



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

Intent to Plan for a New Program

UNIVERSITY:	SDSU
DEGREE(S) AND TITLE OF PROGRAM:	B.S. in Data Science A.S. in Data Science
INTENDED DATE OF IMPLEMENTATION:	2018-2019 Academic Year

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.

Barry H. Dunn

President of the University

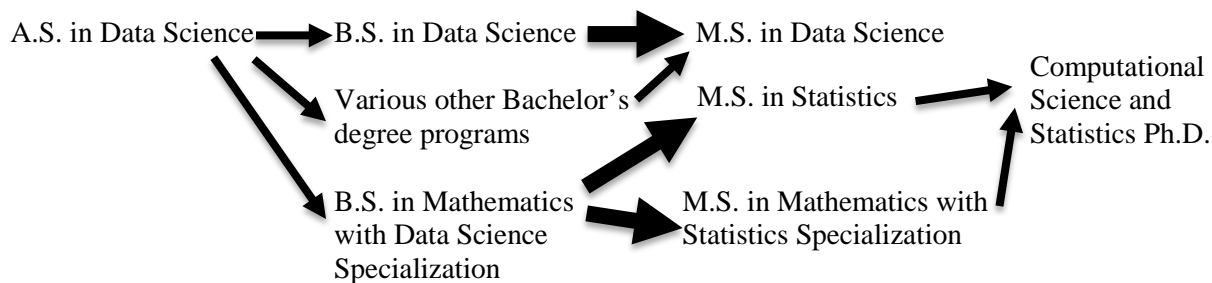
3/26/2018

Date

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

South Dakota State University (SDSU) requests authorization to develop a proposal to offer both an Associate of Science and a Bachelor of Science in Data Science degree. The proposed programs will draw upon the wide range of data-science-centered mathematics, statistics, and statistical computation courses created over the past several years by the Department of Mathematics and Statistics as it has developed a strong regional and national presence in the field of data science. The A.S. in Data Science would stack naturally into the B.S. in Data Science, the B.S. in Mathematics with Data Science Specialization, or many other degree programs in the applied, social, or natural sciences that can be enhanced by additional data science focus. The programs will offer students an exceptionally strong undergraduate preparation in the field of data science that will prepare them either for direct entry into the workforce or for entry into competitive graduate data science programs. In particular, the B.S. in Data Science will allow students to transition seamlessly into SDSU’s M.S. in Data Science program.

The chart below depicts the potential paths through the SDSU Department of Mathematics and Statistics’ existing and proposed data science, statistics, mathematics, and computational science programs that would exist if the two proposed programs are approved. Thicker arrows indicate situations in which it currently is or will be possible to follow an accelerated path to completion of a combined bachelor’s plus master’s degree. The result is a comprehensive set of programs that will prepare students for entry into the workforce of many sectors of the economy, with many different levels of data proficiency.



The University does not request new state resources for either program.

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.)?

Evidence of the substantial, wide-spread demand for data science skills is abundant.

- The first major report to this effect came from McKinsey in 2011 when it published its study *Big data: The next frontier for innovation, competition, and productivity* which predicted that by 2018 “140,000-190,000 more deep analytical talent positions, and 1.5 million more data-savvy managers are needed to take full advantage of big data in the United States.”¹
- Since then, a steady flow of reports and articles from the likes of the Harvard Business Review, Forbes, Glassdoor, CareerCast, and InfoWorld continued to confirm the substantial, ongoing shortage of skilled data scientists. For example, Glassdoor rated Data Scientist the best job in the nation in both 2016 and 2017 based on the number of job openings, the job satisfaction rating, and the median annual base salary, while a new study by CareerCast.com found that Data Science jobs have the best growth potential over the next seven years.²
- More recently (2017), IBM’s *The Quant Crunch: How the Demand for Data Science Skills is Disrupting the Job Market* projected that by 2020 the number of annual job openings for all data savvy professionals in the U.S. will increase by 364,000 openings to 2,720,000.³
- Placing this extraordinary demand for data scientists in a broader context of demand in the Mathematical Sciences Occupations is the most recent available (2016) Conference Board/Wall Street Journal Labor Shortages Index, in which the Mathematical Sciences Occupations trail only Occupational/Physical Therapy Assistants in terms of demand for qualified employees outstripping supply.⁴ Much of this demand comes in the form of demand for data scientists.
- The most recent evidence indicates that the demand for data science will continue to grow.
 - In October 2017, the U.S. Bureau of Labor Statistics released its 2016-26 employment projections, which separately placed both statisticians and mathematicians in the top ten fastest growing occupations⁵ (these are the BLS categories that include data science).
 - In December, LinkedIn named the top 20 emerging jobs of 2017, with four distinct data science jobs in the top ten. Specifically, they are (with rankings) Machine Learning Engineer (1), Data Scientist (2), Big Data Developer (5), and Director of Data Science (8).⁶

¹ <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation>

² https://www.glassdoor.com/List/Best-Jobs-in-America-LST_KQ0,20.htm

³ <https://www.ibm.com/analytics/us/en/technology/data-science/quant-crunch.html>

⁴ http://graphics.wsj.com/table/LABORSHORTAGEINDEX_0419

⁵ <https://www.bls.gov/news.release/pdf/ecopro.pdf>

⁶ <https://economicgraph.linkedin.com/research/LinkedIns-2017-US-Emerging-Jobs-Report>

At the state and regional level, demand in this area is already strong and is predicted to grow. For example, the South Dakota Department of Labor and Regulation's July 2016 e-Labor Bulletin⁷ puts the "Professional, Scientific, and Technical Services" industry fourth on the list of highest projected employment growth from 2014 through 2024, with growth projected at 13.2%.

Similarly, *Growth and Change in South Dakota Labor Markets*⁸ states that with respect to new jobs created between 2001 and 2013,

"Especially rapid growth occurred in the health professions, computer/mathematical and engineering occupations...",

noting that,

"The strongest job growth was concentrated in the professional fields including scientific, engineering and math-related fields".

It goes on to state that when looking to the future,

"The South Dakota professional, scientific and technical services industry is a major employer of a large variety of workers in various business and management professions as well as scientific, engineering and computer science and mathematical technology occupations. Strong job growth and very low unemployment rates in this industry and among the major professional occupations that make up this industry also suggest growing labor scarcity",

and finally that,

"With extraordinarily low unemployment in the PST (professional, scientific and technical) industry, a strong long-term record of job growth with only modest cyclical swings in employment and very bright national outlook, we believe that the prospects for growth in this industry are quite bright in South Dakota. The basic constraint on this growth will be access to qualified professionals."

Both proposed programs will provide direct responses to this ongoing, extraordinary demand for data science expertise in the workforce.

Traditionally, careers such as data scientist have been thought of as being open to those with Bachelor's, Master's, or Doctoral degrees. However, national and regional interest in alternative credentials has grown substantially in recent years, and is having an impact in tech fields similar in nature to data science such as coding, where certificates, boot camps, and other credentialing mechanisms have become very popular and effective.⁹ Major employers such as IBM want to and do hire substantial numbers of employees who don't have four-year degrees in hard to hire areas.¹⁰ Employers would be expected to be as at least as receptive to hiring employees with a high-quality A.S. in Data Science as they are to hiring those with various alternative coding credentials.

In South Dakota more data-enabled people are needed in workforce at every level and across many disciplines. The proposed A.S. program will help the state meet this need by:

- preparing graduates who have the valuable set of data management and basic data analysis skills that can be delivered in a program at the Associate degree level.

⁷ https://dlr.sd.gov/lmic/lb/2016/lbart_july2016_industry_employment_trends_to_2024.pdf

⁸ https://dlr.sd.gov/publications/documents/sdwins_sd_labor_markets_may2014.pdf

⁹ <https://www.wsj.com/articles/coding-boot-camps-attract-tech-companies-1470945503>

¹⁰ <https://www.cnbc.com/2017/11/07/why-ibm-wants-to-hire-employees-who-dont-have-a-4-year-college-degree.html>

- serving as an accessible entry point into the important discipline of data science for students at all levels including high school, traditional college, and non-traditional.
- giving students in a wide variety of majors and disciplines the opportunity to enhance their professional capabilities by enhancing their ability to manage and analyze data.
- leading naturally into more advanced study in data science for interested students.

It is also expected that the A.S. in Data Science will be of interest to students pursuing bachelor's degrees in various applied, social, and natural sciences degrees. It would stack naturally into bachelor's degree programs including but not limited to Biology, Biotechnology, Business Economics, Computer Science, Economics, Exercise Science, Food Science, Geographic Information Sciences, Microbiology, Psychology, Precision Agriculture, and Sociology. Stacking the A.S. in Data Science into these bachelor's degree programs will produce data-enabled graduates in these fields that will deliver more value in the workplace than their less data-enabled colleagues with otherwise similar credentials. The A.S. in Data Science will also stack naturally into the B.S. in Data Science and the B.S. in Mathematics with Data Science Specialization.

Employers of recent graduates of the SDSU Department of Mathematics and Statistics who have emphasized data science in their program of study are diverse, cutting across many sectors of the economy. They include Allianz, Amazon, Bancorp, Bluestem Brands, Cabela's, CAPITAL Card Services, Cargill, Citibank, Clickrain, Cornerstone Bank, Cortrust Bank, Dacotah Bank, Daktronics, Deloitte, Experian, First Bank and Trust, First National Bank of Omaha, First Premier Bank, Great West Casualty, Impact Radius, MARTA, Meta Payment Systems, Microsoft, Midland National Life, Mutual of Omaha, Optum, Plains Commerce Bank, POET, Premier Bankcard, Premier, Inc., Raven Industries, Reliamax, Sanford Health, Sanford Research, SD PUC, Target Corporation, US Census Bureau, Weather Analytics, and Wells Fargo.

Job titles of these recent graduates are also quite diverse, including Actuary, Advanced Analytics Consultant, Analyst, Analytics Leader, Analytics Manager, BP&A Lead Analyst, Business Analyst, Business Intelligence Analyst, Business Risk Analyst, Chief Data Scientist, Contract Analyst, Credit Analyst, Credit Risk Analyst, Credit Risk Manager, Data Analyst, Data Engineer, Data Science Director, Data Scientist, Decision Support Developer, Director of Decision Analytics, Financial Analyst, Portfolio Analyst, Risk Analyst, Statistician, and Vice President of Analytics.

Many other recent graduates have gone on to graduate programs in data science, statistics, mathematics, or closely related areas. Particularly popular choices of these graduates have been SDSU's M.S. in Data Science, M.S. in Statistics, M.S. in Mathematics, and Ph.D. in Computational Science and Statistics.

3. How would the proposed program benefit students?

As discussed in the response to question 2, demand for data-enabled graduates is substantial and cuts across many economic sectors. The proposed programs will produce data-enabled graduates capable of direct entry into the workforce in any of these sectors. They will also provide a means for students to either develop deep data science expertise through further study in graduate programs such as the M.S. in Data Science, or to incorporate enhanced data science skills into careers, undergraduate programs of study, or graduate programs of study in the applied, social, or natural sciences. Any of these paths lead to enhanced professional value in the students' chosen disciplines. In addition, any student who is pursuing a bachelor's degree and has fulfilled the requirements of the associate's degree will be awarded the associate's degree.

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?¹¹

As a land grant university, SDSU is charged with serving the state and its citizens through education, research, and service. Given the professional value of data science education to individuals, and the capacity of a data-enabled workforce to drive economic growth and enhance quality of life, it is clear that the proposed program's goals align directly with SDSU's mission. The proposed major in Data Science supports the statutory mission of SDSU as provided in SDCL 13-58-1: *Designated as South Dakota's land grant university, South Dakota State University, formerly the state college of agriculture and mechanical arts, shall be under the control of the Board of Regents and shall provide undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, home economics, nursing and pharmacy, and other courses or programs as the Board of Regents may determine.*

Board Policy 1:10:2 South Dakota State University Mission Statement provides: *The legislature established South Dakota State University as the Comprehensive Land Grant University to meet the needs of the State and region by providing undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, human sciences, nursing, pharmacy, and other courses or programs as the Board of Regents may determine (SDCL 13-58-1).*

The proposed programs build on SDSU's existing faculty expertise, research programs, and portfolio of existing academic programs in data science, statistics, mathematics, and computational science as depicted in the diagram on the bottom of page 1 of this document.

Both the proposed A.S. and B.S. in Data Science also align well with the current South Dakota Board of Regents Strategic Plan 2014-2020. The SDBOR's strategic plan calls out the five target sectors identified in the South Dakota Science and Innovation Strategy as expressed in SD EPSCoR's 2020 Vision report: Value Added, Agriculture and Agribusiness, Energy and Environment, Materials and Advanced Manufacturing, Human Health and Nutrition, Information Technology/Cyber-Security/ Information Assurance. The availability of data-enabled workforce members such as those who will graduate from the proposed A.S. and B.S. in Data Science programs and the existing M.S. in Data Science program to which they can lead is a key ingredient to progress in each of these sectors. Additionally, the proposed programs are STEM degrees, another area of emphasis in SDBOR's plan.

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?¹²

There are no related programs comparable to the proposed A.S. in Data Science at other public

¹¹ 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.

¹² Lists of existing system programs are available through university websites and the RIS Reporting: Academic Reports database available from <http://apps.sdbor.edu/ris-reporting/AcademicProgramReports.htm>.

universities in South Dakota.

Programs related to the proposed B.S. in Data Science include:

- SDSU B.S. in Mathematics with Data Science Specialization
- USD B.B.A. in Operational Analytics¹³

The proposed program’s primary difference from the B.S. in Mathematics with Data Science Specialization is the removal or alteration of many of the courses required of all students in the B.S. in Mathematics with Data Science Specialization program. These courses are those primarily intended to prepare students for progression on to a program such as the M.S. in Mathematics or M.S. in Statistic, and from there on to the Ph.D. in Computational Science and Statistics. These courses are not necessary to prepare students for progression on to the M.S. in Data Science. These courses, which include MATH 253 Logic, Sets, and Proof, MATH 315 Linear Algebra, MATH 413 Abstract Algebra, and MATH 425 Real Analysis among others, are substantially more challenging than other courses in the specialization, and thus present barriers to graduation for some students. There are many students who would succeed admirably in the proposed B.S. in Data Science program who would have substantial difficulty passing these courses. Removing these barriers provides a path for these students not only to graduation but also to the outstanding data science opportunities that follow. Removing these courses will also allow for a greater emphasis to be placed on the development of computer science skills than the existing program without creating a burdensome credit load needed to graduate. The B.S. in Mathematics with Data Science Specialization will remain in existence upon approval of the proposed programs. It will continue to serve as the best path for progression on to the M.S. in Mathematics, M.S. in Statistics, and Ph.D. in Computational Science and Statistics programs.

The Data Science major differs from USD’s B.B.A. in the very different emphases of the programs. The USD program appropriately has a heavy business focus. The proposed SDSU program has a heavy mathematical, statistical, and computational focus, and is designed to prepare students to work with data originating in any context, including but not limited to business settings.

6. Do related programs exist at public colleges and universities in Minnesota, North Dakota, Montana, and/or Wyoming?

	Institution	Program Title
Minnesota	Winona State University	B.S. in Data Science ¹⁴
North Dakota	None	None
Montana	Montana Tech	B.S. in Data Science ¹⁵
	University of Montana	Undergraduate Big Data Analytics Certificate ¹⁶
Wyoming	None	None

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

It is expected that students for these new programs will be both new to the University and redirected from other university programs. Students majoring in Computer Science, various engineering disciplines, and possibly Economics may possibly pursue a double major. Students

¹³ http://catalog.usd.edu/preview_program.php?catoid=24&poid=3904

¹⁴ <https://www.winona.edu/math-stat/data-science.asp>

¹⁵ <https://www.mtech.edu/academics/clsp/data-science/>

¹⁶ <https://www.business.umt.edu/programs/information-systems/big-data-analytics-certificate.php>

pursuing a variety of Bachelor’s degrees in the applied, social, or natural sciences may choose to complete the A.S. in Data Science in addition to their Bachelor’s degree.

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.

Enrollment estimates for the B.S. in Data Science below are based on:

- Known interest among current B.S. in Mathematics students.
- Known interest in double majors among current students in other SDSU programs.
- Enrollment trends observed when the Department started the M.S. in Data Science program alongside the existing M.S. in Mathematics and M.S. in Statistics programs.

Year 1 (2018/19)	Year 2	Year 3	Year 4	Year 5 (2022/23)
30	60	70	70	70

Enrollment estimates for the A.S. in Data Science below are based on:

- Interest in the M.S. in Data Science program and Graduate Certificate in Data Science expressed by students in other graduate programs.
- The heavy emphasis being placed on alternative, non-four-year degree credentials by the IT industry and multiple levels of government.

These estimates are necessarily less precise than those for the proposed B.S. in Data Science program. It is important to note that no new classes will be required for either of these degrees, so no courses offered in the A.S. of Data Science program will be depending on large enrollment in this program in order to be financially viable.

Year 1 (2018/19)	Year 2	Year 3	Year 4	Year 5 (2022/23)
5	10	15	15	15

9. Complete the following charts to indicate if the university intends to seek authorization to deliver the entire program on campus, at any off campus location (e.g., UC Sioux Falls, Capital University Center, Black Hills State University-Rapid City, etc.) or deliver the entire program through distance technology (e.g., as an on-line program)?¹⁷

	Yes/No	Intended Start Date
On campus	Yes	2018-2019 Academic Year

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

B.S. in Data Science

	Yes/No	If Yes, identify delivery methods ¹⁸	Intended Start Date
Distance Delivery	No		

¹⁷ The Higher Learning Commission (HLC) and Board of Regents policy requires approval for a university to offer programs off-campus and through distance delivery.

¹⁸ Delivery methods are defined in [AAC Guideline 5.5](#).

A.S. in Data Science

	Yes/No	If Yes, identify delivery methods ¹⁹	Intended Start Date
Distance Delivery	Yes	Internet	2018-2019 Academic Year

10. What are the university’s plans for obtaining the resources needed to implement the program?

All courses and faculty necessary to offer this program are already in place as part of existing programs. The A.S. and B.S. in Data Science programs would be supported by the applying the same MATH and STAT program fees applied to the B.S. in Mathematics.

	Development/ Start-up	Long-term Operation
Reallocate existing resources	No	No
Apply for external resources ²⁰	No	No
Ask Board to seek new State resources ²¹	No	No
Ask Board to approve a new or increased student fee	Yes	Yes

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.

The attached curriculum in Appendix A is for the B.S. in Data Science from Montana Tech. Montana Tech’s program was selected because it is representative of the “Curriculum Guidelines for Undergraduate Programs in Data Science.”²² These guidelines represent current best practices for data science bachelor’s degrees as defined in 2016 by a nationally representative group of 25 faculty members from institutions engaged in developing and offering programs of this nature. These guidelines have been used in designing the curriculum of the proposed program.

No suitable curriculum similar to the A.S. in Data Science could be located.

¹⁹ Delivery methods are defined in [AAC Guideline 5.5](#).

²⁰ If checking this box, please provide examples of the external funding sites identified

²¹ 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.

²² <http://www.annualreviews.org/doi/pdf/10.1146/annurev-statistics-060116-053930>

Appendix A Curriculum Example: Montana Tech’s B.S. in Data Science

Additional information regarding the B.S. in Data Science may be found at:

<https://www.mtech.edu/academics/clsp/data-science/> or
http://catalog.mtech.edu/preview_program.php?catoid=9&poid=1787&returnto=1067

SEMESTER 1: Course Name	Credits	SEMESTER 5: Course Name	Credits
M 171 - Calculus I	3 credits	STAT 421 - Probability Theory	3 credits
CSCI 102 - Computational Thinking with Lab	3 credits	CSCI 347 - Data Mining	3 credits
CSCI 135 - Fundamentals Of Computer Science I	3 credits	ESOF 322 - Software Engineering	3 credits
WRIT 121 - Introduction To Technical Writing	3 credits	ECNS 203 - Principles of Micro and Macro	3 credits
Science Elective	3 credits	Elective	3 credits
SEMESTER 2: Course Name	Credits	SEMESTER 6: Course Name	Credits
COMX 111 - Introduction to Public Speaking **	3 credits	STAT 422 - Mathematical Statistics	3 credits
M 172 - Calculus II	3 credits	STAT 432 - Regression and Model Building	3 credits
CSCI 136 - Fundamentals Of Computer Science II	3 credits	STAT 456 - Bayesian Statistical Inference	3 credits
Science Elective	4 credits	CSCI 444 - Data Visualization	3 credits
Humanities Elective	3 credits	Elective	3 credits
SEMESTER 3: Course Name	Credits	SEMESTER 7: Course Name	Credits
M 273 - Multivariable Calculus	4 credits	STAT 441 - Experimental Design	3 credits
M 333 - Matrices & Linear Algebra	3 credits	STAT 453 - Statistical Learning & Data Science I	3 credits
CSCI 232 - Data Structures and Algorithms	3 credits	CSCI 446 - Artificial Intelligence	3 credits
CSCI 246 - Discrete Structures	3 credits	WRIT 321W - Advanced Technical Writing	3 credits
Humanities Elective	3 credits	Elective	3 credits
SEMESTER 4: Course Name	Credits	SEMESTER 8: Course Name	Credits
M 274 - Introduction to Differential Equation	3 credits	STAT 435 - Statistical Computing & Exploratory Data Analysis	3 credits
STAT 332 - Statistics for Scientists and Engineers	3 credits	STAT 454 - Statistical Learning & Data Science II	3 credits
CSCI 332 - Design & Analysis of Algorithms	3 credits	CSCI 447 - Machine Learning	3 credits
CSCI 340 - Database Design	3 credits	STAT 499 - Capstone: Data Science Project –OR-	4 credits
Elective	3 credits	CSCI 499 - Capstone: Data Science Project	4 credits