SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

New Specialization

UNIVERSITY:	SDSU
TITLE OF PROPOSED SPECIALIZATIONS:	- **Data Science** - **Mathematics** - **Statistics**
NAME OF DEGREE PROGRAM IN WHICH SPECIALIZATION IS OFFERED:	**Computational Science and Statistics (Ph.D.)**
INTENDED DATE OF IMPLEMENTATION:	**2019-2020 Academic Year**
PROPOSED CIP CODE:	**Data Science Specialization: 27.0501** **Mathematics Specialization: 27.0304** **Statistics Specialization: 27.0502**
UNIVERSITY DEPARTMENT:	**Mathematics & Statistics**
UNIVERSITY DIVISION:	**Graduate School**

University Approval

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

Barry H. Dunn

	3/27/2019
Institutional Approval Signature	Date
President or Chief Academic Officer of the University	

1. **Level of the Specialization:**

   Baccalaureate ☐   Master's ☐   Doctoral ☒

2. **What is the nature/purpose of the proposed specialization?**

South Dakota State University (SDSU) requests authorization to offer Data Science, Mathematics, and Statistics Specializations in the Ph.D. in Computational Science and Statistics. Students in the Computational Science and Statistics program will be required to select one of the three specializations. This request is in response to a need to better align both the name of the degree conferred and the specific curricular preparation associated with it to distinct career paths open to and pursued by graduates of the program. The proposed specialization names are terms that are well understood by potential employers in each of these career paths. The specialization curricula and names will also align well with the names of the department's existing M.S. degree programs, those being the M.S. in Data Science, the M.S. in Mathematics, and the M.S. in Statistics. This will improve the department's ability to recruit high quality graduate students in each of these areas, and in particular those with a desire to continue on for the Ph.D.

- Data Science Specialization: The purpose of this specialization is to educate students and conduct research programs aimed at supporting local, regional and national industry by analyzing complex datasets. For example, students in this specialization will support decision-making by healthcare providers, financial institutions, engineers or plant scientists by designing data collection procedures and analyzing complex datasets.

  The Data Science Specialization is aligned with the other two degree programs offered by the Department in the area of data science: the B.S. in Data Science and the very popular M.S. in Data Science. It is also aligned with the M.S. in Statistics that has proven popular among students who want to gain a deeper understanding of statistical science. The increased readability of the specialization within the degree program will be an effective recruiting tool when attempting to attract M.S. in Statistics graduates from SDSU and other universities who want to further their education.

- Mathematics Specialization: The purpose of the specialization is to educate students and conduct research programs in areas related to computational strategies for large and complex dataset. For example, students in this specialization will investigate computational methods to find solutions to problems that do not have a direct algebraic solution. These methods are commonly applied to the analysis of large and complex datasets in engineering, precision agriculture, healthcare and finance.

  The Mathematics Specialization is aligned with the M.S. in Mathematics offered by the department. The increased readability of the specialization within the degree program will be an effective recruiting tool when attempting to attract M.S. in Mathematics graduates who want to further their education.

- Statistics Specialization: The purpose of this specialization is to educate and conduct research programs that are at the forefront of modern statistical methods, and in particular, that are focused on exploring the computational strategies needed to enable accurate predictions directly from decentralized devices that also perform the data collection (e.g., remote sensors, wearable technologies, smartphones). Students in this specialization will received a multidisciplinary education combining the curriculums of the Mathematics and Data Science specializations.

  The Statistics Specialization is aligned with the MS. in Mathematics with specialization in Statistics offered by the department. The Department's best students are recruited among students graduating with the M.S. in Mathematics or M.S. in Statistics. The proposed specialization will offer the opportunity to retain the graduates at SDSU and further their education in this multidisciplinary area and to contribute to develop SDSU's reputation as a research organization.

  Students in the Statistics specialization will have the opportunity to address problems that are at the forefront of the current issues in the field of statistics and to develop the solutions that will be used by data scientists in the future.

The University does not request new state resources. No new courses are being requested as part of this proposal.

3. Provide a justification for the specialization, including the potential benefits to students and potential workforce demand for those who graduate with the credential.[1]

The benefits of the specializations for students are more structured, rigorous and consistent curricula and better marketability of their degree: the current name of the degree is not specific enough and is difficult to read by potential employers. 'Mathematics, 'Data Science', and 'Statistics' are well-understood terms that reflects the specific education that the students will receive. Additionally, these specializations are aligned with the existing bachelor's and master's degree programs offered by the department. The increased clarity of this alignment will improve the University's ability to recruit highly qualified students for the Ph.D. program.

The expected demand for people trained in all three proposed specializations is currently extremely high in the region and the nation. The demand is not likely to reduce in the future. The Department of Mathematics and Statistics has an extremely good track record of graduates' employment in these areas.

Evidence of the substantial, wide-spread demand in the mathematical sciences (those being mathematics, statistics, and data science) 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."[2]
- 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 exceptional demand for skilled mathematical scientists and the high quality of jobs in this area. For example, Glassdoor rated Data Scientist the best job in the nation in 2016, 2017, 2018, and 2019[3] based on the number of job openings, the job satisfaction rating, and the median annual base salary.
- IBM's report *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.[4]
- The most recent available (2016) Conference Board/Wall Street Journal Labor Shortages Index shows that the Mathematical Sciences Occupations trail only Occupational/Physical Therapy Assistants in terms of demand for qualified employees outstripping supply.[5]
- The most recent evidence indicates that the demand for the mathematical sciences 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 occupations[6] (these are the BLS categories that include data science).
    - Annual "Best Careers" reports from Career.Cast.com have routinely placed four to six mathematical sciences careers in the top ten. The most recent, 2018 report[7] included six

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[1] For workforce related information, please 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] http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation

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

[4] https://www.ibm.com/analytics/us/en/technology/data-science/quant-crunch.html

[5] http://graphics.wsj.com/table/LABORSHORTAGEINDEX_0419

[6] https://www.bls.gov/news.release/pdf/ecopro.pdf

[7] https://www.careercast.com/jobs-rated/2018-jobs-rated-report

career paths open to graduates of the proposed specializations in the top ten, They are (with rankings) Mathematics (2), University Professor (3), Statistician (5), Data Scientist (7), Operations Research (9), and Actuary (10).

- LinkedIn named its 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).[8]
- In January 2019, the U.S. News and World Report "100 Best Jobs of 2019"[9] included only four non-health-care professions in the top 20. Two of those were Statistician (2) and Mathematician (17).

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 Bulletin[10] 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[11]* 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."

The proposed specializations will provide direct responses to this ongoing, extraordinary demand for mathematical sciences expertise in the workforce.

[8] https://economicgraph.linkedin.com/research/LinkedIns-2017-US-Emerging-Jobs-Report
[9] https://money.usnews.com/careers/best-jobs/rankings/the-100-best-jobs
[10] https://dlr.sd.gov/lmic/lb/2016/lbart_july2016_industry_employment_trends_to_2024.pdf
[11] https://dlr.sd.gov/publications/documents/sdwins_sd_labor_markets_may2014.pdf

4. List the proposed curriculum for the specialization (including the requirements for completing the major – *highlight courses in the specialization*):

Data Science Specialization Requirements

Prefix	Number	Course Title	Credit Hours	New (yes, no)
MATH	625	Advanced Calculus I	3	No
MATH	741	Measure and Probability	3	No
STAT	684	Statistical Inference I	3	No
STAT	685	Statistical Inference II	3	No
CSS	890	Seminar in Computational Science and Statistics	3	No
CSS	898	Dissertation	30	No
STAT	686	Regression Analysis I	3	No
STAT	687	Regression Analysis II	3	No
STAT	715	Multivariate Statistics	3	No
STAT	721	Statistical Computation and Simulation	3	No
STAT	752	Advanced Data Science	3	No

Students must also pass qualifying exams based on the program's core sequences, and written and oral comprehensive exams as designed by the student's advisory committee

Total number of hours required for completion of specialization	15
Total number of hours required for completion of major	60
Total number of hours required for completion of degree	60

Mathematics Specialization Requirements

Prefix	Number	Course Title	Credit Hours	New (yes, no)
MATH	625	Advanced Calculus I	3	No
MATH	741	Measure and Probability	3	No
STAT	684	Statistical Inference I	3	No
STAT	685	Statistical Inference II	3	No
CSS	890	Seminar in Computational Science and Statistics	3	No
CSS	898	Dissertation	30	No
MATH	571	Numerical Analysis I	3	No
MATH	770	Numerical Linear Algebra	3	No
MATH	773	Numerical Optimization	3	No
MATH	751	Applied Functional Analysis	3	No
MATH	774	Advanced Linear Algebra	3	No

Students must also pass qualifying exams based on the program's core sequences, and written and oral comprehensive exams as designed by the student's advisory committee

Total number of hours required for completion of specialization	15
Total number of hours required for completion of major	60
Total number of hours required for completion of degree	60

Statistics Specialization Requirements

Prefix	Number	Course Title	Credit Hours	New (yes, no)
MATH	625	Advanced Calculus I	3	No
MATH	741	Measure and Probability	3	No
STAT	684	Statistical Inference I	3	No
STAT	685	Statistical Inference II	3	No
CSS	890	Seminar in Computational Science and Statistics	3	No
CSS	898	Dissertation	18	No
MATH	571	Numerical Analysis I	3	No
MATH OR	770	Numerical Linear Algebra (3)	3	No
MATH	774	Advanced Linear Algebra (3)		
MATH	773	Numerical Optimization	3	No
STAT	686	Regression Analysis I	3	No
STAT	687	Regression Analysis II	3	No
STAT	715	Multivariate Statistics	3	No
STAT	716	Asymptotic Statistics	3	No
STAT	721	Statistical Computation and Simulation	3	No
STAT	752	Advanced Data Science	3	No

Students must also pass qualifying exams based on the program's core sequences, and written and oral comprehensive exams as designed by the student's advisory committee

Total number of hours required for completion of specialization	27
Total number of hours required for completion of major	60
Total number of hours required for completion of degree	60

5. **Delivery Location[12]**

   A. Complete the following charts to indicate if the university seeks 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)?

	Yes/No	*Intended Start Date*
On campus	Yes	**2019-2020 Academic Year**

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

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

	Yes/No	If Yes, identify delivery methods[13]	Intended Start Date
Distance Delivery (online/other distance delivery methods)	No		

B. Complete the following chart to indicate if the university seeks authorization to deliver more than 50% but less than 100% of the certificate through distance learning (e.g., as an on-line program)? [14]

	Yes/No	If Yes, identify delivery methods	Intended Start Date
Distance Delivery (online/other distance delivery methods)	No		

0% of the Data Science, Mathematics, or Statistics Specialization will be available online.

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[13] Delivery methods are defined in AAC Guideline 5.5.

[14] This question responds to HLC definitions for distance delivery.