June 24, 2022

Michael Baumgartner, Ph.D.
Executive Director
Coordinating Commission for Postsecondary Education
PO Box 95005
Lincoln, NE 68509-5005
mike.baumgartner@nebraska.gov

Dear Dr. Baumgartner:

Enclosed is a copy of the proposal to create the Bachelor of Arts (BA) and Bachelor of Science (BS) in Data Science in the Department of Mathematics in the College of Arts and Sciences, the Department of Statistics in the College of Agricultural Sciences and Natural Resources, and the School of Computing in the College of Engineering at the University of Nebraska-Lincoln. The proposal was approved by the Board of Regents at their June 23, 2022 meeting. Also enclosed is the Proposal for New Instructional Programs Form 92-40.

Please do not hesitate to contact Dr. Jackson or me if you have any questions.

With warmest personal regards,

Jeffrey P. Gold, M.D.
Executive Vice President and Provost

Enclosures

JPG/kd

cc: Ronnie Green, Chancellor
Katherine Ankerson, Executive Vice Chancellor
Mark Button, Dean, College of Arts and Sciences
Tiffany Heng-Moss, Dean, College of Agricultural Sciences and Natural Resources
Lance Perez, Dean, College of Engineering
David Jackson, Vice Provost

COORDINATING COMMISSION
FOR POSTSECONDARY EDUCATION

140 N. 8th Street, Suite 300
Lincoln, NE 68508

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PROPOSAL FOR NEW INSTRUCTIONAL PROGRAM

Form 92-40

SECTION I

Institution Submitting Proposal: University of Nebraska-Lincoln

Title of Program: Bachelor of Arts in Data Science
Bachelor of Science in Data Science

CIP Code: 30.7001

Organizational Unit in which program will be located:

Department of Mathematics, College of Arts and Sciences (BA and BS)
Department of Statistics, College of Agricultural (BS)
Department of Computing, College of Engineering (BS)

Name of contact person in the event additional information is needed: David S. Jackson, Ph.D., Vice Provost

Telephone: 402-472-5242

Degree, Diploma, or Certificate to be offered (use separate submittal for each level):

Bachelor of Arts and Bachelor of Science

Proposed date to initiate program: When approved by the Coordinating Commission

List the location(s) where this program will be offered: UNL

If the program has a projected ending date, please so indicate:

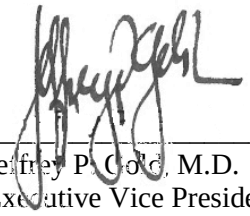
Date approved by Governing Board: June 23, 2022
(Attach all documents related to this proposal upon which the Governing Board made its decision to approve the proposal.)

Chief Executive Officer's or other Authorized Officer's signature: _____
Jeffrey P. Gold, M.D.

TO:	The Board of Regents	Addendum XI-A-3
	Academic Affairs Committee	
MEETING DATE:	June 23, 2022	
SUBJECT:	Creation of the Bachelor of Arts and Bachelor of Science degrees in Data Science to be administered by the Department of Mathematics in the College of Arts and Sciences, the Department of Statistics in the College of Agricultural Sciences and Natural Resources, and the School of Computing in the College of Engineering at the University of Nebraska-Lincoln	
RECOMMENDED ACTION:	Approval to create the Bachelor of Arts (BA) and Bachelor of Science (BS) degrees in Data Science to be administered by the Department of Mathematics in the College of Arts and Sciences, the Department of Statistics in the College of Agricultural Sciences and Natural Resources, and the School of Computing in the College of Engineering at UNL	
PREVIOUS ACTION:	August 13, 2021 – The Board approved the creation of a BS in Statistics and Data Analytics in the College of Agricultural Science and Natural Resources at UNL.	
EXPLANATION:	The proposed Data Science major is designed to prepare students with skills and competency in data analysis, data interpretation, and algorithm design, coupled with skills to implement data-driven decisions and interdisciplinary problem solving. Thus, this program will enable students to take advantage of career and employment opportunities across diverse fields involving data-rich systems and applications. Students will gain foundational knowledge and expertise in: (a) the mathematical, statistical, and computational aspects of data science and (b) the application of computing and modeling to multidisciplinary problems. In addition, students will select two fields-of-interest/focal areas (Artificial Intelligence, Software Applications, Data Pipeline, Mathematical Modeling, Statistical Modeling, Applied Computing: Journalism and Humanities, Applied Computing: Sociology, and Applied Computing: Natural Resources). Depending upon their focal areas of interest, students can receive this interdisciplinary degree from the UNL College of Arts and Sciences (BS or BA), College of Agricultural Sciences and Natural Resources (BS in Data Science), or College of Engineering (BS in Data Science) This proposal has been reviewed by the Council of Academic Officers; it also has been reviewed by the Academic Affairs Committee.	
PROGRAM COST:	$16,500 for Year 1; $1,748,485 over five years	
SOURCE OF FUNDS:	Tuition and fees	
SPONSORS:	Michael J. Boehm Vice President, Agriculture and Natural Resources, University of Nebraska Harlan Vice Chancellor, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln	

Katherine Ankerson
Executive Vice Chancellor

Ronnie D. Green, Chancellor
University of Nebraska-Lincoln

RECOMMENDED: 

Jeffrey P. Gold, M.D.
Executive Vice President and Provost

DATE: May 19, 2022

March 6, 2022

Dr. Jeffrey Gold, Executive Vice President and Provost
University of Nebraska
3835 Holdrege Street
Lincoln, Ne 68583-0745

Dear Dr. Gold,

I am forwarding materials related to a proposal to create a new shared undergraduate degree program in Data Science to be administered by the Department of Mathematics in the College of Arts and Sciences, the Department of Statistics in the College of Agricultural Sciences and Natural Resources, and the School of Computing in the College of Engineering. The major is designed to fill a significant demand for workers skilled and knowledgeable in data science to solve multidisciplinary problems.

The three departments currently have adequate resources to support this program and no new physical facilities are required. This proposed program has the full endorsement of the Academic Planning Committee, and Executive Vice Chancellor for Academic Affairs; the Deans of the College of Arts and Sciences, College of Agricultural Sciences and Natural Resources, and the College of Engineering; and it has my approval. I am requesting you approve it and that it be reported to the Board of Regents at an upcoming meeting.

Sincerely,

Ronnie D. Green, Ph.D.
Chancellor

c: Frauke Hachtmann, Chair, Academic Planning Committee
Katherine Ankerson, Executive Vice Chancellor
Michael Boehm, Vice Chancellor, IANR
Mark Button, Dean, College of Arts and Sciences
Tiffany Heng-Moss, Dean, College of Agricultural Sciences and Natural Resources
Lance Perez, Dean College of Engineering
Bertrand Clarke, Department Head, Statistics
Marilyn Wolf, Director, School of Computing
Tom Marley, Chairperson, Department of Mathematics
Mike Zeleny, Associate to the Chancellor
Renee Batman, Assistant Vice Chancellor
Suzi Tamerius, Project Coordinator
Karen Griffin, Coordinator of Faculty Governance, APC

University of Nebraska-Lincoln
New Undergraduate Major or Degree

I. Descriptive Information

Name of Institution Proposing New Major or Degree
University of Nebraska - Lincoln
Name of Proposed Major or Degree
Data Science
Degree to be Awarded to Graduates of the Major
Bachelor of Arts and Bachelor of Science (College of Arts and Sciences – CAS) Bachelor of Science in Data Science (College of Agricultural Sciences and Natural Resources – CASNR) Bachelor of Science in Data Science (College of Engineering – CoE)
Other Majors or Degrees Offered in this Field by Institution
None
CIP Code
30.7001 Data Science
Administrative Units for the Major or Degree
Department of Mathematics, College of Arts and Sciences, University of Nebraska – Lincoln Department of Statistics, College of Agricultural Sciences and Natural Resources, University of Nebraska-Lincoln School of Computing, College of Engineering, University of Nebraska-Lincoln
Proposed Delivery Site
University of Nebraska – Lincoln campus
Program will be Offered *[full program, not individual courses]*
___X__ On-campus only _____ Distance only _____ Both (on-campus and distance)
Date Approved by the Governing Board
[leave blank]
Proposed Date the New Major or Degree will be Initiated
Fall 2022

II. Details

A. Purpose of the Proposed Major or Degree:

The purpose of the Data Science major is to prepare students with skills and competency in data analysis and interpretation, algorithm design and implementation, and help them develop aptitudes for interdisciplinary problem solving. Thus, this program enables students to take advantage of career and employment opportunities across diverse fields involving data-rich, data-driven systems and applications. Ultimately, this will help address the increasing societal and economic need for qualified workforce in today's digital age.

According to the NSF sponsored report ``Data Science for Undergraduates: Opportunities and Options" published by the National Academy of Sciences, Engineering, and Medicine (available at http://nap.edu/25104):

"Today, the term "data scientist" typically describes a knowledge worker who is principally occupied with analyzing complex and massive data resources. However, data science spans a broader array of activities that involve applying principles for data collection, storage, integration, analysis, inference, communication, and ethics. In future decades, all undergraduates will benefit from a fundamental awareness of and competence in data science." The report makes several recommendations for developing competency in data science in all undergraduates, developing faculty to teach in the field, attracting students with various backgrounds and preparing them for successful careers in data-science related fields through a diversity of educational pathways (e.g. full degrees, a range of minors and certificates).

Moreover, the letter from the Co-Chairs of the ACM Education Board, as part of the release of the ACM Data Science Task Force report on "Computing Competencies for Undergraduate Data Science Curricula" (Draft 2, December 2019) [1] states: "In 2009, Turing award winner Jim Gray spoke of data science as a fourth paradigm of science (empirical, theoretical, computational and data-driven) arising from and capitalizing on the huge amount of data that is now available for investigation. The confluence of the availability of data and increasingly sophisticated tools, processes, and algorithms for analyzing and drawing knowledge and insight from data has impacted every area of scientific engagement. It has also opened up exciting new opportunities for interdisciplinary work across the many fields including (but certainly not limited to) computer science, mathematics, statistics, and information science from which it draws foundational knowledge." The design of this proposed interdisciplinary major is aligned with the elements emphasized in the idea of data science being a fourth paradigm of science.

The Colleges of Arts and Sciences, Agricultural Sciences and Natural Resources, and Engineering are seeking approval to establish an interdisciplinary major in Data Science. Students would be able to pursue the data science major through one of four degree program pathways:

- Bachelor of Arts (CAS)
- Bachelor of Science (CAS)
- Bachelor of Science in Data Science (CoE)
- Bachelor of Science in Data Science (CASNR)

B. Description of the Proposed Major or Degree:

The goal of the curricular content of the Data Science major is to develop foundational knowledge and expertise in: (a) the mathematical, statistical, and computational aspects of data science (processing, analyzing, modeling, and implementing software solutions for large data sets) and (b) the application of computing and modeling to multidisciplinary problems, and to develop professional skills and familiarity in communication, teamwork, problem solving in interdisciplinary settings and domains. In addition, students select two fields-of-interest/focal areas from a constellation of approved areas. These areas are Artificial Intelligence, Software Applications, Data Pipeline, Mathematical Modeling, Statistical Modeling, Applied Computing: Journalism and Humanities, Applied Computing: Sociology, and Applied Computing: Natural Resources. The curriculum and approved areas of focus also facilitate double majoring and dual matriculation in the focal discipline and Data Science by including a broad range of areas and using the most fundamental courses that could easily be used for the second major or a minor. The choice of computing-related courses also follows the guidance from the aforementioned report by ACM Data Science Task Force [1].

The goal of the curricular structure of the Data Science major is to prepare graduates to solve multidisciplinary problems as professional members of interdisciplinary teams. This structure engages student teams with real-world problems for which they have passion and see meaningful impacts. By completing the major, graduates are better prepared by this structure for the multi-faceted nature of Data Science in professional careers and graduate studies.

The goal of the curricular design of the Data Science major is three-fold. First, the Data Science major is designed to fill a significant demand from the industry for workers skilled and knowledgeable in data science to practice and carry out effective and efficient data-driven problem solving. Not all such job positions require a computer science graduate as not all such positions require workers to have a high level of programming skills and algorithm development knowledge, or involve the development of large software systems. Thus, the program is designed to support double majors. The Data Science major is designed to facilitate double majoring/dual matriculation with other disciplines such as journalism, sociology, agricultural economics and biosystems engineering. The set of focus areas will allow students to double major and graduate in a timely manner while preparing students better for a competitive job market. Graduates will have additional skills and expertise in data science, or for a graduate research career, or for an interdisciplinary position that solves complex, real-world problems and within a discipline that relies on data but is not data science. Third, the Data Science major is designed with meeting the N2025 strategic vision in mind, to broaden participation in computing by making data science accessible to our students, strengthening student pipelines for advanced, post-graduate research work, and accelerating data-rich, data-driven faculty research.

Student Learning Outcomes

The primary student learning outcomes of the interdisciplinary Data Science major are:

- foundational knowledge and expertise in the analysis of large-scale data sources from the interdisciplinary perspectives of applied computer science, data modeling, mathematics, and statistics;
- foundational knowledge and expertise in the application of computing, informatics, and modeling to solve multidisciplinary problems;
- abilities and professional skills to solve multidisciplinary data science problems as a member of an interdisciplinary team; and
- familiarity with ethical challenges in data science, including ethical collection of data, responsible use of data, and algorithmic bias.

Data Science Major Requirements

In the interdisciplinary Data Science major, described here and offered by the School of Computing, Department of Mathematics and Department of Statistics, the Data Science Foundations, Focus Areas, and Professional Experience comprise the major. The design of the proposed major is motivated with three key elements in mind: (1) analysis of large-scale data and its associated processes, (2) interdisciplinary contexts and experiences, and (3) professional development grounded on application-driven problem solving.

The Data Science Foundation courses consist of a set of core courses in Computer Science, Statistics, and Mathematics, customized for topics in Data Science. These courses will provide a strong foundation for students to pursue more advanced courses at a later stage of their Data Science degree program, in particular: computational thinking, fundamental programming skills, data structures, algorithm development and evaluation, statistical analysis, mathematical thinking, calculus, and linear algebra. See Appendix B for course descriptions for the Data Science Foundation Courses and the Professional Experience Courses. Most of these courses are considered foundational in their respective discipline. No new courses are required to offer the Data Science major. New courses may be created as enrollment grows.

The Data Science program has a strong interdisciplinary component. First, the Data Science program requires interdisciplinary coursework where students from different disciplines work as a team to solve an interdisciplinary problem, guided by faculty of different disciplines collaborating on data intensive projects. Second, another emphasis of the program is to partner with interested undergraduate degree programs to design and chart viable pathways to dual matriculate in a timely manner with the proposed Data Science degree and another degree program. Towards this emphasis, the program is committed to (1) regularly review and add new courses to the list of focus areas, (2) regularly review and add new field-of-study focus areas to the list, (3) coordinate advising to support students who double-major, and (4) coordinate course scheduling to accommodate students taking courses in the two majors. The degree program will provide professional experience in each of its four pathways, each tuned to the needs of its students.

The Data Science program has a strong application-driven, real-world component. As alluded to above, the Focus Area courses and the Professional Experience courses will encourage and facilitate real-world collaborative projects in advanced research and application development that are data-driven and data-rich. Many of these are collaborative.

Questions integral to the topic of data collection are mainly discussed as part of the statistics foundation courses. As part of this, students will receive training on ethical issues in data collection, processing, analysis, dissemination and sharing, and general use. Indeed, as data types and volumes have increased, ethical issues have come to the forefront and this is discussed in the foundational courses as appropriate, as well as part of the capstone experience.

The planned program of study especially with the Focus Area courses, will provide broad literacy and fluency in Data Science and the focal discipline, and provide the basis for life-long learning and for mastery in select sub-fields. There are too many important topics in data science to deeply cover all, given the explosion of knowledge in the information age.

Together, the Data Science curriculum meets several general education and college requirements and enriches students' experiences with interdisciplinary practice and professional development. The program is designed to support a wide variety of student interests and goals by specifically allowing for dual matriculation in other majors and encouraging the addition of minors from other disciplines.

Computer Science (9 hours)	
CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A: Computer Science I	3
CSCE 311: Data Structures & Algorithms for Informatics or CSCE 310: Data Structures & Algorithms	3
CSCE 320: Data Analysis	3
Mathematics (9-12 hours)	
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
MATH 315: Linear Algebra for Data Science [NEW] or MATH 314: Linear Algebra	3
Statistics (6 hours)	
STAT 101: Introduction to Data STAT 102: Principles of Statistical Analysis	6
TOTAL CORE REQUIREMENTS	**24-27**

Professional Experience/Capstone (varies by college)

- CAS – 3 hours of MATH 435
- CASNR – 3 hours of STAT 425, STAT 451, or STAT 471
- COE– 9 hours – Practicum and Capstone

Additional College-Specific Courses (varies by college)
- CAS – None
- CASNR – 10 hours of STAT
- COE - None

Focus Area Coursework (varies by college)
- CAS – 15 hours from at most two subareas
- CASNR – 15 hours from at most two subareas
- COE – 12 hours from at most two subareas

Total Hours in the Data Science Major (varies by college)
- CAS 42-45 hours
- CASNR 52-55 hours plus 12-18 hours for a Minor
- COE 45-48 hours

Data Science Focus Areas

The Data Science Focus Areas allow students to pursue topics of interest in breadth or depth. Students must complete 15 credits (for CAS and CASNR students) or 12 credits (for COE students) from at most two of the following areas:
- Artificial Intelligence
- Software Development
- Data Pipeline
- Mathematical Modeling
- Statistical Modeling
- Applied Computing: Journalism & Humanities
- Applied Computing: Sociology
- Applied Computing: Natural Resources

Since Data Science is an evolving field and it is critical for the curriculum to be current for its time, the list of courses in each subarea will be reviewed on an ongoing basis. We expect other units will add elective courses as the synergy developed in the Data Science program grows. Most of these courses do not have any prerequisites beyond the Data Science Foundations courses and several have prerequisites that count as Data Science Foundations or for the Focus Areas. This extensive list of frequently offered focus area courses allows students to easily meet the requirement without taking additional prerequisites, but also allows students with interests to choose focus area courses that require additional preparation.

Data Science Focus Areas	
Artificial Intelligence • CSCE421 Foundations of Constraint Processing • CSCE472 Digital Image Processing • CSCE473 Computer Vision • CSCE474 Introduction to Data Mining • CSCE475 Multiagent Systems	*Applied Data Science: Sociology* • SOCI 310 Applied Sociology: Community-Based Research • SOCI 333 Applied Research in Public Opinion Research • SOCI 362 Ethics and the Responsible Conduct of Research

• CSCE476 Introduction to Artificial Intelligence • CSCE478 Introduction to Machine Learning OR STAT 485 Statistical Learning • CSCE479 Introduction to Deep Learning	• SOCI 430 Advanced Social Network Analysis • SOCI 407 Strategies of Social Research: Qualitative Methods • SOCI 463 Advanced Social Research Methods • SOCI 465 Survey Design and Analysis • SOCI 485 Agent-Based Social Simulation
Software Applications • CSCE361 Software Engineering • CSCE378 Human-Computer Interaction • CSCE412 Data Visualization • CSCE460 Software Engineering for Robotics • CSCE461 Advanced Topics in Software Engineering • CSCE464 Internet Systems & Programming • CSCE466 Software Design and Architecture • CSCE467 Testing, Verification and Analysis • CSCE468 Advanced Topics in Software Engineering	*Data Pipeline* • STAT251 Statistical Computing I: Data Wrangling • STAT351 Statistical Computing II: Data Management and Visualization • CSCE411 Data Modeling for Systems Development • CSCE413 Introduction to Database Systems • CSCE436 Advanced Embedded Systems • CSCE438 Internet of Things • CSCE458 Molecular and Nanoscale Communication • CSCE463 Data and Network Security • CSCE465 Wireless Communication Networks
Statistical Modeling • STAT212 Principles of Study Design • STAT301 Mathematical Statistics and Modeling I • STAT302 Mathematical Statistics and Modeling II • STAT325 Statistical Collaboration I • STAT412 Advanced Statistical Design • STAT414 Survey Sampling • STAT432 Introduction to Spatial Statistics • STAT443 Statistical Analysis of Genomics Data • STAT450 Introduction to Regression Analysis • STAT462 Introduction to Mathematical Statistics I: Distribution Theory • STAT463 Introduction to Mathematical Statistics II: Statistical Inference • STAT464 Model Selection and Prediction • STAT474 Introduction to Nonparametric Statistics	*Mathematical Modeling* • Math 208 Calculus in three dimensions • Math 221 Differential Equations • Math 415 Theory of Linear Transformations • Math 424 Partial Differential Equations • Math 428 Principles of Operations Research • Math 433 Nonlinear Optimization • Math 440 Numerical Analysis • Math 450 Combinatorics • Math 452 Graph Theory • Math 447 Numerical Linear Algebra • Math 471 Introduction to Topology • Math 487 Probability Theory OR STAT 262 Probability • Math 489 Stochastic Processes

• STAT475 Introduction to Categorical Data • STAT478 Time Series Analysis • SOCI 465 Survey Design and Analysis • STAT486 Introduction to Bayesian Analysis • AGRO 420 Bioinformatics Applications in Agriculture	
Applied Data Science: Journalism + Humanities • HIST 461 Geospatial Approaches in Digital Humanities and Social Sciences • HIST 470 Digital History • JOMC 358 UX/UI Design • JOUR 307 Data Journalism • JOUR 407 Data Visualization • NSST 376 Analysis for the National Security Establishment • SPMC 350: Sports Data Visualization and Analytics	*Applied Data Science: Natural Resources* • NRES 218 Introduction to Geospatial Sciences • NRES 412 Introduction to GIS • NRES 415 GIS for Agriculture and Natural Resources • NRES 418 Introduction to Remote Sensing • AECN 401 Advanced Farm Management and Linear Programming • AECN 406 Commodity Price Forecasting • AGRO 420 Bioinformatics Applications in Agriculture • AGRO 431 Site-specific Crop Management • MSYM 433 Equipment and Tractor Testing

Admission Procedures
Admission requirements for the Data Science major are the same as admission to the University of Nebraska-Lincoln and the respective college for each degree program pathway. (For the College of Engineering, the requirements will be consistent with the exception of the physics and chemistry entrance requirements.) In particular, the program will seek:

- Students who demonstrate analytical interests and capabilities.
- Students with various fields-of-study and interests in multidisciplinary problem-solving.
- Equity with respect to gender, economic status, age, culture, disability, color, and national origin.
- Links to financial support that enable students to obtain their degree.

Advising
Students with a Data Science major will be assigned an advisor from one of three colleges, based on the planned degree program pathway. Data Science faculty will mentor students on career pathways, and the professional advisors will assist students with scheduling coursework, designing an academic success plan, and completing their degree in a timely fashion. Transferring between colleges within the Data Science major would be similar to standard processes, where additional hours may be required for degree completion based upon completed courses and at what point the decision to transfer is made.

Accreditation
Professional accreditation will not be sought for this program at this time.

Administration and Governance of the Major
All of the contributing units intend to follow and collaborate together in keeping with the Guidelines for the Administration and Governance of Shared Academic Programs (Appendix D).

III. Review Criteria

A. Centrality to UNL Role and Mission

As stated on the UNL Role and Mission website: "The University of Nebraska-Lincoln serves as both the land-grant and comprehensive public university of the State of Nebraska." This proposed major addresses the imperative needs and demands for foundational knowledge and expertise in computing and informatics and the abilities and skills to apply those technologies in virtually every aspect of human endeavor. "[UNL] is the state's primary intellectual center providing leadership throughout the state through quality education and the generation of new knowledge." [3] With this proposed major, UNL will provide intellectual leadership in its "fundamental mission" of educating students for the 21st century.

The proposed program is consistent with the University of Nebraska-Lincoln's 2025 Strategic Plan by:

- Increasing student enrollment by attracting in-state, out-of-state, and international students,
- Innovating student experiences that prepare graduates to be life-long learners and contributors to the workforce in Nebraska and the world,
- Focusing student experience to foster innovative, interdisciplinary endeavors and solve challenges critical to Nebraska and the world, and
- Building upon areas of strength within the Colleges of Arts and Sciences, Engineering, and Agricultural Sciences and Natural Resources.

B. Relationship of the proposal to the NU 5-Yr Strategy

The Data Science major delivers computing and informatics instruction in a cost-efficient unified program serving multiple fields and units, thereby potentially limiting more costly duplication of such instruction across those units.

The Data Science major provides a unique educational experience with interdisciplinary and cross-disciplinary elements that will attract high-school graduates, including high-achieving students from Nebraska and elsewhere, and appeal to more diverse demographics than are the current STEM- and computing-focused majors at UNL, thereby increasing enrollments and the diversity of students.

The School of Computing, Department of Mathematics, and Department of Statistics are all highly ranked programs for the University of Nebraska [4, 5]. This program will leverage the internationally recognized excellence of the Computer Science and Engineering, Mathematics, and Statistics faculty in areas of importance (Data Science) to Nebraska.

The practicum and capstone courses will incorporate instruction in entrepreneurship and undertake projects drawn from real-world business, education, government, military, and non-profit stakeholders and involve undergraduates in R&D activities of the faculty and the university. The experience will strengthen graduate research pipelines and facilitate prototyping of innovative and creative efforts of faculty participating in the courses and capstone project.

Across virtually every field of human endeavor, the workforce of the future will be more engaged with analytical, design, and computing methods and technologies for data analytics, informatics, robotics, intelligent systems, etc. These developments will allow workers to tackle ever more difficult and complex multidisciplinary problems which require interdisciplinary collaboration. Nebraska's future economic growth and development depend on having an educated workforce proficient in these ways. The Data Science major provides foundations in computing methods and technologies and in interdisciplinary collaboration to meet multidisciplinary challenges. This program will help the University of Nebraska deliver "robot-proof higher education in the age of artificial intelligence" [6].

The structure of the major involves students in interdisciplinary instruction and collaborative team projects infused with multidisciplinary problems and solutions.

C. Consistency with the Comprehensive Statewide Plan for Post-Secondary Education

The Nebraska Coordinating Commission for Post-Secondary Education's Comprehensive Statewide Plan for Postsecondary Education (CSPPE) [9] states: "Institutions will see a growing demand from business and from students for specialized knowledge and skill certifications (in professional, vocational, and technical areas such as information technology) to meet workforce needs." The revolutionary changes of the still-emerging information age are profound and Nebraska's institutions for post-secondary education face significant challenges to provide, as termed by Joseph Aoun [6], "robot-proof education in the age of artificial intelligence" for its students and a highly effective workforce and citizenry for the state's economic and societal future. Accordingly, one of the CCPE's major goals is that: Nebraska colleges and universities will foster critical thinking skills and provide their graduates with the knowledge and workplace skills needed to be successful employees, innovative entrepreneurs, and responsible citizens on a global stage.

The proposed Data Science program recognizes that an information-age education requires quantitative and analysis skills not only for professionals with mathematics, statistics, computer science and engineering degrees, but also for professionals across business, life sciences, agriculture, social sciences, education, journalism, humanities, arts, etc. This program is designed to provide an educational foundation in computing and informatics, but with a focus on their applications that encourages for a student's field of interest to guide personalization of their program and that supports diverse multidisciplinary problems.

Information-age educational programs that deliver value to students are fundamental to addressing demographic challenges. The CCPE notes: "Overall, institutions of higher education will see increased competition for traditional-age, in-state students." In response, the CCPE calls for Nebraska institutions to intensify efforts to recruit and retain Nebraska students, out-of-state students, and students from demographically under-represented groups. Accordingly, one of the CCPE's major goals is that: Nebraska's institutions and policymakers will increase participation and success in postsecondary education, particularly for low-income and underrepresented populations, and ensure that all Nebraskans are able to access and successfully complete postsecondary education appropriate to their individual needs and abilities, unrestricted by age, culture, disabilities, religion, race, ethnicity, gender, sexual orientation, gender identity, nationality, socioeconomic status, or geographic location.

The proposed program offers a unique, enriched on-campus curriculum, training, and experience that bring together students and faculty from diverse disciplines to work on multidisciplinary, real-world problems that will excite the students' passions for impact. With respect to the demographics of the current majors in the School of Computing, Department of Mathematics, and Department of Statistics, this program promises to help draw more women and members of other under-represented groups into the computing and information science and engineering, mathematical, and statistical aspects of not only the traditional science, technology, engineering, and mathematics (STEM) fields but also non-STEM fields that will increasingly be engaged with data science.

Information-age education that produces a future-ready workforce is fundamental to addressing economic challenges. The CCPE notes: "Employers are demanding a workforce that can keep pace with an explosion of knowledge and rapid technological change. Businesses are seeking technical assistance in using technology to become more productive and profitable. Economic growth in Nebraska is limited by shortages of workers, especially those with technical training." Accordingly, one of the CCPE's major goals is that: Higher education in Nebraska will be responsive to the workforce development and ongoing training needs of employers and industries to sustain a knowledgeable, trained and skilled workforce in both rural and urban areas of the state.

The proposed program addresses the increasing need for workers with a foundational education in computing and information systems, particularly as computing is applied in diverse disciplines. Because computing and information systems are increasingly ubiquitous across domains, organizations frequently struggle to find computing personnel who have a sufficient foundation in the operational domains of the organization and domain personnel who have a sufficient foundation computing and information systems. There is a great and growing need in the workforce for personnel who can span or bridge both roles. The proposed program is specifically designed to educate students in using computing and information systems to solve multidisciplinary problems in diverse fields, using real-world examples from stakeholders such as business, government, and non-profit organizations.

The CCPE recognizes the growing "competition for state funding" and demands for "accountability and performance" in higher education. Accordingly, one of the CCPE's major goals is that: Higher education in Nebraska will be effective in meeting the needs of students and the state, will be efficient in its expenditure of the state's resources, and will be accountable for developing, sustaining, and demonstrating exemplary teaching, learning, research, and public service.

This new interdisciplinary Data Science program is a shared program for a single major. Building on the success of other shared program, the faculty and units will collectively work together to leverage resources and be effective in an exemplary way. Sharing courses and resources is what makes this program possible.

D. Evidence of Need and Demand

1. Need:

One of the most notable and disruptive impacts of the emerging age of artificial intelligence and robotics is the replacement of human work by ever-more-capable computing systems and associated machinery. These trends already are challenging the equilibrium of our society. Educational institutions have a great responsibility to prepare its graduates for the workforce of the twenty-first century, in which the workplace, lives, and careers will be significantly altered by these technologies. As summarized by Joseph Aoun, President of Northeastern University, universities must: "develop and empower a new generation of creators, women and men who can employ all the technological wonders of our age to thrive in an economy and society transformed by intelligent machines."

The replacement of jobs in manufacturing is the leading edge of the broader revolution. Of course, this revolution creates jobs for math and computer science majors, but there are broader needs related to the broader changes. For example, Aoun cites:

- An executive at Wells Fargo who notes the replacement of tellers, bankers, and accountants with data scientists and applications developers who create, modify, and use sophisticated financial models based on massive stores and streams of financial data and provide diverse online customer services. These workers need analytical and computational skills, but also financial expertise.
- A CEO of a legal technology company who notes the replacement of legal professionals for research, fact-checking, and cross-referencing by AI systems that are more rapid, more accurate, and less expensive. Successful team members will understand how to effectively deploy and employ these computing and information technologies to meet legal needs.
- Executives in the media industry who note the increasing reliance on the power of big data and advanced analytics software to structure and deliver content and advertising. Media companies require employees who can understand and utilize these tools effectively and creatively.
- A vice president of an advanced engineering and manufacturing firm who notes the impact of sensors and the Internet of Things (IoT) not only for product engineering and manufacturing, but also for monitoring and maintenance of products even at customer sites, changing the nature of customer services. Employees in engineering, advanced manufacturing, maintenance, and customer service must utilize increasingly sophisticated product information systems.
- Medical experts who note the emerging use of AI for medical research, assistive diagnoses, and personalized medicine, and of robots for surgery. Creating and using these systems will require workers with proficiencies in data analytics, computing and informatics technologies, and medicine.

A theme across these examples is that the future workforce will require employees with foundations in both computing technologies and a field of application, but, beyond that, the ability to solve domain and multidisciplinary problems with computing technologies in an organizational context.

Projections about such a dynamic future are difficult and there are few sources for projections about the growth of technology-related jobs in diverse fields. (Most projections, e.g., from the Bureau of Labor Statistics, break down jobs by discipline without regard to the changing nature of those jobs.) However, IDC projected 14 million new jobs related to just cloud computing, with a 27% compound annual growth rate (CAGR) in banking, 28% CAGR in insurance, 26% in healthcare, and similar rates in other fields [10]. Taking just the banking industry, issues such as open banking, regulatory compliance, robo-advisers and voice assistants, cybersecurity, biometrics, and blockchain applications will transform the industry [11].

Furthermore, at the heart of these advances and emerging technologies is data. According to a report by World Economic Forum [12], "Volumes of data are growing at a rate of 40% per year and will increase 50 times by 2020. A measure of the speed of growth is the estimate from Singapore-based Aureus Analytics that 90% of all data in the world was created in the last two years. As mobile usage goes up, so do personal data volumes. Over half (51%) of all internet users worldwide are in Asia: China has 1.3 billion mobile

subscriptions out of a population of 1.36 billion, while India has 0.91 billion mobile subscriptions out of a 1.25 billion population." Microsoft reported with the advances brought forth by cloud computing, there will be new jobs related to data science (e.g., big data analysts) created because of data volumes growing at a rate of 40% per year due to cloud computing [13].

Indeed, Data Scientist was ranked #1 on Best Jobs in America (https://www.glassdoor.com/List/Best-Jobs-in-America-LST_KQ0,20.htm) in 2016, 2017, 2018, and 2019, and is ranked #3 in 2020, with a Job Satisfaction rates of at least 4.0 out of 5 each year. The demand for Data Scientist in terms of the number of job openings has increased each year from 1,700+ to 6,000+, and is expected to grow further.

Additional indications of need are provided by other research universities that offer informatics degrees, even if they differ with the innovative program proposed for UNL. The University of Indiana Luddy School of Informatics, Computing, and Engineering offers a Bachelor of Science in Informatics degree, which requires more informatics coursework and less coursework in the cognate focal area and which does not have an interdisciplinary core [14]. The program's class of 2017 & 2016 graduates had a 96% placement rate (with 86% in jobs and 10% in graduate school) and class of 2018 & 2017 graduates had a 95% placement rate (with 84% in jobs and 11% in graduate school) [15]. The University of Washington Information School offers a Bachelor of Science in Informatics degree, with five concentrations including one in data science, and the curriculum does not particularly emphasize interdisciplinary aspects [16]. It has a 90% employment rate in various fields, including IT, consulting, business/finance, and retail [17], with the median starting salary for full-time employment is $85,000. In addition, 89% of the survey respondents completed at least one internship [17], indicating the demand for students with skills in informatics as well as a practicum opportunity for better preparing and training students.

The proposed Data Science major will offer a broader interdisciplinary experience than is the case for many computing institutions. It will also offer an integrated approach as opposed to a Computer Science + X (also known as CS+X) approach where additional discipline-based courses are added to existing computing curriculum, without providing data science-flavored or -oriented computing courses. To compare, a B.S. in Data Science or similar field is offered through these colleges: the Luddy School of Informatics, Computing, and Engineering at Indiana University; the School of Informatics and Computing at IUPUI; the College of Engineering at the University of Michigan; the College of Natural Science at Michigan State; the Data Science Program at Iowa State; the College of Liberal Arts and Sciences at the University of Iowa; the College of Natural Sciences at Colorado State University.

Online degrees and M. S. degrees are offered by several institutions, including: an online M.S. by UIUC; both campus and online M.S. degrees in Analytics at Georgia Tech. We believe that a bachelor's level degree that can be obtained in person will be attractive to many students.

2. Demand:

In Nebraska, the workforce demands for Data Scientists are significant and growing. On a monthly basis, there are over 8,000 positions posted in LinkedIn for Data Scientists. Employers like Kiewit, Union Pacific, Spreetail, and Bryan Health are actively recruiting in Nebraska for these high-skill, high-demand, and high paying positions. National and international companies, like Google, Amazon, and Facebook, also recruit in Nebraska to help supply their need for data-driven decision making.

The increasing demand from students for coursework and degrees in the computing field can be seen in the numbers of students in the School of Computing, Department of Mathematics, and Department of Statistics. In particular, there are over a dozen students already enrolled in the new Statistics and Data Science option offered by the Department of Mathematics in Fall 2020. We believe that the proposed Data Science major will attract new students who come to UNL because of this major. This program will be unique in the Big 10

region; although there are programs with some similarities, e.g., the CS+X programs at Illinois and the Informatics program at Indiana, none offer the integrated program that is proposed. It is somewhat difficult to quantify the numbers, but high student interest in computing and the career opportunities indicate that there will be more than a viable number of students.

The structure of the program requires at least one viable batch of approximately 20 entering students. We have sized the program with up to 20 students for the first cohort and then ramping up to 40 entering students per year for a steady-state of 160 majors within five years.

Note also that based on data from the National Center for Education Statistics (NCES)'s Integrated Postsecondary Education Data System (IPEDS), using all six-digit CIP codes related to Data Science, there has been a steady growth in terms of number of bachelor degrees conferred:

Year	# Bachelor Degrees Conferred
2013	3,903
2014	3,633
2015	4,186
2016	4,407
2017	4,907
2018	5,370
2019	6,867

In particular, the University of Indiana's Informatics program's graduation numbers for the past five years are: 2014-2015: 307, 2015-2016: 371, 2016-2017: 433, 2017-2018: 548, 2018-2019: 501, showing steady growth over the years. Meanwhile, the University of Illinois's CS+X program and the University of Washington graduate more than 100 students per year, which indicates viable demand frIom students. The CS+X program is fairly new and limited to a few arts and sciences fields, but already had enrollments in the fall of 2017 of 172 majors with 69 students in CS+Linguistics, 46 in CS+Chemistry, 31 in CS+Astronomy, and 26 in CS+Anthropology. It graduated 77 students in 2017. Although the University of Illinois is a larger school than the University of Nebraska, the proposed focal areas at UNL span more disciplines and the program features an attractive interdisciplinary core.

The U. S. Bureau of Labor Statistics provides employment and projections in several areas related to data science.

- The total number of Data Science jobs will increase by 28% through 2026, representing 11.5 million new jobs in the field.
- Computer and information research scientists: $126,830 median annual pay in 2020; 33,000 jobs in 2020, 22% growth in 2020-30
- Mathematicians and statisticians: $93,290 median annual pay in 2020; 44,800 jobs in 2020; 33% growth in 2020-30.

E. Avoidance of Unnecessary Duplication

Data Science is the combination of Statistics, Mathematics, Computer Science, and subject-matter knowledge. The essential breadth of data science precludes the focus on any one of these aspects. The proposed degree program gives students exposure to all facets of data science.

A key challenge for UNL and other universities is how to address the growing need for computing education across disciplines and, in that, a key issue is how to avoid unnecessary programmatic duplication. The Data Science major delivers mathematical modeling, statistics, and computing and informatics instruction in a cost-

efficient, unified program serving students across fields and units, thereby avoiding more costly duplication of such instruction across those units.

The Department of Mathematics rolled out the Statistics and Data Science option for math majors in Fall 2020, an option that has already seen a lot of interest from our students. This major, however, requires a heavy load of advanced mathematics courses, many of them proof-theory based courses which are not needed by users in many data science fields, where practical applications are more important than theoretical questions. The proposed Data Science major offers a pathway for scientists focused on implementation and communication, rather than design of algorithms.

The Department of Statistics has an undergraduate major in Statistics and Data Analysis starting in Fall 2022. This major requires students to complete significant math and statistical prerequisites, and most of the computing load is taught within the statistics department. Specifically, the degree program focuses on data collection, data analysis, and making decisions based on data. Students develop an understanding of the theory underlying the methods they are learning, a depth not possible given the breadth of the data science curriculum. The proposed Data Science major offers a pathway for students to develop a more interdisciplinary view of the field of data science. In addition, students who are double majoring in other CASNR areas will be able develop interdisciplinary data science skills along with their discipline-specific skills.

The proposed major shares some elements with existing minor programs at UNL, which also avoids duplication. Two courses, CSCE 155T and CSCE 311, can be taken for the computer science, computational biology and bioinformatics, digital humanities, and informatics minors. Although these minors share some elements with the proposed program, they do not deliver the breadth of content and interdisciplinary professional development for students as the proposed program, nor engender the same level interdisciplinary collaboration among faculty and units as the proposed program as a catalyst for graduate and research programs, or have the same potential for engagement with external stakeholders, and do not have the potential that a major degree program has for providing a signature attraction for the university.

The proposed data science undergraduate degree program would be unique within the NU system. The University of Nebraska Kearney provides a data analytics minor. The University of Nebraska at Omaha provides a master of data science, as well as a certificate in data analytics. Creighton University offers a bachelor of science in data science and the degree program offers specializations in advanced computing and in advanced mathematics and statistics. The degree requires 23 credits from mathematics; 21 credits from journalism, media, and computing; and a collaborative capstone. The UNL program allows for more interdisciplinary with more and broader focus areas and will be more accessible at a public, land-grant institution.

F. Adequacy of Resources:

1. Faculty/Staff

   The three departments currently have adequate resources to support this program for the Year One for approximately 20 data science majors. As the number of majors increase, additional faculty and other instructional resources, such as Graduate Teaching Assistants (GTAs) or possibly undergraduate teaching assistants (UGTAs)will be needed.

   Table 1 indicates the extra resources that will be needed year-over-year for the first five years of the operation of the program; these are essentially all personnel. In year two, three additional GTA positions will be required for the operation of the program, assigned to first-year and second-year courses. In year three, another three Graduate Teaching Assistants (GTA) positions and one new tenure-track faculty member will be needed. The GTA positions will be required to handle the volume of students entering

the first and second year of the programs; the additional faculty member will be required to ensure that upper-level undergraduate courses can be accommodated. Likewise, in year five, two additional tenure-track faculty members will be required to ensure the steady state of the data science program. A director will be selected from the current faculty and will receive an administrative stipend and course buyout for overseeing the program, estimated at $14,000.

General program operating for recruitment and experiential learning are also included and are expected to increase as enrollment in the program grows by $2,500 each year, total year five, $12,500.

The instructional salary for year two would be supported through the Colleges' existing budgets and future instructional salaries would be supported through enrollment growth revenue within the University's budget model. Support for operational expenses will include sources from within the College deans' offices. Colleges will have the opportunity to submit cross-collaborative requests for seed funding for faculty positions through established strategic hiring processes.

2. Physical Facilities and Equipment

   At this time no additional physical facilities are required for this program.

3. Instructional Equipment and Informational/Library Resources
   No additional instructional equipment and informational/library resources are required to support the program as described in this proposal.

4. Budget Projections

   There are no course and lab fees associated with the courses in the major. Projected enrollment is 2022-23 (20-new students), 2023-24 (40-new students; 60 total), 2024-25 (40- new students; 100 total), 2025-26 (40-new students; 140 total), and 2026-27 (40-new students; 160 total). Projected revenue is using the Fall 2020 proportion of resident vs. non-resident undergraduate students for an estimated total revenue of $6,187,968. See Table 2. Some of the proposed courses for the major fall under existing differential tuition practices. Those courses will be charged at the differential rate.

IV. References

1. ACM Data Science Task Force report on “Computing Competencies for Undergraduate Data Sceince Curricula”, December 2019, Draft 2. [Online]. Available: http://dstf.acm.org/DSReportDraft2Full.pdf.
2. The Networking and Information Technology Research and Development Program, "The Federal Big Data Research and Development Strategic Plan," May 2016. [Online]. Available: The Federal Big Data Research and Development Strategic Plan (nitrd.gov). [Accessed 05 September 2021].
3. University of Nebraska - Lincoln, "Role & Mission," [Online]. Available: https://www.unl.edu/about/role-mission/. [Accessed 03 July 2020].
4. The Chronicle of Higher Education, "Doctoral Programs by the Numbers," 30 September 2010. [Online]. Available: https://www.chronicle.com/article/NRC-Rankings-Overview-/124721. [Accessed 03 July 2020].
5. USNews Ranking of Best Grad Schools. [Online]. Available: https://www.usnews.com/best-graduate-schools/top-science-schools/university-of-nebraska-lincoln-181464. [Accessed 03 July 2020].
6. J. E. Aoun, Robot-Proof: Higher Education in the Age of Artificial Intelligence, Cambridge MA: MIT Press, 2017.
7. N150 Commission Report. [Online]. Available: https://www.unl.edu/chancellor/the-n150-commission. [Accessed 03 July 2020].
8. N2025 Strategic Plan, Office of the Chancellor, February 14, 2020. Available: https://www.unl.edu/chancellor/n2025-strategic-plan. [Accessed 03 July 2020].
9. Nebraska's Coordinating Commission for Postsecondary Education, "Comprehensive Statewide Plan for Postsecondary Education," Last substantive revision: July 21, 2016. [Online]. Available: https://ccpe.nebraska.gov/sites/ccpe.nebraska.gov/files/COMP%20PLAN-updated%20October%202018.pdf. [Accessed 03 July 2020].
10. J. F. Gantz, S. Minton and A. Toncheva, "Cloud Computing's Role in Job Creation," IDC, Sponsored by Microsoft, March 2012. [Online]. Available: https://news.microsoft.com/download/features/2012/IDC_Cloud_jobs_White_Paper.pdf. [Accessed 09 July 2020].
11. S. Carey, "How technology will transform banking in 2018: Open banking, GDPR and robo advice," IDG, ComputerWorldUK, 22 December 2017. [Online]. Available: https://www.computerworlduk.com/it-business/how-technology-will-transform-banking-in-2018-3669442/. [Accessed July 09 2020]
12. World Economic Forum, “What is the future of the internet?” [Online]. https://www.weforum.org/agenda/2016/01/what-is-the-future-of-the-internet/ [Accessed 09 July 2020]
13. Microsoft News Center, “Four ways the cloud is creating, not eliminating, jobs”, June 12, 2018. [Online]. Available: https://news.microsoft.com/en-xm/2018/06/12/four-ways-the-cloud-is-creating-not-eliminating-jobs/
14. Indiana University Bloomington, "Bachelor of Science in Informatics," [Online]. Available: https://www.sice.indiana.edu/undergraduate/degrees-certificates/bs-informatics/index.html. [Accessed 09 July 2020].
15. Indiana University Luddy School of Informatics and Computing Career Services, "Undergraduate Hiring Report," [Online]. Available: https://luddy.indiana.edu/career-services/hiring-data-report.html. [Accessed 09 July 2020].
16. University of Washington Information School, "Informatics Academics," 2020. [Online]. Available: https://ischool.uw.edu/programs/informatics/curriculum. [Accessed 09 July 2020].

17. University of Washington Information School, Bachelor of Science in Informatics, [Online]. https://ischool.uw.edu/sites/default/files/PDFs/Informatics%20career%20infographic.pdf [Accessed 09 July, 2020]

V. Appendices

A. Course Listings and Four-Year Plans
B. Course Descriptions of the Data Science Foundation and Professional Experience Courses
C. Catalog Text
D. Guidelines for the Administration and Governance of the Data Science Program
E. Internal Letters of Support
F. External Letters of Support
G. ADV Report

Appendix A

Course Listings and Four Year Plans

- College of Arts and Sciences Track
- College of Agricultural Sciences and Natural Resources Track
- College of Engineering Track
- Side-by-Side Comparison

College of Arts and Sciences Track (BA/BS)

The Data Science major has three components, for a total of at least 42 required credit hours:

- Data Science Foundations, including statistics [at least 24 credits].
- Data Science Focus Area [15 credits], with courses chosen from at most 2 focus areas.
- Data Science Professional Experience [3 credits]

Core Requirements

Data Science Foundations [24-27 credits]	
CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A: Computer Science I	3
CSCE 311: Data Structures & Algorithms for Informatics or CSCE 310: Data Structures & Algorithms	3
CSCE 320: Data Analysis	3
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
MATH 315: Linear Algebra for Data Science [NEW] or MATH 314: Linear Algebra	3
STAT 101 and STAT 102	6
Data Science Professional Experience [3 credits]	
MATH 435: Math in the City	3
Total Core Credit Hours	**27-30 hrs**

Example Four-Year Program of Study

First Semester	**Hours**
CSCE 155T (ACE 3)	3
MATH 104 or 106	3
Elective (ACE 1, Writing)	3
Foreign Language III (CDR Lang)	3
Elective (ACE 6, Social Science)	3
Total	**15**

Second Semester	**Hours**
CSCE 311	3
MATH 203 or 107	3
Elective (ACE 5, Humanities)	3
Foreign Language IV (CDR Lang)	3
Elective (CDR Humanities)	3
Total	**15**

Third Semester	**Hours**
Statistics 1	3

Fourth Semester	**Hours**
CSCE 320	3

MATH 315 or 314	3
Elective (ACE 4, Science)	3
Elective (CDR Writing)	3
Elective (ACE 8, Ethics)	3
Total	**15**

Statistics 2	3
Focus Area Course 1	3
Elective (ACE 2, Communication)	4
Elective (CDR Science + Lab)	3
Total	**16**

Fifth Semester	**Hours**
Focus Area Course 2	3
Focus / 2nd major 1	3
Focus / 2nd major 2	3
Elective (ACE 7, Arts)	3
Elective (ACE 9, Diversity)	3
Total	**15**

Sixth Semester	**Hours**
Focus Area Course 3	3
Focus / 2nd major 3	3
Focus / 2nd major 4	3
Elective (CDR Social Sciences)	3
Elective (CDR Human Diversity)	3
Total	**15**

Seventh Semester	**Hours**
MATH 435 (ACE 10)	3
Focus Area Course 4	3
Focus / 2nd major 5	3
Elective (or Focus / 2nd major 7)	3
Elective (or Focus / 2nd major 8)	3
Total	**15**

Eighth Semester	**Hours**
Focus Area Course 5	3
Focus / 2nd major 6	3
Elective (or Focus / 2nd major 9)	3
Elective (or Focus / 2nd major 10)	3
Elective (or Focus / 2nd major 11)	2
Total	**14**

College of Agricultural Sciences and Natural Resources Track (BS)

The Data Science major has three components, for a total of at least 42 required credit hours:

- Data Science Foundations, including statistics [at least 24 credits].
- Data Science Focus Area [15 credits], with courses chosen from at most 2 focus areas.
- Data Science Professional Experience [3 credits]

Core Requirements

Data Science Foundations [24-28 credits]	
CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A: Computer Science I	3
CSCE 311: Data Structures & Algorithms for Informatics or CSCE 310: Data Structures & Algorithms	3
CSCE 320: Data Analysis	3
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
MATH 315: Linear Algebra for Data Science [NEW] or MATH 314: Linear Algebra	3

Select courses from the following: (college-level requirements) STAT 101 and STAT 102 -	6
Data Science Professional Experience [ACE 10; 3 credits] Choose one of: (Prerequisites that are not part of the core will be addressed through advising and consideration of prior coursework)	
STAT 425: Statistical Collaboration II	3
STAT 471: Analysis of Messy Data	3
STAT451: Development of Statistical Software	3
Total Core Credit Hours	**27-30 hrs**

Additional Requirements for Data Science (CASNR)	
STAT 212: Principles of Study Design	4
STAT 325: Statistical Collaboration I	3
STAT 349: Technical Skills for Statisticians	3
Select any CASNR minor in consultation with an academic advisor	12-18
Total Credit Hours	**22-28 hrs**

Note: CASNR students must meet the CASNR residency requirement of 30 CASNR credits, 18 at 300 level or higher.

Example Four-Year Program of Study

First Semester	**Hours**
CSCE 155T (ACE 3)	3
MATH 106	5
STAT 101	3
SCIL 101 (ACE 8)	3
Total	**14**

Second Semester	**Hours**
CSCE 311	3
MATH 107	4
ENGL 150 (ACE 1)	3
ALEC 102 (ACE 2)	3
STAT 102	3
Total	**16**

Third Semester	**Hours**
STAT 212	3
MATH 315 or 314	3
LIFE 120/120L (ACE 4)	4
AECN 141 (ACE 6)	3
Total	**14**

Fourth Semester	**Hours**
ACE 5	3
CSCE 320	3
ACE 7	3
CHEM 105A/105L (ACE 4)	4
STAT 349	3
Total	**16**

Fifth Semester	**Hours**
Focus Area Course 1	3

Sixth Semester	**Hours**
Focus Area Course 2	3

STAT 325	3
CASNR Minor 1	3
ACE 9	3
Elective	3
Total	**15**

CASNR Minor 2	3
CASNR Minor 3	3
Elective	3
Elective	3
Total	**15**

Seventh Semester	**Hours**
Focus Area Course 3	3
Focus Area Course 4	3
CASNR Minor 4	3
Elective (or CASNR Minor 5)	3
Elective	3
Total	**15**

Eighth Semester	**Hours**
Capstone (ACE 10)	3
Elective (or CASNR Minor 6)	3
Focus Area Course 5	3
Elective	3
Elective	3
Total	**15**

College of Engineering Track (BS)

The Data Science major has four components, for a total of 45-48 required credit hours:

- Data Science Foundations [24 or 27 credits].
- Data Science Focus Area [12 credits]
- Data Science Professional Experience [9 credits]

Core Requirements

Data Science Foundations [21 or 24 credits]	
CSCE 155T Computer Science I: Informatics Focus *CSCE 155T is recommended, but any of the CSCE 155 courses may be used.*	3
CSCE 311 Data Structures & Algorithms for Informatics *CSCE311 is recommended, but CSCE310 may be used.*	3
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
CSCE 320 Data Analysis	3
MATH 315 Linear Algebra for Data Science [NEW]	3
STAT 101 and STAT 102	6
Data Science Professional Experience [9 credits]	
CSCE 495 Internship in Computing Practice, OR CSCE 492 Special Topics in Computer Science, OR *If project is related to Data Science* CSCE 386 Professional Practice and Development: Design and Implementation [NEW]	3
CSCE 486 Professional Practice and Development: Capstone Prep *May be replaced by a student's second major's capstone*	3

CSCE 487 Computer Science Senior Design Project, OR CSCE 493A Interdisciplinary Capstone, OR MATH 435 Math in the City	3
Total Core Credit Hours	**33 - 36 hrs**

Students that are Data Science majors in the College of Engineering must complete 12 credits with at least two of the areas. Students may take at most one course in the Applied Data Science subarea and that course must be outside of their focal area unless it is used to complete a double major. In addition, students also may complete an approved internship for up to 3 credits in the Applied Data Science subarea.

Example Four-Year Program of Study (with Statistics Option 1; for Statistics Option 2, replace one of the Focus courses with the second Statistics course)

First Semester	**Hours**
CSCE 155T (ACE 3)	3
MATH 104	3
STAT 101	3
Elective (ACE 1, Writing)	3
Elective (ACE 6, Social Science)	3
Total	**15**

Second Semester	**Hours**
CSCE 311	3
MATH 203	3
Elective (ACE 5, Humanities)	3
STAT 102	3
Elective (Ancillary Requirement Breadth: Arts, Humanities, and Social Science)	3
Total	**15**

Third Semester	**Hours**
CSCE 320	3
MATH 315	3
Elective (ACE 4, Science)	3
Elective (Ancillary Requirement Technical Writing)	3
Elective (ACE 8, Ethics)	3
Total	**15**

Fourth Semester	**Hours**
Focus / 2nd major 1	3
Focus / 2nd major 2	3
Elective (ACE 2, Communication)	3
Elective (Ancillary Requirement Science: Chemistry, Physics & Astronomy, Biological Sciences, Earth & Atmospheric Sciences)	4
DS Elective 1	3
Total	**16**

Fifth Semester	**Hours**
DS Elective 2	3
CSCE 386	3
Focus / 2nd major 3	3
Elective (ACE 7, Arts)	3
Elective (ACE 9, Diversity)	3

Sixth Semester	**Hours**
DS Elective 3	3
Focus / 2nd major 4	3
Focus / 2nd major 5	3
Elective (Ancillary Requirement Breadth: Arts, Humanities, and Social Science)	3
Elective (Ancillary Requirement Science: Chemistry, Physics &	3

Total	**15**

Astronomy, Biological Sciences, Earth & Atmospheric Sciences)	
Total	**15**

Seventh Semester	**Hours**
CSCE 486 (or CSCE486H) (satisfies ACE 8)	3
DS Elective 4	3
Focus / 2nd major 6	3
Elective (or Focus / 2nd major 7)	3
Elective (or Focus / 2nd major 8)	3
Total	**15**

Eighth Semester	**Hours**
CSCE 487 or CSCE 493A (ACE 10, Capstone) or CSCE 487H	3
DS Elective 5	3
Elective (or Focus / 2nd major 9)	3
Elective (or Focus / 2nd major 10)	3
Elective (or Focus / 2nd major 11)	2
Total	**14**

Side-by-Side Track Comparison

Arts and Sciences Track		**Agricultural Sciences and Natural Resources Track**		**Engineering Track**	
Data Science Foundations					
CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A: Computer Science I	3	CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A: Computer Science I	3	CSCE 155T Computer Science I: Informatics Focus *CSCE 155T is recommended, but any of the CSCE 155 courses may be used.*	3
CSCE 311: Data Structures & Algorithms for Informatics or CSCE 310: Data Structures & Algorithms	3	CSCE 311: Data Structures & Algorithms for Informatics or CSCE 310: Data Structures & Algorithms	3	CSCE 311 Data Structures & Algorithms for Informatics *CSCE311 is recommended, but CSCE310 may be used.*	3
CSCE 320: Data Analysis	3	CSCE 320: Data Analysis	3	CSCE 320 Data Analysis	3
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5	MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5	MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4	MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4	MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
MATH 315: Linear Algebra for Data Science [NEW] or MATH 314: Linear Algebra	3	MATH 315: Linear Algebra for Data Science [NEW] or MATH 314: Linear Algebra	3	MATH 315 Linear Algebra for Data Science [NEW]	3
Select two courses from the following: STAT 101 and STAT 102	6	Select courses from the following: (college-level requirements) STAT 101 and STAT 102 -	6	Select courses from the following: STAT 101 and STAT 102	6
Foundations Subtotal	**24-27**	**Foundations Subtotal**	**24-27**	**Foundations Subtotal**	**24-27**
Data Science Professional Experience					
MATH 435: Math in the City	3	Choose One STAT 425: Statistical Collaboration II STAT 471: Analysis of Messy Data STAT451: Development of Statistical Software	3	Choose One: CSCE 495 Internship in Computing Practice CSCE 492 Special Topics in Computer Science (If project is related to Data Science) CSCE 386 Professional Practice and Development: Design and Implementation [NEW]	3
				CSCE 486 Professional Practice and Development: Capstone Prep	3

				May be replaced by a student's second major's capstone and also CSCE486H, the honors version of the above course	
				Choose One CSCE 487 Computer Science Senior Design Project CSCE 493A Interdisciplinary Capstone MATH 435 Math in the City	3
Professional Experience Subtotal	**3**	**Professional Experience Subtotal**	**3**	**Professional Experience Subtotal**	**9**
Data Science Focus Areas					
Select 5 courses from at most 2 of the focus areas below for at least 15 hours	15	Select 5 courses from at most 2 of the focus areas below for at least 15 hours; Courses used above may not count toward these 15 credits	15	Select 4 courses from at most 2 of the focus areas below for at least 12 hours	12
Focus Area Subtotal	**15**	**Focus Area Subtotal**	**15**	**Focus Area Subtotal**	**12**
		Additional Requirements			
		STAT 212: Principles of Study Design	4		
		STAT 325: Statistical Collaboration I	3		
		STAT 349: Technical Skills for Statisticians	3		
		Select any CASNR minor in consultation with an academic advisor	12-18		
		Additional Requirements Subtotal	**22-28**		
Total Credit Hour Requirement	**42-45**	**Total Credit Hour Requirement**	**67-73**	**Total Credit Hour Requirement**	**45-48**

Appendix B

Data Science Major Course Descriptions

Data Science Foundation

- CSCE 155T COMPUTER SCIENCE I: INFORMATICS FOCUS
  Prerequisites: Appropriate score on the School of Computing Placement Exam or CSCE101; MATH 103 or equivalent
  Description: Introduction to computers and problem-solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
  Credit Hours: 3
  ACE: ACE 3 Math/Stat/Reasoning
  Note: For the College of Engineering, CSCE 155A, 155E, 155H, or 155N can be substituted for CSCE 155T.

- CSCE 311 DATA STRUCTURES AND ALGORITHMS FOR INFORMATICS
  Prerequisites: Grade of "Pass" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160.
  Description: An introduction to algorithms and data structures for informatics. Foundational coverage of algorithms includes both problems (such as indexing, searching, sorting, and pattern matching) and methods (such as greedy, divide-and-conquer, and dynamic programming). Foundational coverage of data structures includes lists, tables, relational databases, regular expressions, trees, graphs, and multidimensional arrays. The topics will be studied in the context of informatics applications.
  Credit Hours: 3
  Note: For the College of Engineering, CSCE 310 can be substituted for CSCE 311.

- CSCE 320 Data Analysis
  Prerequisites: CSCE 220
  Description: Practical experience on how to model data through existing techniques including object-oriented and relational models. These models then can be used at the center of systems to promote efficient and effective data processing and analysis.
  Credit Hours: 3
  CSCE 320 will be updated with new prerequisites (including "versions of CSCE155").

- MATH 104 APPLIED CALCULUS
  Prerequisites: Appropriate score on the Math Placement Exam; or grade of P, C, or better in MATH 101, MATH 102, or MATH 103
  Description: Rudiments of differential and integral calculus with applications to problems from business, economics, and social sciences
  Credit Hours: 3
  ACE: ACE 3 Math/Stat/Reasoning

- MATH 203/203J CONTEMPORARY MATH
  Prerequisites: None
  Description**:** Applications of quantitative reasoning and methods to problems and decision making in the areas of management, statistics, and social choice. Includes networks, critical paths, linear programming, sampling, central tendency, inference, voting methods, power index, game theory, and fair division problems.

Credit Hours: 3
ACE: ACE 3 Math/Stat/Reasoning

- MATH 315 LINEAR ALGEBRA FOR DATA SCIENCE
  Prerequisites: A grade of P, C, or better in MATH 104 and MATH 203
  Description: Fundamental concepts of linear algebra, including properties of matrix arithmetic, systems of linear equations, vector spaces, inner products, determinants, eigenvalues and eigenvectors, and diagonalization, with emphasis in data science applications.
  Credit Hours**:** 3
  Note: MATH 315 cannot be used toward a major in Mathematics. Students that would like to pursue a math major will be advised to take Math 106, Math 107, and Math 314 instead of 104, 203, and 315. Students that would like to pursue a computer science major will be advised to take CSCE 155E and CSCE 310 instead of CSCE 155T and CSCE 311 in addition to the alternative math courses previously listed. Students that are Data Science majors are not eligible to double major in Math under the Statistics and Data Science option, or to pursue a Math minor.

- STAT 101 INTRODUCTION TO DATA (NEW)
  Prerequisites: Removal of all entrance deficiencies in mathematics
  Description: An introduction to statistics through exploratory data analysis and data visualization. Topics include data types, chart types, methods for working with and reducing data, simple regression, regression diagnostics. Focuses on how to communicate statistical information and how to critically consume statistical information presented in the media and popular press.
  Credit Hours: 3
  ACE: ACE 3 Math/Stat/Reasoning
  Note: This is the first course of a two-course sequence for Statistics Alternative 2

- STAT 102 PRINCIPLES OF STATISTICAL ANALYSIS (NEW)
  Prerequisites: Stat 101, Concurrent enrollment in STAT 151 (Introduction to Statistical Computing)
  Description: An introduction to statistics through exploratory data analysis and data visualization. Topics include data types, chart types, methods for working with and reducing data, simple regression, regression diagnostics. Focuses on how to communicate statistical information and how to critically consume statistical information presented in the media and popular press. Introduction to formal statistical inference and elementary probability for statistics majors. Explores the practical application of statistical techniques to meaningful scientific problems. Inference topics will be implemented using both simulation-based approaches and classical, theory-based methods.
  Credit Hours: 3
  ACE: ACE 3 Math/Stat/Reasoning
  Note: Students that would like to pursue a math or statistics major will be advised to take Math 106, Math 107, and Math 314 instead of 104, 203, and 315. Students that would like to pursue a computer science major will be advised to take CSCE 155E and CSCE 310 instead of CSCE 155T and CSCE 311 in addition to the alternative math courses previously listed. Students who intend to complete courses in the statistics focus area will be advised to take Stat 101 and Stat 102 instead of Stat 218, 318, 380, or 462. This is the second course of a 2-course sequence for Statistics Alternative 2

Data Science Professional Experience

- MATH 435 MATH IN THE CITY
  Prerequisites: Grade of "Pass" of "C" in MATH 104 (or MATH 106), MATH 203 (or MATH 107), and MATH 315 (or MATH 314).
  Description: A research experience modeling problems of current interest to the local community, businesses, or government. Professional practice through interactions with local collaborator.

Credit Hours: 3
ACE: ACE 10 Creative or Scholarly Product

- CSCE 486 (or 486H) COMPUTER SCIENCE PROFESSIONAL DEVELOPMENT
  Prerequisites: Grade of "Pass" of "C" in SOFT 261, CSCE 361, or CSCE361H; Must be taken exactly one semester before CSCE 487
  Description: Preparation for the senior design project. Professional practice through familiarity with current tools, resources, and technologies. Professional standards, practices and ethics, and the oral and written report styles used specifically in the field of computer science.
  Credit Hours: 3
  Note: In the case of dual matriculation where a student has a capstone project associated with a second major, this class may be waived.

- CSCE 487 (or 487H) COMPUTER SCIENCE SENIOR DESIGN PROJECT
  Prerequisites: CSCE486; Must be taken in the immediate next term after CSCE486.
  Description: A substantial computer science project requiring design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and software engineering.
  Credit Hours: 3
  Note: In the case of dual matriculation where a student has a capstone project associated with a second major, this class may be replaced by CSCE493A

- CSCE 493A INTERDISCIPLINARY CAPSTONE
  Prerequisites: Grade of "Pass" of "C" in CSCE 486, taken exactly one semester previous.
  Description: Innovative team projects executed under the guidance of members of the faculty of the Department of Computer Science and Managing Director of the CSCE Innovation Lab. Work in teams and collaboration with School of Computing research faculty and sponsors that include private sectors and UNL faculty to design and develop real-world systems to solve interdisciplinary problems.
  Credit Hours: 3

- CSCE 386 PRACTICE AND PROFESSIONAL DEVELOPMENT: DESIGN AND IMPLEMENTATION
  Prerequisites: Grade of "Pass" of "C" in CSCE 311 and STAT 218 (or approved statistics class).
  Description: Studies in informatics practice and professional development. Students across informatics fields work together on several short modules in multidisciplinary applications of informatics with involvement of faculty and other experts in those applications. The modules focus on design and implementation skills — especially design methods and program design and implementation. Informatics topics include data-centric and model-driven approaches; information and knowledge structures, organization, and access; searching and mining; and visualization. Professional development involves instruction in career development, entrepreneurship, professional ethics, and professional communications.
  Credit Hours: 3

Appendix C

Catalog Copy – Data Science Major in the College of Arts and Sciences

Quick Points

College: Arts and Sciences
Degree Offered: Bachelor of Arts or Bachelor of Science
Hours Required: 120
Minimum Cumulative GPA: 2.0
Minor Available: No
Advisor: TBD

Overview Tab

Description

The Data Science major prepares students with skills and competency in data analysis and interpretation, algorithm design and implementation, and helps them develop aptitudes for interdisciplinary problem solving. The interdisciplinary program enables students to take advantage of career and employment opportunities across diverse fields involving data-rich, data-driven systems and applications. Ultimately, this will help address the increasing societal and economic need for a qualified workforce in our digital age.

Students can select a major of Data Science through one of three colleges: Arts and Sciences (Department of Mathematics), Engineering (School of Computing), or Agricultural Science and Natural Resources (Department of Statistics). Students in the College of Arts and Sciences will have the opportunity to pair the major with a strong liberal arts education offering flexibility and a multidisciplinary set of courses across the college. In addition, CAS students may choose to add a minor that both compliments and enhances the Data Science major.

Major Tab

Major Requirements

Complete the Data Science Foundations

Core Requirements

Data Science Foundations	
CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A: Computer Science I	3
CSCE 311: Data Structures & Algorithms for Informatics or CSCE 310: Data Structures & Algorithms	3
CSCE 320: Data Analysis	3
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
MATH 315: Linear Algebra for Data Science [NEW] or MATH 314: Linear Algebra	3
STAT 101 and STAT 102	6

Data Science Professional Experience	
MATH 435: Math in the City	3
Total Core Requirements Credit Hours	**27-30 hrs**

Specific Major Requirements

Data Science Focus Areas Select 5 courses from at most 2 of the focus areas below for at least 15 hours
Artificial Intelligence • CSCE421 Foundations of Constraint Processing • CSCE472 Digital Image Processing • CSCE473 Computer Vision • CSCE474 Introduction to Data Mining • CSCE475 Multiagent Systems • CSCE476 Introduction to Artificial Intelligence • CSCE478 Introduction to Machine Learning OR STAT 485 Statistical Learning • CSCE479 Introduction to Deep Learning
Applied Data Science: Sociology • SOCI 310 Applied Sociology: Community-Based Research • SOCI 333 Applied Research in Public Opinion Research • SOCI 362 Ethics and the Responsible Conduct of Research • SOCI 430 Advanced Social Network Analysis • SOCI 407 Strategies of Social Research: Qualitative Methods • SOCI 463 Advanced Social Research Methods • SOCI 465 Survey Design and Analysis • SOCI 485 Agent-Based Social Simulation
Software Applications • CSCE361 Software Engineering • CSCE378 Human-Computer Interaction • CSCE412 Data Visualization • CSCE460 Software Engineering for Robotics • CSCE461 Advanced Topics in Software Engineering • CSCE464 Internet Systems & Programming • CSCE466 Software Design and Architecture • CSCE467 Testing, Verification and Analysis • CSCE468 Advanced Topics in Software Engineering
Data Pipeline • STAT251 Statistical Computing I: Data Wrangling • STAT251 Statistical Computing II: Data Management and Visualization • CSCE411 Data Modeling for Systems Development • CSCE413 Introduction to Database Systems • CSCE436 Advanced Embedded Systems • CSCE438 Internet of Things • CSCE458 Molecular and Nanoscale Communication • CSCE463 Data and Network Security • CSCE465 Wireless Communication Networks
Statistical Modeling • *STAT212 Statistical Design* • *STAT301* Mathematical Statistics and Modeling I

- STAT302 Mathematical Statistics and Modeling II
- STAT325 Statistical Collaboration I
- STAT412 Advanced Statistical Design
- STAT414 Survey Sampling
- STAT432 Introduction to Survey Statistics
- STAT443 Statistical Analysis of Genomics Data
- STAT450 Introduction to Regression Analysis
- STAT462 Introduction to Mathematical Statistics I: Distribution Theory
- STAT463 Introduction to Mathematical Statistics II: Statistical Inference
- STAT464 Model Selection and Prediction
- STAT474 Introduction to Nonparametric Statistics
- STAT475 Introduction to Categorical Data
- STAT478 Time Series Analysis
- SOCI 465 Survey Design and Analysis
- STAT486 Introduction to Bayesian Analysis
- AGRO 420 Bioinformatics Applications in Agriculture

Mathematical Modeling

- Math 208 Calculus in three dimensions
- Math 221 Differential Equations
- Math 415 Theory of Linear Transformations
- Math 424 Partial Differential Equations
- Math 428 Principles of Operations Research
- Math 433 Nonlinear Optimization
- Math 440 Numerical Analysis
- Math 450 Combinatorics
- Math 452 Graph Theory
- Math 447 Numerical Linear Algebra
- Math 471 Introduction to Topology
- Math 487 Probability Theory OR STAT 262 Probability
- Math 489 Stochastic Processes

Applied Data Science: Journalism + Humanities

- HIST 461 Geospatial Approaches in Digital Humanities and Social Sciences
- HIST 470 Digital History
- JOMC 358 UX/UI Design
- JOUR 307 Data Journalism
- JOUR 407 Data Visualization
- NSST 376 Analysis for the National Security Establishment
- SPMC 350: Sports Data Visualization and Analytics

Applied Data Science: Natural Resources

- NRES 218 Introduction to Geospatial Sciences
- NRES 412 Introduction to GIS
- NRES 415 GIS for Agriculture and Natural Resources
- NRES 418 Introduction to Remote Sensing
- AECN 401 Advanced Farm Management and Linear Programming
- AECN 406 Commodity Price Forecasting
- AGRO 420 Bioinformatics Applications in Agriculture
- AGRO 431 Site-specific Crop Management
- MSYM 433 Equipment and Tractor Testing

Additional Major Requirements

Grade Rules

C- and D Grades

A grade of C or above is required for all courses in the major.

Pass/No Pass

No course taken Pass/No Pass will be counted toward the major, unless offered exclusively with a grade option of Pass/No Pass.

Restriction

Data Science majors, regardless of degree-seeking college, are not eligible for the Mathematics major with Option in Statistics and Data Science, or the Mathematics minor.

Learning Outcomes Tab

The primary student learning outcomes of the interdisciplinary Data Science major are:

- foundational knowledge and expertise in the analysis of large-scale data sources from the interdisciplinary perspectives of applied computer science, data modeling, mathematics, and statistics.
- foundational knowledge and expertise in the application of computing, informatics, and modeling to solve multidisciplinary problems; and
- abilities and professional skills to solve multidisciplinary data science problems as a member of an interdisciplinary team.

Catalog Copy – College of Agricultural Sciences and Natural Resources Track (BS)

DESCRIPTION

The Data Science major prepares students with skills and competency in data analysis and interpretation, algorithm design and implementation, and helps them develop aptitudes for interdisciplinary problem solving. The interdisciplinary program enables students to take advantage of career and employment opportunities across diverse fields involving data-rich, data-driven systems and applications. Ultimately, this will help address the increasing societal and economic need for a qualified workforce in our digital age.

Students can select a major of Data Science through one of three colleges: Arts and Sciences (Department of Mathematics), Engineering (School of Computing), or Agricultural Science and Natural Resources (Department of Statistics). Students in the College of Agricultural Sciences and Natural Resources (CASNR) will take additional courses geared specifically toward developing communication and collaboration skills and gain breadth in an allied discipline by selecting a CASNR minor

COLLEGE REQUIREMENTS

College Admission

Requirements for admission into the College of Agricultural Sciences and Natural Resources (CASNR) are consistent with general University admission requirements (one unit equals one high school year): 4 units of English, 4 units of mathematics, 3 units of natural sciences, 3 units of social studies, and 2 units of foreign language. Students must also meet performance requirements: ACT composite of 20 or higher OR combined SAT score of 1040 or higher OR rank in the top one-half of graduating class; transfer students must have a 2.0 (on a 4.0 scale) cumulative grade point average and 2.0 on the most recent term of attendance.

Admission Deficiencies/Removal of Deficiencies

Students who are admitted to CASNR with core course deficiencies must remove these deficiencies within the first 30 credit hours at University of Nebraska – Lincoln, or within the first calendar year at Nebraska, whichever takes longer, excluding foreign languages. Students have up to 60 credit hours to remove foreign language deficiencies. College-level coursework taken to remove deficiencies may be used to meet degree requirements in CASNR.

Deficiencies in the required entrance subjects can be removed by completion of specified courses in the University or by correspondence.

The Office of Admissions, Alexander Building (south entrance), City Campus, provides information to new students on how deficiencies can be removed.

COLLEGE DEGREE REQUIREMENTS

Curriculum Requirements

The curriculum requirements of the College consist of three areas: ACE (Achievement-Centered Education), College of Agricultural Sciences and Natural Resources Core, and Degree Program requirements and electives. All three areas of the College Curriculum Requirements are incorporated within the description of the Major/Degree Program sections of the catalog. The individual major/degree program listings of classes ensures that a student will meet the minimum curriculum requirements of the College.

World Languages/Language Requirement

Two units of a foreign language are required. This requirement is usually met with two years of high school language.

Minimum Hours Required for Graduation

The College grants the bachelors degree in programs associated with agricultural sciences, natural resources, and related programs. Students working toward a degree must earn at least 120 semester hours of credit. A minimum cumulative grade point average of C (2.0 on a 4.0 scale) must be maintained throughout the course of studies and is required for graduation. Some degree programs have a higher cumulative grade point average required for graduation. Please check the degree program on its graduation cumulative grade point average.

Grade Rules

Removal of C-, D, and F Grades

Only the most recent letter grade received in a given course will be used in computing a student's cumulative grade point average if the student has completed the course more than once and previously received a grade or grades below C in that course.

The previous grade (or grades) will not be used in the computation of the cumulative grade point average, but it will remain a part of the academic record and will appear on any transcript.

A student can remove from his/her cumulative average a course grade of C-, D+, D, D-, or F if the student repeats the same course at the University of Nebraska and receives a grade other than P (pass), I (incomplete), N (no pass), W (withdrew), or NR (no report). If a course is no longer being offered, it is not eligible for the revised grade point average computation process.

For complete procedures and regulations, see the Office of the University Registrar website at http://www.unl.edu/regrec/course-repeats (http://www.unl.edu/regrec/course-repeats/).

Pass/No Pass

Students in CASNR may take any course offered on a Pass/No Pass basis within the 24-hour limitation established by the Faculty Senate. However, a department may specify that the Pass/No Pass status of its courses be limited to non-majors or may choose to offer some courses for letter grades only.

GPA Requirements

A minimum cumulative grade point average of C (2.0 on a 4.0 scale) must be maintained throughout the course of studies and is required for graduation. Some degree programs have a higher cumulative grade point average required for graduation. Please check the degree program on its graduation cumulative grade point average.

Transfer Credit Rules

To be considered for admission, a transfer student, Nebraska resident or nonresident, must have an accumulated average of C (2.0 on a 4.0 scale) and a minimum C average in the last semester of attendance at another college. Transfer students who have completed less than 12 credit hours of college study must submit either ACT or SAT scores.

Ordinarily, credits earned at an accredited college are accepted by the University. The College, however, will evaluate all hours submitted on an application for transfer and reserves the right to accept or reject any of them. Sixty (60) is the maximum number of hours the University will accept on transfer from a two-year college. Ninety (90) is the maximum number of hours the University will accept from a four-year college. Transfer credit in the degree program must be approved by the degree program advisor on a Request for Substitution Form to meet specific course requirements, group requirements, or course level requirements in the major. At least 9 hours in the major field, including the capstone course, must be completed at the University of Nebraska– Lincoln regardless of the number of hours transferred.

The College will accept no more than 10 semester hours of C-, D+, D, and D- grades from other schools. The C-, D+, D, and D- grades can only be applied to free electives. This policy does not apply to the transfer of grades from UNO or UNK to the University of Nebraska–Lincoln.

Joint Academic Transfer Programs

The College of Agricultural Sciences and Natural Resources has agreements with many institutions to support joint academic programs. The transfer programs include dual degree programs and cooperative degree programs. Dual degree programs offer students the opportunity to receive a degree from a participating institution and also to complete requirements for a bachelor of science degree in CASNR. Cooperative programs result in a single degree from either the University of Nebraska–Lincoln or the cooperating institution.

Dual Degree Programs

A to B Programs

The A to B Program, a joint academic program offered by the CASNR and participating community colleges, allows students to complete the first two years of a degree program at the participating community college and continue their education and study in a degree program leading toward a bachelor of science degree.

The A to B Program provides a basic knowledge plus specialized coursework. Students transfer into CASNR with junior standing.

Depending on the community college, students enrolled in the A to B Program may complete the requirements for an associate of science at the community college, transfer to the University of Nebraska–Lincoln, and work toward a bachelor of science degree.

Participating community colleges include:

Central Community College

Metropolitan Community College

Mid-Plains Community College

Nebraska College of Technical Agriculture

Northeast Community College

Southeast Community College

Western Nebraska Community College

3+2 Programs

Two specialized degree programs in animal science and veterinary science are offered jointly with an accredited college or school of veterinary medicine. These two programs permit CASNR animal science or veterinary science students to receive a bachelor of science degree from the University of Nebraska–Lincoln with a degree in animal science or veterinary science after successfully completing two years of the professional curriculum in veterinary medicine at an accredited veterinary school. Students who successfully complete the 3+2 Program, must provide transcripts and complete the Application for Degree form via MyRED. Students without MyRED access may apply for graduation in person at Husker Hub in the Canfield Administration Building, or by mail. Students should discuss these degree programs with their academic advisor.

Cooperative Degree Programs

Academic credit from the University and a cooperating institution is applied towards a four-year degree from either the University of Nebraska–Lincoln (University degree-granting program) or the cooperating institution (non University degree-granting program). All have approved programs of study.

UNL Degree-Granting Programs

A University of Nebraska–Lincoln degree-granting program is designed to provide students the opportunity to complete a two-year program of study at one of the four-year institutions listed below, transfer to CASNR, and complete the requirements for a bachelor of science degree.

Chadron State College. Chadron State College offers a 2+2 program leading to a grassland ecology and management degree program and a transfer program leading to a bachelor of science in agricultural education in the teaching option.

Wayne State College. Wayne State College offers a 3+1 program leading to a bachelor of science in plant biology in the ecology and management option and a 3+1 program leading to a bachelor of science in Applied Science.

University of Nebraska at Kearney. Transfer programs are available for students pursuing degree programs leading to a bachelor of science degree.

University of Nebraska at Omaha. The University of Nebraska at Omaha (UNO) cooperates with CASNR in providing four-semester pre-agricultural sciences, pre-natural resources, pre-food science and technology, pre- horticulture, and pre-turfgrass and landscape management transfer programs.

Non University of Nebraska–Lincoln Degree-Granting Programs

CASNR cooperates with other institutions to provide coursework that is applied towards a degree at the cooperating institution. Pre-professional programs offered by CASNR allow students to complete the first two or three years of a degree program at the University prior to transferring and completing a degree at the cooperating institution.

Chadron State College–Range Science. The 3+1 Program in range science allows Chadron State College students to pursue a range science degree through Chadron State College. Students complete three years of coursework at Chadron State College and one year of specialized range science coursework (32 credit hours) at CASNR.

Dordt College (Iowa)–Agricultural Education: Teaching Option. This program allows students to pursue an Agricultural Education Teaching Option degree leading toward a bachelor of science in agricultural education. Students at Dordt College will complete 90 credit hours in the Agricultural Education: Teaching Option Transfer Program.

Residency

Students must complete at least 30 of the total hours for their degree using University of Nebraska–Lincoln credits. At least 18 of the 30 credit hours must be in courses offered through CASNR[1] (>299) including the appropriate ACE 10 degree requirement or an approved ACE 10 substitution offered through another Nebraska college and excluding independent study regardless of the number of hours transferred. Credit earned during education abroad may be used toward the residency requirement if students register through UNL and participate in prior- approved education abroad programs. University of Nebraska–Lincoln open enrollment and summer independent study courses count toward residence.

[1] *Includes courses taught by CASNR faculty through interdisciplinary prefixes (e.g., LIFE, MBIO, ENVR, SCIL, EAEP, HRTM, ENSC) and CASNR crosslisted courses taught by non-CASNR faculty.*

Online and Distance Education

There are many opportunities to earn college credit online through the University of Nebraska–Lincoln. Some of these credits may be applicable not only as elective credits, but also toward the fulfillment of the College's education requirements. Credits earned online may count toward residency. However, certain offerings may not be counted toward scholarship requirements or academic recognition criteria.

For further information, contact:

Office of Online and Distance Education University of Nebraska–Lincoln

305 Brace Labs

Lincoln, NE 68588-0109

402-472-4681

http://online.unl.edu/

Independent Study Rules

Students wishing to take part in independent studies must obtain permission; complete and sign a contract form; and furnish copies of the contract to the instructor, advisor, departmental office, and the Dean's Office. The contract should be completed before registration. Forms are available in 103 Agricultural Hall or online at the CASNR website.

Independent study projects include research, literature review or extension of coursework under supervision and evaluation of a departmental faculty member.

Students may only count 12 hours of independent study toward their degrees and no more than 6 hours can be counted during their last 36 hours earned, excluding senior thesis, internships, and courses taught under an independent study number.

Other College Degree Requirements

Capstone Course Requirement

A capstone course is required for each CASNR degree program. A capstone course is defined as a course in which students are required to integrate diverse bodies of knowledge to solve a problem or formulate a policy of societal importance.

ACE REQUIREMENTS

All students must fulfill the Achievement Centered Education (ACE) requirements. Information about the ACE program may be viewed at ace.unl.edu (https://ace.unl.edu/).

The minimum requirements of CASNR reflect the common core of courses that apply to students pursuing degrees in the college. Students should work with an advisor to satisfy ACE outcomes 1, 2, 3, 4, 6, and 10 with the college requirements.

CATALOG RULE

Students must fulfill the requirements stated in the catalog for the academic year in which they are first admitted to the University of Nebraska–Lincoln or when they were first admitted to a Joint Academic Transfer Program. In consultation with advisors, a student may choose to follow a subsequent catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at Nebraska in the College of Agricultural Sciences and Natural Resources. Students must complete all degree requirements from a single catalog year. The catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Learning Outcomes

The primary student learning outcomes of the interdisciplinary Data Science major are:

- foundational knowledge and expertise in the analysis of large-scale data sources from the interdisciplinary perspectives of applied computer science, data modeling, mathematics, and statistics.
- foundational knowledge and expertise in the application of computing, informatics, and modeling to solve multidisciplinary problems; and
- abilities and professional skills to solve multidisciplinary data science problems as a member of an interdisciplinary team.

Major Requirements

College Integrative Course (ACE 8)		Credits
SCIL 101	Science and Decision-Making for a Complex World	3
	Credit Hours Subtotal	3

Communications		
Written Communication (ACE 1)		
Select one of the following:		3
ENGL 150	Writing and Inquiry	
ENGL 151	Writing and Argument	
ENGL 254	Writing and Communities	
JGEN 120	Basic Business Communication	

JGEN 200	Technical Communication I	
JGEN 300	Technical Communication II	
Oral Communication (ACE 2)		
Select one of the following:		3
ALEC 102	Interpersonal Skills for Leadership	
COMM 101	Communication in the 21st Century	
COMM 209	Public Speaking	
COMM 210	Communicating in Small Groups	
COMM 215	Visual Communication	
COMM 283	Interpersonal Communication	
COMM 286	Business and Professional Communication	
JGEN 300	Technical Communication II	
NRES 301	Environmental Communication Skills	
TMFD 121	Visual Communication and Presentation	
	Credit Hours Subtotal	6

Natural Sciences (ACE 4)		
Select one each from two of the following areas:		8
Select from CASNR Approved Life Sciences:		
AGRO 131/HORT 131/ & AGRO 132	Plant Science and Agronomic Plant Science Laboratory	
BIOS 101 & BIOS 101L	General Biology and General Biology Laboratory	
ENTO 115/BIOS 115 & ENTO 116/BIOS 116	Insect Biology and Insect Identification	
LIFE 120 & LIFE 120L	Fundamentals of Biology I and Fundamentals of Biology I Laboratory	
LIFE 121 & LIFE 121L	Fundamentals of Biology II and Fundamentals of Biology II Laboratory	
Select from the following:		
CHEM 105	Chemistry in Context I	
CHEM 109	General Chemistry I	
Select from the following:		
MYSM 109	Physical Principles in Agriculture and Life Sciences	
PHYS 141	Elementary General Physics I	
PHYS 151	Elements of Physics	
PHYS 211	General Physics I	
	Credit Hours Subtotal	8

Economics, Humanities, and Social Sciences		
Select one of the following (ACE 6)		3
ECON 211	Principles of Macroeconomics	
ECON 212	Principles of Microeconomics	
AECN 141	Introduction to the Economics of Agriculture	
ACE Courses		
Select one course each from ACE outcomes 5, 7, and 9		9
	Credit Hours Subtotal	12

Data Science Requirements		
Data Science Foundations		
CSCE 155T, CSCE 155E, CSCE 155N, CSCE 155H, or CSCE 155A	Computer Science I	3
CSCE 311 or CSCE 310	Data Structures & Algorithms for Informatics or Data Structures & Algorithms	3
CSCE 320	Data Analysis	3
MATH 104 or 106 (ACE 3)	Applied Calculus or Calculus I	3 or 5
MATH 107 or MATH 203/203J	Calculus II or Contemporary Mathematics	3 or 4
MATH 315 or MATH 314	Linear Algebra for Data Science or Linear Algebra	3
STAT 101	Introduction to Data	3
STAT 102	Principles of Statistical Analysis	3
STAT 425 or STAT 451 or STAT 471	Statistical Collaboration II or Development of Statistical Software or Analysis of Messy Data	3
	Credit Hours Subtotal	27-30
Additional Requirements for Data Science (CASNR)		
STAT 212	Principles of Study Design	4
STAT 325	Statistical Collaboration I	3
STAT 349	Technical Skills for Statisticians	3
Select any CASNR minor		12-18
	Credit Hours Subtotal	22-28

Data Science Focus Areas
Select 5 courses from at most 2 of the focus areas below for at least 15 hours
Artificial Intelligence
• CSCE421 Foundations of Constraint Processing
• CSCE472 Digital Image Processing
• CSCE473 Computer Vision
• CSCE474 Introduction to Data Mining
• CSCE475 Multiagent Systems
• CSCE476 Introduction to Artificial Intelligence
• CSCE478 Introduction to Machine Learning OR STAT 485 Statistical Learning
• CSCE479 Introduction to Deep Learning
Applied Data Science: Sociology
• SOCI 310 Applied Sociology: Community-Based Research
• SOCI 333 Applied Research in Public Opinion Research
• SOCI 362 Ethics and the Responsible Conduct of Research
• SOCI 430 Advanced Social Network Analysis
• SOCI 407 Strategies of Social Research: Qualitative Methods
• SOCI 463 Advanced Social Research Methods
• SOCI 465 Survey Design and Analysis

• SOCI 485 Agent-Based Social Simulation
Software Applications • CSCE361 Software Engineering • CSCE378 Human-Computer Interaction • CSCE412 Data Visualization • CSCE460 Software Engineering for Robotics • CSCE461 Advanced Topics in Software Engineering • CSCE464 Internet Systems & Programming • CSCE466 Software Design and Architecture • CSCE467 Testing, Verification and Analysis • CSCE468 Advanced Topics in Software Engineering
Data Pipeline • STAT251 Statistical Computing I: Data Wrangling • STAT351 Statistical Computing II: Data Management and Visualization • CSCE411 Data Modeling for Systems Development • CSCE413 Introduction to Database Systems • CSCE436 Advanced Embedded Systems • CSCE438 Internet of Things • CSCE458 Molecular and Nanoscale Communication • CSCE463 Data and Network Security • CSCE465 Wireless Communication Networks
Statistical Modeling • *STAT212 Statistical Design* • *STAT301* Mathematical Statistics and Modeling I • STAT302 Mathematical Statistics and Modeling II • STAT325 Statistical Collaboration I • STAT412 Advanced Statistical Design • STAT414 Survey Sampling • STAT432 Introduction to Survey Statistics • STAT443 Statistical Analysis of Genomics Data • STAT450 Introduction to Regression Analysis • STAT462 Introduction to Mathematical Statistics I: Distribution Theory • STAT463 Introduction to Mathematical Statistics II: Statistical Inference • STAT464 Model Selection and Prediction • STAT474 Introduction to Nonparametric Statistics • STAT475 Introduction to Categorical Data • STAT478 Time Series Analysis • SOCI 465 Survey Design and Analysis • STAT486 Introduction to Bayesian Analysis • AGRO 420 Bioinformatics Applications in Agriculture
Mathematical Modeling • Math 208 Calculus in three dimensions • Math 221 Differential Equations • Math 415 Theory of Linear Transformations • Math 424 Partial Differential Equations • Math 428 Principles of Operations Research • Math 433 Nonlinear Optimization • Math 440 Numerical Analysis • Math 450 Combinatorics • Math 452 Graph Theory

• Math 447 Numerical Linear Algebra • Math 471 Introduction to Topology • Math 487 Probability Theory OR STAT 262 Probability • Math 489 Stochastic Processes
Applied Data Science: Journalism + Humanities • HIST 461 Geospatial Approaches in Digital Humanities and Social Sciences • HIST 470 Digital History • JOMC 358 UX/UI Design • JOUR 307 Data Journalism • JOUR 407 Data Visualization • NSST 376 Analysis for the National Security Establishment • SPMC 350: Sports Data Visualization and Analytics
Applied Data Science: Natural Resources • NRES 218 Introduction to Geospatial Sciences • NRES 412 Introduction to GIS • NRES 415 GIS for Agriculture and Natural Resources • NRES 418 Introduction to Remote Sensing • AECN 401 Advanced Farm Management and Linear Programming • AECN 406 Commodity Price Forecasting • AGRO 420 Bioinformatics Applications in Agriculture • AGRO 431 Site-specific Crop Management • MSYM 433 Equipment and Tractor Testing

Note: CASNR students must meet the CASNR Residency Requirement of 30 CASNR credits, 18 at 300 level or higher.

Additional Major Requirements:

Grade Rules - Pass/No Pass: Students in Data Science (CASNR) may not take major courses Pass/No Pass unless the course is offered exclusively with a grade option of Pass/No Pass

Catalog Copy - Data Science Major in the College of Engineering

Quick Points

College: Engineering
Degree Offered: Bachelor of Science
Hours Required: 120
Minimum Cumulative GPA: 2.0
Minor Available: No
Advisor: TBD

Overview Tab

Description

The Data Science major prepares students with skills and competency in data analysis and interpretation, algorithm design and implementation, and helps them develop aptitudes for interdisciplinary problem solving. The interdisciplinary program enables students to take advantage of career and employment opportunities across diverse fields involving data-rich, data-driven systems and applications. Ultimately, this will help address the increasing societal and economic need for a qualified workforce in our digital age.

Students can select a major of Data Science through one of three colleges: Arts and Sciences (Department of Mathematics), Engineering (School of Computing), or Agricultural Science and Natural Resources (Department of Statistics). Students in the College of Engineering (COE) will have the opportunity to investigate and learn about the various aspects of the Data Science from data collection to data visualization, from foundations of computational methodologies to software and hardware applications in Data Science. In particular, students in the COE track will have a year-long senior capstone and a practicum to enrich their experience in building Data Science solutions and working with research and development in Data Science. The Data Science program offers flexibility for non-engineering students to earn a dual degree in Data Science and their chosen discipline's degree program. In addition, students may choose to add a minor that both compliments and enhances the Data Science major.

Major Tab

Major Requirements

Complete the Data Science Foundations

Core Requirements

Data Science Foundations [21 or 24 credits]	
CSCE 155T Computer Science I: Informatics Focus *CSCE 155T is recommended, but any of the CSCE 155 courses may be used.*	3
CSCE 311 Data Structures & Algorithms for Informatics *CSCE311 is recommended, but CSCE310 may be used.*	3
MATH 104: Applied Calculus or MATH 106: Calculus I	3 or 5
MATH 203/203J: Contemporary Mathematics or MATH 107: Calculus II	3 or 4
CSCE 320 Data Analysis	3
MATH 315 Linear Algebra for Data Science [NEW]	3
STAT 101 and STAT 102	6
Data Science Professional Experience [3-9 credits]	
CSCE 495 Internship in Computing Practice, OR CSCE 492 Special Topics in Computer Science, OR *If project is related to Data Science* CSCE 386 Professional Practice and Development: Design and Implementation [NEW]	3
CSCE 486 Professional Practice and Development: Capstone Prep *May be replaced by a student's second major's capstone and also CSCE486H, the honors version of the above course*	3
CSCE 487 Computer Science Senior Design Project, OR CSCE 493A Interdisciplinary Capstone, OR MATH 435 Math in the City	3
Total Core Credit Hours	**33 -36 hrs**

Specific Major Requirements

Data Science Focus Areas Select 4 courses from at most 2 of the focus areas below for at least 12 hours
Artificial Intelligence • CSCE421 Foundations of Constraint Processing • CSCE472 Digital Image Processing • CSCE473 Computer Vision • CSCE474 Introduction to Data Mining • CSCE475 Multiagent Systems • CSCE476 Introduction to Artificial Intelligence • CSCE478 Introduction to Machine Learning OR STAT 485 Statistical Learning • CSCE479 Introduction to Deep Learning
Applied Data Science: Sociology • SOCI 310 Applied Sociology: Community-Based Research • SOCI 333 Applied Research in Public Opinion Research • SOCI 362 Ethics and the Responsible Conduct of Research • SOCI 430 Advanced Social Network Analysis • SOCI 407 Strategies of Social Research: Qualitative Methods • SOCI 463 Advanced Social Research Methods • SOCI 465 Survey Design and Analysis • SOCI 485 Agent-Based Social Simulation
Software Applications • CSCE361 Software Engineering • CSCE378 Human-Computer Interaction • CSCE412 Data Visualization • CSCE460 Software Engineering for Robotics • CSCE461 Advanced Topics in Software Engineering • CSCE464 Internet Systems & Programming • CSCE466 Software Design and Architecture • CSCE467 Testing, Verification and Analysis • CSCE468 Advanced Topics in Software Engineering
Data Pipeline • STAT251 Statistical Computing I: Data Wrangling • STAT351 Statistical Computing II: Data Management and Visualization • CSCE411 Data Modeling for Systems Development • CSCE413 Introduction to Database Systems • CSCE436 Advanced Embedded Systems • CSCE438 Internet of Things • CSCE458 Molecular and Nanoscale Communication • CSCE463 Data and Network Security • CSCE465 Wireless Communication Networks
Statistical Modeling • *STAT212 Statistical Design* • *STAT301* Mathematical Statistics and Modeling I • STAT302 Mathematical Statistics and Modeling II • STAT325 Statistical Collaboration I • STAT412 Advanced Statistical Design • STAT414 Survey Sampling • STAT432 Introduction to Survey Statistics • STAT443 Statistical Analysis of Genomics Data

• STAT450 Introduction to Regression Analysis • STAT462 Introduction to Mathematical Statistics I: Distribution Theory • STAT463 Introduction to Mathematical Statistics II: Statistical Inference • STAT464 Model Selection and Prediction • STAT474 Introduction to Nonparametric Statistics • STAT475 Introduction to Categorical Data • STAT478 Time Series Analysis • SOCI 465 Survey Design and Analysis • STAT486 Introduction to Bayesian Analysis • AGRO 420 Bioinformatics Applications in Agriculture
Mathematical Modeling • Math 208 Calculus in three dimensions • Math 221 Differential Equations • Math 415 Theory of Linear Transformations • Math 424 Partial Differential Equations • Math 428 Principles of Operations Research • Math 433 Nonlinear Optimization • Math 440 Numerical Analysis • Math 450 Combinatorics • Math 452 Graph Theory • Math 447 Numerical Linear Algebra • Math 471 Introduction to Topology • Math 487 Probability Theory OR STAT 262 Probability • Math 489 Stochastic Processes
Applied Data Science: Journalism + Humanities • HIST 461 Geospatial Approaches in Digital Humanities and Social Sciences • HIST 470 Digital History • JOMC 358 UX/UI Design • JOUR 307 Data Journalism • JOUR 407 Data Visualization • NSST 376 Analysis for the National Security Establishment • SPMC 350: Sports Data Visualization and Analytics
Applied Data Science: Natural Resources • NRES 218 Introduction to Geospatial Sciences • NRES 412 Introduction to GIS • NRES 415 GIS for Agriculture and Natural Resources • NRES 418 Introduction to Remote Sensing • AECN 401 Advanced Farm Management and Linear Programming • AECN 406 Commodity Price Forecasting • AGRO 420 Bioinformatics Applications in Agriculture • AGRO 431 Site-specific Crop Management • MSYM 433 Equipment and Tractor Testing

Ancillary Requirements

CODE	TITLE	CREDIT HOURS
BREADTH COURSES - ARTS, HUMANITIES AND SOCIAL SCIENCES		**6**

Fulfilled by the completion of six (6) credit hours in Arts, Humanities and Social Sciences courses.		
Select from a set of approved courses in Anthropology, Art History, Classics, Communication Studies, Economics, English History, Ethnic Studies, Geography, Foreign Languages & Literature, Philosophy, Political Science, Psychology, Religious Studies, Sociology, and Women's and Gender Studies as listed in the degree audit.		
Credit Hours Subtotal:		6
TECHNICAL WRITING		
JGEN 200	Technical Communication I	3
or BSAD 220H	Honors Business Writing	
Credit Hours Subtotal:		3
FOREIGN LANGUAGE		
Fulfilled by the completion of the 6-credit-hour second-year sequence in a single foreign language in one of the following departments: Classics and religious studies or modern languages and literatures. Instruction is currently available in Arabic, Chinese, Czech, French, German, Greek, Japanese, Latin, Russian, and Spanish.		
A student who has completed the fourth-year level of one foreign language in high school is exempt from the language requirement, but encouraged to continue on in their language study.		
SCIENCE		
Select 6 credit hours of courses intended for science or engineering majors including at least one laboratory. Acceptable disciplines and courses are (not an exhaustive list):		6
Chemistry		
CHEM 109A & CHEM 109L	General Chemistry I and General Chemistry I Laboratory	4
CHEM 110A & CHEM 110L	General Chemistry II and General Chemistry II Laboratory	4
CHEM 221	Elementary Quantitative Analysis	
CHEM 113A & CHEM 113L	Fundamental Chemistry I and Fundamental Chemistry I Laboratory	4
CHEM 114	Fundamental Chemistry II	
Physics and Astronomy		
PHYS 141	Elementary General Physics I	
PHYS 142	Elementary General Physics II	

PHYS 211	General Physics I	
PHYS 221	General Physics Laboratory I	
PHYS 212	General Physics II	
PHYS 222	General Physics Laboratory II	
PHYS 213	General Physics III	
PHYS 223	General Physics Laboratory III	
ASTR 204	Introduction to Astronomy and Astrophysics	
ASTR 224	Astronomy and Astrophysics Laboratory	
Biological Sciences		
BIOS 111	Introduction to Microbiology and Human Health	
BIOS 205	Genetics, Molecular and Cellular Biology Laboratory	
BIOS 206	General Genetics	
BIOS 207	Ecology and Evolution	
LIFE 120 & LIFE 120L	Fundamentals of Biology I and Fundamentals of Biology I laboratory	
LIFE 121 & LIFE 121L	Fundamentals of Biology II and Fundamentals of Biology II Laboratory	
Earth and Atmospheric Sciences		
GEOG 155	Elements of Physical Geography	
GEOL 101	Dynamic Earth	
GEOL 103H	Honors: Historical Geology	
GEOL 410	Geochemistry	
METR 100	Weather and Climate	
METR 205	Introduction to Atmospheric Science	
METR 370	Applied Climatology	
Anthropology		
ANTH 242	Introduction to Biological Anthropology	
ANTH 242L	Introduction to Biological	

	Anthropology Laboratory	
Credit Hours Subtotal:		15
Total Credit Hours		**45-51**

Additional Major Requirements

Grade Rules

C- and D Grades

A grade of C or above is required for all courses in the major.

Pass/No Pass

No course taken Pass/No Pass will be counted toward the major, unless offered exclusively with a grade option of Pass/No Pass.

Graduation Requirements

1. ***Total Credits Applying Toward 120 Total Hours***
2. A minimum 2.000 GPA required for graduation.
3. Complete 30 hours in residence at UNL.
4. Complete 30 hours at the 300 or 400 level.
5. Complete 60 hours of Scientific-Base courses in the Natural and Mathematical Sciences.

Learning Outcomes Tab

The primary student learning outcomes of the interdisciplinary Data Science major are:

- foundational knowledge and expertise in the analysis of large-scale data sources from the interdisciplinary perspectives of applied computer science, data modeling, mathematics, and statistics.
- foundational knowledge and expertise in the application of computing, informatics, and modeling to solve multidisciplinary problems; and
- abilities and professional skills to solve multidisciplinary data science problems as a member of an interdisciplinary team.

Appendix D

Guidelines for the Administration and Governance of the Data Science Program

These guidelines are intended to provide a framework for the administration and governance of the Data Science Program

1. Administrative Home:
   The Data Science Program will have a designated administrative home. The designated administrative unit will have responsibility for the administrative tasks associated with the degrees offered by the program, such as oversight over student advising, coordination with home units for scheduling of courses, maintaining financial accounts associated with the Program, ensuring timely communications with the Office of the University Registrar and Academic Services and Enrollment Management (ASEM). Funding to support costs associated with the Program, including Director compensation, will be proportionally shared by the constituent units.

2. Program Director:
   Administrative oversight of the Data Science Program will be the primary responsibility of the Program Director. The Program Director will be recruited through an approved internal recruitment process and will typically be appointed to a 3-year term; they may also be selected through an approved national search process, through the established faculty hiring approval process in one or more of the constituent colleges.

   The Director is responsible for providing primary leadership for the academic administration of the data science major. The Director's responsibilities include convening the Academic Program Faculty, collaborating with DEOs of the academic units to ensure the delivery of the curriculum, appropriate academic advising for majors, supporting Program Faculty on ongoing curricular development, and working with ASEM to support recruitment efforts in for the Program. In keeping with established university practices, the Director may also provide input into annual performance reviews of Academic Program Faculty for consideration by their home departments. The Director will advance input for each of these areas of responsibility in consultation and close coordination with the Academic Program Faculty, the deans and DEOs of the academic units contributing to the shared degree program, ASEM, and other university stakeholders.

3. Academic Program Faculty:
   Primary governance responsibility for the Program falls to the Academic Program Faculty. Academic Program Faculty should be faculty with research expertise and teaching responsibilities in the disciplines and subdisciplines of the shared academic degree program. The Academic Program Faculty will be responsible for reviewing the credentials of proposed and interested Program Faculty members. The Academic Program Faculty will recommend approved Academic Program Faculty appointments to the Personnel Committee of the faculty member's existing College. The Director will be responsible for providing annually a list of all Academic Program Faculty to the Personnel Committee of each participating College.

   Academic Program Faculty will have voting rights within the Program and have primary governance responsibilities over such matters as curriculum development, modification, and review. The Program Director will be responsible for convening meetings of the Academic Program Faculty at regular intervals and at least once per semester.

4. Administrative Oversight and Partnership with Contributing Colleges, Schools, and other Academic Units

   The Director will be responsible for convening an administrative Stakeholder Group that will include the deans of participating Colleges and the DEOs of participating departments and schools. The Director will be responsible for ensuring that the collaborating units are informed on an ongoing basis about the status of the shared degree program and will report on enrollment, academic progress, and financial outcomes at least annually. The Director will be responsible for consulting with the Stakeholder Group about strategic initiatives, including proposed curricular changes.

   The Stakeholder Group has responsibility for responding to requests for consultation and collaborating to ensure the success of the shared academic program.

5. Curricular Development, Approval and Consultation Process

   Modifications to the degree program and curriculum are the primary responsibility of the Program Faculty. The Faculty Program Committee are responsible for developing, reviewing, and approving, by majority vote, additions and/or modifications to the established curriculum. Any new course that will be offered by one of the constituent departments, under an established departmental prefix, will require approval through the curriculum committee of that college. Any new course that will be offered by the Program, under a Program-specific prefix, will require approval through the curriculum committees of all colleges that are participating in the shared degree program. Proposed modifications to the degree program that would impact either the contributing departments, or other academic units, require written consultation with the affected units. Such consultations align with established university practice and should be undertaken as early in the process as practical.

Appendix E

Internal Letters of Support

- Martha Mamo, Professor and Head, Agronomy and Horticulture
- Larry Van Tassell, Professor and Head, Agricultural Economics
- David Jones, Professor and Head, Biological Systems Engineering
- John Carroll, Professor and Director, School of Natural Resources
- Adam Wagler, Associate Professor and Associate Dean, College of Journalism and Mass Communications
- Megan Elliott, Director, Johnny Carson Center for Emerging Media Arts
- Tom Marley, Professor and Chair, Mathematics
- Kevin Smith, Professor and Chair, Political Science
- Marilyn Wolf, Professor and Chair, Computer Science and Engineering/Director, School of Computing
- Jolene Smyth, Professor and Chair, Sociology
- James Le Sueur, Professor and Chair, History
- Bertrand Clarke, Professor and Chair, Statistics

University of Nebraska Lincoln

INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES
DEPARTMENT OF AGRONOMY AND HORTICULTURE

September 20, 2021

Dr. Clarke:

On behalf of the Department of Agronomy and Horticulture, I confirm that we will be glad to accept students from your proposed major into AGRO 420-Bioinformatics Applications in Agriculture and AGRO 431-Site Specific Crop Management.

Thank you for including these courses in the program. We wish you success with your new major.

Sincerely,

Martha Mamo
Professor and Head

202 Keim Hall / P.O. Box 830915 / Lincoln, NE 68583-0915
(402) 472-2811 / FAX (402) 472-7904 / E-mail: AgroHort@unl.edu / Websites: http://agronomy.unl.edu/ and http://hort.unl.edu/

September 20, 2021

Dear Profs. Clarke, Marley, Wolf:

I am writing in support of your proposal for an undergraduate major in Data Science. In particular, on behalf of the Department of Agricultural Economics I confirm that we will be glad to accept students from your proposed major into our quantitatively oriented courses as listed in the proposal, including AECN 401 Advanced Farm Management and Linear Programming and AECN 406 Commodity Price Forecasting.

I wish you every success with your new major.

Sincerely,

Larry W Van Tassell
Department Head and Professor

University of Nebraska Lincoln
Department of Agricultural Economics
1625 Arbor Drive, Filley Hall 102 | Lincoln, NE 68583-0922 | 402.472.3401 | agecon@unl.edu
agecon.unl.edu

University of Nebraska Lincoln

DEPARTMENT OF BIOLOGICAL SYSTEMS ENGINEERING

September 14, 2021

Dear Profs. Clarke, Marley, Wolf,

I am writing in support of your proposal for an undergraduate major in Data Science.

In particular, on behalf of the Department of Biological Systems Engineering, I confirm that we will be glad to accept students into AGEN, BSEN, and MSYM courses provided they meet the appropriate pre-requisites.

I wish you every success with your new major.

Sincerely,

David Jones, PhD, PE
Professor and Department Head
david.jones@unl.edu

15 September 2021

Dear Profs. Clarke, Marley, Wolf:

I am writing in support of your proposed undergraduate major in Data Science. In particular, on behalf of the School of Natural Resources I confirm that we will be glad to accept students from your proposed major into our quantitatively oriented courses as listed in the proposal, including NRES 312 Introduction to Spatial Sciences, NRES 412 Introduction to GIS, NRES 415 GIS for Agriculture and Natural Resources and NRES 418 Introduction to Remote Sensing.

I wish you every success with your new major.

Sincerely,

John P Carroll
Director
School of Natural Resources

University of Nebraska Lincoln
School of Natural Resources
3310 Holdrege St., 101 Hardin Hall | Lincoln, NE 68583-0961 | 402-472-3471
snr.unl.edu

University of Nebraska Lincoln

COLLEGE OF JOURNALISM AND MASS COMMUNICATIONS
Advertising & Public Relations

September 14, 2021

Bertrand Clarke, Ph.D.
Professor and Department Head
Department of Statistics
bclarke3@unl.edu

Tom Marely, Ph.D.
Professor and Chair
Department of Mathematics
tmarley1@unl.edu

Marilyn Wolf, Ph.D.
Professor and Chair
Computer Science & Engineering
mwolf@unl.edu

CC: Shari Veil, Dean, CoJMC; John Bender, Associate Dean, CoJMC

Dear Professors Clarke, Marley, and Wolf,

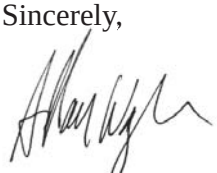
The College of Journalism and Mass Communications (CoJMC) faculty voted on February 19, 2021 and April 16, 2021 to support the inclusion of the following CoJMC courses in the proposed Data Science undergraduate major as part of the focus area Applied Computing: Journalism + Humanities:

- JOMC 358 UX/UI Design
- JOUR 307 Data Journalism
- JOUR 407 Data Visualization
- SPMC 350: Sports Data Visualization and Analytics

In addition, the committee supported the following courses be considered.

- ADPR 434: Digital Insights & Analytics
- ADPR 458 Interactive Media Design
- SPMC 460: Advanced Sports Data Analysis

Sincerely,



Adam Wagler, Ph.D.
Associate Dean for Academic Programs
Associate Professor of Advertising and Public Relations
College of Journalism and Mass Communications
University of Nebraska–Lincoln
132 Andersen Hall
adamwagler@unl.edu

April 7, 2021

Dear Profs. Clarke, Marley, Wolf,

I am writing in support of your proposal for an undergraduate major in Data Science.

The rise of ubiquitous sensing, scalable cloud infrastructure, and new methods in data storage, analysis, and visualization have contributed to an epochal shift in how math, the sciences, and traditional STEM disciplines are conducted. Less obvious are the impacts of these changes on traditionally "soft" disciplines such as the arts and humanities. The three proposed Data Science majors are the ideal place to examine this emerging condition: considering both how analytic techniques enable new understandings of culture, and how the proliferation of data in everyday life changes the ways that culture is produced, distributed, and influenced.

In my capacity as the Director of the Johnny Carson Center for Emerging Media Arts, I need to plan for a future which is partially unknowable, equipping our students to chart new paths in emerging fields of technology, culture, and media as they are coming into formation. I find the same pioneering spirit evident in these proposed Data Science majors and am tremendously excited by what it will add to our academic community: educating students with the necessary mix of mathematical analysis, statistical knowledge, computational abilities, and critical thought to make meaningful contributions to their chosen subject domains.

Looking forward, the Emerging Media Arts program would seek an active role in a new Data Science major, seeking Data Science students for dual matriculation in Emerging Media Arts, and working to establish an additional focus area around Data Science and the Arts alongside the current subareas. The proposed curriculum aligns well with our courses in Human Computer Interaction, Machine Learning for the Arts, Data + Art, and Augmented and Virtual Worlds. Crucially, illuminating these subjects through the histories of cultural production complements technical knowledge from CS and STEM. Our faculty have previous experience teaching in an undergraduate data science (Prof. Twomey), extensive interdisciplinary research, and would be valuable partners to the new degree through Capstone and Practicum projects and lectures.

I am convinced that the Data Science curricula presented in these proposals would produce students who are as literate with the means and methods of quantitative analysis as they are with the application domains they specialize in: whether AI, Mathematical & Statistical Modeling, Journalism and Humanities, or eventually Emerging Media Arts.

I look forward to fruitful collaborations with our colleagues in these proposed Data Science majors. Do not hesitate to contact me if you have any questions.

I wish you every success with your new major.

Yours,

Megan Elliott
Director, Johnny Carson Center for Emerging Media Arts

September 13, 2021

To: Bert Clarke
Chair, Department of Statistics

Marilyn Wolf
Director, School of Computing

From: Tom Marley
Chair, Department of Mathematics

Re: Support for use of mathematics courses in the proposed Data Science program

Dear Profs. Clarke and Wolf,

I am writing to confirm for the use of the following Mathematics courses in the proposed Data Science major:

Math 104: Applied Calculus
Math 106: Calculus I
Math 203/203J: Contemporary Mathematics
Math 107: Calculus II
Math 314: Linear Algebra
Math 315: Linear Algebra for Data Science (new)
Math 208: Calculus III
Math 221: Differential Equations
Math 487: Probability Theory
Math 415: Theory of Linear Transformations
Math 424: Introduction to Partial Differential Equations
Math 428: Principles of Operations Research
Math 433: Nonlinear Optimization
Math 440: Numerical Analysis I
Math 450: Combinatorics
Math 452: Graph Theory
Math 447: Numerical Linear Algebra

University of Nebraska Lincoln
Department of Mathematics
203 Avery Hall | Lincoln, NE 68588-0130 | 402.472.3731

Math 471: Introduction to Topology
Math 489: Stochastic Processes

We are happy to accommodate the anticipated students in this proposed major in these courses. We are pleased to support this exciting new major!

Best regards,

Tom Marley
Chair, Department of Mathematics

University of Nebraska Lincoln

DEPARTMENT OF POLITICAL SCIENCE

September 14, 2021

Dear Profs. Clarke, Marley, Wolf,

I am writing in support of your proposal for undergraduate major in Data Science, specifically with regard to the focus area Applied Computing: Journalism + Humanities. In particular, on behalf of the Department of Political Science, I confirm that we will be glad to accept students from your proposed major into our quantitatively oriented courses as listed in the proposal, including in particular NSST 376 Analysis for the National Security Establishment.

I wish you every success with your new major.

Yours,

Kevin B. Smith, Chair
Department of Political Science

511 Oldfather Hall / P.O. Box 880328 / Lincoln, NE 68588-0328 / USA
(402) 472-2341 or (402) 472-2343 / FAX (402) 472-8192 / http://polisci.unl.edu/

14 September 2021

Dear Profs. Clarke and Marley,

I am pleased to write this letter to express the wholehearted support of the School of Computing for the proposed major in Data Science. This major is part of a broad effort across the university to enhance our data science offerings. The proposed major is a critical component of that effort. We will be happy to collaborate with Mathematics and Statistics to make this major a success. Please feel free to contact me with any questions you may have.

Sincerely,

Marilyn Wolf

Marilyn C. Wolf
Koch Professor of Engineering
Director, School of Computing
University of Nebraska–Lincoln

University of Nebraska Lincoln
School of Computing
256 Avery Hall | Lincoln, NE 68588-0115 | 402.472.2401
computing.unl.edu

September 22, 2021

Dear Professors Clarke, Marley, and Wolf,

I am writing in support of your proposal for an undergraduate major in Data Science, specifically with regard to the focus area Applied Computing: Sociology.

In particular, on behalf of the Department of Sociology, I confirm that we will be glad to accept students from your proposed majors into our quantitatively oriented courses as listed in the proposal, including in particular

- SOCI 206 Introduction to Social Research II

as an elective and

- SOCI 310 Applied Sociology: Community-Based Research
- SOCI 333 Applied Research in Public Opinion Research
- SOCI 362 Ethics and the Responsible Conduct of Research
- SOCI 430 Advanced Social Network Analysis
- SOCI 407 Strategies of Social Research: Qualitative Methods
- SOCI 465 Survey Design and Analysis
- SOCI 485 Agent-Based Social Simulation

as part of the focus area in Computing and Sociology.

I wish you every success with your new program.

Sincerely,

Jolene D. Smyth
Professor and Chair
Department of Sociology

University of Nebraska Lincoln
Department of Sociology
711 Oldfather Hall | Lincoln, NE 68588-0324 | 402.472.3631 | sociology@unl.edu

September 27, 2021

Dear Professors Wolf, Marley, and Clarke,

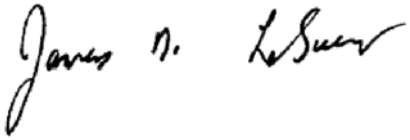
I am writing to confirm our support for including the following History courses in the proposed Data Science undergraduate major. We are very pleased to see Applied Computing: Journalism + Humanities included.

On behalf of the Department of History, I assure you that our department will be happy to accommodate students who wish to take our courses:

- HIST 461: Geospatial Approaches in Digital Humanities and Social Sciences
- HIST 470: Digital History
- HIST 472: Digital Humanities Practicum

as part of their program.

With kind wishes,



James D. Le Sueur
Samuel Clark Waugh Distinguished Professor of International Relations
- Chair of the Department of History
- Director of *The Art of Dissent*
- & Four Seasons of COVID – Pandemic on the Plains
- Editor of France Overseas Series with the University of Nebraska Press

University of Nebraska, Lincoln
612 Oldfather Hall, 68588-0327
402 472 2414

Department page
The Art of Dissent site
IMDb page
For more about

University of Nebraska Lincoln

Department of Statistics

September 14, 2021

Dear Profs. Marley and Wolf

I am pleased to write this letter to express the wholehearted support of the Department of Statistics for the proposed major in Data Science. This major is part of a broad effort across the university to enhance our data science offerings. The proposed major is a critical component of that effort. We will be happy to collaborate with Mathematics and the School of Computing to make this major a success. Please feel free to contact me with any questions you may have.

Regards,

Bertrand Clarke

Bertrand Clarke
Chair & Professor
Department of Statistics
University of Nebraska Lincoln

340 Hardin Hall – North Wing / P.O. Box 830963 / Lincoln, NE 68583-0963 / (402) 472-2903
FAX (402) 472-5179
statistics@unl.edu / http://statistics.unl.edu

Appendix F

External Letters of Support

- Lucas Sabalka, Chief Scientist, Ocuvera, LLC
- Michael Parks, Manager, Computational Mathematics Dept., Sandia National Laboratories
- Dandan Zheng, Professor and Director of Medical Physics Residency, University of Nebraska Medical Center
- Christopher Hans, Associate Professor of Statistics; Co-director, Undergraduate Data Analytics Major; Director of Undergraduate Major and Minor Programs in Statistics
- Mike Lechtenberger, Chief Information Officer, Mutual of Omaha
- Brian Kaiser, Chief Technology Officer, Hudl

29 March 2021

To Whom It May Concern:

This letter is in support of the new Data Science program at UNL. I am an alum of the UNL Department of Mathematics. I work for Ocuvera, a medical technology company headquartered in Lincoln, Nebraska. Ocuvera uses three-dimensional cameras called depth cameras together with machine-learned algorithms to automatically monitor patients in hospital settings. If the patient's risk of falling increases (for example, if they try to get out of bed when they're not supposed to be up without help), the Ocuvera system automatically sends a video-based alert to nurses. I am the Chief Scientist for Ocuvera. I am a co-engineer of many of the computer vision and data science algorithms that underpin the Ocuvera system. I am also responsible for data analysis for per-deployment and aggregate system performance, and I am the Principal Investigator on close to $1 million of state and federal grants.

As a local business, I can categorically state that we would not exist if there was not talent being generated in data science and machine learning from UNL. Over half of our engineers hold UNL degrees. Data science, including machine learning, computer vision, and 3D geometry, are critical to our jobs every day. It is difficult to understate how important data science is to my job, but more importantly to you, core competency with data science will be a key skill we plan to seek in many future hires.

Ocuvera has filled more than 8 internships in recent years from the UNL Departments of Mathematics and Computer Science. Their focus has been on data science, computer vision, and most recently machine learning. These internships have produced valuable progress for us as a company. Moreover, they help us identify future job candidates while helping develop an interdisciplinary problem-solving perspective for the students. In fact, we have a UNL graduate starting for us in May as a result of an internship, and we have another intern returning to us this summer because of her tremendous work.

I have also worked in Lincoln as a data science consultant, both through Ocuvera and its sister companies and on my own time. There is significantly more demand in the broader Lincoln community than can be met by the current data science labor supply.

The proposed major is well-timed: jobs in data science have exploded in demand recently. Jobs in data science are frequently ranked as some of the fastest growing jobs in the nation. The interdisciplinary emphasis is needed as technology continues to blur the boundaries between traditional disciplines, especially computer science and engineering and the pure mathematical disciplines.

The emphasis on real-world learning through courses like the capstone Math in the City accomplishes something I'm passionate about: translating abstract academic lessons to real-world implementation. That's a skill that everyone in industry must learn and producing students that have already made that mental adaptation reduces valuable time from the training and onboarding timeline.

Sincerely,

Dr. Lucas Sabalka
Chief Scientist
Ocuvera, LLC

Sandia National Laboratories
Operated for the U.S. Department of Energy by
National Technology and Engineering Solutions of Sandia, LLC
P.O. Box 5800
Albuquerque, NM 87185-1320

September 22, 2021

To Whom It May Concern:

I am writing in strong support of the proposed new undergraduate major of Data Science by the University of Nebraska-Lincoln. I manage the Computational Mathematics Department at Sandia National Laboratories and have long-standing research collaborations with faculty in the Department of Mathematics at UNL. Sandia is a multi-mission lab operated for the U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA) and supports numerous federal, state, and local government agencies, companies, and organizations. Sandia employs over 14,000 scientists and researchers and has an annual operating budget of approximately $3.8 billion. A strong science, technology, and engineering foundation enables Sandia's missions in nuclear weapons, national security programs, energy, and global security through a capable research staff working at the forefront of innovation, collaborative research with universities and companies, and discretionary research projects. Data science is an evolving need in all of Sandia's mission areas.

The Data Science major proposed at the University of Nebraska-Lincoln offers an interdisciplinary degree in this fast-growing discipline, with balanced foundational courses in the three core disciplines (mathematics, computer science, and statistics). The variety of focus areas leverages the broad applicability of data science and offers students a wide perspective towards its implementation in different fields. The capstone course Math in the City offers students a hands-on experience which allows students to immerse in real-world projects, thus preparing them for their future careers. Students graduating from this program would have the technical skills and knowledge to pursue a variety of opportunities in this space at a time when tens of thousands of positions need to be filled. In research, business, and government positions the skills provided by Data Science are valuable in understanding, organizing, classifying data sets towards optimizing efficiency and performance. The newest research in data science shows its deep and wide capabilities and provides user-friendly tools towards applicability at all scales, from a small office to large industries.

At Sandia, there is a very strong interest in data science, especially with a mathematical emphasis. As one highly visible example, you may be aware of the SIAM Journal on Mathematics of Data Science (SIMODS), the newest journal of the Society of Industrial and Applied Mathematics (SIAM). The founding editor for SIMODS is Dr. Tamara (Tammy) Kolda, a retired Distinguished Member of the Technical Staff at Sandia. Tammy is an internationally recognized researcher for her work in the mathematical analysis of tensor decompositions with application to problems of DOE interest.

Data science research and applications is the primary focus of several departments at Sandia. There are active research projects on the accurate characterization of real networks, counter-adversarial graph analytics, counter-adversarial data analytics, algorithms and models for infinite streams, and

graph algorithms for autonomous data centers, to name only a few. Data science tools are used for national security applications to allow high-confidence decisions to be made in short time windows.

To execute cutting-edge data science projects with national security implications, we must recruit the best data science talent in the nation. Active recruiting of talented newly graduated data scientists is such a priority for Sandia that it has established a named Postdoctoral Fellowship in Data Science[1]. This prestigious Fellowship comes with a salary much greater than our ordinary postdoc salary and allows Fellows to pursue self-directed research in data science while also working to address complex problems in support of broad-ranging national security areas.

Traditional academic disciplines (mathematics, computer science, statistics) by themselves do not produce graduates with the proper skills in data science to join Sandia or similar institutions and have immediate impact. The interdisciplinary training required by the proposed Data Science major provides graduates with the skills to be sought-after job candidates. The key differentiating features of this program as compared to other data science programs are (1) a strong mathematical emphasis, and (2) a strong application-driven, real-world component. This educational focus will produce graduates with the requisite skills and experience have impact on real-world applications.

Sincerely,

Michael L. Parks

Dr. Michael L. Parks
Manager, Computational Mathematics Dept.
Center for Computing Research
Sandia National Laboratories

[1] https://www.sandia.gov/careers/career-possibilities/students-and-postdocs/fellowships/data-science-fellowship/

September 22, 2021

To Whom It May Concern,

I am writing to enthusiastically recommend the new undergraduate major proposal of "Data Science" by University of Nebraska-Lincoln. I am a Professor of Radiation Oncology at the UNMC Campus and my research is focused on using radiomics and clinical data science to develop clinical decision support models, with the ultimate goal of advancing these studies into early detecting aggressive cancers and offering optimal personalized treatments to therapy-resistant cancer patients. For this research, I actively collaborate with researchers from UNL departments of mathematics, biology, and computer science to leverage the multidisciplinary expertise for innovative approaches and synergistic breakthroughs that would be otherwise unattainable with a single-field endeavor.

I am excited to hear that a new Data Science major is under consideration at UNL. As big data based artificial intelligence reaches almost every aspect of our lives, data science has become one of the most demanded expertise on today's job market. From self-driving vehicles, personalized recommendations from webpages for movies and products, to multi-omics propelled discoveries in biology and healthcare, artificial intelligence has been bringing transformative changes into our everyday lives. The explosive amount of big data being generated in every aspect of our lives is a treasure mine for AI, and data scientists who know how best to mine these data is the key. Having such a new major at UNL will both offer students in and around Nebraska an opportunity to develop their careers in this important field, and serve the industries as well as universities in the region with a steady input of graduates in this much demanded field.

In healthcare, with the wide usage of electronic medical charting, increasing application of advanced digital medical imaging, together with the genomics and proteomics data that are increasingly collected medically or even voluntarily with commercial products such as 23&me, data science plays a critical role in standardizing and optimizing how data should be accumulated, as well as analyzing the data for all kinds of important purposes. I have worked with several undergraduate and graduate students from various UN campuses and Creighton University who went on pursuing a data science certificate from UNO for better job opportunities or for acquiring needed skills, some even after completing an M.S. degree. While the certificate program gives graduates from other majors an opportunity to get trained in data science, a new Data Science major at UNL could directly provide a more systematical education and training for many students in the region interested in such a career and supply a healthy stream of quality graduates to the companies, hospitals, and laboratories in the region.

In reviewing the new major, I believe that the proposal meets the educational needs of the students interested in data science. Especially, as data science is in itself a multidisciplinary subject, having three different majors will be a strength of this program, and will benefit the entire field by developing unique yet complementary perspectives from

mathematics, computer science, and statistics for this evolving discipline and outputting data scientists with integrative knowledge base and skill sets.

Sincerely,

Dandan Zheng, Ph.D., DABR
Professor and Director of Medical Physics Residency
Radiation Oncology
University of Nebraska Medical Center
42nd and Emile, Omaha, NE 68198

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Department of Statistics

404 Cockins Hall
1958 Neil Avenue
Columbus, OH 43210-1247

614-292-2866 Phone
614-292-2096 Fax

stat.osu.edu

September 30, 2021

Dear Professors Clarke, Marley and Wolf,

I am writing in support of your proposal to establish a new, interdisciplinary major in Data Science at the University of Nebraska-Lincoln. I have reviewed the proposal documents and believe that the proposed curriculum is well structured and properly aligned with the knowledge, competencies and skills that are generally expected of undergraduate students earning degrees with majors in Data Science. In addition, the general structure of the major and its proposed curriculum are broadly compatible with similar programs at other major research universities. Based on my experience with a similar program at Ohio State University, I expect that the implementation of your proposed major will lead to successful achievement of its learning outcomes and that students in your major will be well-prepared to engage in a wide range of career and employment opportunities.

By way of background, I have served as Co-Director of Ohio State University's interdisciplinary undergraduate major in Data Analytics since its establishment in 2014 and was one of the members of the committee that designed the major. Our major is co-directed by two departments in two different colleges (the Department of Statistics in the College of Arts and Sciences and the Department of Computer Science and Engineering in the College of Engineering) and has additional curricular partnerships with the College of Medicine, the College of Public Health, and the Fisher College of Business. The major's curriculum was developed by a small committee of faculty from across the university, with input from other university stakeholders and large regional and national employers. The major has grown considerably over the past seven years; we have had nearly 200 students graduate with a major in Data Analytics, and we started this academic year with 379 students in the program. Our program was one of the first of its kind at a major research university when it was established in February of 2014, with similar programs appearing at other universities in subsequent months and years. In 2014, the terms "Data Analytics" and "Data Science" were less-well differentiated than they are today; our major is, I believe, more strongly aligned with what is now typically described as "Data Science."

The proposal for a major in Data Science at the University of Nebraska-Lincoln uses an interdisciplinary curriculum to meet three learning outcomes (paraphrased as): foundations and expertise in large-scale data analysis from an interdisciplinary perspective; foundations and expertise in applied, multidisciplinary problem solving; and abilities and skills for team-based problem solving. To achieve these outcomes, the curriculum is structured to have three components: Data Science Foundations, Data Science Focus Areas, and Data Science Professional Experience. The Foundations courses focus on areas of computer science, mathematics, statistics, and data analysis that are fundamental to all areas of Data Science; the Focus Areas are comprised of elective courses that provide students with breadth and depth in specific areas of Data Science; and the Professional Experience component can be completed via a variety of courses/experiences that build professional practice and development. Finally, there are three different degree program pathways via which students can pursue the major. The different pathways reflect the fact that students interested in Data Science tend to have a wide range of general academic interests and diverse backgrounds, and as a result the students' points of entry to the university may be spread across different colleges and institutes. While the different pathways through the major have slightly different

course requirements, the pathways appear to be structured in a way that allows the learning outcomes to be achieved no matter the path a student takes.

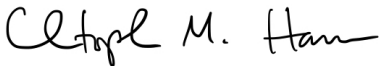
I believe the proposed major curriculum is sensibly structured and is broadly comparable to similar programs at other universities. For example, though different in number and wording, the learning outcomes for our Data Analytics major at Ohio State touch on knowledge and key competencies that are similar to the ones described in your outcomes. Our curriculum is based on a hub-and-spoke model: a Core Curriculum is at the center with areas of Specialization attached as spokes, and the curriculum is tied together with a Capstone Experience that has an emphasis on data analytics problem solving in practice. This roughly mirrors the structure in your proposal. While the details of our two programs are somewhat different—e.g., our students have a slightly more uniform experience in the Foundations/Core component with a slightly different balance of disciplinary courses—both seem to me to be appropriate structures for a Data Science major and reflect natural diversity across institutions. Other institutions have Data Science majors with similar structures, e.g., the University of Michigan's Data Science major has a Core covering topics in mathematics, computer science and statistics, additional required courses in areas relevant to Data Science, advanced technical electives in areas of application, and a capstone experience. UNL's proposed major fits squarely within the constellation of undergraduate Data Science education.

Beyond the structure of the proposed major, the courses, topics and areas of knowledge covered in each of the curricular components are appropriate for a major in Data Science and appear to be at the right level of rigor. The required courses in computer science, mathematics, and statistics have significant overlap with similar requirements at Ohio State (and other peer institutions). The foundational work in programming, data structures, algorithms, mathematics through calculus II and linear algebra, probability, inferential statistics, and data analysis will set the students up to succeed in the more advanced data science focus area courses. The curriculum will ultimately familiarize the students with the topics, concepts, and skills they will need in careers in Data Science. Overall, the courses in and the pathways through the curriculum provide an intellectually sound basis for an interdisciplinary major in Data Science.

Based on our experiences at Ohio State, I recommend careful monitoring and assessment of the major, especially during its first few years. Early feedback from students, advisors and faculty led to revisions to our major that made the curriculum easier for students to navigate. The revisions included the addition of two new specializations as well as a major revision of one of the original specializations that introduced the College of Public Health as a new curricular partner. Your proposal recognizes the need for regular review of the curriculum (page 15), and I expect that the proposed shared governance structure will provide an appropriate framework for evolving the major as needed as it grows over its first few years.

Congratulations on a well-structured proposal for an exciting, interdisciplinary major. I look forward to hearing of its future success.

Sincerely,



Christopher M. Hans, Ph.D.
Associate Professor of Statistics
Co-director, Undergraduate Data Analytics Major
Director of Undergraduate Major and Minor Programs in Statistics

Mutual of Omaha

3300 Mutual of Omaha Plaza
Omaha, NE 68175

February 21, 2022

Dr. Lance Pérez
Dean
College of Engineering
University of Nebraska-Lincoln

Dear Dr. Pérez,

I am writing to express my strong support for the proposed Data Science Degree program at UNL. Developing this academic program is strategically important to provide industry with talent in an emergent discipline, and students with opportunities to advance into compelling career fields. Industry clearly has a strong need for more and better prepared graduates in data science. As a leader in industry, I appreciate the contemplation of the wide variety of data science skills and problem-solving domains considered within the proposed program. The program also provides students the opportunity to pursue data science degree pathways that will prepare them to impact the companies they join.

Companies like Mutual of Omaha are leveraging vast amounts of data with advanced analytics, modeling, artificial intelligence and machine learning to deliver products and services to benefit our customers. Thus, we are seeking graduates who have a command of data science principles and disciplines to operate and advance our business strategies. It goes without saying that data science enables companies to innovate and develop competitive differentiation in the marketplace. I am very excited for the possibilities the Data Science Degree program offers to provide more and better trained graduates.

Mutual of Omaha hires nationally and thus has a general awareness of other higher education technology programs like the proposed Data Science Degree program. It is not surprising that peer universities in the Big 10 and elsewhere are also investing significantly in similar degree programs. Making this investment in the University of Nebraska Lincoln is a wise decision and will promote the ongoing relevance for the State and the University.

I appreciate the opportunity to express my support for this new degree program. I am excited that the University is developing this important academic program. If you have any questions I am happy to provide additional input.

Sincerely,

Mike Lechtenberger
Chief Information Officer
Mutual of Omaha

Cc: Gail Graeve, Brian Poppe

Agile Sports Technologies, Inc. dba Hudl

(402) 817-0060
hudl.com

600 P Street Suite #400
Lincoln, NE 68508

February 28, 2022

University of Nebraska-Lincoln
1400 R St.
Lincoln, NE 68508

Dr. Perez,

I'm writing in support of the proposed Data Science major at the University of Nebraska-Lincoln.

As co-founder and Chief Technology Officer of Hudl, a Nebraska-based sports technology company, my undergraduate education at UNL enabled me and my co-founders, David Graff and John Wirtz, to create a product that revolutionized the world of sport. Since 2006, we've been dedicated to helping coaches and athletes prepare for and stay ahead of the competition with video. We offer a complete suite of products that empower more than 200,000 global sports teams at every level—from grassroots to professional organizations—to combine video and data to improve performance and showcase talent.

Beyond Hudl, there's an undeniable fact: we exist in a data-driven world. More often than not, the success or failure of a business depends on their ability to identify opportunities, understand their customer and make informed, data-backed decisions. Because of this, we've seen increased competition when recruiting and retaining talent with data science expertise, especially in Nebraska. Establishing the undergraduate Data Science program would foster a talent pipeline that would benefit a wide range of local industries.

As a Lincoln-based company, Hudl would be able to stay closely aligned and lend support to the ongoing success of both the program and its students. We can offer a variety of potential partnerships, speaking opportunities and internship programs to provide students with real-world experience.

In conclusion, I fully support establishing the new undergraduate Data Science major. This program will not only provide students with a world-class education, it will prepare them for success in a range of disciplines.

Sincerely,

Brian Kaiser
Chief Technology Officer

Appendix G

ADV Report on Data Science

ADV | MARKET RESEARCH & CONSULTING

gderoo@advmrc.com | 603.686.1928 | advmarketresearch.com

University of Nebraska-Lincoln

Data Science

January 2021

Grant De Roo

Economic and Technological Context for a Data Science Program

We Generate and Collect Data Like Never Before

- We are in an unprecedented period of generating and collecting data on human behavior, enabled by a combination of:
  - Growing recognition of the use of data in business decisions;
  - Enhanced methods of collecting traditional data (demographic and, increasingly, digital behavior);
  - New forms of data generation and collection (i.e., wearable technology);
  - Greater access to stored data (i.e., cloud storage); and
  - Declining costs of data storage
- Billions of people worldwide have gradually shifted more of their lives online, using their smartphones as ever-present personal command centers.
- Figures on the amount of data generated, stored, and used today are staggering. It is estimated, for instance, that ***90% of all data in the world was created in the past two years*** and that ***every two days humans create as much information as we did from the beginning of time until 2003***.
- At the same time, it is estimated that ***just 0.5% of all the data generated and stored is ever used***.

Notable statistics for big data today

- The data analytics market is set to reach $103 billion by 2023
- Neglecting to use customer data costs the U.S. economy $1.3 trillion annually
- 97.2% of Fortune 1000 companies are investing in big data initiatives
  - 62.5% have appointed a Chief Data Officer
- Every person generates approximately 1.7 megabytes of information per second
- Google receives 3.5 billion searches every day
- The amount of computing power a dollar can buy has increased 10x every four years in that past quarter century

95%

of large and medium-sized businesses cite the need to manage unstructured data as a problem for their business

Harnessing and using this collected data holds enormous potential

- Virtually no sector is untouched by the potential to enhance operations, sales, customer engagement, etc. by collecting, analyzing, and acting upon data.
- In a sense, data is the new corporate asset and has evolved the relationship between a company and its customers. Whereas customers used to exchange money for a good or service, they now are increasingly exchanging their data as well *or instead of* their money. In fact, many companies such as Facebook, Google, LinkedIn, and countless others charge no fee for using their service; instead, users consent to providing their data in exchange for free use of services.
- This wealth of collected information has enabled several business enhancements and disruptions that are sure to continue evolving in the coming years:
  - Enhanced decision-making
  - Radical personalization
  - Hyperscale, real-time matching
  - Massive data integration capabilities (i.e., breaking silos within an organization)
  - Data-driven discovery (e.g., new product or service lines)
  - Business models enabled by orthogonal data (e.g., new forms of data from products like wearable technology)

This potential is limited by the available talent

- The enormous potential of this unprecedented collection and storage of data is constrained by access to a workforce able to take advantage of it. Human capital has proven to be one of the biggest barriers standing in the way of realizing the full potential of data and analytics.
- There are four broad roles to consider (with some overlapping responsibilities):
  1. Data Architects who design data systems
  2. Data Engineers who scale data solutions and build products
  3. Data Scientists who analyze data with increasingly sophisticated techniques to derive insights
  4. Business Translators who have technical and domain knowledge to be able to interpret data insights into business implications
- Added to these four broad categories has been added the Data Visualizer who is able to translate data findings into interpretable insights (a “last mile” role in discovering value).
- Companies report that finding the right talent in these roles is the biggest hurdle they face in trying to integrate data and analytics into their operations. In a recent McKinsey & Company survey, half of executives reported greater difficulty recruiting analytical talent than filling any other kind of role. Forty percent say retention is also an issue.

Rising demand for data scientists

- Demand for data scientists has risen sharply as a result of businesses' growing desire to act on the data they've collected combined with the challenge of finding top talent.
- Average wages for data scientists in the United States rose by approximately 16 percent a year from 2012 to 2014 (beating the economy-wide average of 2%).
- Further, Data Scientist has been on LinkedIn's list of top jobs in each of the past five years, topping the list in 2017, 2018, and 2019 due to employer demand and salary.

56%

year-over-year growth in LinkedIn job postings for Data Scientists

…offering a median salary of

$130k

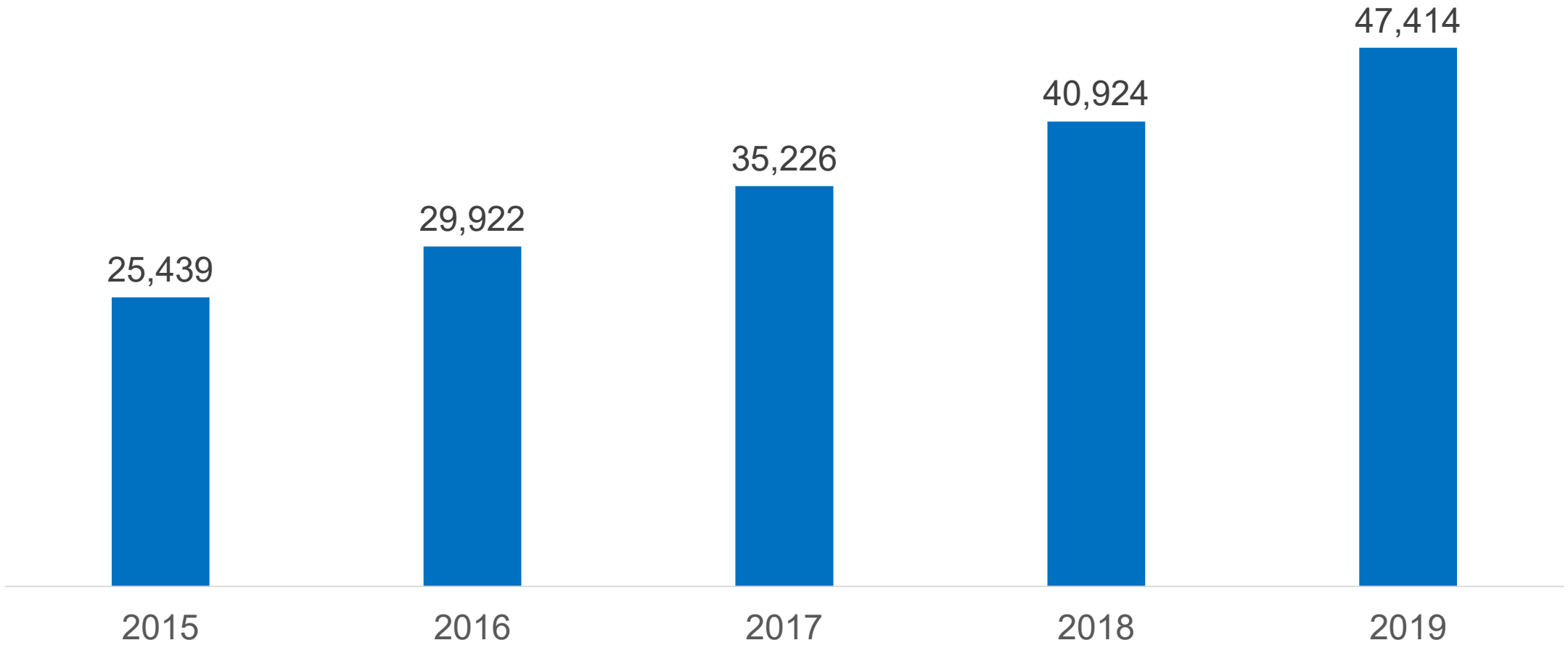
Emerging role of the business translator

- As noted earlier, one of the key personnel areas of a data science and analytics team is the business translator, who has both technical and domain expertise to be able to translate data insights into business implications.
- A data science skillset alone may not be enough to make meaning of the information generated. Business translators, therefore, serve as the link between analytical talent and applications to business questions.
- Additionally, As data grows more complex, distilling it and bringing it to life through visualization is becoming critical to help make the results of data analyses digestible for decision makers.
- It was estimated that demand for visualization grew roughly 50 percent annually from 2010 to 2015. In many instances today, organizations are seeking data scientist or business translator candidates who can also execute visualizations.

Student Demand for Data Science

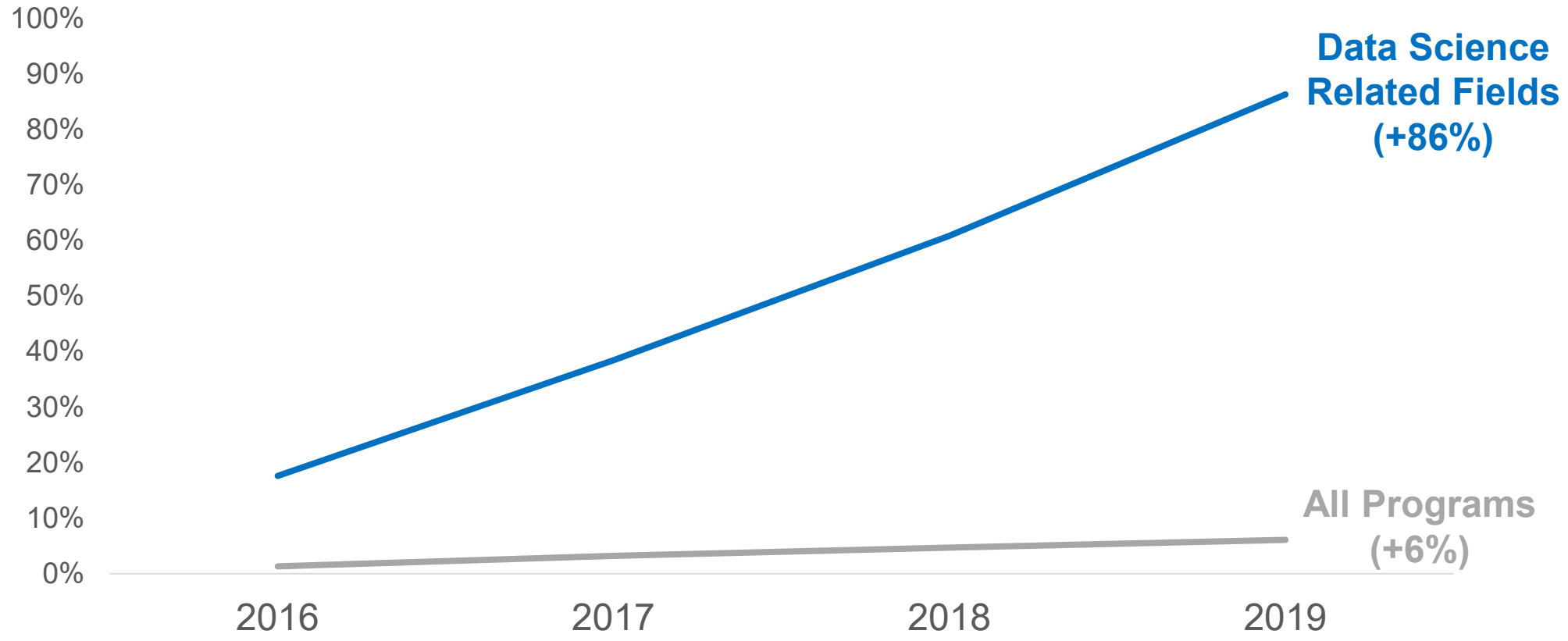
Rising demand for Data Science programs

Bachelor's Degrees Awarded in Data Science-Related Programs – Nationally, All Institutions



Demand for Data Science rose *much faster* than the average for BA programs

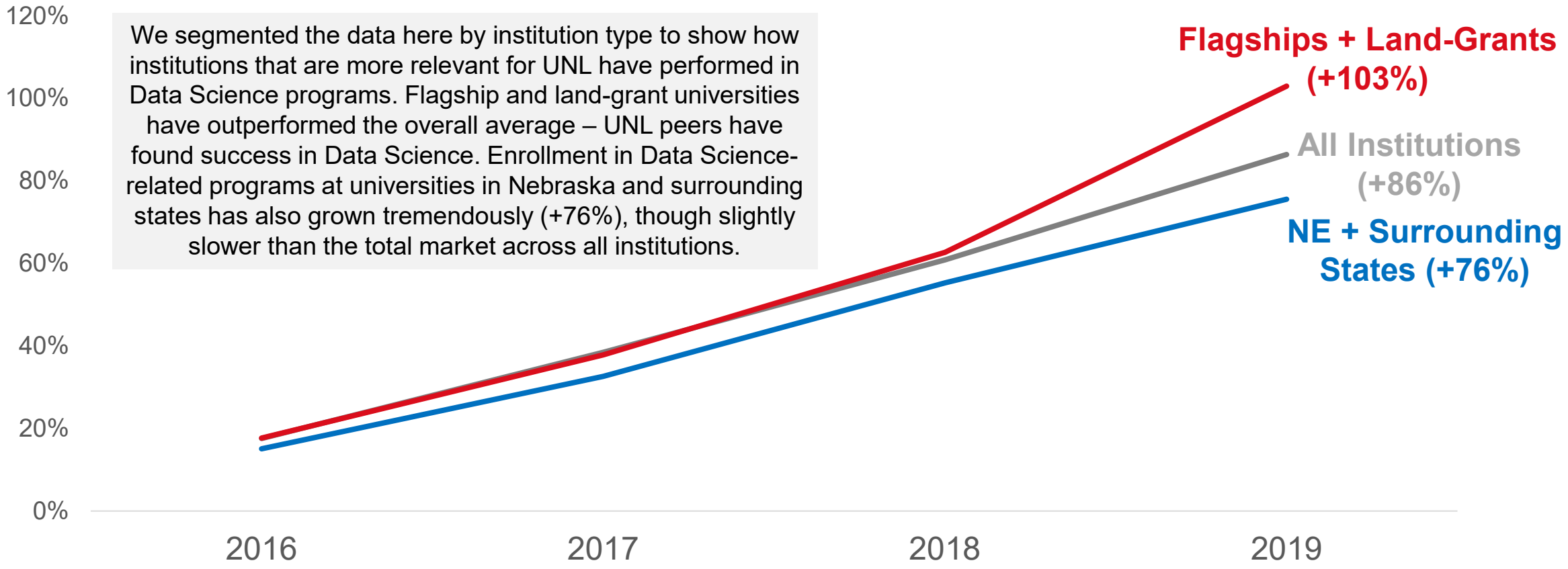
Bachelor's Degrees Awarded – Nationally, All Institutions
Cumulative % Growth in Degrees Since 2015



Strong demand for Data Science among UNL-like universities

Bachelor's Degrees Awarded in Data-Science Related Fields by Institution Category
Cumulative % Growth in Degrees Since 2015

We segmented the data here by institution type to show how institutions that are more relevant for UNL have performed in Data Science programs. Flagship and land-grant universities have outperformed the overall average – UNL peers have found success in Data Science. Enrollment in Data Science-related programs at universities in Nebraska and surrounding states has also grown tremendously (+76%), though slightly slower than the total market across all institutions.



Growth across all fields related to Data Science

Program Category	Average Degrees/Year (2015-2019)	5-Year Change (%)	Share of Total
Computer Science	23,924	92%	67%
Management Science	3,940	32%	11%
Statistics, General	2,830	92%	8%
Applied Mathematics	2,540	45%	7%
Management Sciences and Quant. Methods, Other	913	411%	3%
Business Statistics	349	309%	1%
Mathematical Statistics and Probability	244	9%	1%
Computational and Applied Mathematics	229	253%	1%
Computational Mathematics	198	71%	1%
Statistics, Other	169	285%	0%
Data Modeling/Warehousing and Database Admin.	166	15%	0%
Mathematics and Statistics	113	135%	0%
Data Processing	112	159%	0%
Computational Science	56	323%	0%

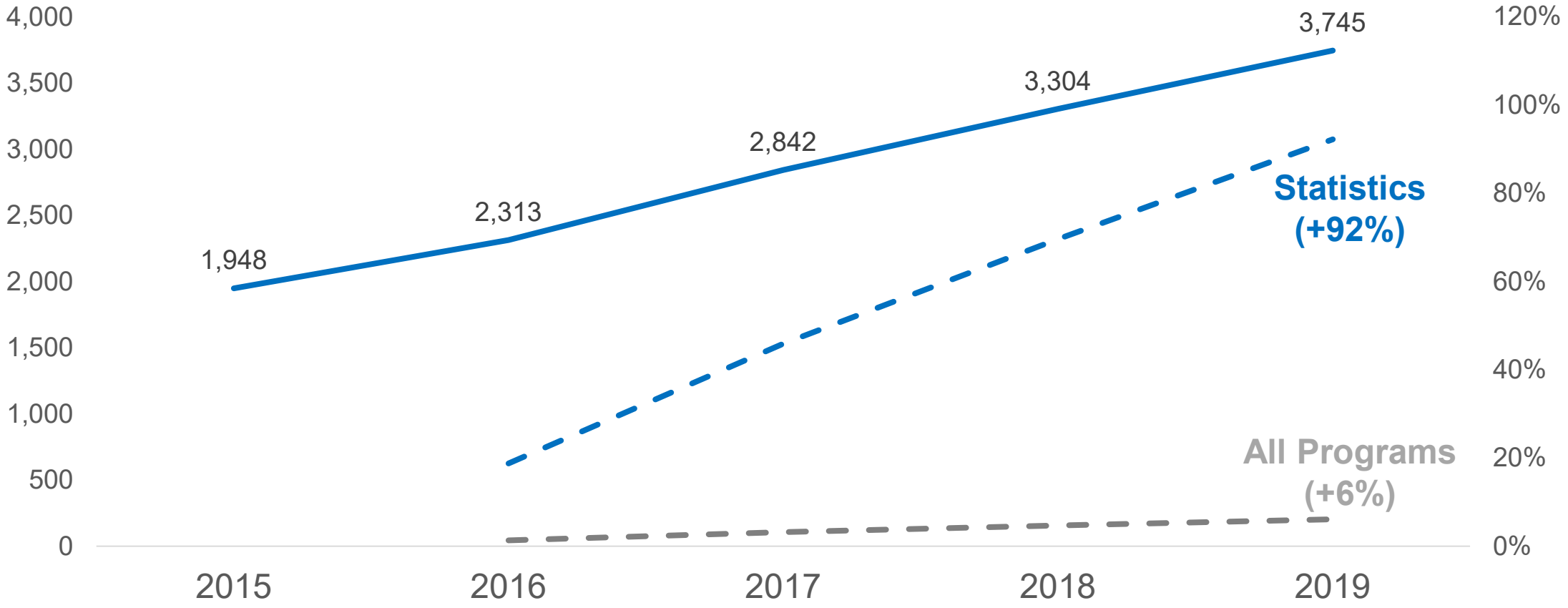
- The table at left shows trend data for the 14 Data Science-related programs we included in the analysis.
- All related programs experienced growth between 2015 and 2019, many *substantial* growth.
- Computer Science is by far the largest related program and accounts for two-thirds of degrees in Data Science-related fields.
- Even after removing Computer Science, however, collective growth in these areas is still impressive.

Encouraging trends for Statistics programs as well

- As discussed later in the report, the curriculum of the CASNR proposal emphasizes statistical applications in data science (as opposed to other mathematical areas and computing sciences found in the other proposals).
- Therefore, it is worth focusing on student demand for Statistics programs alone (rather than as one program in a suite of Data Science-related fields).
- The chart on the following page shows that demand for Statistics has grown rapidly in recent years (+92%).
- In 2015, Statistics was the 148th most popular degree field (in terms of number of degrees awarded). By 2019, it had become the 98th.
- ***Thus, there is strong demand for both Data Science and Statistics at the bachelor's degree level based on degrees students have earned in the past several years.***

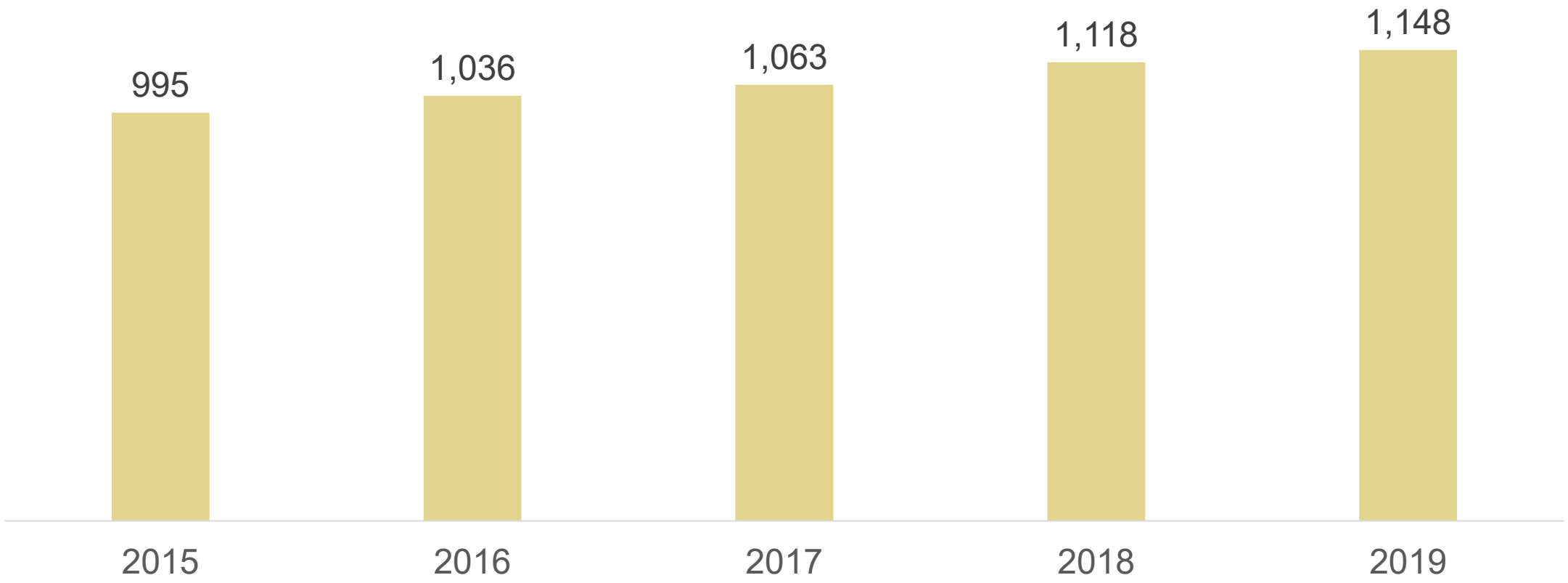
Rapid growth in statistics programs

Bachelor's Degrees Awarded in Statistics – Nationally, All Institutions
Actual Number and Cumulative % Growth in Degrees Since 2015



Competition for Data Science programs has also increased

Universities Awarding Degrees in Data Science-Related Programs – Nationally, All Institutions

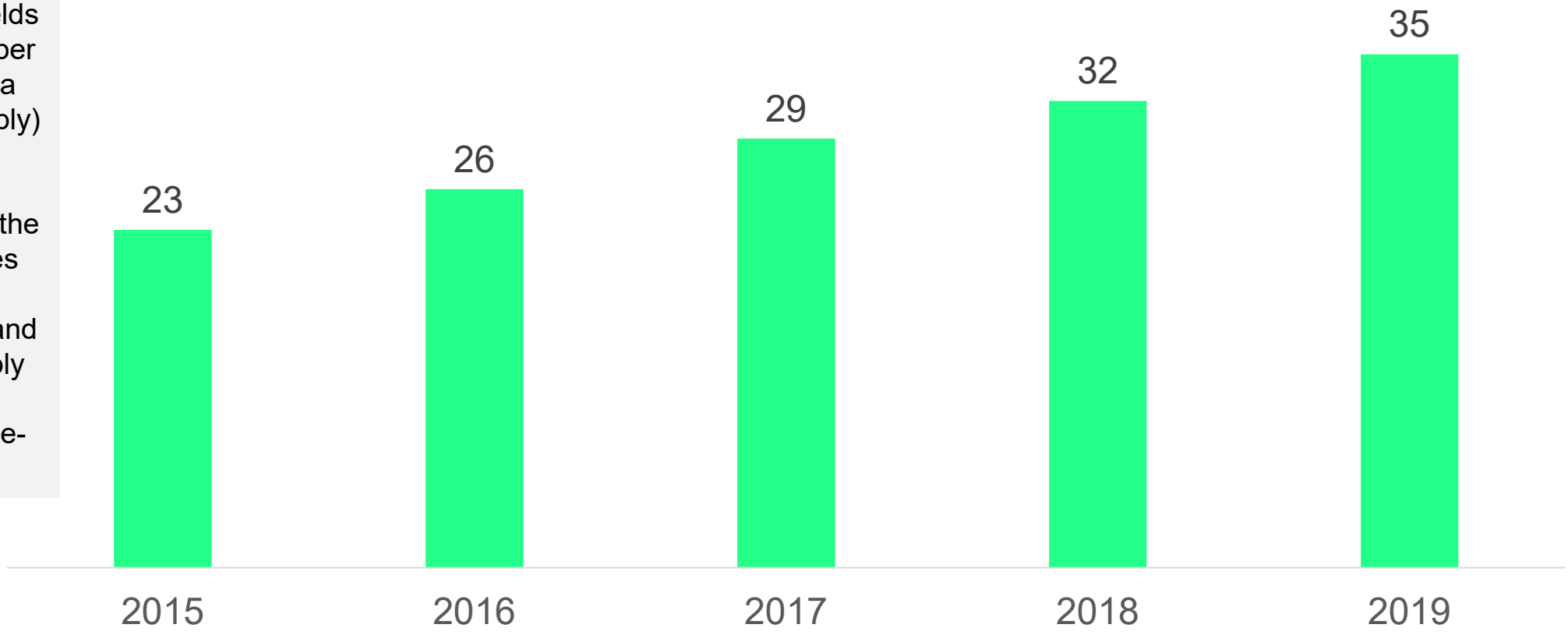


But average enrollments per institution are still growing

Avg. Degrees Awarded per Institution in Data Science-Related Fields – Nationally, All Institutions

Both the number of students enrolling in Data Science fields (i.e., demand) and the number of universities offering Data Science programs (i.e., supply) have grown.

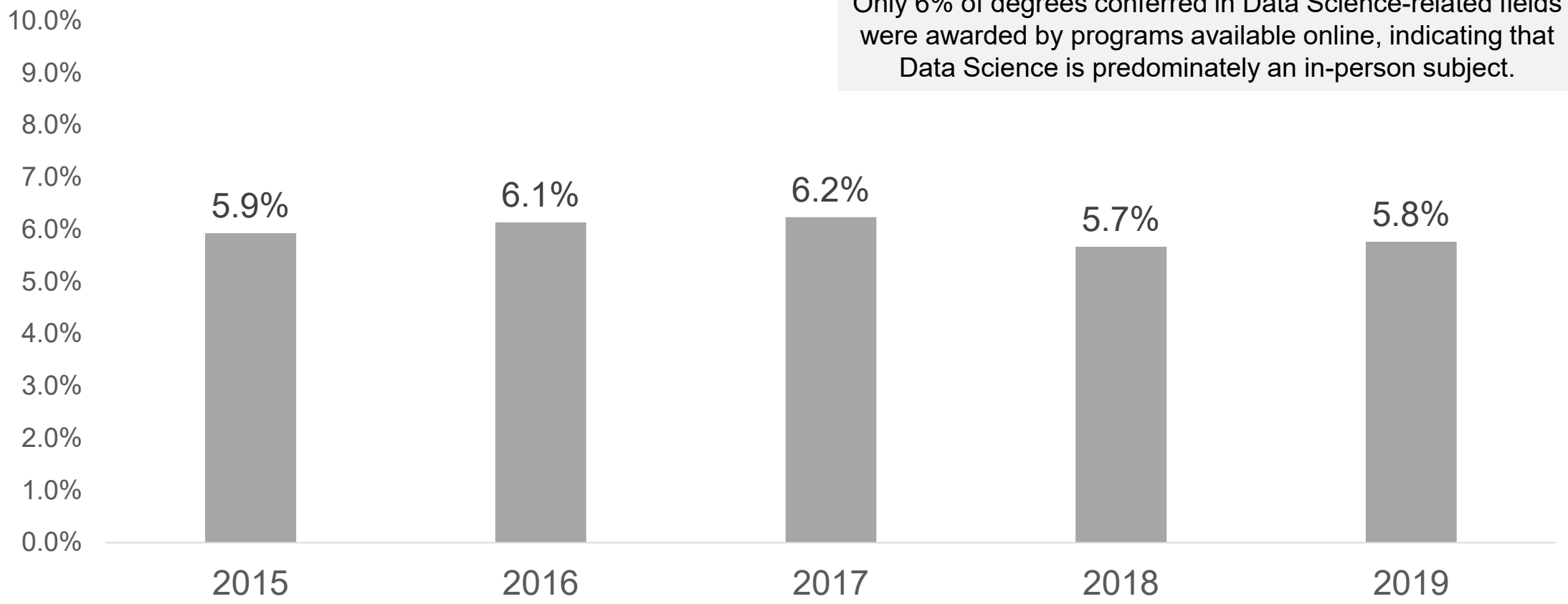
Encouragingly, the fact that the average number of degrees awarded per institution is growing indicates that demand is growing faster than supply and the market is not yet saturated with Data Science-related programs.



Data Science fields are predominately delivered in-person

Degrees Awarded in Data Science-Related Fields by Programs Available Online
% of All Degrees Awarded

Only 6% of degrees conferred in Data Science-related fields were awarded by programs available online, indicating that Data Science is predominately an in-person subject.



Summary: Student Demand for Data Science is Strong and Growing

- Nationally, students' interest in bachelor's programs in Data Science is large and growing rapidly (nearly 15x the average for all bachelor's degree programs). ***Data Science is clearly a high-demand field***.

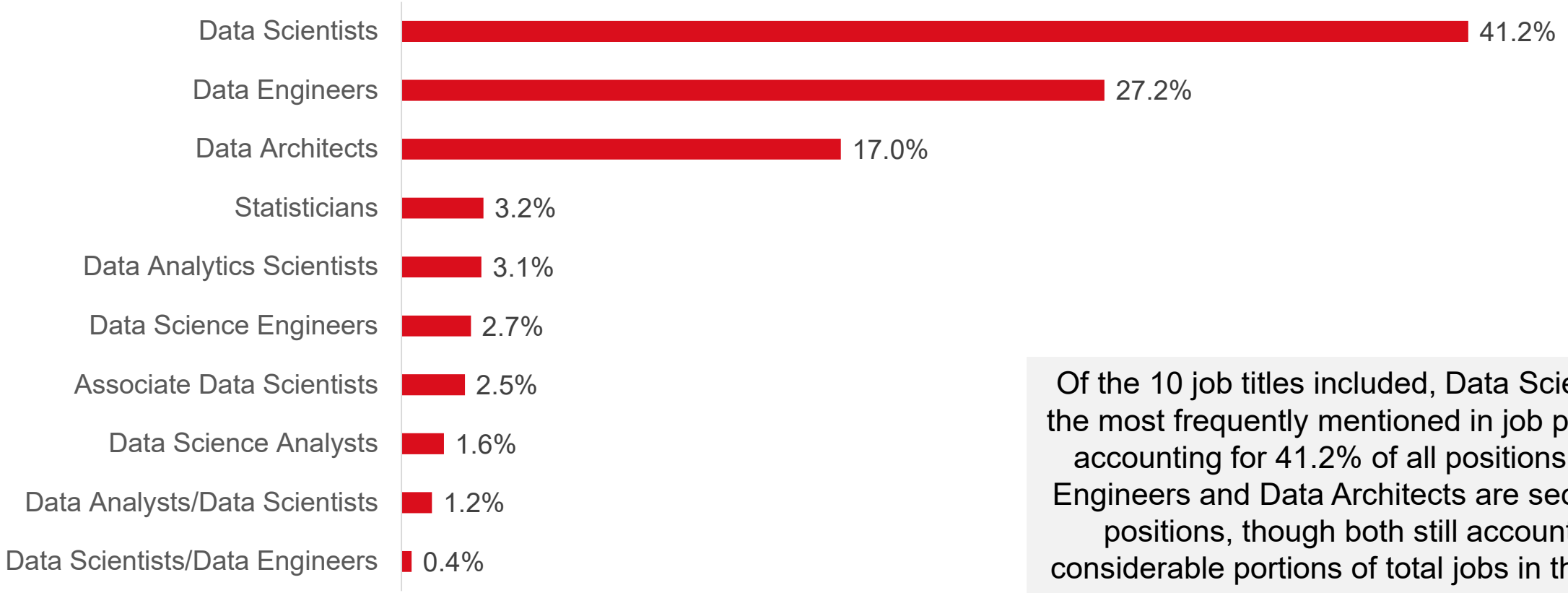
- And while other universities have taken note of this demand and begin offering Data Science programs, ***the growth in demand has exceeded the growth in supply – a favorable market for a new entrant***.

- In such an environment, ***UNL should be able to find sufficient demand to meet enrollment goals of 30 students per year initially before ramping up to 30-40 students/year***. This is consistent with the experience of UNL peers such as Big 10 or Big 12 universities and other large public research universities.

Labor Market Demand

“Data Scientist” leads among related job titles

Job Title’s Share of Total Related Postings for Data Scientists
% of Total Related Postings Coming from Each Job Title



Of the 10 job titles included, Data Scientist is the most frequently mentioned in job postings, accounting for 41.2% of all positions. Data Engineers and Data Architects are secondary positions, though both still account for considerable portions of total jobs in this field.

Above-Average Demand

175,090

Unique job postings between Jan. 2017 and Dec. 2020

There were 175k+ unique job postings for data scientists and related positions in the past four years, indicating high demand for professionals in this field.

5:1

Ratio of total postings to unique postings

A ratio of 5:1 means that for every unique position, the posting was placed five times (exceeding the 4:1 average for all jobs). This indicates that employers are applying extra effort to hire data scientists.

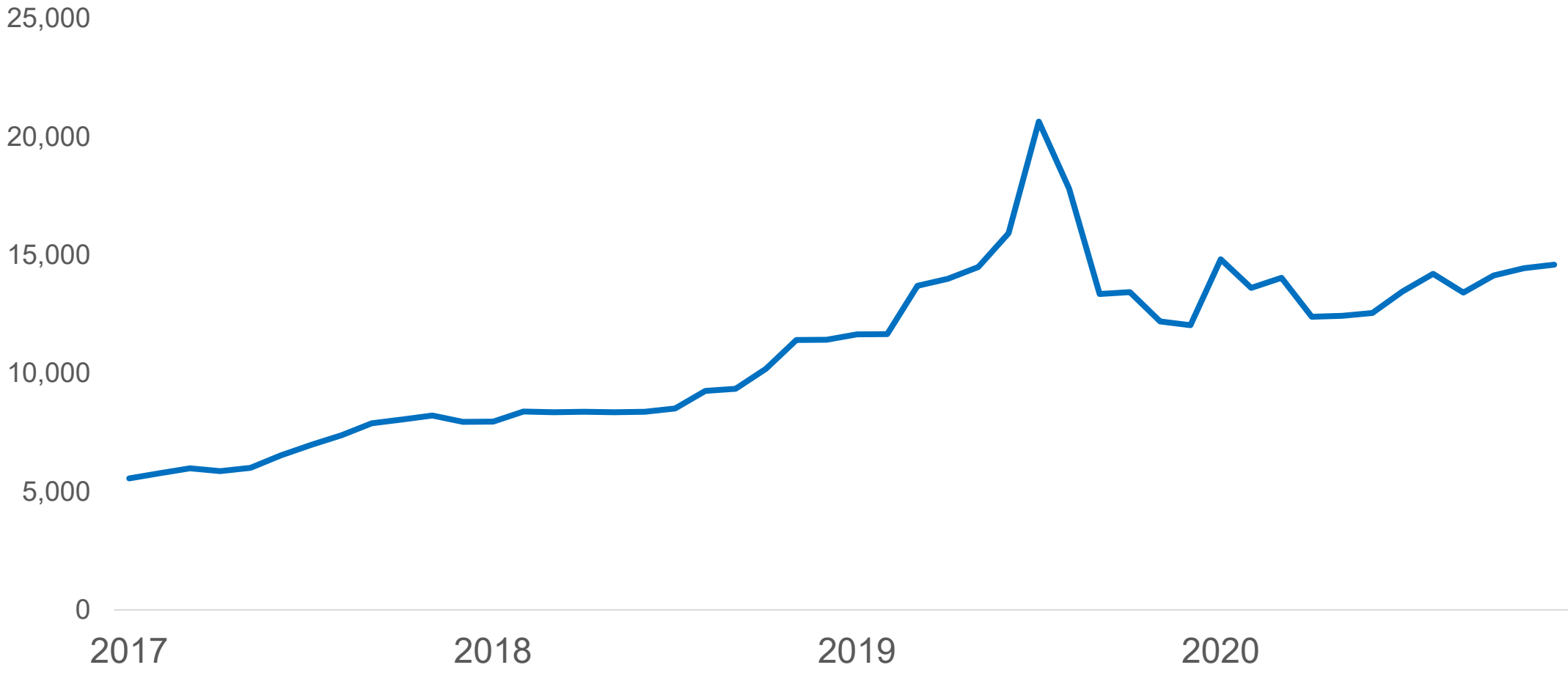
34

Median duration for a job posting

The typical data scientist position is posting for 34 days before being filled, exceeding the average of 31 days for all positions. This demonstrates that employers find it more challenging to fill data scientist roles than other positions.

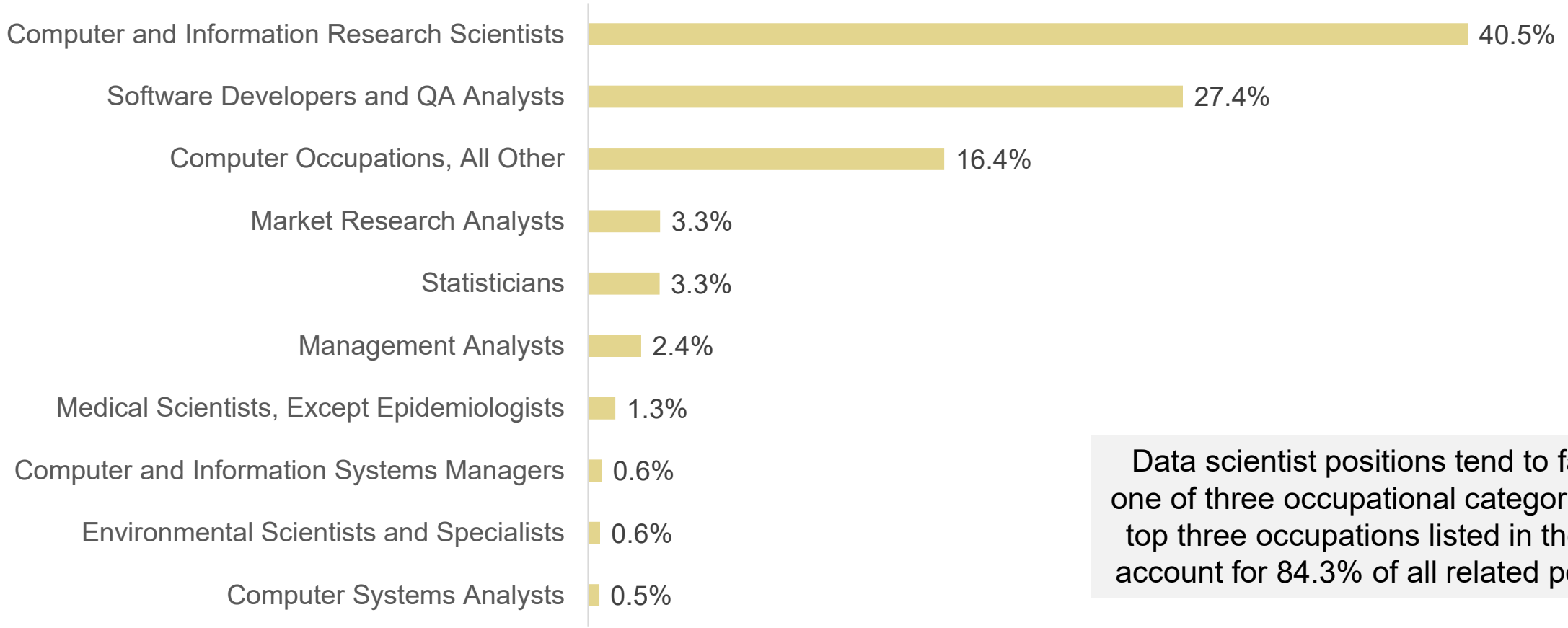
Job postings for data scientists have risen steadily in recent years

Unique Job Postings for Data Scientists (Jan. 2017 – Dec. 2020)



Data science positions categorized into three top occupations

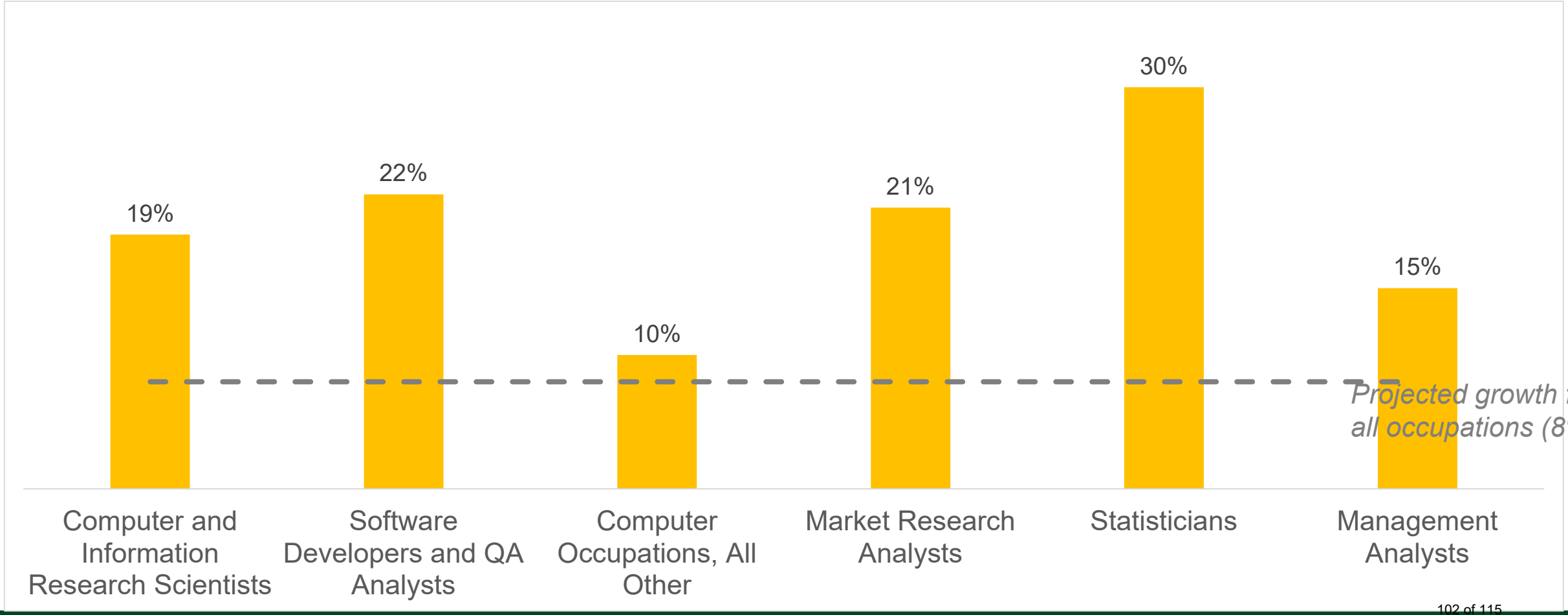
Occupation Categories for Data Scientist Positions



Data scientist positions tend to fall into one of three occupational categories. The top three occupations listed in the chart account for 84.3% of all related postings.

Data science occupations projected to grow in the 2020s, especially statisticians

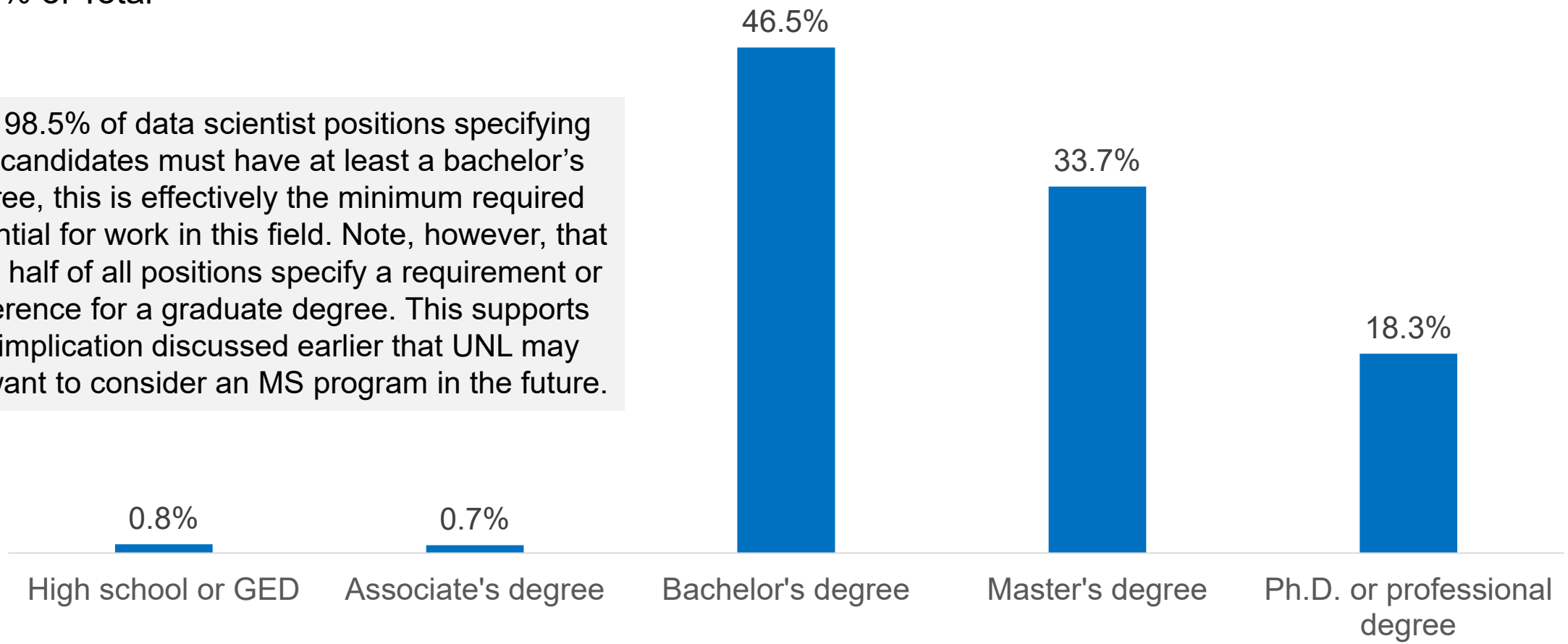
Projected Growth in Employment for Top Occupations for Data Scientists, 2019-2029



BS is the minimum required credential; some preference for MS or higher

Education Level Specified in Job Posting
% of Total

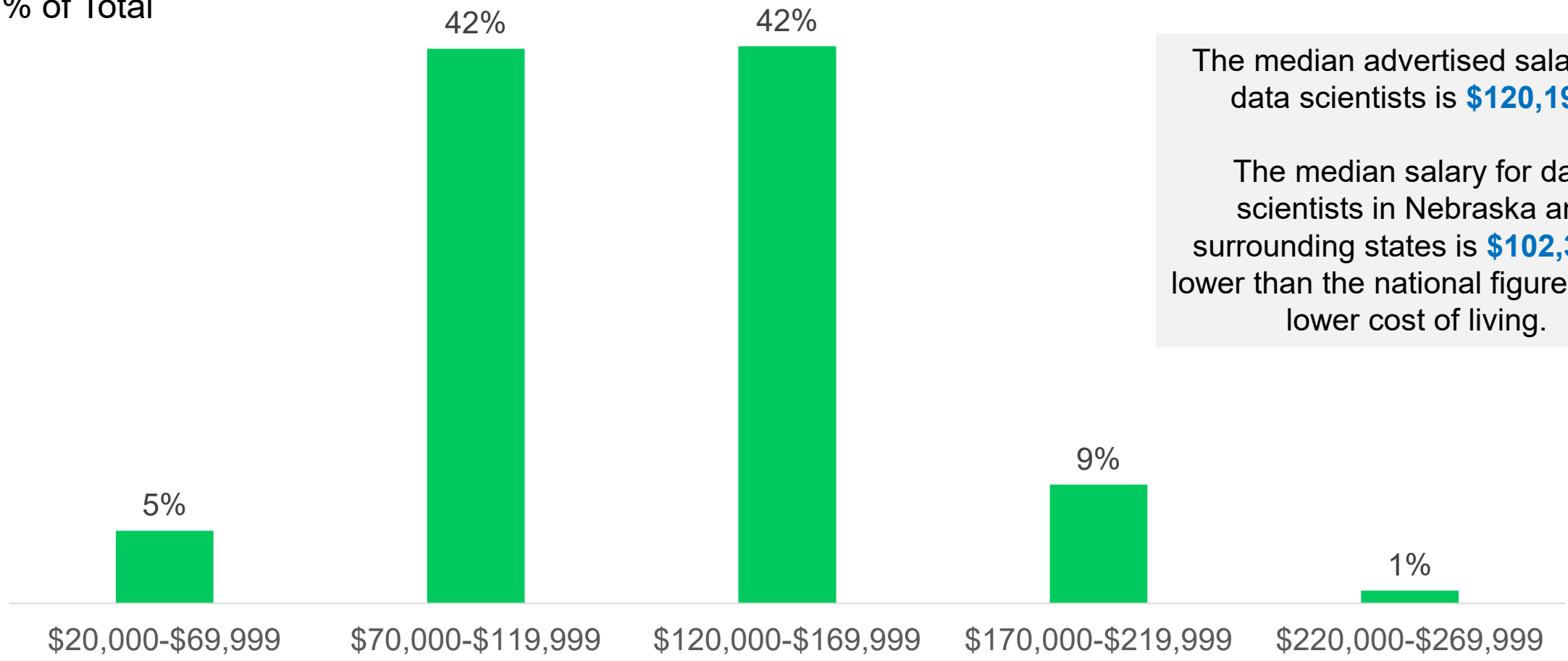
With 98.5% of data scientist positions specifying that candidates must have at least a bachelor's degree, this is effectively the minimum required credential for work in this field. Note, however, that about half of all positions specify a requirement or preference for a graduate degree. This supports the implication discussed earlier that UNL may also want to consider an MS program in the future.



Data scientists command high salaries

Advertised Salary for Data Scientist Positions

% of Total

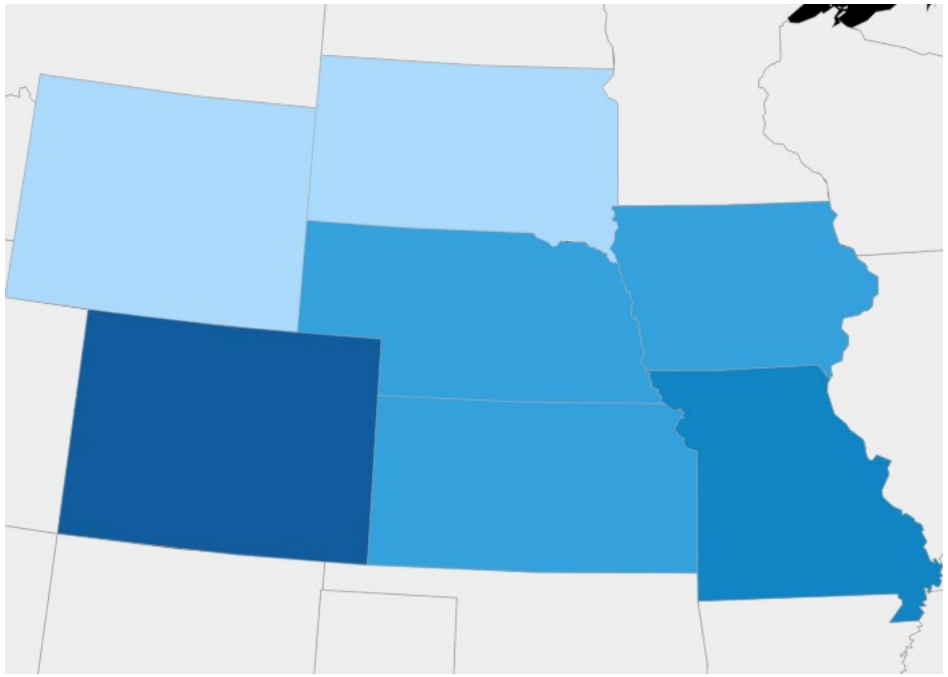


The median advertised salary for data scientists is **$120,192**.

The median salary for data scientists in Nebraska and surrounding states is **$102,300** – lower than the national figure due to lower cost of living.

Greater Denver area is the top destination for data scientists in the region

- Top cities in Nebraska and surrounding states for data scientists (unique postings in the past four years):
  - Denver, CO (1,519)
  - St. Louis, MO (1,277)
  - Kansas City, MO (600)
  - Omaha, NE (513)
  - Des Moines, IA (309)
  - Englewood, CO (308)
  - Boulder, CO (297)
  - Colorado Springs, CO (288)
  - Aurora, CO (214)
  - Chesterfield, MO (200)

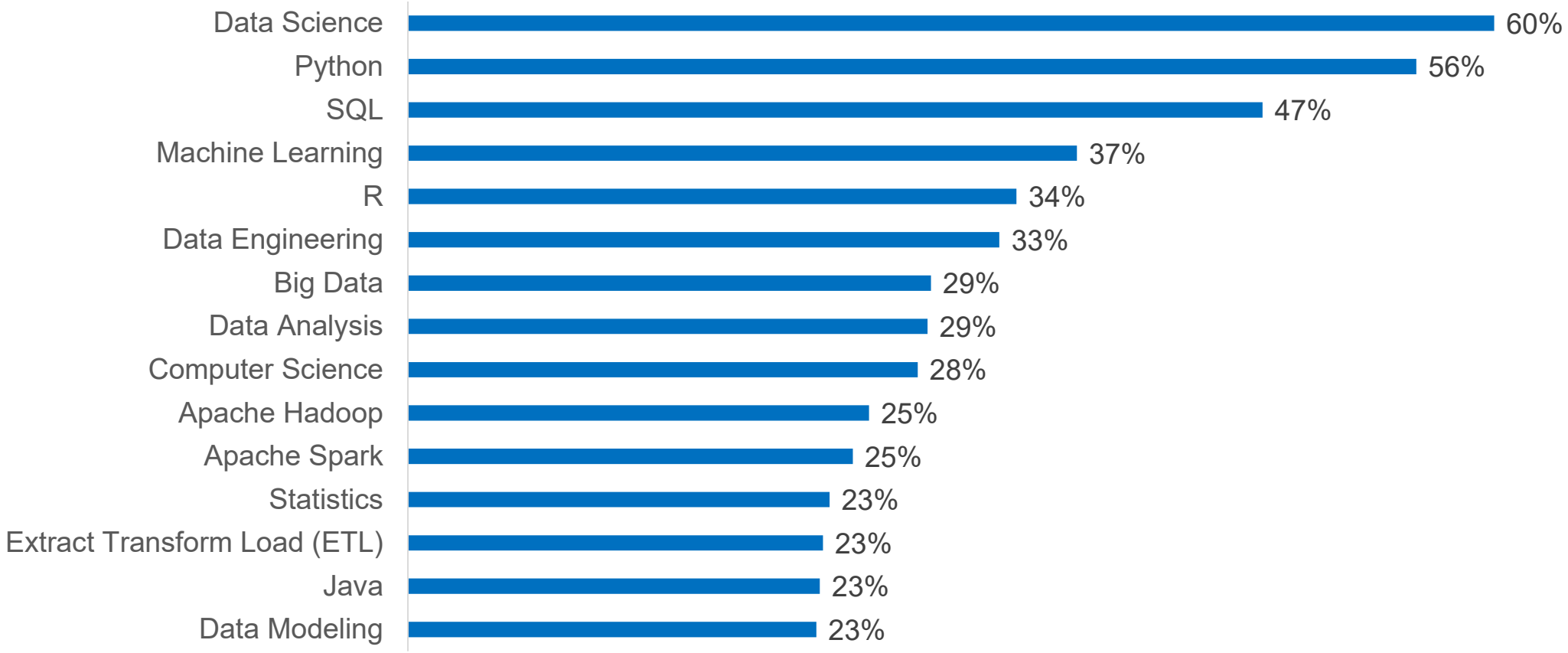


Top employers represent a range of industries and data science focuses

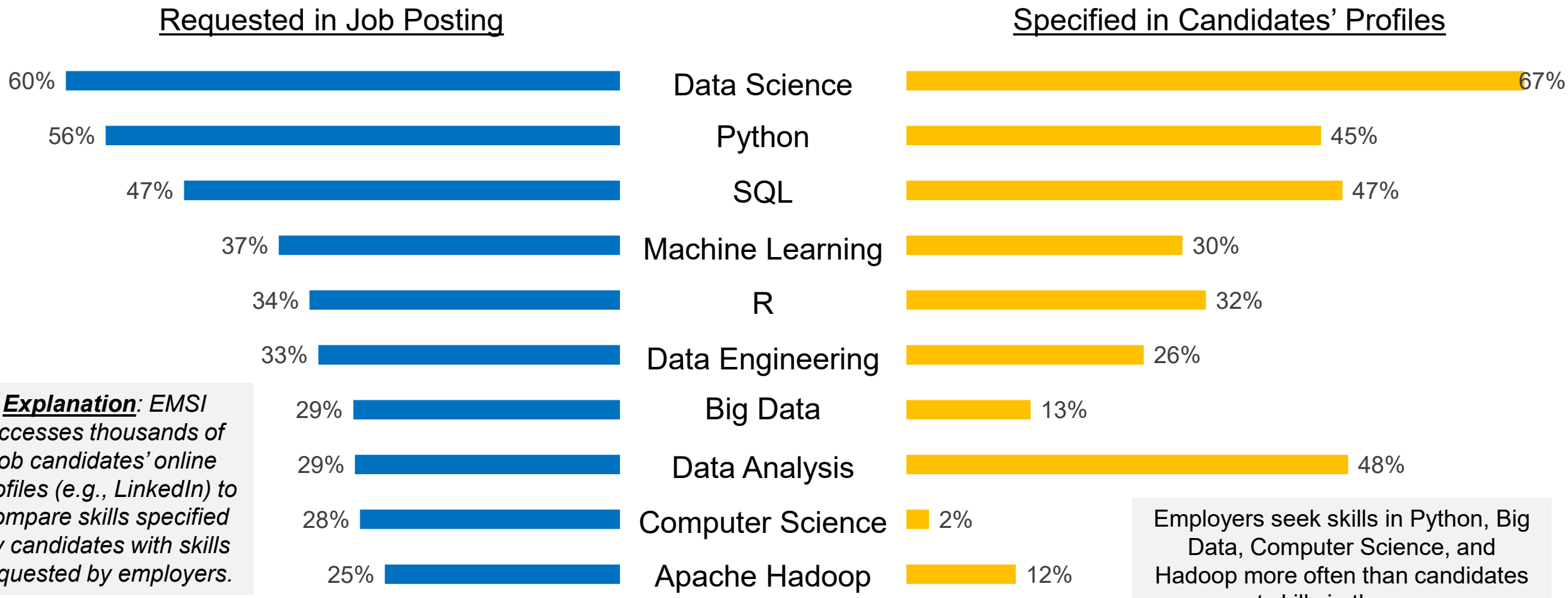
- Top 15 employers nationally:
  - Oracle
  - Amazon
  - Booz Allen Hamilton
  - IBM
  - Applied Materials
  - Anthem
  - Bayer
  - National Geospatial Intelligence Agency
  - Apex Systems
  - Capital One Financial
  - Accenture
  - Deloitte
  - Microsoft
  - Apple
  - Humana
- Top 15 employers regionally:
  - Oracle
  - National Geospatial Intelligence Agency
  - Bayer
  - Applied Materials
  - Booz Allen Hamilton
  - Spectrum
  - Monsanto
  - IBM
  - Cerner Corporation
  - Comcast
  - Anthem
  - Computer Task Group
  - Accenture
  - Amazon
  - KPMG

Employers expect domain knowledge and skills in programming languages

Top Technical Skills Required for Data Scientist Positions
% of Related Job Postings Specifying the Skill



Some candidates lack skills requested by employers *(see explanation below)*

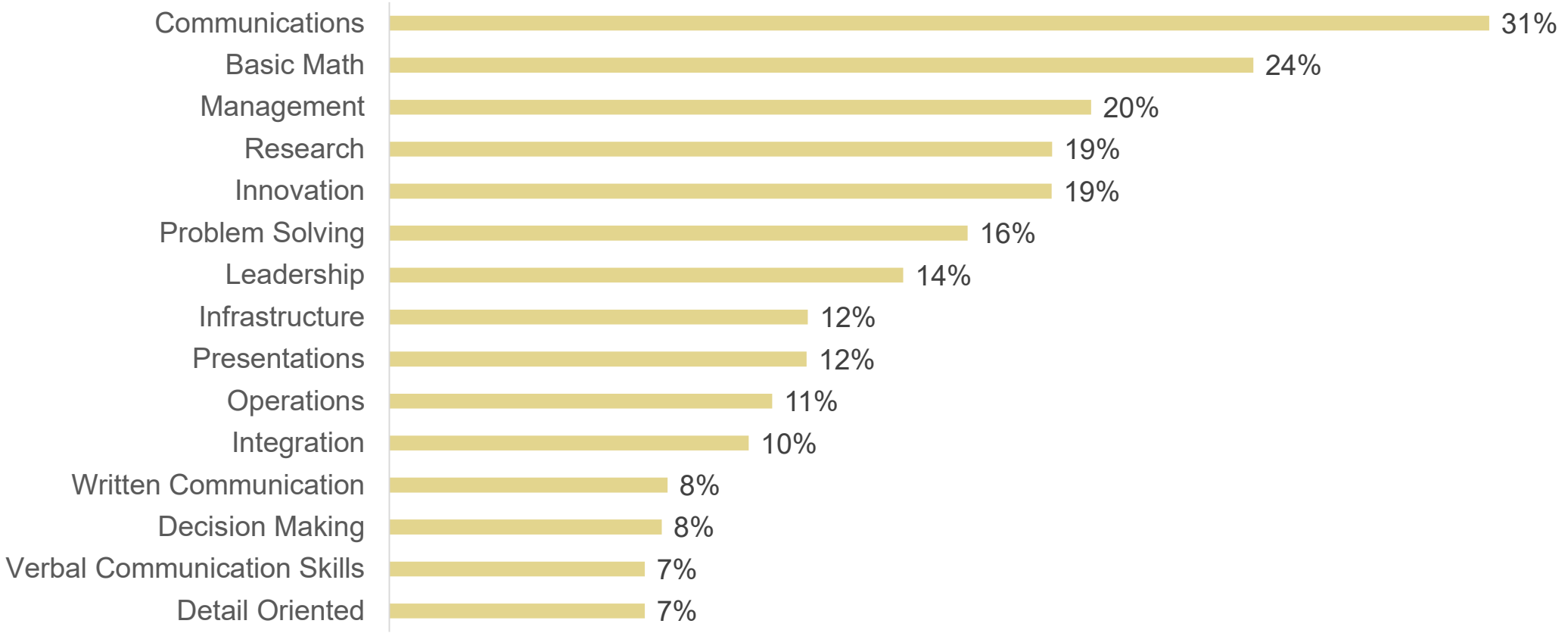


***Explanation**: EMSI accesses thousands of job candidates' online profiles (e.g., LinkedIn) to compare skills specified by candidates with skills requested by employers.*

Employers seek skills in Python, Big Data, Computer Science, and Hadoop more often than candidates report skills in these areas.

Employers also expect non-technical skills like communication and management

Top Common Skills Required for Data Scientist Positions
% of Related Job Postings Specifying the Skill



Summary: The Labor Market Needs Data Scientists

- Job postings for data scientists have increased in recent years as demand has grown.
- This demand has driven up salaries to the point that median earnings for an associate-level data scientist come to $120,000+.
- Data scientists are employed in a variety of industries for a variety of purposes (healthcare, finance, operations, software, etc.).
- Data scientists need a variety of technical and non-technical skills, especially in domain knowledge of data science and machine learning as well as top programming languages.
- ***Graduates of a UNL program in Data Science would have employment options, both regionally and nationally and would earn strong starting salaries.***

Sources

Sources

Bughin, Jacques; Manyika, James; and Jonathan Woetzel, “The Age of Analytics: Competing in a Data-Driven World.” *McKinsey Global Institute*. December 2016.

Fenlon, Mike and Julie Peters, “What’s next for the data science and analytics job market? *PwC: Research and Insights*. 2019.

Gottlieb, Joshua, “Catch Them If You Can: How Leaders in Data and Analytics Have Pulled Ahead” *McKinsey & Company*. September 19, 2019.

Henke, Nicolaus and Noshir Kaka, “Analytics Comes of Age.” *McKinsey Analytics*. January 2018.

Muenchen, Bob, “Data Science Jobs Report 2019: Python Way Up, TensorFlow Growing Rapidly, R Use Double SAS.” *KD Nuggets*. 2019.

Sources

National Academies of Sciences, Engineering, and Medicine 2018. *Data Science for Undergraduates: Opportunities and Options*. Washington, DC: The National Academies Press.

National Center for Education Statistics. “Degree Completions.” *NCES: Integrated Postsecondary Education Data System*. Sourced 2021.

Pattabiraman, Kumaresh, “LinkedIn’s Most Promising Jobs of 2019.” *LinkedIn*. January 10, 2019.

Petrov, Christo, “25+ Impressive Big Data Statistics for 2020.” *TechJury*. September 10, 2020.

Willems, Karljn, “The Data Science Industry: Who Does What.” *DataCamp Tutorials*. November 10, 2015.

TABLE 1: PROJECTED EXPENSES - NEW INSTRUCTIONAL PROGRAM
UNL Bachelor of Arts/Bachelor of Science in Data Science

	(FY2023-24) Year 1		(FY2024-25) Year 2		(FY2025-26) Year 3		(FY2026-27) Year 4		(FY2027-28) Year 5		**Total**
Personnel	**FTE**	Cost	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost	**Cost**
Faculty [1]					1.00	$130,000	1.00	$262,600	3.00	$527,852	$920,452
Director Stipend & Course Buyout [2]		$14,000		$14,000		$14,000		$14,000		$14,000	$70,000
Graduate Assistants [3]			3.0	$99,477	6.0	$202,933	6.00	$206,992	6.00	$211,132	$720,533
Support Staff											
Benefits											
Subtotal	0.00	$14,000	3.00	$113,477	7.00	$346,933	7.00	$483,592	9.00	$752,984	$1,710,985
Operating											
General Operating [4]		$2,500		$5,000		$7,500		$10,000		$12,500	$37,500
Equipment											
Library/Information Resources											
Subtotal		$2,500		$5,000		$7,500		$10,000		$12,500	$37,500
Total Expenses		$16,500		$118,477		$354,433		$493,592		$765,484	**$1,748,485**

[1] Instructional salaries (1.0 FTE) requested in Years 2 and 3 are estimated at a salary of $100,000 plus 30% fringe benefits. A 2% annual growth rate is assumed for salaries and benefits.
[2] Funds to cover the administrative stipend and course buy-out for the director, estimated at $14,000 annually.
[3] Graduate Teaching Assistants (GTAs) in years 2 and 3 are estimated at an assistantship of $21,000 plus tuition remission for 18 resident credit hours and health insurance (https://research.unl.edu/sponsoredprograms/fringe-benefit-rates/). A 2% annual growth rate is assumed for salaries and benefits.
[4] General operating consists of an incremental $2,500 each year to cover recruitment and experiential learning expenses.

	FY 24	FY 25	FY 26	FY 27
Graduate Assistantship	$21,000	$21,420	$21,848	$22,285
Benefits	$12,159	$12,402	$12,650	$12,903
Total	$33,159	$33,822	$34,499	$35,189

TABLE 2: PROJECTED REVENUES - NEW INSTRUCTIONAL PROGRAM
UNL Bachelor of Arts/Bachelor of Science in Data Science

	(FY2023-24) Year 1	(FY2024-25) Year 2	(FY2025-26) Year 3	(FY2026-27) Year 4	(FY2027-28) Year 5	**Total**
Reallocation of Existing Funds						
Required New Public Funds						
1. State Funds						
2. Local Tax Funds (community colleges)						
Tuition and Fees [1]	$244,476	$733,428	$1,222,380	$1,711,332	$1,955,808	$5,867,424
Other Funding [2]	$13,356	$40,068	$66,780	$93,492	$106,848	$320,544
Total Revenue	$257,832	$773,496	$1,289,160	$1,804,824	$2,062,656	$6,187,968

[1] Tuition only. Gross base tuition projected based on projected enrollment. See table below.

[2] Differential tuition projected based on projected enrollment in courses that include Differential Tuition. See table below.

Base Tuition

	(FY23) Year 1		(FY24) Year 2		(FY25) Year 3		(FY26) Year 4		(FY27) Year 5	
Student Type	R	NR	R	NR	R	NR	R	NR	R	NR
Est. Tuition per student	$7,770	$24,900	$7,770	$24,900	$7,770	$24,900	$7,770	$24,900	$7,770	$24,900
Est. New Enrollment in Major	20		60		100		140		160	
Est. New Enrollment - Student Type	15	5	44	16	74	26	104	36	118	42
Est. New Tuition & Fees	$114,996	$129,480	$344,988	$388,440	$574,980	$647,400	$804,972	$906,360	$919,968	$1,035,840
Est. New Tuition & Fees	$244,476		$733,428		$1,222,380		$1,711,332		$1,955,808	
Est. New Total Tuition & Fees	**$5,867,424**									

Differential Tuition

	(FY23) Year 1		(FY24) Year 2		(FY25) Year 3		(FY26) Year 4		(FY27) Year 5	
Student Type	R	NR	R	NR	R	NR	R	NR	R	NR
CoE Diff. Tuition Rate (per CH)	$ 112	$ 252	$ 112	$ 252	$ 112	$ 252	$ 112	$ 252	$ 112	$ 252
% CoE courses - non-CoE Track	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
% CoE courses - CoE Track	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Est. % non-CoE Track Students	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%
Est. % CoE Track Students	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
SCH per Student per Year	30	30	30	30	30	30	30	30	30	30
Average Diff. Tuition per Student	$ 504	$ 1,134	$ 504	$ 1,134	$ 504	$ 1,134	$ 504	$ 1,134	$ 504	$ 1,134
Enrollment	15	5	44	16	74	26	104	36	118	42
Estimated New Differential Tuition	$ 7,459	$ 5,897	$ 22,378	$ 17,690	$ 37,296	$ 29,484	$ 52,214	$ 41,278	$ 59,674	$ 47,174
Estimated New Differential Tuition	**$13,356**		**$40,068**		**$66,780**		**$93,492**		**$106,848**	