



**SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS**

Intent to Plan for a New Program

Use this form to request authorization to plan a new baccalaureate major, associate degree program, or graduate program; formal approval or waiver of an Intent to Plan is required before a university may submit a related request for a new program. The Board of Regents, Executive Director, and/or their designees may request additional information. After the university President approves the Intent to Plan, submit a signed copy to the Executive Director through the system Chief Academic Officer. Only post the Intent to Plan to the university website for review by other universities after approval by the Executive Director and Chief Academic Officer.

UNIVERSITY:	DSU
DEGREE(S) AND TITLE OF PROGRAM:	Ph.D. in Computer Science
INTENDED DATE OF IMPLEMENTATION:	Fall 2019

University Approval

To the Board of Regents and the Executive Director: I certify that I have read this intent to plan, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.

J. M. Gussler

President of the University

4/9/2018

Date

1. What is the general nature/purpose of the proposed program?

Dakota State University (DSU) requests authorization to plan a doctoral (Ph.D.) program in Computer Science. The program will be offered on the Madison campus and online. It is responding to a national need for professionals educated in computer science. Development of this new degree program is a university priority and strategic focus. A Ph.D. in Computer Science offers the opportunity to conduct theoretical and practical research in a broad range of subfields of computer science or in the intersection of computer science and other disciplines. The field's interdisciplinary nature means that graduates will be able to work in a wide range of industries in both the private and public sector.

Computer science teaches algorithmic and analytical principles that can be applied to develop optimized, and possibly intelligent solutions to various data and process centric problems. Computer science has interdisciplinary relevance to every other discipline, ranging from medical science to liberal arts.¹ According to the Bureau of Labor Statistics: "Computer and information research scientists invent and design new approaches to computing technology and find innovative uses for existing technology. They study and solve complex problems in computing for business, medicine, science, and other fields." In the absence of a Computer

¹<https://www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm>

Science Ph.D. program, DSU risks missing out on various opportunities, including many high paying jobs for its graduates, and numerous interdisciplinary grants for its researchers.

DSU currently has doctoral programs in information systems and cyber operations. Information systems and cyber operations are just two of many specializations in computer science (see Table 1). While developing specializations in each of the remaining areas of computer science is not realistic, a general computer science Ph.D. program can include necessary coverage on various areas, as needed.

In addition, co-existence of a general Computer Science Ph.D. program with doctoral programs in information systems and cyber operations should strengthen each of these programs by developing broader expertise in various interdependent components.

Table 1: Employment of New Computer Science Ph.D. Recipients by Specialty (North America; 2013-14)²

Artificial Intelligence	Computer-Supported Cooperative Work	Databases/Information Retrieval	Graphics/Visualization	Hardware/Architecture	Human-Computer Interaction	High-Performance Computing	Informatics: Biomedical/Other Science	Information Assurance/Security	Information Science	Information Systems	Networks	Operating Systems	Programming Languages/Compilers	Robotics/Vision	Scientific/Numerical Computing	Social Computing/Social Informatics	Software Engineering	Theory and Algorithms	Other	Total
139	2	108	83	71	35	43	57	55	36	36	124	55	56	69	14	24	130	63	211	1,411

Source: 44th annual CRA Taulbee Survey (2014) <https://cra.org/wp-content/uploads/2015/06/2014-Taulbee-Survey.pdf>

DSU intends to request authorization to deliver the degree program on-campus and online. The university is not requesting any new state resources or any new or increased student fees to implement this program. The courses in the proposed degree program would qualify for existing CSC course fees. In addition to those course fees, the program would be supported with internal redirections, external resources and off-campus (formerly called self-support) tuition revenue generated by off-campus and distance students. It is our intention to design a program that will allow students to take advantage of courses offered as part of the existing M.S in Computer Science and Ph.D. programs as program electives.

Currently DSU has 14 tenure-track, 9 instructors, and 4.6 FTE adjunct faculty in the Beacom College of Computer and Cyber Sciences. Additional faculty positions would be funded through a mix of off-campus (formerly called self-support) tuition revenue and reallocation of internal resources. DSU has nearly 400 students in its computer science program and more than a 1,000 students in computer science, analytics and cyber sciences. The Ph.D. is important as it will provide an important field to augment our programs.

- 2. What is the need for the proposed program (e.g., Regental system need, institutional need, workforce need, etc.)? What is the expected demand for graduates nationally and in South Dakota (provide data and examples; data sources may include but are not limited to the South Dakota Department of Labor, the US Bureau of Labor Statistics, Regental system dashboards, etc.)?**

² <https://cra.org/wp-content/uploads/2015/06/2014-Taulbee->

The US government, the 50 state governments, large- and medium-size corporations, the military, including the National Guard and Reserve, all demand people educated with this type of degree. The national Job Outlook for a doctoral student in computer science is very strong. The Bureau of Labor Statistics forecasts an increase of 33,480 more of these professionals than the United States had in 2016. That's an increase of 19%. The primary purpose for introducing this program is workforce development, as the United States anticipates dramatic workforce demand in computer science professionals. Computer science professionals who write, test and debug the code have a median pay of \$111,840 per year (see table on page 4).

Occupational projections for computer science related professions within South Dakota indicate strong demand, as described below:

**South Dakota Department of Labor and Regulation
Occupational Estimates and Projections, 2014-2024
Selected Occupations Related to Computer Science**

Occupation	Occupation Code	2014 Estimated Employment	2024 Projected Employment	Total 2014-2024 Employment Change	2014-2024 Annual Average Percent Change	Total Percent Change
Computer and Mathematical	150000	7,437	8,251	814	1.04%	10.95%
Computer Network Architects	151143	191	207	16	0.81%	8.38%
Computer Network Support Specialists	151152	759	831	72	0.91%	9.49%
Computer Occupations, All Other	151199	203	211	8	0.39%	3.94%
Computer Programmers	151131	609	564	-45	-0.76%	-7.39%
Computer Systems Analysts	151121	580	694	114	1.81%	19.66%
Computer User Support Specialists	151151	1,687	1,872	185	1.05%	10.97%
Information Security Analysts	151122	146	168	22	1.41%	15.07%
Network and Computer Systems Administrators	151142	1,645	1,802	157	0.92%	9.54%
Software Developers, Applications	151132	852	994	142	1.55%	16.67%
Software Developers, Systems Software	151133	238	272	34	1.34%	14.29%
Statisticians	152041	22	28	6	2.44%	27.27%
Web Developers	151134	309	383	74	2.17%	23.95%

Source: South Dakota estimates and projections from South Dakota Department of Labor <http://dlr.sd.gov/lmic/default.aspx>

**United States Department of Labor
Occupational Estimates and Projections, 2016-2026
Selected Occupations Related to Computer Science**

Occupation Title	SOC Code	Employment 2016	Employment 2026	Employment Change 2016-2026	Employment Change percent	Occupational Openings	2016 median annual wage
Computer and information research scientists	15-1111	27.9	33.2	5.4	19.2	2.5	111,840
Computer and information systems managers	11-3021	367.6	411.4	43.8	11.9	32.5	135,800
Computer hardware engineers	17-2061	73.6	77.6	4.0	5.5	5.1	115,080
Computer network architects	15-1143	162.7	173.1	10.4	6.4	11.7	101,210
Computer network support specialists	15-1152	198.8	214.8	16.1	8.1	16.5	62,670
Computer numerically controlled machine tool programmers, metal and plastic	51-4012	25.1	29.2	4.1	16.3	3.1	50,580
Computer occupations, all other	15-1199	287.2	313.1	25.9	9.0	22.3	86,510
Computer programmers	15-1131	294.9	272.3	-22.6	-7.6	15.4	79,840
Computer science teachers, postsecondary	25-1021	39.7	42.8	3.2	8.0	3.4	77,570
Computer systems analysts	15-1121	600.5	653.5	53.0	8.8	44.8	87,220

Source: Estimates and projections from United States Department of Labor <https://data.bls.gov/projections/occupationProj>

3. How would the proposed program benefit students?

The 44th annual CRA Taulbee Survey (2014) reports that among all new 2013-14 Ph.D. graduates seeking jobs in North America, 57.5% were hired by industries, 27.3% were hired by academia, 3% were hired by the government, 1.2% were self-employed, and only 0.7% were unemployed at the time of the survey.² The Bureau of Labor Statistics projects that the number of jobs requiring a doctorate degree in Computer Science will increase by 15.3% by the year 2022 (Table 2).³

Table 2: Computer and mathematical occupations employment by educational requirement, 2012 and projected 2022 (employment in thousands)

³<https://www.bls.gov/opub/mlr/2013/article/occupational-employment-projections-to-2022.htm>

Education level	Employment		Projected change, 2012–2022	
	2012	2022	Number	Percent
Bachelor’s degree	2,893.1	3,415.2	522.1	18.0
Some college, no degree	547.7	658.5	110.8	20.2
Associate’s degree	316.1	356.6	40.6	12.8
Master’s degree	31.1	39.2	8.2	26.3
Doctoral or professional degree	26.7	30.8	4.1	15.3

Source: U.S. Bureau of Labor Statistics.

South Dakota currently does not produce doctoral candidates in this area. Doctorate degrees are necessary to fill jobs and help with research at the federal, state, local and corporate levels and we believe offering a Ph.D. in Computer Science will help students in filling those jobs. Computer science provides graduates with the tools, knowledge, and vision to build systems and applications and these students will be the beneficiaries of good, relatively high paying career-predictive jobs. This program will further strengthen our current programs in cyber operations and cyber defense by creating expertise among the faculty in the area of artificial intelligence and software development, the emerging tools of cyber infrastructure.

Federal – According to FederalPay.org, computer scientist was the 146th most popular job in the U.S. Government in 2016, with 1,306 employed. The most common payscale was the general schedule payscale. In 2016, the Federal Aviation Administration hired the most employees titled Computer Science, with an average salary of \$123,922. According to US News, Computer Science is number four on the list of fields in which doctorates lead to jobs.⁴ And according to fortune.com, a Ph.D. in Computer Science is #3 on the Best 15 Graduate Degrees for Jobs (MS in Computer Science is #6).⁵

Agencies hiring Computer Scientist	Employees Hired	Average Salary
Federal Aviation Administration	225	\$123,921.56
National Institute of Standards and Technology	194	\$131,781.84
National Institutes of Health	167	\$133,210.54
Federal Bureau of Investigation	118	\$101,699.68
Ames Research Center	64	\$153,990.83
Geological Survey	60	\$98,055.23
Centers for Disease Control and Prevention	58	\$113,983.22
National Science Foundation	50	\$167,286.82
Food and Drug Administration	49	\$109,529.96
Internal Revenue Service	39	\$130,484.03

Source: FederalPay is a free public resource site <https://www.federalpay.org/employees/occupations/computer-science>

⁴ <https://www.usnews.com/education/best-graduate-schools/articles/2017-04-03/4-fields-where-doctorates-lead-to-jobs>

⁵ <http://fortune.com/2016/03/21/best-worst-graduate-degrees-jobs-2016/>

4. How does the proposed program relate to the university's mission as provided in South Dakota Statute and Board of Regents Policy, and to the current Board of Regents Strategic Plan 2014-2020?⁶

Dakota State University's mission includes integrating technology into various disciplines, and this unique program is another step in fulfilling DSU's mission. The university's statutory mission includes a specialization in "computer management, computer information systems, electronic data processing, and other related undergraduate and graduate programs" (SDCL § 13-59-2.2). BOR Policy 1:10:5 authorizes Dakota State to offer graduate programs "that are technology-infused" and that provide service to state and the region.

The proposed programs align with multiple action steps related to graduate education in the SDBOR Strategic Plan 2014-2020. These include growing the number of graduate degrees awarded, growing the number of new graduate programs, and increasing the number of graduate STEM programs. In addition, the SDBOR Strategic Plan 2014-2020 includes the following vision statements:

- South Dakotans will have increased access to continuing education opportunities needed to upgrade their credentials while remaining in the workforce;
- South Dakota will have a working-age population with advanced levels of education needed to support our democracy and the modern, knowledge-based economy; and
- South Dakota will be a recognized national leader in the use of information technology to enhance its educational, economic, social, scientific, and political development.
- Contribute to the state's workforce and economic development, in particular "encourage development of academic programs and certificates that align with existing and future state workforce needs

DSU is involved in two of the statewide EPSCOR proposals because of our Computer Science expertise and much of the work in cyber operations is intimately connected to Computer Science.

- \$318,041 grant received for cybersecurity curriculum development with capacity building and NSA has invited this faculty member to present his results in multiple forums.
- Awarded \$85,040 from Great Plains Educational Foundation for CybHer and another \$299,855 from SSF SaTc: Edu on CybHer. Each is for a different component of the program but both contribute to workforce development focusing specifically on gender diversification of the cybersecurity fields.
- Another request of \$373,585 sub-award was submitted on an anti-counterfeiting technology collaboration with SDSMT and a \$235,968 sub-award on Research Experiences for Teachers (RET) site that's also a collaboration with SDMST, centered around security printing and anti-counterfeiting technology.
- Applied for R&D Innovation grants and a grant for \$214,000 to develop a collaborative pilot with NSA which has workforce relevance.

⁶ South Dakota statutes regarding university mission are located in SDCL 13-57 through 13-60; Board of Regents policies regarding university mission are located in Board Policies 1:10:1 through 1:10:6. The Strategic Plan 2014-2020 is available from https://www.sdbor.edu/the-board/agendaitems/Documents/2014/October/16_BOR1014.pdf.

Adding a doctoral program in Computer Science will provide an opportunity for either business or technology professionals to augment their skills for computer programming, testing; and anticipatory national, state, and local infrastructure protection. It helps in dealing with a real threat in our modern, knowledge-based economy and serves as another program which integrates technology across multiple disciplines.

5. **Do any related programs exist at other public universities in South Dakota? If a related program already exists, explain the key differences between the existing programs and the proposed program, as well as the perceived need for adding the proposed new program. Would approval of the proposed new program create opportunities to collaborate with other South Dakota public universities?**⁷ *If there are no related programs within the Regental system, enter “None.”*

None.

6. **Do related programs exist at public colleges and universities in Minnesota, North Dakota, Montana, and/or Wyoming? If a related program exists, enter the name of the institution and the title of the program; if no related program exists, enter “None” for that state. Add additional lines if there are more than two such programs in a state listed**⁸

	Institution	Program Title
<i>Minnesota</i>	University of Minnesota	Computer Science (Ph.D.)
<i>North Dakota</i>	North Dakota State University	Computer Science (Ph.D.)
<i>Montana</i>	Montana State University	Computer Science (Ph.D.)
<i>Wyoming</i>	University of Wyoming	Computer Science (Ph.D.)
<i>Iowa</i>	University of Iowa	Computer Science (Ph.D.)
	Iowa State University	Computer Science (Ph.D.)

In a research of programs on the above list, we found NDSU to be the only program which listed a significant number of online courses. It is unclear that any degrees are 100% online, at least from our review of the Ph.D. computer science sites as the information was not prominently stated. Approval of the program would put DSU in position to have one of the few, if not the only, online computer science doctoral programs in the region

7. **Are students enrolling in this program expected to be new to the university or redirected from other existing programs at the university?**

DSU has a very healthy enrollment in the BS in Computer Science (Fall 2017 = 339) and the MS in Computer Science (Fall 2017 = 26). According to the SDBOR Dashboard on graduate production, DSU graduates the second largest number of computer science bachelor and master graduates in the system. For the years 2013-17, DSU had 145 graduates in the two programs

⁷ South Dakota statutes regarding university mission are located in SDCL 13-57 through 13-60; Board of Regents policies regarding university mission are located in Board Policies 1:10:1 through 1:10:6. The Strategic Plan 2014-2020 is available from https://www.sdbor.edu/the-board/agendaitems/Documents/2014/October/16_BOR1014.pdf.

⁸ This question addresses opportunities available through Minnesota Reciprocity and WICHE programs such as the Western Undergraduate Exchange and Western Regional Graduate Program in adjacent states. List only programs at the same degree level as the proposed program. For example, if the proposed program is a

baccalaureate major, then list only related baccalaureate majors in the other states and do not include associate or graduate programs.

(117 undergrads and 28 grad students).⁹ These graduates provide a strong market for a doctorate program. On average, about 10 percent of DSU's baccalaureate graduates go on to graduate school. That number is higher for DSU's baccalaureate graduates in computer science-based degree programs, with an average of 22 percent of the group going on to graduate school each year.

- 8. What are the university's expectations/estimates for enrollment in the program through the first five years? What are the university's expectations/estimates for the annual number of graduates from the program after the first five years? Provide an explanation of the methodology the university used in developing these estimates.**

Estimated enrollment for the new Ph.D. in Computer Science

Year	Enrollment Expectations	Number of Graduates
Year 1	8	0
Year 2	16	0
Year 3	32	0
Year 4	45	4
Year 5 and up	45	8

According to the SDBOR Dashboard⁹, System MS graduates in Computer Science for 2013-17 totalled 91 students. Because there currently is no Ph.D. program in SD in Computer Science, students interested in a Ph.D. had to take it from a university outside of SD.

It's difficult to estimate the number of graduates in a Ph.D. program due to time needed to complete the dissertation so the numbers above are conservative during the five year period required. Based on DSU's other graduate program success, we believe we will meet and exceed the BOR's requirement for graduate degrees after the program is created and marketed.

- 9. Complete the following charts to indicate if the university intends to seek authorization to deliver the entire program at any off-campus location (e.g., UC Sioux Falls, Capital University Center, Black Hills State University-Rapid City, etc.) or intends to seek authorization to deliver the entire program through distance technology (e.g., as an on-line program)?¹⁰**

	Yes/No	If Yes, list location(s)	Intended Start Date
Off-campus	No		

	Yes/No	If Yes, identify delivery methods	Intended Start Date
Distance Delivery	Yes	Live streaming of lectures, skype office hours, D2L management of course material	Fall 2019

⁹ <https://www.sdbor.edu/dashboards/Pages/Graduate-Production.aspx>

¹⁰ The accreditation requirements of the Higher Learning Commission (HLC) require Board approval for a university to offer programs off-campus and through distance delivery.

10. What are the university’s plans for obtaining the resources needed to implement the program? Indicate “yes” or “no” in the columns below.

	Development/ Start-up	Long-term Operation
Reallocate existing resources	Yes	Yes
Apply for external resources	No	No

Ask Board to seek new State resources ¹¹	No	No
Ask Board to approve a new or increased student fee	No	No

11. Curriculum Example: Provide (as Appendix A) the curriculum of a similar program at another college or university. The Appendix should include required and elective courses in the program. Catalog pages or web materials are acceptable for inclusion. Identify the college or university and explain why the selected program is a model for the program under development.

APPENDIX A

The University of Iowa Ph.D. in Computer Science was chosen due to it’s well respected reputation in the area of Computer Science. University of Iowa Ph.D. in Computer Science (72 credit hours). <https://cs.uiowa.edu/graduate-programs/Ph.D.-program>

The **Doctor of Philosophy** (Ph.D.) program in computer science (CS) is a research-oriented degree. Students pursuing a Ph.D. in CS are required to do original research in a subarea of CS with mentoring from a CS faculty advisor. Ph.D. students are expected to disseminate their research via conference and journal publications and presentations. The Ph.D. in CS emphasizes preparation for research and teaching in academic settings or for research in private, industrial, or government laboratories.

The Ph.D. program in CS requires completion of a minimum number of 72 credit hours of graduate credit, satisfactory performance on the *qualifying exam*, *comprehensive exam* and the *proposal* and the production and formal *defense* of a written dissertation describing original research results. This page provides a short outline of the Ph.D. program requirements.

Basic Ph.D. requirements are as follows.

Core Requirement

This course:

Course Number & Name	Semester Hours
CS:5350 Design and Analysis of Algorithms	3 s.h.

¹¹ Note that requesting the Board to seek new State resources may require additional planning and is dependent upon the Board taking action to make the funding request part of their budget priorities. Universities intending to ask the Board for new State resources for a program should contact the Board office prior to submitting the intent to plan.

And one of these:

Course Number & Name	Semester Hours
CS:4330 Theory of Computation	3 s.h.
CS:5340 Limits of Computation	3 s.h.

Breadth

Ph.D. students must complete at least three of the following courses, with at least one course selected from each area (9 s.h.).

Systems and Software

Course Number & Name	Semester Hours
CS:4640 Computer Security	3 s.h.
CS:4980 Topics in Computer Science II (section approved by advisor)	3 s.h.
CS:5610 High Performance Computer Architecture	3 s.h.

Networks and Distributed Systems

Course Number & Name	Semester Hours
CS:4980 Topics in Computer Science II (section approved by advisor)	3 s.h.
CS:5620 Distributed Systems and Algorithms	3 s.h.
CS:5630 Cloud Computing Technology	3 s.h.

Programming Languages and Compilers

Course Number & Name	Semester Hours
CS:4980 Topics in Computer Science II (section approved by advisor)	3 s.h.
CS:5810 Formal Methods in Software Engineering	3 s.h.
CS:5850 Programming Language Foundations	3 s.h.
CS:5860 Lambda Calculus and its Applications	3 s.h.

Practice

Ph.D. students must complete at least one course (3 s.h.) with significant practical or implementation-oriented content. With advisor approval, examples of courses that satisfy this requirement would include:

Course Number & Name	Semester Hours
CS:4400 Database Systems	3 s.h.
CS:4420 Artificial Intelligence	3 s.h.
CS:4440 Web Mining	3 s.h.
CS:4470 Health Data Analytics	3 s.h.
CS:4480 Knowledge Discovery	3 s.h.
CS:4500 Research Methods in HCI	3 s.h.
CS:4630 Mobile Computing	3 s.h.
CS:4700 High Performance and Parallel Computing	3 s.h.
CS:4720 Optimization Techniques	3 s.h.
CS:4980 Topics in Computer Science II (section approved by advisor)	3 s.h.
CS:5800 Fundamentals of Software Engineering	3 s.h.

Course Number & Name	Semester Hours
CS:5990 Individualized Research or Programming Project	3 s.h.

Cognate Area

In consultation with their advisor, students are required to select three courses, totaling 9 s.h. or more, that constitutes coherent coverage of an external cognate area; the courses need not be offered by the same department. Choices include, but are not limited to, mathematics, statistics, genetics, biology, and engineering disciplines.

Colloquium

Students must earn at least 4 s.h. in the following: [CS:6000](#) Research Seminar: Colloquium Series (must enroll at least four times for 1 s.h. each)

Responsible Conduct of Research Requirement: The Department of Computer Science offers the course CS:5980: Topics in CS III-Computing Research Ethics for 1 s.h. credit every spring semester. It is required that all Ph.D. students complete this course within their first two years.

Electives

Students fill their remaining semester hours with a selection of computer science graduate courses numbered 4000 or above and graduate courses outside of the Department of Computer Science, approved by their advisor.