

**Submission date:** 11 February 2020

**Program/s in this review:** Comp Science (BA-BS)

**Specialized accrediting agency (if applicable):** ABET

**Campuses where the program is delivered:** University of Alaska Anchorage

**Members of the program review committee:**

- Frank Moore, Professor and Chair, Program Committee Chair, UAA
- Shawn Butler, Term Assistant Professor, UAA
- Christoph Lauter, Assistant Professor, UAA
- Sebastian Neumayer, Assistant Professor, UAA
- Frank Witmer, Assistant Professor, UAA

## **1. Centrality of Program Mission and Supporting Role (700 words or less)**

### *Program relevancy*

The Computer Science program at UAA plays a key role in supporting the UAA Strategic Plan 2020. In particular, Goal 3 aspires to graduate more students to fill Alaska's needs. The data below show a strong upward trend in graduation rates, and our surveys of alumni indicate most are working in the computer science field and employed by companies in the State of Alaska. EMSI data from 2008-2019 indicates that approximately 75% of our graduates remain in Alaska to work.

Our graduates have little trouble finding employment, which is not surprising given both the state and national demand for computing professionals, as well as the quality of our graduates. For students interested in graduate studies, UAA CS Alumni have had good success in being admitted to Computer Science graduate programs at prestigious universities, including Carnegie-Mellon University, the University of Southern California, the University of California at Los Angeles, Clemson University, and the University of Utah.

### *Support for other academic programs*

Our Computer Science & Engineering program formally supports two other academic programs, and informally we attract students from a variety of fields. The BSEE requires four courses taught by our department, and the Developers track of the BS Geomatics requires three. See Section 2 for more detail.

### *Partnerships with outside agencies, business, and organizations*

The Computer Science and Engineering department has strong ties to State and business organizations. The advisory board members represent local companies and organizations such as Resource Data Inc, Alaska Railroad Corporation, Anchorage School District, Alaska Developer's Alliance, Honeywell, Olgoonik and Stage 2 Studios. Furthermore, we have developed research connections with companies such as Axiom Data Science and ConocoPhillips, and government agencies such as NASA, NOAA Alaska Sea Grant, NSF EPSCoR, Department of Homeland Security (DHS) Arctic Domain Awareness Center (ADAC), UAF Alaska Center for Energy and Power (ACEP), the UAA Institute for Circumpolar Health Studies (ICHS) and the Army Corp of Engineers. We also have strong connections with the Alaska Developer's Alliance, a group dedicated to creating a community of programmers within Alaska. We have worked with this organization to host multi-day hackathons coordinated across UAA, UAF, and UAS campuses. Lastly, we have supported the creation of the newly formed Alaska Data Science and AI Lab (ADSAIL). This lab has partnered with McKinley Capital Management to provide internships and learning opportunities to our students in the fields of machine learning and artificial intelligence.

### *Workforce development and employment opportunities*

Computer Science students often complete internships with local and regional employers. Students have recently participated in internships at the Alaska Railroad Corporation, United Postal Service, and GCI. Graduates go on to work as software engineers, software developers, programmers, and database administrators for employers such as Intel, Microsoft, the State of Alaska (e.g. Department of Transportation), the Alaska Railroad Corporation, Resource Data Inc., PangoMedia, Alutiiq, Alaska USA Federal Credit Union, Anchorage School District, USGS, Southcentral Foundation, Anchorage Water and Wastewater Utility (AWWU), Honeywell, and others.

Based on a 2018 survey of recent (2008-2017) graduates from CS&E, 78% of respondents reported being currently employed in the computing field. Furthermore, nearly three quarters (70%) were interested in pursuing a Master's degree or were already enrolled in a Master's program.

### *Extramural support and funding*

In addition to the ConocoPhillips High Performance Computing (HPC) hardware donation (approximate value: \$141,000), ConocoPhillips provides a yearly cash donation of \$500 for the College of Engineering to support the maintenance of the HPC hardware.

### *High demand job designation*

In Anchorage and beyond, demand currently exceeds the supply of locally produced CS graduates. We frequently receive requests from organizations for CS students to fill their Information Technology (IT) positions. This sentiment is echoed by our Computer Science & Engineering Industry Advisory Board and state and national statistics. The U.S. Bureau of Labor and Statistics notes that Computer Technology Occupations are projected to grow 12 percent through 2028, much faster than the average for all occupations. The median annual wage in May 2018 was between \$86,320 and \$118,370, which is 2.2 to 3.1 times higher than the national average. Within the State of Alaska, the Department of Labor and Workforce Development projects an increase in demand for computer occupations of 3% through 2026.

## **2. Program Demand (including service to other programs), Efficiency, and Productivity (7 year trend; 1400 words or less)**

Student demand for our program is steadily increasing. The number of Computer Science BS and BA majors at UAA has shown a 20% increase since 2013/2014. Furthermore, the number of CS degrees awarded over the last 6 years has doubled, which is in alignment with the national trend. Students are also earning these degrees over fewer years and semesters.

Our department experiences lower pass rates for our lower level courses. We are currently addressing this situation by revising our curriculum to add a CSCE A101 requirement, which will provide a gentler introduction to programming. These pass rates for lower level courses are in-line with the national average of 68% for introductory computer science courses (Watson & Li, 2014). Once students pass the lower level courses, they achieve good pass rates in the upper level courses.

Our in-major and out-of-major demand shows diverging trends. For in-major student credit hours (SCH), there has been a quadrupling since 2013, and a doubling since 2014. The out-of-major decline in SCH is a result of the College of Arts & Sciences removing introductory computer science courses from their degree requirements. Despite this removal, we have continued to draw non-CS students to our introductory courses, and even a few upper level courses.

We also draw out-of-major students due to other program dependencies. The BS Electrical Engineering program requires the following courses taught by Computer Science & Engineering faculty:

1. CSCE A201 Computer Programming I (or CSE A205)
2. CSE A205 Introduction to C Programming for Engineers (or CSCE A201)
3. CSCE A248 Computer Organization and Assembly Language Programming
4. CSCE/EE A241 Computer Hardware Concepts

5. Advanced engineering electives: CSCE A365, CSCE A445, CSCE A465

In addition to the BS EE degree, the BS Geomatics degree has a Developers track that requires the following courses:

1. CSCE A201 Computer Programming I
2. CSCE A222 Object Oriented Programming
3. CSCE A360 Database Systems

As another example, the Computer Science Department's CSCE A415 Machine Learning course attracts undergraduate and graduate students from across the university since it is a cross-disciplinary course that is in high demand. Students from biology and geomatics regularly enroll in other courses, such as CSCE A490 Geospatial Programming.

The Instructional Efficiency of our program is very strong. Based on our department student credit hours, our average annual Full Time Equivalent Faculty (FTEF) number is 6.5. Given our current staffing of about 5.3 faculty, we are demonstrating better than expected efficiency in delivering our classes.

For the UAA campus, SCH/FTEF is 463.5, Enrollment/FTEF is 168.1, FTES/FTEF is 15.7, and average class size is 17.7. For each of these metrics, our program numbers exceed the campus-wide values by 5.4%, 10.5%, 4.5%, and 8.5% respectively.

The gap between cost and tuition per student credit hour has closed from over \$60 in 2015 to less than \$30 in 2019. Though both values have increased over time, the Tuition Revenue/SCH increase has dominated, driven in part due to the "differential tuition" extra cost of 20% that College of Engineering students have paid over the last three years. This higher tuition also explains why our recent Tuition Revenue/SCH values are about 20% higher than the UAA values for those years.

#### *External sources of revenue*

Several of our faculty members are actively engaged in research activities. These external funding sources (e.g. NSF, NIH, NASA, NOAA Alaska Sea Grant) provide funding for undergraduate research projects, equipment, and faculty course buyouts.

### **3. Program Quality, Improvement and Student Success (1500 words or less)**

#### *Accreditation and program quality*

Since 2011, the BS CS program has been continuously accredited by the Computing Accreditation Commission of ABET. This is a robust accreditation process with high standards. For instance, ABET Criterion 5 requires us to show that our curriculum is modern and rigorous, and Criterion 4 requires us to show continuous improvement in the extent to which student outcomes are being attained. At each required review period, we have met or exceeded these standards.

#### *Currency of the curriculum*

The CS curriculum is continually reviewed and frequently updated to maintain high quality and relevance. For example, we recently added a required upper-division Computer and Network Security course (CSCE A465). This course improves students' ability to understand and maintain network security for Alaska employers, an especially important task given the increasing interconnectivity of devices and services, and the associated risks of security breaches and risk of exposure of personal information.

Another example of a change to our curriculum is the addition of CSCE A101, Introduction to Programming, as a required class. This course will be taught using the Python programming language, a popular language and relatively easy to learn. Our goal is to improve the pass rate and increase student retention. This is in direct support of the UAA Strategic Plan 2020, Goal 2 of having more students persist and complete their educational goals.

Our Machine Learning class, CSCE A415, provides an example of a course in high demand both within and beyond the major. It currently has nearly 40 students enrolled, of which 15% are either graduate or undergraduate students in non-computer science disciplines. These students have said that the machine learning class is highly relevant to their field, or that there is high demand for this expertise in their workplace. One of the fastest growing disciplines in computer science is machine learning. One of the reasons that it is in high demand is that machine learning is applicable across most engineering and science disciplines. ConocoPhillips is investing in high performance parallel distributed computers so that they can process terabytes of data using machine learning techniques. In addition, they donated more than \$141,000 of equipment and time to the College of Engineering in support of educating students in machine learning and parallel computing skills. Graduating students will be able to bring those skills to Alaska's financial, oil & gas, and health fields in both the public and private sectors.

#### *Innovative program design*

There are several components of our program that are innovative. Writing skills are important for a successful career both within computing fields and beyond. Recognizing that not all of our graduates will stay in computing throughout increasingly dynamic careers, CS majors are required to take three Writing/English courses, including an upper-division writing-centered course. We also added lab sections to the introductory level programming courses, CSCE A201 and CSCE A211. These lab sections used to be delivered by faculty, but we changed to hiring upper-level students to teach the lab sections. This resulted in increased efficiency and cost reductions without sacrificing the quality of delivery. Overall, these innovative changes have improved student learning and retention.

#### *Distance course offerings*

We have recently increased our distance offerings, both for UAA students, and also as part of an effort to increase collaboration with the UAF computer science department. We have delivered the following courses via distance: CSCE A201, CSCE A321, CSCE A342, CSCE A415, CSCE A448, and CSCE A490. These courses have been highly enrolled on both campuses.

#### *Program Student Learning Outcomes*

While data are collected and reviewed for all six ABET Program Student Learning Outcomes (PSLOs), during the most recent academic year we chose to carefully assess Student Outcome 3: Communicate Effectively in a Variety of Professional Contexts. (This outcome aligns closely to UAA GER Student Learning Outcome 1: Communicate effectively in a variety of contexts and formats.)

Our assessment results for PSLO 3 show a positive trend, as summarized by the following data from CSCE A401 and CSCE A470. The number of students achieving Excellent (E), Satisfactory (S), Developing (D), and Poor (P) in each category is given by the following:

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|--------------------------------------|--|
| a. Organization and Structure:       | E = 15, S = 11, D = 0, P = 2 (E/S 92.9%) |
| b. Content and Knowledge:            | E = 12, S = 12, D = 2, P = 2 (E/S 88.9%) |
| c. Effectively Communicates Details: | E = 12, S = 12, D = 2, P = 2 (E/S 88.9%) |
| d. Visual Aids and Graphics:         | E = 12, S = 12, D = 2, P = 2 (E/S 88.9%) |
| e. Spelling and Grammar:             | E = 26, S = 0, D = 2, P = 0 (E/S 92.9%)  |
| f. Delivery and Speaking Skills:     | E = 15, S = 6, D = 5, P = 2 (E/S 75.0%)  |

In CSCE A470, students present their project results at the end of the semester. The above data reflects, in part, the quality of their work, and we have specifically targeted improving their presentation materials and skills in recent years to improve our students' ability to communicate results to a general audience.

### *Student success and high impact teaching practices*

We promote student success by requiring a capstone course, facilitate internship opportunities, and provide research experiences. Our CSCE A470 Capstone course requires students to use a broad range of skills to analyze, design, document, implement, and present a real-world project of moderate complexity under the supervision of an industry or faculty mentor.

Many students complete internships (CSCE A395 and/or CSCE A495) in a professional work setting. Recent internships have been with the Alaska Railroad Corporation, United Postal Service, and GCI. Other students participate with research under faculty supervision (CSCE A498). The following titles are representative of student research projects:

- “Exploring Adaptive Algorithms in Generative Artificial Intelligence”
- “Rigorous Implementation of Ramez Algorithm”
- “Agent-based Modeling of Non-Native Tick Species in Alaska”
- “Machine Learning for Predicting the Impact of Climate Change on Sockeye Salmon Returns”

### *Student support and academic advising*

For academic advising, the Computer Science & Engineering Department requires all students to meet with a faculty advisor (or visit the College Advising Center) each semester prior to registration. The purpose of this “mandatory advising” is to assure that students stay on the best path towards graduation.

### *Student accomplishments*

Our student success can also be measured by their accomplishments. For instance, they consistently place in the 80<sup>th</sup> percentile for the ETS Major Field Test for Computer Science. This is a nationally administered exam, providing evidence that students leaving the department are well above average when compared with students from other institutions.

Our students have been recognized through competitive internships. Several students have been awarded NASA summer internships and summer NSF Research Experiences for Undergraduates (REU).

Our students are active in the UAA CyberSecurity club, Computer Science club, and Robotics club. These are all active clubs that provide additional learning and leadership opportunities for students. The CS club regularly hosts speakers both from within the department and outside (last semester they hosted a Visiting Fulbright Scholar from Pakistan). The UAA CyberSecurity club has recently had great success in national competitions, finishing 1<sup>st</sup> place in the National Cyber League Team Game (2019) and 4<sup>th</sup> place in the National Collegiate Cyber Defense Competition (2019). The UAA Robotics club was invited to compete in the 2019 University Rover Challenge (36 teams were selected out of 84 submissions).

## **4. Program Duplication / Distinctiveness (300 words or less)**

The University of Alaska Fairbanks (UAF) offers a BS program in Computer Science. The UAF student body differs substantially from our students at UAA. UAF students typically live on campus and are full-time students, whereas our students frequently commute from Anchorage, Eagle River, or the Mat-Su valley and are working part-time or even full-time. Though there are similarities between the programs (as expected given they are both accredited by ABET), their program has more of a focus on Computer Graphics, whereas our program has a more applied focus on topics such as Software Engineering.

As mentioned above, we collaborate with the UAF department to offer common courses at the other campus using distance delivery. We have been at the forefront in such course sharing both in terms of the number of courses and volume of students. The UAF CS department has lost several faculty in recent years, and so such cooperation helps deliver courses efficiently and meet demand.

Even with the program at UAF, there are not enough graduates to fill the needs of Alaska employers. With 75% of UAA CS graduates accepting employment in Alaska, growing these CS programs will result in more students placed into stimulating and lucrative careers.

#### **5. Summary Analysis (500 words or less)**

The Computer Science program at UAA is growing rapidly, helping to fill an urgent gap in computing professionals within the state of Alaska. The number of BS and BA CS degrees awarded over the last six years has doubled, and our students have little trouble finding employment within the state. As mentioned above, 75% of our graduates are employed in the State of Alaska. Of those UAA CS graduates, 97% are employed in Anchorage, Wasilla, or Eagle River. We have strong demand from students to continue to offer our high-quality degrees, and we are delivering the degrees with higher than average SCH/FTEF and Enrollment/FTEF ratios.

Computer Science is currently among the best career choices in the US. Looking forward, we hope to continue to expand the number of students graduating from our degree programs through outreach and recruitment efforts. By increasing the number of students graduating with computing degrees, we can help to fulfill the needs of Alaska employers and enable Alaskans to contribute meaningfully to the betterment of society. To help make our graduates competitive, we will maintain the high quality of teaching, course offerings, and supporting organizations such as student clubs and the newly created Alaska Data Science and AI Lab.