 5% -- a discrepancy that we believe is due to different accounting mechanisms). On average, about half of these are actually our best students doing dual degrees, such as Computer Science plus Electrical and Computer Engineering, taking a minimum of five years. The majority of our regular, four-year, double-major students do so with mathematics as the second major because the requirements of the two BS degrees are aligned in such a manner that for a mathematically oriented student, doing a math double major involves careful selection of electives and only a modest amount of extra work. Thus, at five years out our goal is for 20% of the students in the new program to be in double majors, but in a broader range of disciplines.

The BA program also provides an easier entry path for community college students. We currently see a good number of transfers into the BS (30% of graduates) who are very technically oriented. However, from our contacts with the community colleges we believe that there are a significant number who could succeed in the BA program but who go elsewhere because they see the BS as either too challenging or lacking the flexibility to combine with another discipline. Thus, we also anticipate 30% of our BA majors will come from community college transfers.

**C. Identify in general the strategies for achieving these goals and for ensuring the continuing quality of the program.**

The new program is largely based on our existing program. The significant differences are some relaxation of the math requirements to be more compatible with the math that is required by other degree programs across the campus, and the replacement of four upper-level CS courses with a four-course concentration in another discipline (with an option to use a related course in CS as one of the four concentration courses). While the rigor of our current calculus requirements serves our BS majors well, it is not absolutely necessary if certain upper level electives are not included a student's program. On the other hand, it is an impediment to double-majoring by students in other fields that require, for example, the business-oriented calculus sequence.

The quality of the program will be maintained by continuing to require that students take the fundamental computer science curriculum, and by designing concentrations that are cohesive and rigorous. We do not want to dilute the value of a UMass Computer Science degree with a weaker program, but rather create a comparable program that stands beside it with greater flexibility for combining CS with other arts and sciences. We hope to use this flexibility to attract top students from across the country who are looking for a program that offers them the opportunity to engage in novel combinations of disciplines.

**III. MISSION CONTEXT**

**A. Describe in detail how the proposed program supports the mission and current priorities of the campus. Also comment on whether and how the proposed program supports the mission and priorities of the University and the system of public higher education in Massachusetts.**

Our goal in adding this program is to increase enrollment, both of Massachusetts residents and non-residents, in our major.

Through this, we seek to train a new generation of computing professionals to serve the Commonwealth and nation in ways that apply computer science more broadly than in the past. The result will be novel developments in industry that expand the economy of our state and nation. This program will be unique in the system and the Commonwealth by providing a BA in Computer Science from a top-20 public computer science department.

**B. Explain the general impact of expanding the campus' academic degree offerings through the addition of the proposed program as well as the likely effect of the new program on the quality of the campus' existing offerings.**

Current BS students, through their comments in exit interviews, have largely said that they would not have preferred a BA after having gone through the BS. These are students who chose our current program because of its focus and depth in the field. Through the BA, we hope to attract new students, including those directly entering the program (particularly students who might otherwise be undecided due to multiple areas of interest), late adopters, double majors, and community college transfers.

**C. Describe whether students will be drawn from the enrollments in existing program offerings, or whether new students will be attracted to the campus by the program (if the latter, describe what evidence supports this conclusion).**

As noted above, most of our current BS students have indicated that they would not have gone through a BA, given that choice. Thus, we do not believe that this new program will draw students away from our BS. We might attract some students who would otherwise do a BDIC program. We do hope that the BA enables more double majors, which will not decrease the enrollment in other programs. However, we expect the majority of our new majors will come from additional enrollment in the university, based on how we feature the advantages of the new BA in our program description. We particularly intend to

target underrepresented groups in recruitment for this program, as it offers programmatic flexibility that is likely to be attractive to women and minorities.

#### IV. NEED

##### A. Provide evidence of student demand and current career opportunities for graduates of the program.

At the national level, computer science faces a number of challenges. Programs have experienced declining enrollments (particularly among women and minorities) that result from a number of factors: perception of the job market (outsourcing, the dot-com bust); perception of what computing is, and what computer scientists do (the “Dilbert view”); the perceived narrow technological focus of degree programs, the need for strong mathematics preparation, a “filter” approach to introductory curricula; etc.

The reality is, in fact, very different from much of this perception. A 2006 survey from Money magazine rates “Software Engineer” as the best job for the coming decade out of 200 job titles – best according to a blend of growth potential, pay, and working conditions. A recent, more focused, report from the Bureau of Labor Statistics projects that the professional level IT workforce, which includes computer science, will grow at more than twice the rate of the workforce at large in the US between 2004 and 2014. Despite this, many students reject computing out of hand, because they regard the field, and particularly computer science, as the province of white male “techies” – another misconception, but also, increasingly a self-fulfilling prophesy.

The Computer Science Department currently offers a single degree, a Bachelor’s of Science in Computer Science. Driven by faculty interests, the curriculum has focused on a software and mathematics core, supplemented by a wide variety of electives that reflect faculty research areas. It prepares students well for graduate studies and for careers in companies like Google, IBM, Microsoft, etc., that have a principle emphasis on computing technology. However, there are many more jobs available in industries that apply computing in sophisticated ways, including entertainment, the financial sector, medicine, education, and so on. Such jobs now expect graduates to have both a strong foundation in computer science and depth of knowledge in a second domain. There is also increasing emphasis on teamwork, communication skills, and lifelong learning.

Presently we have approximately 290 undergraduate majors, down from about 550 at the peak of the dot-com craze. We believe that by creating a more flexible program that bridges to other fields of study, we will see an increase in the number of majors, and especially in the area of underrepresented groups. The proposed BA program will facilitate more tailored studies in areas such as bioinformatics, computer arts, digital forensics, computational linguistics, etc., and will offer more flexibility for structuring double majors.

In corroboration, at other schools, we see that the enrollment and diversity of information technology degree programs (i.e., IT majors, IS majors, that combine computer science with, e.g., business, pre-law, entertainment) has not declined, but has grown, over the last decade. Clearly there is student interest in studies that combine other disciplines with computer science.

Computer science and allied fields are important for our national scientific and economic life, and represent a continuing source of interesting, valued, and well-compensated work. UMass students recognize the need for IT skills – our IT minor has grown rapidly since its inception. Importantly, 40% are women and 15% are African American or Latino/Hispanic. In Fall 2006, new students enrolled with a female/male ratio of 59%/41%. The BA in Computer Science will provide another option for those students who desire greater depth in computer science without committing to a traditional BS program.

##### B. If the proposed program is similar to a program in existence at the University or at another public or private institution in Massachusetts, describe how the program differs from, and how it complements, that (those) program(s). If there are similar programs within the University, explain why the purposes of the proposed program cannot be achieved through these related, existing programs or through modifications to those programs.

We are confident that our proposed BA does not duplicate any existing degree program in Massachusetts. Our size and our extensive research activities make it possible for us to offer a wide variety of upper-level courses and research opportunities for undergraduates --- there *are* no comparable programs within the public system. Private colleges and universities in Massachusetts offer some programs that are more comparable. For example, all degrees at the four colleges of the Five College system are BA’s rather than BS’s. Our new BA is somewhat similar to the computer science degrees at Amherst, Mount Holyoke, or Smith, with two caveats – each major exists in the context of its own overall undergraduate curriculum, and we offer a greater range of courses and greater accessibility. At Harvard, which is comparable to UMass in its graduate and research programs, the AB degree in computer science requires only eight computer science and four mathematics courses, compared with ten or eleven computer science and three math in our proposed BA, or fourteen computer science and four math in our existing BS.

We have examined the undergraduate degree programs in computer science at all the public universities with research programs ranked in the top 30, and this information is included in Appendix A (attached).

##### C. Are other campuses planning similar programs?

Within the UMass system, Lowell and Dartmouth offer only BS degrees, while Boston offers both a BS and a BA. Unlike our BA, Boston’s uses a strict subset of their BS requirements, with no counterpart of our outside concentration. The Lowell Computer Science department has recently been collaborating with several other departments there in the area of “exhibition and performance technologies” (see <http://teaching.cs.uml.edu/performamatics>) and this could conceivably be the basis of a BA proposal for them in the future.

## V. STUDENTS

- A. Provide an estimate of full-time and part-time student enrollment by year, for the first year and for the year (which should be specified) in which it is expected that the program will be fully implemented. Indicate if students will be drawn from existing programs or from attracting new enrollments.**

We estimate 8 to 12 students enrolling in the first year, based on interest we have seen through advising. We anticipate a gradually rising number joining the program each year until it reaches steady state at 20 to 40 students per year and a total of 100 to 140 in the BA program in 2015. Most of our existing students have indicated in exit interviews that they have been satisfied with the BS program, and would not have switched to a BA program. The interest we have seen in the BA has been primarily from describing it as a potential future option to incoming students. Thus, we expect that only a small number (fewer than 5) of our existing majors would change to the BA in the first year, and that afterward all of the students entering the BA program would be in addition to those in the BS.

- B. Describe the kinds of students to be served (e.g., traditional/non-traditional, minority and non-minority students, members of a particular profession) and any special recruitment efforts planned.**

Diversity has always been a challenge for the field of computer science. Most of our majors are drawn from those with a strong interest in computers before college, and this population is largely male and white or Asian. To attract a broader student population, we must attract students who have other interests and do not fit the "computer geek" stereotype. This is, admittedly, an uphill battle, but progress is being made and we believe the introduction of a BA is an important step in the right direction. While the stereotypical computer science major was valued by traditional computer hardware and software vendors, the modern computer industry is more diverse and values computer science graduates who are broadly educated with good communication skills. We believe that providing a program that emphasizes preparation for such positions will help to increase our diversity.

The level of mathematical training required for the current BS (comparable to that for an engineer) is another potential barrier to a wider student audience. We think students with a lower but still significant level of mathematical training (that of business or life science majors) can complete a CS degree, especially with the CS-oriented mathematics now being taught in some of our new core courses. Some BA students, such as those bound for graduate school, will do more than the minimum math that their degree requires.

- C. Discuss the types of student retention strategies that will be utilized, and the support services that will be offered, which are different from existing institutional practices and procedures.**

Because of the similarities between the BS and BA, we expect that the only difference in student retention strategies will be in educating our faculty regarding the possible BA concentrations so as to better advise undecided students in their choice. The BA may offer a retention option for students in the BS who find, after their initial experience in the program, that their interests are broader than the BS requirements.

## VI. ADMINISTRATION AND OPERATION

- Describe the organizational structure for the administration and operation of the proposed program and strategies designed to ensure its continued quality.**

The new program will be administered through the existing departmental organization of faculty advisors, chief advisor, undergraduate program director, and associate chair for academics. If the program proves to be more successful than our projections, then it may be necessary to designate an assistant undergraduate program director to manage the tracking and certification of concentrations, as this is not currently supported through any automatic mechanism in SPIRE.

## VII. CURRICULUM AND FACULTY

- A. Include a complete description of the curriculum and plans for delivering the proposed program, including a semester-by-semester sequence of courses and other requirements.**

The exact major requirements are given in VIII.A. below. We plan to continue offering all the lower division courses in the major, those required for all students, in every fall and spring semester. The most common upper-level elective courses will be offered every semester as well, and most electives will be offered at least once per year. A student thus may take any of a wide variety of paths through the major, depending on when they decide on a BA in computer science and what relevant technical courses they have completed when they make this decision. Here are a number of examples of possible paths to a BA degree, using the newly adopted General Education requirements:

**Student 1:** Decides as a freshman on a BA in computer science with concentration in biology, looking toward a career in bioinformatics. The concentration consists of three upper-level biology courses (which need first-year biology as prerequisite) and the bioinformatics course in CMPSCI). This student is taking the minimum amount of math and is assumed to have passed foreign language in high school:

Semester 1: CMPSCI 121, BIOLOGY 100, ENGLWRIT 112, Humanities Gen-ed  
Semester 2: CMPSCI 187, BIOLOGY 101, MATH 127, Humanities Gen-ed  
Semester 3: CMPSCI 220, MATH 128, Biology concentration course, Humanities Gen-ed

Semester 4: CMPSCI 201, CMPSCI 250, Biology concentration course, Humanities Gen-ed  
Semester 5: CMPSCI 445 (databases), Biology concentration, CMPSCI 305 (junior writing), RES ECON 211 (stats)  
Semester 6: CMPSCI 311 (algorithms), humanities elective, integrative course Gen-ed, free elective  
Semester 7: CMPSCI 5xx (bioinformatics), CMPSCI elective, CMPSCI elective, free elective  
Semester 8: CMPSCI 320 (software engineering), CMPSCI elective, humanities elective, free university elective

**Student 2:** Begins as a Classics major, discovers first an interest in linguistics and then a further interest in computer science. Had some Latin in high school. The upper-level Latin could have been accepted as one of the four courses in the Linguistics concentration, had the student not chosen to complete a Linguistics minor with a fourth upper-level course. The extra language courses fill the college requirement for extra humanities courses.

Semester 1: GREEK 126 (6cr), LATIN 230, ENGLWRIT 112, Humanities Gen-ed  
Semester 2: GREEK 246 (6cr), LATIN 240, LINGUIST 201, Science Gen-ed  
Semester 3: LATIN 310, LINGUIST 401, Humanities Gen-ed, Science Gen-ed  
Semester 4: CMPSCI 121, MATH 127, LINGUIST 404, Humanities Gen-ed  
Semester 5: CMPSCI 187, LINGUIST 409, MATH 128, RES ECON 212 (stats), Humanities Gen-ed  
Semester 6: CMPSCI 220, CMPSCI 250, LINGUIST 402, CMPSCI 305 (writing)  
Semester 7: CMPSCI 311 (algorithms), integrative course Gen-ed, CMPSCI elective, CMPSCI 201,  
Semester 8: CMPSCI 585 (natural language processing), CMPSCI 401 (formal language theory), CMPSCI 383 (AI), free university elective

**Student 3:** Enters undecided with an interest in business, decides during freshman year to double-major in accounting and computer science. As accounting is the primary major, the foreign language requirement is waived and the student takes only the ISOM writing course. The computer science and extra humanities courses meet the ISOM breadth requirement, and four of the upper-level accounting courses (211, 212, 311, 312), closely involving the business use of computers, count as the outside concentration for the BA in computer science. This double major is still difficult to complete in four years and may be complicated by scheduling conflicts, but the student might be able to take advantage of summer or winter courses, which often include required ISOM offerings.

Semester 1: MATH 104, ECON 103, ENGLWRIT 112, Humanities Gen-ed, Science Gen-Ed  
Semester 2: CMPSCI 121, MATH 131, ECON 104, Humanities Gen-ed, Science Gen-Ed  
Semester 3: ACCTNG 221, CMPSCI 187, MATH 132, SCH-MGMT 210, FINOPMGT 250  
Semester 4: ACCTNG 222, RES ECON 212 (stats), CMPSCI 220, CMPSCI 250, MANAGMNT 250  
Semester 5: CMPSCI 445 (databases), CMPSCI 311 (algorithms), FINOPMGT 301, SCH-MGMT 310 (junior writing), Humanities elective  
Semester 6: CMPSCI 201, MANAGMNT 301, MARKETING 301, SCH-MGMT 497, ACCOUNTNG 311  
Semester 7: CMPSCI 446 (search engines), CMPSCI 453 (networks), ACCOUNTNG 312, ACCOUNTNG 321, integrative course Gen-ed, humanities elective  
Semester 8: CMPSCI 320 (software engineering), ACCOUNTNG 322, ACCOUNTNG 371, SCH-MGMT 541, MANAGMNT 361

**Student 4:** Transfers to UMass Amherst after two years at Holyoke Community College getting an AS in Forensic Science. By the Commonwealth Transfer Compact, all Gen-Ed requirements except writing and the integrative course are satisfied by HCC work. As UMass has no program in Forensic Science, the outside concentration consists of CRJ 205 and FOR 201 at HCC, plus LEGAL 297F (evidence, witnessing, testifying and reporting) and CMPSCI 365 (digital forensics). Also at HCC, the student took pre-calculus math and an equivalent to CMPSCI 121. Since the student took three years of French in high school, they complete their foreign language requirement with two semesters of Spanish.

Semester 1/5: CMPSCI 187, MATH 131, LEGAL 297F, SPAN 110, Humanities elective  
Semester 2/6: CMPSCI 220, CMPSCI 305 (writing), MATH 132, RES ECON 212 (stats), SPAN 120  
Semester 3/7: CMPSCI 240, CMPSCI 250, CMPSCI 365 (forensics), integrative Gen-ed, humanities elective  
Semester 4/8: CMPSCI 311 (algorithms), CMPSCI 445 (databases), CMPSCI 446 (search engines), CMPSCI 453 (networks)  
Summer following Semester 4/8: CMPSCI 496 (independent study in computer forensics)

**Student 5:** Transfers to UMass Amherst after two years at Springfield Technical Community College getting an AS in their Computer Science Transfer program. (This program has been the largest single source of transfers into our BS program in recent years.) Gets equivalents of CMPSCI 121, 187, 201, and 250 at STCC, along with all required math and science, College Writing, and 12 credits of humanities Gen-Eds. (The Commonwealth Transfer Compact does not apply to this program.) Discovers an interest in journalism during the CMPSCI junior writing course in the first semester at UMass Amherst and switches from the BS to a BA with concentration in journalism. Still needs all four foreign language courses. Of

the five journalism courses taken, three (391B, 391JC, 391W) are focused on new-media journalism and form the concentration along with the fourth CMPSCI core – the other two are the extra humanities courses.

Semester 1/5: CMPSCI 220, CMPSCI 240, CMPSCI 305 (writing), LATIN 110

Semester 2/6: CMPSCI 311 (algorithms), CMPSCI 320 (soft. eng.), JOURN 201 (intro), LATIN 120, Humanities Gen-ed

Semester 3/7: CMPSCI 365 (forensics), CMPSCI 446 (search engines), JOURN 300 (writing/reporting), integrative Gen-ed, LATIN 230

Semester 4/8: CMPSCI 445 (databases), JOURN 391B (feedback journalism), JOURN 391JC (journalism as conversation), JOURN 392W (writing for web), LATIN 240

**B. Explain how the program makes sense academically and how the proposed curriculum adequately covers the subject areas. Provide evidence that the program is considered a legitimate academic discipline. If the program is interdisciplinary, provide a rationale for the inclusion of the relevant disciplines and faculty.**

The BA complements the BS by reducing the upper level CS requirements and substituting a concentration in a second field. Because the dependence on engineering-level mathematics may be reduced as a result of a particular choice of concentration, a greater range of math courses are accepted in the BA. Otherwise, the BA retains the same overall composition as the BS. The concentrations will be designed to ensure that students obtain a significant level of depth in the second discipline. A concentration will merely specify a set of courses that are accepted, rather than involving specific faculty.

**C. Show course numbers, titles, and a brief description of each with an indication of which courses already exist (either on that campus or another campus) and which are to be newly developed. Include a summary by course category (major, cognate areas, general education, electives). If applicable, describe procedures for any required independent exercise and for any required internship of clinical experience. In the latter case, describe the proposed arrangements for the placement of students.**

Course development is ongoing for the revision of the BS, and there will be no specific courses developed for the BA. There will not be any requirements for independent exercises, internships, or clinical experience, although these could conceivably be an optional component of an outside concentration, depending on the standards of the other discipline.

**D. Submit current curriculum vitae for all participating faculty**

All faculty in the Computer Science Department will participate in the BA. Curriculum vitae are on file and on the web (<http://www.cs.umass.edu/faculty/faculty-directory>).

**E. If applicable, provide information concerning certification, licensure, and specialized accreditation.**

Not applicable.

## **VIII. ADMISSION AND GRADUATION**

**A. Describe standards for admission to the program and degree requirements in detail, such as general education requirement, major requirement, required work in related fields, electives, practical experience, internships, clinical practices and the like. Include admission requirement for transfer students, if applicable.**

Admission to the BA program will work just as admission to the BS program works now. Some students are admitted directly to the Computer Science major on their admission as freshmen or transfers, based on a profile given to the Admissions office by the department. Freshmen need grades and test scores somewhat above the average of the total pool, and a strong high school mathematics record, to be admitted. Transfers need coursework comparable to the introductory courses for the major in mathematics and computer science. Students already at UMass in other majors may apply to enter the Computer Science major at any time. They are evaluated based on grades for their current semester or that immediately following – they are given a grade target on their planned schedule and admitted if they meet the target. We are not interested in turning away qualified students – the purpose of the admission procedure is to require some evidence that the student can handle the technical work required. We plan no difference in the initial admission standards for the BA and BS, and students will be able to move from one degree program to the other on request.

### **Requirements for the Proposed BA in Computer Science**

The proposed BA in Computer Science requires 11 computer science courses, three math courses, and a four-course concentration.

#### **Two introductory Computer Science courses:**

CmpSci 121 Introduction to Problem Solving with Computers (or AP exam)

CmpSci 187 Programming with Data Structures (or equivalent)

#### **Three core Computer Science courses selected from:**

CmpSci 201 Architecture and Assembly Language Programming

CmpSci 220 Programming Methodology

CmpSci 240 Reasoning About Uncertainty

CmpSci 250 Introduction to Computation

**Social Issues in Computing (CmpSci 305)** Junior-level writing requirement

**Five Computer Science Electives:** Five computer science electives at the 300-level or higher (not including 305). These must be chosen from the department's regularly numbered courses 300 or higher. Experimental classes (numbered X90 through X99) may be used as electives only with Undergraduate Program Director (UPD) approval. Courses taken outside the CS Department (including non-CS courses in special cases) may be used by petition.

**Three Math Courses:** Three math courses, including either Math 127-128 or Math 131-132 plus one additional math course to be approved by the department. Appropriate candidates include Res-Econ 211, Res-Econ 212, Stat 240, Stat 501, Stat 515, or any other Math course at the 200-level or higher. Equivalent courses or appropriate AP exam placements are acceptable in place of Math 127-128 or Math 131-132.

**Four-course Outside Concentration:** Four courses approved by the UPD or designate as forming a focused study in another discipline (or, where appropriate, more than one discipline) with relevance to the theory or practice of computer science. Typically these courses are required for the other discipline, and are at the 200 level or higher (thus they may require preliminary coursework at a lower level as prerequisites for the concentration). The Department will establish "pre-approved" concentrations (in areas such as computational biology, computational linguistics, computational economics, etc.) or individual concentrations may be created with approval of the UPD, based on the relationship of the concentration to the study of computer science, and its cohesiveness and depth.

At most one course in the concentration may be a sixth CS elective, or the fourth course in the CS core. These options require UPD approval that the course contributes significantly to the overall thrust of the concentration.

**GPA Requirement:** A computer science major may not use any course taken on a pass/fail basis to fulfill the BA requirements. Moreover, a cumulative grade point average of 2.0 or better must be achieved in courses required for the major.

**Residency Requirement:** At least three of the five Computer Science Electives must be taken at UMass, Amherst, and five of the nine courses consisting of the five Computer Science electives and the four-course Outside Concentration must be taken at UMass Amherst.

**College Requirements:** The new College of Natural Sciences has yet to determine what college graduation requirements, if any, it will impose. Currently Computer Science majors are bound by the college requirements of the former College of Natural Science and Mathematics. For a BA degree, these are the foreign language requirement (fourth level of one language, or third level of one language and second level of another), and two humanities courses (from CHFA or CSBS) in addition to courses used for general education.

**General Education:** The newly-adopted General Education requirements consist of four four-credit humanities courses, two four-credit science courses, ENGLWRIT 112 or equivalent, math requirements subsumed in those for the BA, a junior writing course, and an upper-level "integrative course" that has yet to be fully specified. The computer science department already accepts another department's junior writing course in place of CMPSCI 305 in the case of double BS majors and late BS adopters, and would continue to do so with BA's.

**B. Explain how the proposed matriculation requirements provide assurance of the likelihood of student success in pursuing the program to completion, and project percentage of such degree completion rates and expected times from admission to graduation for successful full-time students.**

Our existing BS program, even with its highly directed focus, has an established record of successful completion. The BA provides greater flexibility for structuring of a degree program to meet cross-disciplinary student interests with a corresponding decrease in upper-division computer science requirements and a broadening of the acceptable math and science requirements to correspond with the needs of the other disciplines. So we anticipate that it will directly build upon the existing success of our BS program.

**C. Describe any aspects of the program that are intended to attract students from underrepresented groups into the field, or to prepare graduates for service to diverse populations. Also address the program's potential to increase diversity of the faculty.**

As noted previously, we believe that the flexibility of the BA program will be attractive to a more diverse population of students. In addition, our department is actively engaged in recruitment of students from underrepresented groups both as part of the university's existing outreach activities, and through our own initiatives. These include:

- Northeast Alliance for Graduate Education and the Professoriate (NEAGEP);  
<http://www.neagep.org/index.asp>
- Northeast Louis Stokes Alliance for Minority Participation (NELSAMP);

- <http://www.nelsamp.neu.edu/programs/umass/>
- Participation in the National Center for Women in IT (NCWIT);  
<http://www.ncwit.org/>
- Equal Access to the Sciences for All Genders and Ethnicities (EASAGE);  
[http://www.nsm.umass.edu/NSM\\_Web\\_Pages/easage.htm](http://www.nsm.umass.edu/NSM_Web_Pages/easage.htm)
- Commonwealth Alliance for Information Technology Education (CAITE);  
<http://caite.cs.umass.edu/index.html>
- The department's Diversity Committee and mentoring programs (Women's Lunches) and outreach (CS Saturday diversity recruiting day, in which faculty participate);  
<http://www.cs.umass.edu/outreach/outreach-programs>
- The Commonwealth Information Technology Initiative (CITI).  
<http://www.citi.mass.edu>

All of these are engaged in broadening participation. Many help us identify, mentor, and in some cases fund, minority and female participants. We are strongly committed to working to increase the diversity of minority and women students in our discipline.

Our department also operates an REU summer site program, which combines dedicated grant funding with REU supplements for individual faculty grants to bring together a large cadre of students in a shared experience of working on research. We particularly try to recruit students from underrepresented groups for this program. Most of the students come from outside of the university, but some are UMass undergrads. That program provides a range of enrichment activities for a really engaging summer. We also seek matches through the CRA's NSF-supported programs for summer research internships for women and minorities. Making these opportunities available to our undergraduates is a valuable recruiting tool.

**D. Detail any collaboration with other campuses (or with other colleges and universities) and explain what opportunities or benefits the program offers for university students and faculty at other campuses.**

One goal of the program is to facilitate transfers from Massachusetts community colleges, who might find it easier to complete a BA than a BS even after a two-year program at the community college targeted toward transferring. Once our BA program is in place, we will work with as many community colleges as possible, using the connections we have developed through the CITI and CAITE programs, to establish articulation agreements with them. With these, students can be assured that their community college courses will be the best ones to contribute to their eventual BA at UMass Amherst, and know how these courses will be counted.

BA students will be able to take advantage of Five College cooperation by taking upper-level courses at one of the four colleges and using them as CS electives, as long as our department agrees that they correspond to 300-level or higher courses in computer science. Five College courses can also form part of the outside concentration if appropriate. With the flexibility of the BA, the student need not be as concerned with the exact UMass equivalent of the outside course as they can use any course at the right level.

**IX. RESOURCES**

**A. Describe the amount and kind of faculty and staff, facilities, equipment, and library resources (and field and clinical resources, if applicable) necessary to offer the proposed program for the first year and for the year (which should be specified) in which it is expected that the program will have arrived at a steady state.**

The program will initially rely entirely on the existing faculty, staff, facilities, equipment, and library resources. If our estimate of 20 to 40 extra majors per year is correct, then by 2015, when the program reaches steady state, the department should be able to absorb the increase in majors without requiring additional resources.

**B. Describe funding sources by source, such as external or internal University budget. If external funding sources are not committed, identify the sources of the reallocated internal funding and describe the impact of such reallocation on the programs which will lose funding and on the mission and priorities of the campus.**

No additional funding is needed.

**C. Include detailed program delivery information to show the anticipated date of implementation, location of program facilities, and equipment to be utilized. In the event that additional space or specialized facilities would be needed for the program, indicate clearly what these are and what binding agreements have been obtained to provide and fund them in the event that a program is approved.**

Our goal is to offer the program starting in the Fall of 2010. Because it relies only on existing courses, facilities, and equipment, no additional space or facilities are needed. The only steps required to deliver the program are to finalize the definitions of outside concentrations that are likely to be most popular. Between the initial offering of the program and its reaching steady state, we anticipate a gradual expansion of the range of concentrations.

**D. Include detailed budgets to show the first-year implementation costs and, for the year (which should be specified) in which it is expected that the program will have arrived at a steady state, the budget at that time. The term "budget" includes that for any and all resources, including personnel, facilities, equipment, library, and other resources. Include budget projections of the campus' internal contribution through reallocations, expected internal support and sources and, if any, new internal funding to be requested through University budget process.**

The new BA program does not require course offerings or staffing beyond that which is already in place for the existing BS program. There are no courses specific to the BA, and while there are many new undergraduate courses, most of these are recast 500-level courses and their design (which has mostly taken place) has not been a major burden for our faculty. For every new core course, we are phasing out a corresponding old core, and thus our overall course load is not being increased. Increased enrollments resulting from the BA will result in higher enrollments in some courses, but not in more course offerings.

It is impossible to predict with certainty how enrollment might increase as a result of the introduction of a BA. It should be noted, however, that CS enrollment historically fluctuates with economic trends. CS departments across the country have experienced dramatic ups and downs over the years, including a significant decrease due to the dot-com bust a few years ago. We are well positioned to take on an increase in majors.

If our enrollments rise, of course, the department will be doing more teaching and advising than it is doing now. This is an additional burden, but we see it as a highly manageable one because our current enrollments are well below our most recent peak of eight years ago (546 majors in 2001, 290 in 2009). We can and do adjust the offering frequency of courses to meet demand, though all core courses will be offered every term. One administrative change that may result if there is a significant increase in the number of majors associated with the BA could be a new service role of assistant undergraduate program director to manage the tracking of students in their concentrations, since this is not a capability available through SPIRE.

## **Appendix A: Notes on CS Degree Programs at Peer Departments**

Of the top 30 programs in the 1993 NSERC rankings, 13 are public. Five offer BA's.

**UC Berkeley:** EECS is in Engineering, but they offer BS in Engin and BA in Letters & Science, same CS content.

**UT Austin:** CS is in School of Science, offers BS and BA, 45 vs. 39 credits, BA "is better suited in combination with other degrees, majors, or special programs".

**U Illinois UC:** CS is in Engineering, BS only but there are joint Math/CS and Stats/CS BS programs as well as straight CS.

**U Washington:** CS&E is in Engineering, offers BS in either CS or CSE, the CS degree is more flexible and easier to use in a double major.

**U Wisconsin Madison:** CS is in Letters & Science, offers BS and BA but they appear to be identical.

**UCLA:** CS is in Engineering and Applied Science, offers BS in CS and CSE.

**U Maryland College Park:** CS is in Computer, Mathematical, and Physical Sciences, offers BS only.

**UMass Amherst:** CS is in Natural Sciences, currently offers BS only.

**U Michigan:** EECS is in Engineering, offers BS degrees in either Engineering college or in LSA college.

**UCSD:** CS&E is part of Engineering, offers BA or BS in CS, BS in CE, and BS in CS with Bioinformatics specialization. The BA has fewer required courses and allows students flexibility in designing their course schedule.

**Purdue:** CS is in College of Science, offers BS only.

**Rutgers:** CS is in Arts and Sciences, offers both BS and BA, 11 vs. 9 CS courses, same math, BS has required science.

**UNC Chapel Hill:** CS is in Arts and Sciences, offers BS only.