Computer Sciences Certificate Program: 5-Year Review
January 2013

The Department of Computer Science strongly recommends the continuation of the Undergraduate Certificate Program in Computer Science. Since the first certificate was awarded in 2007, approximately 150 students have completed the program. With 41 students receiving a CS certificate in the 2011-2012 academic year, we are reaching and exceeding our proposed goal of approximately 35 students a year.

To earn a CS Certificate, a student must complete at least **six** CS courses, each of at least 2 credits and each with a minimum grade of a C. The courses must include the following:

- **Core Programming:** CS 302 (Intro to Programming) and CS 367 (Intro to Data Structures) (or equivalent transfer of AP credits)
- **Advanced:** At least 2 courses at the 400 level or higher
- **Flexible:** 2 courses at any level

A few CS courses are specifically excluded, such as CS 250 (Digital Society: The Impact Of Computers And Computer Technology), CS 368 (Learning A New Programming Language), CS 402 (Introducing Computer Science To K-12 Students), and CS 699 (Directed Study).

The mission of the CS certificate is to give more students an understanding of the fundamental principles of Computer Science, including the capabilities and limitations of computer technology, as well as basic programming skills. In today's technology-driven world, we believe that it is useful for every student to have these skills; this knowledge will benefit non-CS undergraduates in a variety of careers and enable them to make better-informed decisions on IT issues at the local, state, national, and international levels.

The CS certificate reaches groups of students who are interested in learning more about computer science but who do not major in either CS or Electrical and Computer Engineering; students may choose not to major in CS due to other interests or due to difficulty with the CS major requirements (such as the number of required math courses).

To recruit students, the CS certificate is described in our introductory courses such as CS 202 (Intro to Computation), CS 302, and CS 367. The CS certificate is described on our department web pages and has been advertised at various UW-Madison events (such as the Annual Certificate Showcase co-sponsored by Chadbourne Residential College and Cross College Advising Service and in InterEGR 101: Contemporary Issues in the Engineering Profession).

The number of certificates that have been awarded per academic year since the certificate was approved in 2007 is as follows:

Spring 2007	Spring 2008	Spring 2009	Spring 2010	Spring 2011	Spring 2012	**Fall 2012**	**Total**
1	7	26	25	37	41	**15**	**152**

Advising of students interested in the CS certificate is through the CS department's Undergraduate Advising Committee. The students interested in the CS certificate are advised similarly to those interested in the CS major and must have their program plan approved before completing the certificate. Most students interested in the CS certificate specify their interest and plan their program with an advisor after completing one or two CS courses.

The courses required for the CS Certificate are currently offered on a regular basis. CS 302 and CS 367 are most often taught by Faculty Associates in the CS department. The courses at the 400 level and above are taught by a large set of regular Faculty affiliated with the CS department.

The approximately 190 students who have either completed the CS certificate (152 students) or have officially declared their intent (38 students) have taken more than 20 unique CS courses on the way to fulfilling their requirements. The most popular CS courses in this set are as follows:

Course	Students
367	182
302	164
252	100
354	96
540	74
240	54
537	49
577	52
352	36
412	35
564	34
638	26

We note that if a student completes CS 367, this counts as completing both CS 302 and CS 367 and then only 5 total courses are required. We further note that some students obtaining their CS certificate end up taking more than the minimum of 6 courses, especially those students who take more than four courses at the 200 and 300-levels.

Overall, we believe the CS certificate is meeting the demands of students and that an increasing number of students will desire a CS Certificate in the upcoming years.

CS Certificate Assessment Plan

The CS Certificate is designed to be flexible, so that students can tailor the certificate to their technical interests. As stated above, the CS certificate requires the completion of three categories of courses: two core programming courses (CS 302 and 367) to ensure the students have a basic competency in programming and algorithms; two additional courses that are considered advanced in that they must be at the 400-level or higher; and two remaining courses that can be at any level, but in most cases are at the 200 or 300-level as necessary pre-requisites for the chosen 400-level courses.

We describe our assessment plan as it has been developed and applied to these three categories of courses. For each category, we describe the learning objectives, our assessment approach, our findings, and the resulting changes we have made to the CS Certificate. The minimum grade requirement of a C is a direct measure that students obtain at least the minimal skills for all of these courses.

The two core programming courses, CS 302 and CS 367, have the following learning objectives:

- Students can create robust, user-friendly, well-structured and well-documented Java programs
- Students can read basic Java programs to determine their purpose
- Students have a basic understanding of how computers work.
- Students can implement and use appropriate data structures (e.g., stacks, queues, trees, graphs, and hash tables)
- Students can develop, implement, and analyze different algorithms (e.g., sorting and searching)
- Students can use object-oriented programming languages and techniques

As part of our assessment plan, the syllabus and classroom instruction of CS 302 and CS 367 are periodically reviewed by the Associate Chair to ensure that the learning objectives are still being met. The finding of this assessment has been that CS 302 and 367 remain appropriate for the CS certificate and no significant modifications are required.

The learning objective of the two advanced courses at the 400-level or above for certificate students is that they will understand some specific, technical CS subject material of their choosing in significant depth. The courses for the CS certificate can be chosen with no constraints from any area of Computer Science, such as Theory, Optimization, Operating Systems, Architecture, Databases, Compilers, Artificial Intelligence, or Graphics. It is our belief that different specialties will be appropriate for students with different interests. As shown in the Table above, certificate students do in fact select advanced courses from a range of disciplines.

For this part of our assessment plan, when a new CS course is approved, the Curriculum Committee, the Undergraduate Advising Committee, and the Faculty as a whole determine whether or not the course meets the learning objectives for advanced courses in the CS certificate. The expanding nature of Computer Science necessitates that new 400 and 500-level CS courses are regularly added and existing CS courses evolve.

The key findings of this part of our assessment are as follows. Since the CS certificate was introduced in 2007, four new advanced undergraduate CS courses have been introduced: CS 402 (Introducing CS to K-12 students), CS 407 (Mobile Systems and Applications), CS 534 (Computational Photography), CS 570 (Human-Computer Interaction), and CS 642 (Introduction To Information Security). The CS faculty determined that most of these courses (CS 407, 534, 570, and 642) deliver expertise in a specialized technical area, as desired for the CS certificate. However, CS 402, a 2-credit service-learning course, does not fulfill the certificate's learning objective of introducing undergraduates to

technically demanding advanced CS material; therefore, CS 402 has been placed on a list of excluded courses.

The remaining two courses can be at any level; in most cases, these courses are at the 200 or 300-level and may be pre-requisites for the 400-level courses chosen by the student. Many 400 and 500-level courses require either CS/ECE 354 (Machine Organization and Programming) or CS/Math 240 (Intro to Discrete Mathematics) as prerequisites. Since 2007, two large enrollment 200-level courses have been introduced: CS/ECE 252 (Intro to Computer Engineering) and CS 202 (Intro to Computation).

Assessing the inclusion of CS 252 and CS 202 in the certificate program led to the conclusion that either or both courses could be extremely valuable for certificate students, giving students a broad, motivational overview of the entire field of Computer Engineering or Computer Science, respectively. However, incorporating CS 252 and 202 into the CS certificate required a few changes.

The originally proposed CS certificate required THREE advanced courses above the 400-level, leaving only ONE flexible course at the 200 or 300-level (outside of CS 302 and CS 367). To allow certificate students to take both CS 354, CS 240, and either CS 252 or CS 202, the CS certificate was changed to require just two courses above the 400-level. The original certificate also specified that all courses were to be 3-credits; since CS 252 is 2-credits, the requirement was changed to allow 2-credit courses.

In the upcoming years, we anticipate following the same plan of assessment: reviewing existing and new courses to determine whether or not they are appropriate for the CS certificate and making adjustments accordingly.