THE UNIVERSITY OF ARIZONA

NEW ACADEMIC PROGRAM – MAJOR
Preliminary Proposal Form

I. Program Details

a. **Name (and Degree Type) of Proposed Academic Program:** Data Science & Applied Statistics (Master of Science)
   i. Emphases (if applicable): Computational Biology, Earth Science
b. **Academic Unit(s)/College(s):** Mathematics/Science
c. **Campus/Location(s):** Main
d. **First Admission Term:** Fall, 2023
e. **Primary Contact and Email:** Joseph Watkins, jwatkins@math.arizona.edu

II. Executive Summary (please provide **no more** than 5 bullets/sentences that sum up the rationale, demand, and uniqueness of your proposed major)**:**

- Entrance requirements and six-course core curriculum are comparable to peer institutions.
- Domain science emphases (two initially with more to come) are unique among peer institutions.
- The program allows both vertical and horizontal stacking of certificates in a way that accommodates several educational pathways.
- The program is designed for practicing engineers and scientists who are experiencing an increasing need for data science training to meet evolving workforce needs.
- According to the Bureau of Labor Statistics, over the next decade, nearly three-fourths of the additional jobs in STEM fields will have a significant data science component.

III. Brief Program Description: The College of Science will establish and host a new interdisciplinary Professional Master's Program in Data Science and Applied Statistics. This degree is designed to target working professionals with strong technical backgrounds who seek to add advanced statistical and data science theory and tools to their arsenal. The interdisciplinary nature of the degree makes it accessible and attractive to prospective students in virtually any industry. The program will bridge academics and industry closely, from the curriculum to experiential training to job placement. The core curriculum for the proposed degree has two 3-course sequences, balancing between the foundational theory of data science and industry application tools. The degree requires three additional courses – from an area of emphasis - earth science or computational biology – and completing a capstone experience. For those whose educational goals are more targeted, completion of any three-course sequences will result in a granting of a graduate certificate.

IV. Program Rationale: This proposal impacts all five of the pillars of the Strategic Plan. The first pillar, "Wildcat Journey" and the second Pillar "Grand Challenges" seek to prepare students for the 4th Industrial Revolution. The growth of data scientist and statistician

positions over the next eight years (projected at 31% for 2018-2028 by the Bureau of Labor Statistics) illustrates the potential impact on all industries. This is consistent with the Burning Glass market analysis both regionally and nationally. Data scientists with applied statistical skills are needed in all fields. Workers with an undergraduate degree in industry employment find that additional education in Data Science and Applied Statistics will be enormously beneficial to their career goals.

V. **Projected Enrollment for the First Three Years:** *Note that for the full proposal, you will need to provide evidence to support the projection (through student/alumni surveys, enrollment in existing courses, peer programs, etc.) At this stage, a rough estimate is sufficient.*

Year 1	Year 2	Year 3
15	25	25

VI. **Evidence of Market Demand:** A combined Burning Glass analysis for Data Science, General (30.7001), Applied Statistics, General (27.0601) shows average growth in Arizona and high growth nationally. The growth of statistician positions over the next eight years (projected at 31% for 2018-2028 by the Bureau of Labor Statistics) illustrates the potential impact on all industries. Our domain science approach is designed to target growth industries especially relevant to the state of Arizona.

VII. **Similar Programs Offered at Arizona Public Universities:** The University of Arizona is moving to have a data intensive professional master's program in several colleges - Business Analytics in the Eller College, Data Science in the College of Social and Behavioral Sciences, and Software Engineering in the College of Engineering. Each of these programs are attractive to a distinct audience. Of the nearly one million projected new STEM jobs, approximately three-quarters will be in data science fields and over the coming decade, employers will develop an understanding of the distinctive nature of these four programs in much the same way they presently understand the difference among different degree programs in engineering or in biological sciences.

A mathematics/statistics/computer science/domain science focused professional master's degree does not yet exist at any Arizona public university. Currently, the University of Arizona has two Master's programs with "Data Science" in the title. One is in the School of Information and one is in the Graduate Interdisciplinary Program in Statistics and Data Science. The proposers of this degree are in the Statistics and Data Science GIDP. A letter from the iSchool endorsing the program will be included in final submission.

The full proposal will give a detailed description that compares degree programs.

VIII. **Resources**

a. **Summarize new resources required to offer the program:** The program as it grows will likely require additional faculty with both foundational and domain science data science expertise.

b. **Estimate total expected cost:** Six courses at steady state requires two graduate faculty members, an expense that is approximately 2 times $120K plus employment related expenses..

c. **Estimate total expected revenue of the program:** With an entering class of 25 students taking a two-year program, revenue will be ~$1,000,000 assuming an average tuition of $20,000. These numbers can become substantially larger as the program grows.

IX. Required Signatures

Program Director/Main Proposer:

i. **Signature:** _Joseph C. Watkins____

ii. **Name and Title:** Joseph Watkins, Professor of Mathematics and Director, Data Sciences Academy

iii. **Date:** June 11, 2022

b. **Managing Unit/Department Head:**

i. **Signature:** _____ D L Ulmer _____

ii. **Name and Title:** Douglas Ulmer, Professor and Head, Department of Mathematics

iii. **Date:** June 21, 2022

c. **College Dean/Associate Dean:**

i. **Signature:** _____Jeremiah D. Hackett _____

ii. **Name and Title: Jeremiah D. Hackett, Associate Dean for Graduate and Postdoctoral Studies, College of Science**

iii. **Date: June 14, 2022**

THE UNIVERSITY OF ARIZONA

ACADEMIC ADMINISTRATION
Administration Building, 402
1401 E. University Blvd.
PO Box 210066
Tucson, AZ 85721-0066

To: Joseph Watkins, Professor of Mathematics and Director
Data Sciences Academy
College of Science

From: Greg Heileman, PhD, Vice Provost for Undergraduate Education

Date: July 28, 2022

Subject: Approval of Preliminary Proposal for MS in Data Science & Applied Statistics

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Thank you for submitting the preliminary review proposal for a Master of Science in Data Science & Applied Statistics. The proposed academic program should provide an excellent educational opportunity and a useful degree for students pursuing to add advanced statistical and data science theory and tools to their arsenal. We believe your ideas are sufficiently well developed that it now makes sense to advance through the stages of the formal academic program approval process.

Please proceed to the development of a full proposal, and do not hesitate to reach out the Curricular Affairs Office for assistance with this process.

CC: Liesl Folks, Senior Vice President for Academic Affairs and Provost
Liz Sandoval, Manager, Curricular Affairs
Douglas Ulmer, Professor and Head, Department of Mathematics, College of Science
Jeremiah Hackett, Associate Dean for Graduate and Postdoctoral Studies, College of Science

THE UNIVERSITY OF ARIZONA

ACADEMIC PROGRAM – ADDITIONAL INFORMATION FORM

To be used once the preliminary proposal has been approved.

I. MAJOR DESCRIPTION -provide a marketing/promotional description for the proposed program. Include the purposed nature, and highlights of the curriculum, faculty expertise, emphases (sub-plans; if any), etc. The description should match departmental and college websites, Graduate Catalog and Program Descriptions page, handouts, promotional materials, etc.

In modern days, almost all the scientific research and industry work are data-driven; new and big data are collected everywhere, which require professionals to master advanced data analytical skills to perform data analysis and gain insight. Over the past two decades, the demand for data practitioners has increased dramatically, and Data Science has become one of the most in demand professions and the need for skilled professionals to gain insights from data. To meet the expanding needs for data professionals at all levels, the College of Science will host and establish a new interdisciplinary Professional Master's Program in Data Science and Applied Statistics.

This degree is designed to target working professionals with strong technical backgrounds who seek to add advanced statistical and data science theory and tools to their arsenal. The multidisciplinary nature of the degree, the combination and interaction of the data sciences with a domain science, makes it accessible and attractive to prospective students in virtually any industry.

The new program will bridge academics and industry closely, from the curriculum design to experiential training to job placement. The core curriculum for the proposed degree has two 3-course sequences, balancing between the foundational theory of data science and industry application tools. The degree requires three additional courses – from an area of emphasis - earth science or computational biology (to start) – or taking general data science and applied statistics courses and completing a capstone experience. The program will offer students intensive hands-on experience of tackling real-world problems and challenges, by participating in scientific labs throughout data collection, engineering, analysis, and interpretation.

The College of Science is home to 20 departments and schools, including numerous nationally recognized labs and research centers, which offers rigorous training on the foundation of science in a wide range of subject areas as well as cutting edge data science technologies. Therefore, we expect that the new program will continuously expand emphasis areas to attract industry professionals in various industries who would like to acquire modern and enhanced data science training for career advancement in specialized areas. The program will also offer career guidance, counseling, and networking service for students to optimize internship and job placement.

II. NEED FOR THE MAJOR/JUSTIFICATION-describe how the major fulfills the needs of the city, state, region, and nation. Provide market analysis data or other tangible evidence of the need for and interest in the proposed major (and emphases, if applicable). This might include results from surveys of current students, alumni, and/or employers or reference to student enrollments in similar programs in the state or region. Include an assessment of the employment opportunities for graduates of the program for the next three years. Curricular Affairs can provide a job posting/demand report by skills obtained/outcomes/CIP code of the proposed major. Please contact the Office of Curricular Affairs to request the report for your proposal.

This degree aligns closely with the UArizona strategic plan, including student preparation for modern and high-demand careers of the 4th Industrial Revolution. It will employ vital strategic curricular innovation and development in several key areas of data and computational science, statistics, and machine learning to provide top-quality educational opportunities to Arizona students and address grand challenges in the local and state economy. Statistics and Data Science is known as "The science of using data to make decisions", and it is imperative for us to offer this industry-driven degree to equip our students with strong ability to make big decisions.

UArizona's strength in the fundamentals of data science together with our unparalleled portfolio of domain science opportunities make for a very compelling masters degree. This program will fill an important niche of student and community need and help UArizona lead in developing other needed high-quality, impactful Professional MS degrees. It will support growth in tuition paying MS students and provide income to support PhD education. The program will endeavor to recruit underrepresented minorities and women under the JEDI principle and enhance HSI education. This effort will be the responsibility of a program executive committee

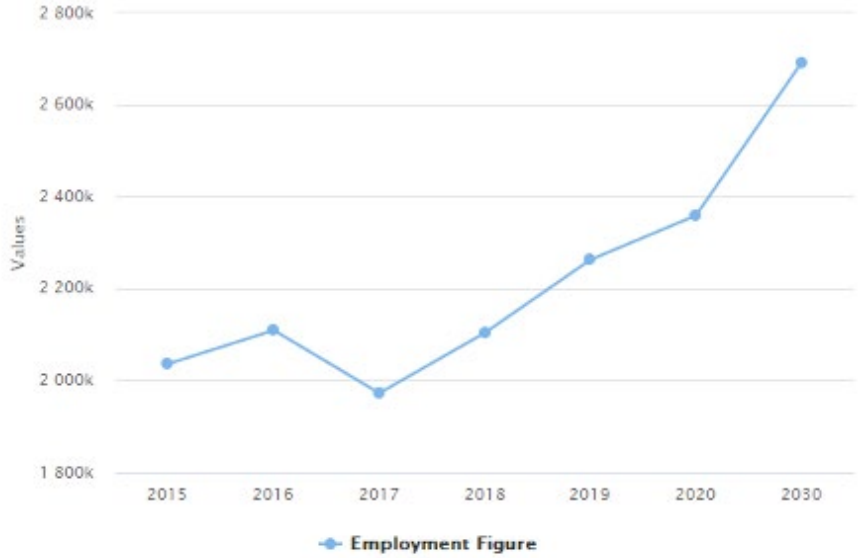
This proposal impacts all five of the pillars of the Strategic Plan. The first pillar, "Wildcat Journey" and the second Pillar "Grand Challenges" seek to prepare students for the 4th Industrial Revolution. The growth of statistician and data scientist positions over the next eight years (projected at 31% for 2018-2028 by the Bureau of Labor Statistics) illustrates the potential impact on all industries. This is consistent with Burning Glass market analysis both regionally and nationally. Data scientists with applied statistics skills are needed in all fields. Workers with an undergraduate degree in industry employment find that additional education in Data Science and Statistics will be enormously beneficial to their career goals.

The Burning Glass analysis for Data Science, General (30.7001), Applied Statistics, General (27.0601) noted 9,352 job postings in the last 12 months. Burning Glass statewide and national trends are given in the table below.

Geography	Selected Occupations	Total Labor Market	Relative Growth
Arizona	18.22 %	16.80 %	Average
Nationwide	10.93 %	3.70 %	High

In response to how has employment changed for career outcomes

	2015	2016	2017	2018	2019	2020	2030
Employment (BLS)	39,176	40,243	39,546	40,361	45,608	48,661	57,521



Employment data between 2020 and 2030 are projected figures.

Several of the nation's research universities have recently developed or are in the process of developing professional master's degree programs. While these programs undertake a national recruitment profile, most students prefer a program close to home or with regional industrial contacts. Currently, there are no modern Applied Statistics and Data Science programs is currently offered at research universities in the mountain Southwest. (See Peer Review document to see that the closest such degree in the Southwest resides at Colorado State.) The core curriculum proposed here has two 3-course sequences, balancing between **the foundational theory** of data science and **industry application tools**. Our plan, in follow-up applications, is to design a program so that completion of each core sequence would earn the student a certificate, which will enhance career development, lead to more job opportunities, and prepare them for continuing education for modern workforce needs. The degree requires three additional courses – either from general courses or from an area of emphasis – and completing a capstone experience, which can capitalize on the unique aspects of our region and the expertise of our research faculty, e.g., hydrology, optics, astronomy, medicine, and engineering. The Statistics and Data Science Interdisciplinary Program and the Mathematics Department are uniquely poised to provide compelling candidates for these positions.

The University of Arizona is moving to have a data intensive professional master's program in several colleges - Business Analytics in the Eller College, and Data Science in the College of Social and Behavioral Sciences. Each of these programs are attractive to a distinctive audience that is generally associated with their home college. The proposed Professional Master's program in Applied Statistics and Data Science will recruit primarily from those disciplines that have significant mathematical (e.g., two to three semesters of calculus and linear algebra) and computational (generally more than one programming course) aspects. In this sense, the degree is primarily aimed at scientists and engineers in the workforce so that they can become current in issues in data science that require the given background knowledge.

Of the nearly one million projected new STEM jobs, three-quarters will be in data science fields and over the coming decade, employers will develop an understanding of the distinctive nature of these programs in much the same way they presently understand the difference among different degree programs in engineering or in biological sciences.

III. MAJOR REQUIREMENTS– complete the table below by listing the major requirements, including required number of units, required core, electives, and any special requirements, including emphases* (sub-plans), thesis, internships, etc. Note: information in this section must be consistent throughout the proposal documents (comparison charts, four-year plan, curricular/assessment map, etc.).

GRADUATE

Total units required to complete the degree	30
Pre-admissions expectations (i.e., academic training to be completed prior to admission)	Earned bachelor's degree; two semesters of calculus, one semester of linear algebra and one semester of a programming language, e.g., python (preferred), R, Matlab, or C
Major requirements. List all major requirements including core and electives. If applicable, list the emphasis requirements for each proposed emphasis*. Courses listed must include course prefix, number, units, and title. Mark new coursework (New). Include any limits/restrictions needed (house number limit, etc.). Provide email(s)/letter(s) of support from home department head(s) for courses not owned by your department.	Complete 18 units of core coursework: MATH 509D (3) **Statistics for Data Science** STAT 675 (3) **Statistical Computing & Optimization** MATH 574M (3) **Statistical Machine Learning** CSC 501 (3) **Advanced Programming** BIOS 576E (3) **Data Management and the R Programming Language** CSC 544 (3) **Advanced Data Visualization** Complete 9 units of coursework from one of the following three emphases. **<u>Earth Science</u>** HAS 5XX (3) **Earth Informatics**

	ATMO 545 (3) **Introduction to Data Assimilation** HWRS 642 (3) **Analysis of Hydrologic Systems** **Computational Biology** MCB 516A (3) **Bioinformatics and Functional Genomic Analysis** MCB 547 (3) **Big Data in Molecular Biology and Biomedicine** MCB 580 (3) **Introduction to Systems Biology** **General** BIOS 647 (3) **Categorical Data Analysis** BIOS 648 (3) **Analysis of High Dimensional Data** BIOS 684 (3) **Mixed Effects Models and Longitudinal Data** CSC 535 (3) **Probabilistic Graphical Models** STAT 568 (3) **Applied Stochastic Processes** STAT 571A (3) **Advanced Statistical Regression Analysis** STAT 574B (3) **Bayesian Statistical Theory and Applications** **Capstone (2 units)** Possibilities include departmental offered internship DEPT 593 (e.g. BIOS 593, CSC 593, HAS 593, MCB 593, STAT 593) or independent study DEPT 599 (e.g. CSC 599, BIOS 599, HAS 599, MCB 599, STAT 599) **Professional Development Course (1)** MATH/CSC 597
Research methods, data analysis, and methodology requirements (Yes/No). If yes, provide description.	No additional requirements in this area beyond those in the stated curriculum. The center of the program is dedicated to research methods, data analysis, and methodology.
Internship, practicum, applied course requirements (Yes/No). If yes, provide description.	Yes. Students complete 2 units of an internship, practicum or other capstone experience in the field.
Master thesis or dissertation required (Yes/No). If yes, provide description.	No
Additional requirements (provide description)	**MATH/CSC 597** 1 unit professional development course
Minor options (as relevant)	No required minor options.

*Emphases are officially recognized sub-specializations within the discipline. ABOR Policy 2-221 c. Academic Degree Programs Subspecializations requires all undergraduate emphases within a major to share at least 40% curricular commonality across emphases (known as "major core"). Total units required for each emphasis must be equal. Proposed emphases having similar curriculum with other plans (within department, college, or university) may require completion of an additional comparison chart. Complete the table found in Appendix B to indicate if emphases should be printed on student transcripts and diplomas.

IV. CURRENT COURSES–using the table below, list all existing courses included in the proposed major. You can find information to complete the table using the UA course catalog or UAnalytics (Catalog and Schedule Dashboard> "Printable Course Descriptions by Department" On Demand Report; right side of screen). If the courses listed belong to a department that is not a signed party to this implementation request, upload the department head's permission to include the courses in the proposed program and w2information regarding accessibility to and frequency of offerings for the course(s). Upload letters of support/emails from department heads to the "Letter(s) of Support" field on the UAccess workflow form. Add or remove rows to the table, as needed.

Course prefix and number (include cross-listings)	Units	Title	Pre-requisites	Modes of delivery (online, in-person, hybrid)	Typically Offered (F, W, Sp, Su)	Dept signed party to proposal? (Yes/No)
STAT 675	3	**Statistical Computing**	Math 509D	In-person	Sp	Yes
MATH 574 M	3	**Statistical Machine Learning**	MATH 509D	In-person	Sp	Yes
CSC 544	3	**Advanced Data Visualization**	CSC 501	In-person	F	Yes
MCB 516A	3	**Bioinformatics and Functional Genomic Analysis**	Basic statistical knowledge and programming experience	In-person	Sp	Yes
MCB 547	3	**Big Data in Molecular Biology and Biomedicine**	Introductory statistics	In-person	F	Yes
MCB 580	3	**Introduction to Systems Biology**	Calculus and one upper division biology course	In-person	F	Yes
ATMO 529	3	**Objective Analysis in the Atmospheric and Related Sciences**	Calculus and upper division Atmo training	in -person	F	Yes

ATMO 545	3	**Introduction to Data Assimilation**	Calculus and upper division Atmo training	In Person	F	Yes
ATMO 555	3	**Introduction to Atmospheric and Hydrology Remote Sensing**	Calculus and upper division Atmo training	in-person	Sp	Yes
HWRS 642	3	**Analysis of Hydrologic Systems**	Second Semester Calculus and upper division Hydro training	in-person	Sp	Yes
BIOS 647	3	**Categorical Data Analysis**	Math 509D	in-person	Sp	Yes
BIOS 648	3	**Analysis of High Dimensional Data**	Math 509D	in-person		Yes
BIOS 684	3	**Mixed Effects Models and Longitudinal Data**	Math 509D	in-person	F	Yes
CSC 535	3	**Probabilistic Graphical Models**	Math 509D	in-person	Sp	Yes
STAT 568	3	**Applied Stochastic Processes**	Math 509D	in-person	Sp	Yes
STAT 571A	3	**Advanced Statistical Regression Analysis**	prerequisites for the degree program	in-person	F	Yes
STAT 574B	3	**Bayesian Statistical Theory and Applications**	Math 509D	in-person	Sp	Yes
MATH/CSC 597	1	**Professional Development in Applied Statistics and Data Science**				

V. **NEW COURSES NEEDED** – using the table below, list any new courses that must be created for the proposed program. If the specific course number is undetermined, please provide level (i.e., CHEM 4XX). Add rows as needed. Is a new prefix needed? If yes, see below table.

Course prefix and number (include cross-listings)	**Units**	**Title**	**Pre-requisites**	**Modes of delivery (online, in-person, hybrid)**	**Status***	**Anticipated first term offered**	**Typically Offered (F, W, Sp, Su)**	**Dept signed party to proposal? (Yes/No)**	**Faculty members available to teach the courses**
MATH 509D	3	**Statistics for Data Science**	prerequisites for the degree program	Hybrid and on-line	D	Fall, 2023	F	Yes	Watkins
CSC 501	3	**Advanced Programming**	prerequisites for the degree program	in person	D	Fall, 2023	F	Yes	Staff
BIOS 576E	3	**Data Management and the R Programming Language**	MATH 509D or equivalent	in-person and online	D	Spring, 2024	TBD	Yes	Rubio
HWRS (GEOG, GEOS, SNRE, ENVS) 5XX	3	**Earth Informatics**		in-person and online	D	Fall 2023	F	Yes	Hoshin Gupta, Laura Condon, Elizabeth Tellman

*In development (D); submitted for approval (S); approved (A)

a. Subject description for new prefix (if requested). Include your requested/preferred prefix, if any:

VI. FACULTY INFORMATION- complete the table below. If UA Vitae link is not provided/available, add CVs to a Box folder and provide that link. UA Vitae profiles can be found in the UA directory/phonebook. Add rows as needed.

Faculty Member	Involvement	UA Vitae link or Box folder link
Joseph Watkins	Coordinate degree program Teach MATH 509D	https://profiles.arizona.edu/person/jwatkins
Helen Zhang	Coordinate Mathematics Department Representation Teach Math 574M	https://profiles.arizona.edu/person/haozhang
Kevin Lin	Teach MATH 568	https://profiles.arizona.edu/person/lin1
Walter Piegorsch	Teach STAT 675 and STAT 571A	https://profiles.arizona.edu/person/wpiegors

Ryan Gutenkunst	Coordinate Computational Biology Emphasis and Teach MCB 547	https://profiles.arizona.edu/search/gutenkunst
Guang Yao	Teach MCB 516A	https://profiles.arizona.edu/person/guangyao
Andrew Capaldi	Teach MCB 580	https://profiles.arizona.edu/person/capaldi
Hoshin Gupta	Coordinate Earth Science Representation Teach HWRS 642	https://profiles.arizona.edu/person/hoshin
Laura Condon	Teach HWRS 5xx	https://profiles.arizona.edu/person/lecondon
Elizabeth Tellman	Teach HWRS 5xx	https://profiles.arizona.edu/person/btellman
Avelino Arellano	Teach ATMO 545	https://profiles.arizona.edu/person/afarellano
Laura Condon	Teach HAS 5xx	https://profiles.arizona.edu/person/lecondon
Antonio Rubio	Teach BIOS 576E	https://profiles.arizona.edu/person/antoniorubio
Adriana Picoral	Teach CSC 544	https://profiles.arizona.edu/person/adrianaps
Jason Pacheco	Teach CSC 535	CV attached
Kwang-Sun Jun	Coordinate Computer Science Department Representation	CV attached
Chengcheng Hu	Teach BIOS 647, BIOS 648 & STAT 674	https://profiles.arizona.edu/person/hucc
Xiaoxiao Sun	Teach BIOS 648	

VII. GRADUATION PLAN – provide a sample degree plan, based on your program that includes all requirements to graduate with this major and takes into consideration course offerings and sequencing. *Undergraduate programs: please complete Addendum D: 4-Year Plan for Degree Search. Use generic title/placeholder for requirements with more than one course option (e.g., Upper Division Major Elective, Minor Course, Second Language, GE Tier 1, GE Tier 2).* Add rows as needed.

Semester 1		**Semester 2**		**Semester 3**		**Semester 4**	
Course prefix and number	**Units**	**Course prefix and number**	**Units**	**Course prefix and number**	**Units**	**Course prefix and number**	**Units**
MATH 509D	3	STAT 675	3	CSC 544	3	MATH 574M	3
CSC 501	3	BIOS 576E	3	MCB 580	3	DEPT 593 or DEPT 599 Capstone (or summer after)	1
MCB 516A	3	MCB 547	3	MATH/CSC 597 Professional Development	1		

				DEPT 593 or DEPT 599 Capstone (or summer before)	1		
Total	9	**Total**	9	**Total**	8	**Total**	4

The Capstone experience can be taken in either the Spring Semester of Year 2 or in the Summer of Year 2. A similar schedule holds for the Earth Science emphasis. This is the "horizontal" approach. Soon, we will submit complementary certificate applications connected to each emphasis. Completion of the coursework in any one column will result in a certificate. "Vertical" approaches can be achieved by taking the columns sequentially Foundations then Application then Emphasis

VIII. Curriculum Map and Assessment Map - Complete this table as a summary of your learning outcomes and assessment plan, using these examples as a model. If you need assistance completing this table and/or the Curriculum Map, please contact the Office of Instruction and Assessment. Attach your Curriculum Map here.

Program: Core Courses

Learning Outcome #1: Integration Integrate statistical thinking with scientific procedures and quantitative modeling and implementing these ideas using statistical software and other computational tools.
Concepts: Students will apply knowledge of probability theory and statistical methodologies to the analysis of data sets.
Competencies: Students will demonstrate this knowledge using statistical software and other computational tools to the analysis of data sets.
Assessment Methods: This outcome will be assessed in homework, exams, papers or other student projects
Measures: Instructor grading of homework, exams, papers, or other student projects based on rubrics with the learning outcomes as criteria.
Learning Outcome #2: Big Data Analysis Employ a variety of modern statistical machine learning tools, algorithms, and techniques and grasp basic concepts and skills for learning from massive and high-dimensional data to find hidden patterns and gain insights.
Concepts: Students will translate the foundational issues in machine learning and advanced algorithms to create scalable and effective learning tools.
Competencies: Students will demonstrate the ability to find latent structures lying inside massive and high-dimensional data
Assessment Methods: This outcome will be assessed in homework, exams, papers or other student projects.
Measures: Instructor grading of homework, exams, papers or other student projects based on the rubrics with the learning outcomes as criteria.
Learning Outcome #3: Data Usage. Using advanced programming skills, extract data from static and streaming sources, clean, munge, transform data for data management, storage, use and manipulation, setting effective queries to facilitate its use.
Concepts: Students will apply knowledge the theory of data management to control workflow of data from an output devise or database.
Competencies: Students will demonstrate their knowledge of data management by choosing appropriate software tools and writing effective programs to prepare data for analysis

Assessment Methods: This outcome will be assessed in homework, exams, papers or other student projects
Measures: Instructor grading of homework, exams, papers or other student projects based on rubrics with the learning outcomes as criteria.
Learning Outcome #4: Data Visualization Design a visualization so that it gives data meaning to a broader audience, highlighting special features like patterns, trends, and outliers and tying the visualization to other aspects of statistical analysis e.g., estimation, hypothesis testing, and machine learning.
Concepts: Students will effectively tie visualization to other aspects of statistical analysis e.g., estimation, classification, hypothesis testing, prediction, and learning.
Competencies: Students will have the skills to create effective visualizations and adapt the presentation to fulfill the needs of any specialize audience.
Assessment Methods: This outcome will be assessed in homework, exams, papers or other student projects.
Measures: Instructor grading of homework, exams, papers or other student projects based on rubrics with the learning outcomes as criteria.

Program: Computational Biology Emphasis

Learning Outcome #1: Evaluation of Analysis Approaches Students will be able to evaluate the suitability of various analysis approaches for different biological questions and data.
Concepts: Students will integrate knowledge of statistical analysis from their Core Courses with knowledge of biological questions and data.
Competencies: Students will analyze a variety of biological data, including RNA sequencing, population genomics, and electronic medical record
Assessment Methods: This outcome will be assessed in homework, exams, papers or other student projects.
Measures: Instructor grading of homework, exams, papers, or other student projects based on rubrics with the learning outcomes as criteria.
Learning Outcome #2: Evaluation of Literature Analyses Students will be able to evaluate the use computational analyses in the biological scientific literature.
Concepts: Students will integrate statistical and biological knowledge with critical reasoning and paper-reading skills.

Competencies: Students will critically analyze and discuss scientific papers that apply statistical analyses to biological data.
Assessment Methods: This outcome will be assessed in homework, exams, papers or thesis projects.
Measures: Instructor grading of homework, exams, papers or other student projects based on rubrics with the learning outcomes as criteria.

Program: Earth Science Emphasis

Learning Outcome #1: Earth Science Data Analysis Students will be able to analyze and digest large earth science data sets
Concepts: Students will apply knowledge and techniques for manipulating and analyzing earth science data.
Competencies: Students will demonstrate knowledge of the use of algorithms, statistics, and computational methods for understanding earth system processes using data.
Assessment Methods: This outcome will be assessed in homework, exams, papers or other student projects.
Measures: Instructor grading of homework, exams, papers or other student projects based on rubrics with the learning outcomes as criteria.
Learning Outcome #2: Data Visualization Students will be able to visualize and analyze large data sets using machine learning and other computational tools
Concepts: Students will effectively utilize machine learning and computational tools for visualization and analysis of earth system data.
Competencies: Students will demonstrate their knowledge of visualization and analysis of data.
Assessment Methods: This outcome will be assessed in homework, exams, papers or thesis projects.
Measures: Instructor grading of homework, exams, papers or other student projects based on rubrics with the learning outcomes as criteria.

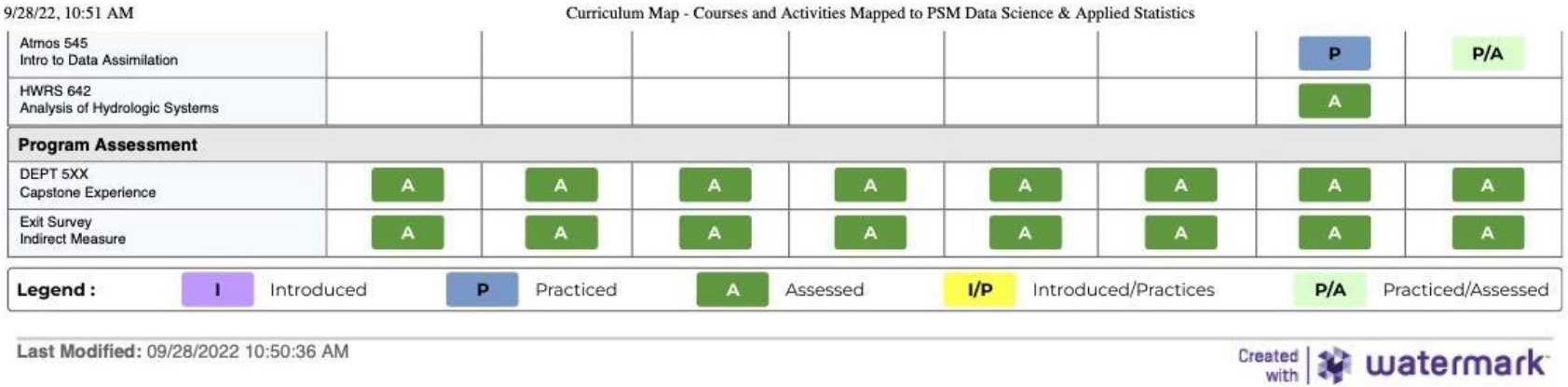
University of Arizona AMS » Sandboxes

Ingrid Novodvorsky Playspace

PSM Data Science & Applied Statistics

Courses and Activities Mapped to PSM Data Science & Applied Statistics

	Outcome							
	Core Outcome 1: Integration Integrate statistical thinking with scientific procedures and quantitative modeling and implement these ideas using statistical software and other computational tools.	Core Outcome 2: Big Data Analysis Employ a variety of modern statistical machine learning tools, algorithms, and techniques and grasp basic concepts and skills for learning from massive and high-dimensional data to find hidden patterns and gain insights.	Core Outcome 3: Data Usage Using advanced programming skills, extract data from static and streaming sources, clean, munge, transform data for data management, storage, use, and manipulation, setting effective queries to facilitate its use.	Core Outcome 4: Data Visualization Design a visualization so that it gives data meaning to a broader audience, highlighting special features like patterns, trends and outliers, adapting and refining the visualization to emphasize various aspects of the data, and tying the visualization to other aspects of statistical analysis e.g., estimation, hypothesis testing, and machine learning.	Comp. Bio. Outcome 1: Evaluation of Analysis Approaches Students will be able to evaluate the suitability of various analysis approaches for different biological questions and data.	Comp. Bio. Outcome 2: Evaluation of Literature Analyses Students will be able to evaluate the use of computational analyses in the scientific literature.	Earth Science Outcome 1: Earth Science Data Analysis Students will be able to analyze and digest large earth science data sets.	Earth Science Outcome 2: Data Visualization Students will be able to visualize and analyze large data sets using machine learning and other computational tools.
Theoretical Foundations								
MATH 509D Statistics for Data Science	I	I	I	I				
STAT 675 Statistical Computing	P							
MATH 574M Statistical Machine Learning	A	A						
Application Tools								
CSC 501 Advanced Programming		I						
BIOS 576E Data Management		P	P					
CSC 544 Advanced Data Visualization				P				
Computational Biology Emphasis								
MCB 516 Bioinformatics & Functional Genomic Analysis					P/A	I		
MCB 547 Big Data in Molecular Biology and Biomedicine					P/A	I/P		
MCB 580 Introduction to Systems Biology					P/A			
Earth Science Emphasis								
HWRS 5XX Earth Infomatics							I	I



9/28/22, 10:51 AM — Curriculum Map - Courses and Activities Mapped to PSM Data Science & Applied Statistics

Atmos 545 Intro to Data Assimilation							P	P/A
HWRS 642 Analysis of Hydrologic Systems							A	
Program Assessment								
DEPT 5XX Capstone Experience	A	A	A	A	A	A	A	A
Exit Survey Indirect Measure	A	A	A	A	A	A	A	A

Legend : I Introduced; P Practiced; A Assessed; I/P Introduced/Practices; P/A Practiced/Assessed

Last Modified: 09/28/2022 10:50:36 AM

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IX. PROGRAM ASSESSMENT PLAN- using the table below, provide a schedule for program evaluation 1) while students are in the program and 2) after completion of the major. Add rows as needed.

Assessment Measure	Source(s) of Evidence	Data Collection Point(s)
Job Placement Statistics	Student/Alumni Survey	At graduation and as part of alumni survey
Academic Program Review	Reviewers' responses	Every 7 years
Exit Interviews	Recent graduates	At graduation
Program Interest	Number of qualified applicants	Every year

X. ANTICIPATED STUDENT ENROLLMENT-complete the table below. What concrete evidence/data was used to arrive at the numbers?

5-YEAR PROJECTED ANNUAL ENROLLMENT					
	1st Year	2nd Year	3rd Year	4th Year	5th Year

5-YEAR PROJECTED ANNUAL ENROLLMENT					
Number of Students	30	60	75	75	75+

Data/evidence used to determine projected enrollment numbers:

With ¾ of the anticipated demand for one million new job openings in STEM related to the use of data and ⅓ of those jobs requiring an advanced degree, the need for a professional master's degree. Workforce needs are evolving, and most currently practicing scientists and engineers had little exposure to modern approaches to applied statistics and data science.

XI. ANTICIPATED DEGREES AWARDED- complete the table below, beginning with the first year in which degrees will be awarded. How did you arrive at these numbers? Take into consideration departmental retention rates. Use National Center for Education Statistics College Navigator to find program completion information of peer institutions offering the same or a similar program.

PROJECTED DEGREES AWARDED ANNUALLY					
	1st Year	2nd Year	3rd Year	4th Year	5th Year
Number of Degrees	0	20	40	60	75

Data/evidence used to determine number of anticipated degrees awarded annually:

We anticipate some attrition from working professionals. Indeed, some may choose to have an initial exposure to data science through one or more certificates rather than receiving a master's degree.

XII. PROGRAM DEVELOPMENT TIMELINE- describe plans and timelines for 1) marketing the major and 2) student recruitment activities.

For the Spring of 2023

- Complete applications for certificates associated with the core course sequences and the emphasis courses.
- Work with the College of Science to build a career counseling center.
- Establish schedule of courses
- Set up web space and recruitment approaches with training and specific strategies for minoritized individuals.
- Create initial executive committee and establish criteria for admission
- Draft graduate handbook.

- Set up professional development series
- Establish mentoring plan and recruit mentors
- Solidify industry contacts and internships opportunities
- Review applications and admit inaugural class.

IX. Program Fees and Differential Tuition (PFDT) Request – For implementation of fees, you must work with University Fees. The annual deadline is December 1. For any questions, please contact the University Fees Program Manager.

No programming fee is contemplated at this time.

Appendix B. Emphasis Print Information-if applicable, complete the table below to indicate if proposed emphases should be printed on transcript and diploma. Add rows as needed. Note: emphases are displayed on transcript and diplomas as " _____ Emphasis".

Emphasis	Print on transcript	Print on diploma
Computational Biology	Yes	Yes
Earth Science	Yes	Yes

Appendix C. ABOR Form

Request to Establish New Academic Program in Arizona

Please complete all fields. Boxes may be expanded to accommodate longer responses. Clarifying field descriptions can be found below. Should you have any questions or concerns, please email Helen Baxendale, Director of Academic Affairs and Policy at helen.baxendale@azregents.edu

University:

Name of Proposed Academic Program: Data Science and Applied Statistics
Academic Department: Department of Mathematics and Computer Science
Geographic Site: Tucson-Main
Instructional Modality: in person
Total Credit Hours: 30
Proposed Inception Term: Fall 2023
Brief Program Description: This degree is designed to target working professionals with strong technical backgrounds who seek to add advanced statistical and data science theory and tools to their arsenal. The interdisciplinary nature of the degree makes it accessible and attractive to prospective students in virtually any industry. The new program will bridge academics and industry closely, from the curriculum design to experiential training to job placement. The core curriculum for the proposed degree has two 3-course sequences, balancing between the foundational theory of data science and industry application tools. The degree requires three additional courses – from an area of emphasis - earth science or computational biology (to start) – or taking general data science and applied statistics courses. and completing a capstone experience. The program will offer students intensive hands-on experience of tackling real-world problems and challenges, by participating in scientific labs throughout data collection, engineering, analysis, and interpretation.
Learning Outcomes and Assessment Plan:

Define the core concepts and competencies that the program will convey and stipulate how these key learning outcomes will be measured and assessed.

Core courses: Integrate statistical thinking with modern scientific procedures, notably machine learning tools, algorithms, and techniques, and quantitative modeling and implementing these ideas using statistical software and other computational tools. Design a visualization so that it gives data meaning to a broader audience and tying the visualization to other aspects of statistical investigations. Using advanced programming skills, extract data from static and streaming sources, to maximize the ease of use of the data.

Emphases: Apply the practices acquired in the core courses and knowledge gained in the emphasis areas to make insightful and sophisticated analysis and predictions in the area of emphasis

Projected Enrollment for the First Three Years:

Three year projected enrollment			
	1st Year	2nd Year	3rd Year
Number of Students	30	60	75

Evidence of Market Demand:

The growth of statistician and data scientist positions over the next eight years (projected at 31% for 2018-2028 by the Bureau of Labor Statistics) illustrates the potential impact on all industries. This is consistent with Burning Glass market analysis both regionally and nationally. Data scientists with applied statistics skills are needed in nearly all fields.

Similar Programs Offered at Arizona Public Universities:

List existing programs at Arizona public universities that deliver similar concepts and competencies to the proposed new program.

The Interdisciplinary Program in Statistics and Data Science offers a Master's Degree. This degree program differs from the current program in its more traditional focus on statistics. The School of Information offers a Master's Degree in Data Science. Its entry requirements are more modest and its core courses - ethics, visualization, and data mining - differ markedly from this degree program.

The Data Science, Analytics and Engineering doctoral program at Arizona State University is a collaboration between the School of Computing and Augmented Intelligence (SCAI) and the School of Mathematical and Statistical Sciences (SoMSS). It does not have a Professional Master's strand and it does not have an emphasis component.

The Data Science Graduate Certificate at Northern Arizona University is hosted by the School of Informatics, Computing, and Cyber Systems (SICCS). It is not a full degree program.

FOR CURRICULAR AFFAIRS USE ONLY

Objection(s) Raised by Another Arizona Public University? YES NO

Has another Arizona public university lodged a written objection to the proposed program with the proposing university and the Board of Regents within seven days of receiving notice of the proposed program?

If Yes, Response to Objections:

Please provide details of how the proposing university has addressed the objection. If the objection remains unresolved, please explain why it is in the best interests of the university system and the state that the Board override it.

New Resources Required? (i.e., faculty and administrative positions; infrastructure, etc.):

The additional course demand will necessitate the hiring of new faculty especially in Mathematics and Computer Science

Plan to Request Program Fee/Differentiated Tuition? YES **NO**

Estimated Amount:

Program Fee Justification:

Note: The fee setting process requires additional steps and forms that need to be completed. Please work with your University Fees office to complete a fee request.

Specialized Accreditation? YES **NO**

Accreditor:

The name of the agency or entity from which accreditation will be sought

THE UNIVERSITY OF ARIZONA

New Academic Program
PEER COMPARISON

Select three peers (if possible/applicable) for completing the comparison chart from ABOR-approved institutions, AAU members, and/or other relevant institutions recognized in the field. The comparison programs are not required to have the same degree type and/or title as the proposed UA program. Information for the proposed UA program must be consistent throughout the proposal documents. Minors and Certificates may opt to include only 2 peer comparisons.

Program name, degree, and institution	Proposed UA Program	Peer 1	Peer 2	Peer 3
Current number of students enrolled	[redacted]	University of Michigan	University of North Carolina	University of Maryland
Program Description		The Master's program in Data Science is focused on statistical and computational skills. This degree will help students to attain the necessary skills and knowledge to: identify relevant datasets, apply the appropriate statistical and computational tools to the data set to answer questions posed by individuals, organizations or governmental agencies, design and evaluate analytical	The **MS program in Data Science and Analytics** offers students a rigorous program of training in the areas of statistics, optimization, stochastic modeling, and probability. The program is designed to be flexible enough to accommodate students with different technical backgrounds and subject matter interests, and it allows students to pursue a variety of	**Master of Professional Studies (MPS) in Data Science and Analytics** **MPS** provides an education in the theory and practice of data science including mathematical and statistical foundations, computational approaches, and communication considerations. In addition, the program covers data science-relevant probability and statistics,

		procedures appropriate to the data, and implement these efficiently over large heterogeneous data sets in a multi-computer environment.	coursework in theory, methodology, computation, and application	algorithms, big data systems, machine learning, data mining, and analysis of networks. Students who successfully complete the **MPS in Data Science and Analytics** are able to design, conduct, interpret and communicate data analysis tasks and studies using methods and tools of statistics, machine learning, computer science, and communications.
Target Careers				
Emphases? (Yes/No) List, if applicable	Yes - 9 units Computational Biology, Earth Science	Yes - 6 units Data Management and Manipulation, Data Science Techniques	No	No
Minimum # of units required	30	33	30	30
Level of Math required (if applicable)	two semesters of calculus, one semester of linear algebra, one semester of programming	two semesters of calculus, one semester of linear algebra, one semester of programming	three semesters of calculus, one semester of linear algebra, intermediate statistics, calculus-based probability	one semester basic statistics, two semesters of calculus, one semester of linear algebra, one semester of programming

Level of Second Language required (if applicable)	NA	NA	NA	NA
Pre-Major? (Yes/No) If yes, provide requirements.	No	No	No	No
Special requirements to declare/gain admission? (i.e. pre-requisites, GPA, application, etc.)	Normal prerequisites for graduate school plus coursework above	Normal prerequisites for graduate school plus coursework above	Normal prerequisites for graduate school plus coursework above	Normal prerequisites for graduate school plus coursework above
Internship, practicum, or applied/experiential requirements? If yes, describe.	Yes - a 1+1 unit capstone experience that could be a university led research project or an industry based internship	Yes - 3 unit capstone experience from one of several participating units - consulting, case studies, directed studies	Yes- 3 unit Master's Essay	3 unit capstone is an elective

Additional questions:

1. How does the proposed program align with peer programs? Briefly summarize the similarities between the proposed program and peers, which could include curriculum, overall themes, faculty expertise, intended audience, etc.

   The chart below is from John C Stewart, GA Davis, and Diane Igoche. Developing a master's degree program in data science. **Issues in Information Systems**, 22(3), 2021. The highlighted courses are those found in the proposed Data Science and Applied Statistics program. Thus, our six core courses are consistent with those of other top-ranked schools. Only one school on this chart, the University of Iowa, is an Arizona Board of Regent peer institution for the University of Arizona. Its program is very different from most programs and so was not used in the comparison chart.

Table 1: Data Science Courses at Top-Ranked Schools

	Intro Data Science	Machine Learning /Data Mining	Data Cleaning/ Wrangling	NLP	Visualize /Explore	Data-base	Optimization/ Simulation	Deep Learning	Programming	Massive Datasets	Stats	Forecast
Purdue	1	3		3		1	2	1	1	1		
Rochester	2	4		3		1	2	1	1	1	3	1
NYU	3	2		2		1	2	1	2	1	2	2
CMU	4	3				4				3		
Columbia	2	2			1			2	1		3	
Colorado State	3		1		1		1				2	
Iowa		2			1	1					6	
NC State	1	4				3			4			
Georgia Tech	4	3		1	2	1	4	1		4	6	1
DePaul	2	3			2	1		1	2	1	2	1
USC LA		2			2	4	4			1	2	
MIT		1						1	1		1	
Boston Univ	3	3			1	1			3			
Northwestern	1	3		1	1	1	2	1	1		2	1
Brown	1				1			1			2	
Chicago		3			1		1		1	1	4	1
VA	1	3			1				2		1	
Seattle	1	2		1	1	1			2	1	1	
Kennesaw		3							1	2	4	1
OK		3			1		2		2	2	2	
Totals	29	49	1	11	16	20	20	10	24	18	43	8

2. How does the proposed program stand out or differ from peer programs? Briefly summarize the differences between the proposed program and peers, which could include curriculum, overall themes, faculty expertise, intended audience, etc.

   Our peer universities have expectations for entry on par with the program we propose. However, their curriculum has substantially different priorities. Here, we compare a few such programs. Most of these programs have a core curriculum and a capstone experience.

- University of California, Los Angeles – Based in the college of Engineering. The core curriculum is largely in the computational sciences (data structures, machine learning, networks)
- University of Illinois, Urbana-Champaign - Partners with Coursera, the Department of Statistics, and the School of Information. The UIUC program also allows shorter non degree programs core is data visualization, machine learning, data mining and cloud computing.
- University of Maryland, College Park - Based in the Office of Extended Studies. The UMD core curriculum has statistics, an introduction to data science, machine learning, data representation, and a course on big data.
- University of Michigan, Ann Arbor - Hosted by the Department of Statistics in the College of Literature, Science and the Arts. Their core curriculum consists of discrete math, data structures, theoretical courses in probability and statistics. The Michigan degree program has an emphasis both in data management and in applied techniques.
- University of Minnesota, Twin Cities - Based in the College of Science and Engineering. The curriculum has three focus areas, statistics, algorithms, and infrastructure and large-scale computing.
- University of North Carolina - Hosted by the Department of Statistics and Operations Research in the College of Arts and Sciences. Their core curriculum is a choice of 5 courses from data science, machine learning, applied statistics, optimization, stochastic modeling, theoretical statistics, and probability.
- University of Washington has an interdisciplinary program. Its required courses include visualization, data security, data management, software design, algorithms, probability and statistics, applied stat, and machine learning.

3. How do these differences make this program more applicable to the target student population and/or a better fit for the University of Arizona?

   The structure of the Arizona program allows a number of streams that will be beneficial to potential students and in later years to alumni of the Professional Master's Degree program. Most institutions focus on rapid progress through the degree.
   - For those who can devote full time to the degree, the Master's Degree can be completed in approximately 18 months.
   - For those who have workforce or personal demands that lead to a preference for part time work can complete the degree program at a more leisurely pace.
   - For those who need a smaller amount of education or who have an advanced background, we are developing graduate certificate options. These certificates can be bundled – with both vertical and horizontal stacking - into a master's degree and certificate students can progress into the master's program.

- In contrast to our peers, the Master's Degree program can devote a third of its course curriculum to a data intensive domain science. The initial sciences are computational biology and earth science. We anticipate more to come as need arises.
- For former professional master's degree students, the program is designed to accommodate continuing education as workforce needs evolve and emphases are added.
- Extensive professional development opportunities in collaboration with the Graduate Center and the College of Science.

Comparison of relevant University of Arizona Programs

Two University of Arizona Programs have the phrase "Data Science" in their title. The Master's Degree in Data Science in the School of Information has a significantly lower entrance level for mathematics. The core curriculum for the two programs has one topic - Data Visualization - that is common. Master's Degree in Statistics and Data Science is housed in a Graduate Interdisciplinary Program. The degree program is more traditional in its curriculum and is designed to allow students to pursue a doctoral degree in Statistics and Data Science. The current proposed degree program is designed to terminate at the master's level specifically to prepare students for immediate professional workforce entry.

Program name, degree, and institution	Proposed UA Program	Statistics and Data Science Graduate Interdisciplinary Program	Data Science School of Information
Current number of students enrolled	[redacted]	~30	~100
Program Description		The Graduate Interdisciplinary Program in Statistics & Data Science supports and encourages the central role of statistical thinking in the biological, physical, engineering, financial, and social sciences. We provide necessary training for students who wish to develop core expertise in statistical theory and methodology, and also for students who intend to apply their statistical knowledge	The MS in Data Science will provide students the confidence and training they need in data collection, exploration, manipulation and storage, analysis, and presentation in order to navigate data-rich workplace environments. The degree will signal to employers that students have dedicated the time and energy necessary to develop the skills and confidence for tackling messy data problems using

		in practical, transdisciplinary research; targeted subject-matter specialties include biometry, bioinformatics, econometrics, educational statistics, operations research & applied probability, psychometrics, spatial/spatio-temporal analysis, statistical genetics, and stochastic modeling.	modern programming languages. The degree will service a diverse student population, training both 1) technically-minded students the nuances associated with successfully developing and communicating data methods and results, and 2) The online Master of Information and Data Science (MIDS) is designed to educate data science leaders.,
Target Careers			
Emphases? (Yes/No) List, if applicable	Yes - 9 units Computational Biology, Earth Science	No	Yes
Minimum # of units required	30	30	30
Level of Math required (if applicable)	two semesters of calculus, one semester of linear algebra, one semester of programming	three semesters of calculus, one semester of linear algebra, one semester of programming	college algebra, college algebra-based statistics, programming,
Level of Second Language required (if applicable)	NA	NA	NA
Pre-Major? (Yes/No) If yes, provide requirements.	No	No	No
Special requirements to declare/gain admission? (i.e. pre-requisites, GPA, application, etc.)	Normal prerequisites for graduate school plus coursework above	Normal prerequisites for graduate school plus coursework above	Normal prerequisites for graduate school plus coursework above
Internship, practicum, or applied/experiential requirements? If yes, describe.	Yes - a 2 unit capstone experience that could be a university led research	Yes – Either a sufficiently high score on the qualifying exam or a Master's thesis	Yes- 3 unit capstone course

	project or an industry based internship		

The Data Science, Analytics and Engineering doctoral program at Arizona State University is a collaboration between the School of Computing and Augmented Intelligence (SCAI) and the School of Mathematical and Statistical Sciences (SoMSS). It does not have a Professional Master's strand and it does not have an emphasis component.

The Data Science Graduate Certificate at Northern Arizona University is hosted by the School of Informatics, Computing, and Cyber Systems (SICCS). It is not a full degree program.

THE UNIVERSITY OF ARIZONA

BUDGET PROJECTION FORM

Name of Proposed Program or Unit:

Budget Contact Person:	Projected		
	1st Year 2023 - 2024	**2nd Year** 2024- 2025	**3rd Year** 2025- 2026
METRICS			
Net increase in annual college enrollment UG	-	-	-
Net increase in college SCH UG			
Net increase in annual college enrollment Grad	30	60	75
Net increase in college SCH Grad	270	540	675
Number of enrollments being charged a Program Fee			
New Sponsored Activity (MTDC)			
Number of Faculty FTE			
FUNDING SOURCES			
Continuing Sources			
UG AIB Revenue			
Grad AIB Revenue *	382,754	765,509	956,886
Program Fee Revenue (net of revenue sharing)			
F and A AIB Revenues			
Reallocation from existing College funds (attach description)			
Other Items (attach description)			
Total Continuing	**$ 382,754**	**$ 765,509**	**$ 956,886**
One-time Sources			
College fund balances			
Institutional Strategic Investment			
Gift Funding			
Other Items (attach description)			
Total One-time	**$ -**	**$ -**	**$ -**
TOTAL SOURCES	**$ 382,754**	**$ 765,509**	**$ 956,886**
EXPENDITURE ITEMS			
Continuing Expenditures			
Faculty	80,000	160,000	240,000
Other Personnel	55,000	55,000	55,000
Employee Related Expense	43,619	69,467	95,315
Graduate Assistantships	50,000	75,000	75,000
Other Graduate Aid (ERE)	6,350	9,525	9,525
Operations (materials, supplies, phones, etc.)	5,000	5,000	5,000
Additional Space Cost			
Other Items (attach description)			
Total Continuing	**$ 239,969**	**$ 373,992**	**$ 479,840**
One-time Expenditures			
Construction or Renovation			
Start-up Equipment			
Replace Equipment			
Library Resources			
Other Items (attach description)			
Total One-time	**$ -**	**$ -**	**$ -**
TOTAL EXPENDITURES	**$ 239,969**	**$ 373,992**	**$ 479,840**
Net Projected Fiscal Effect	**$ 142,786**	**$ 391,518**	**$ 477,047**

* The Grad AIB revenues are the projected net to COS with assumption of 90% SCH in COS owned courses

THE UNIVERSITY OF ARIZONA
Mel and Enid Zuckerman College of Public Health

Department of Epidemiology and Biostatistics

1295 N. Martin Ave.
P.O. Box 245211
Tucson, AZ 85724-5211
Tel: (520) 626-0023
Fax: (520) 626-2767
www.publichealth.arizona.edu

To: Joseph Watkins
From: Edward J. Bedrick, Biostatistics Program Director
Department of Epidemiology and Biostatistics
Date: September 22, 2022
Re: Support for Professional Master's Degree in Data Science and Applied Statistics

With this note, the Department of Epidemiology and Biostatistics affirms its support for the Professional Master's Degree in Data Science and Applied Statistics. In particular, we will accommodate professional master's program student in

BIOS 576E	**Data Management and the R Programming Language**
BIOS 684	**Mixed Effects Models and Longitudinal Data**
BIOS 647	**Categorical Data Analysis**
BIOS 648	**Analysis of High Dimensional Data**

We understand that BIOS 576E is a new course and commit to its development.

Sincerely,

Edward J Bedrick

Edward J. Bedrick
Professor of Biostatistics
Mel and Enid Zuckerman College of Public Health
University of Arizona
Tucson, AZ

Department of Computer Science

THE UNIVERSITY OF ARIZONA
TUCSON ARIZONA

PO Box 210077
Tucson, Arizona 85721-0077

To: Joseph Watkins

From: Christian Colberg, Head
Department of Computer Science

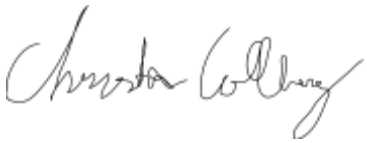
Date: October 5, 2022

Re: Support for Professional Master's Degree in Data Science and Applied Statistics

With this note, the Department of Computer Science affirms its support for the Professional Master's Degree in Data Science and Applied Statistics. In particular, we will accommodate professional master's program students in the following Computer Science courses:

CSC 501 **Advanced Programming**
CSC 544 **Advanced Data Visualization**
CSC 535 **Probabilistic Graphical Models**

We acknowledge that CSC 501 is a new course and commit to its development.



Christian Colberg, Head
Department of Computer Science

THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE
Molecular & Cellular Biology

Ryan Gutenkunst
Associate Professor
Associate Department Head
rgutenk@arizona.edu
http://gutengroup.mcb.arizona.edu

Life Sciences South 325
1007 E. Lowell Street
Tucson, AZ 85721
Tel: (520) 626-0569

Joseph Watkins
Department of Mathematics
University of Arizona

September 28, 2022

Re: Support for Professional Master's Degree in Data Science and Applied Statistics

Hello Dr. Watkins:

I write on behalf of Dr. Joyce Schroeder, MCB Department Head, who is currently unavailable. With this note, the Department of Molecular and Cellular Biology affirms its support for the Professional Master's Degree in Data Science and Applied Statistics. In particular, we will accommodate professional master's program students in

MCB 516A **Bioinformatics and Functional Genomic Analysis**
MCB 547 **Big Data in Molecular Biology and Biomedicine**
MCB 580 **Introduction to Systems Biology**

Sincerely,

Ryan Gutenkunst
Associate Professor and Associate Department Head
Department of Molecular and Cellular Biology
University of Arizona

THE UNIVERSITY OF ARIZONA
COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
School of Information

Harvill Building, 4th Floor
1103 E 2nd St.
Tucson, AZ 85721
520.621.3565
si.arizona.edu

April 16, 2021

Dr. Joseph Watkins
Professor Mathematics and Chair of Statistics GIDP

Dear Dr. Watkins,

This is a letter of support for you as you develop your proposal for a graduate degree in Statistics and Data Science. The support we have now for new graduate programs is similar to the letter we provided in 2018 to support your change of program name from Graduate Interdisciplinary Program in Statistics to the Graduate Interdisciplinary Program in Statistics and Data Science. We look forward to working with you and wish you a positive experience with your new plan. Data Science in many forms is a critical skill needed in many sciences, business and professions and, in our view, more than one academic unit can and should participate in the training of data scientists.

We see no conflict with School of Information and recognize your programs will be grounded in statistics most primarily and in a way that differs subtly but importantly from our proposed more general M.S. Data Science degree.

We look forward to our ongoing collaboration.

Sincerely,

Catherine Brooks
Director, School of Information

Statistics and Data Science
Graduate Interdisciplinary Program (GIDP)
Building #89, Math 522
Tucson, Arizona 85721

THE UNIVERSITY OF
ARIZONA
TUCSON ARIZONA

Phone: (520) 621-6868
Fax: (520) 621-8322
E-mail: hzhang@math.arizona.edu

October 5, 2022

Dear Professor Watkins,

Re: Support for Professional Master's Degree in Data Science and Applied Statistics

I am writing to affirm that the Statistics and Data Science GIDP will provide strong and any necessary teaching and training support for the Professional Master's Degree in Data Science and Applied Statistics. In particular, the GIDP will accommodate professional master's program student in

STAT 675 Statistics Computing Advanced Programming

We are excited about this new program, which is proposed in time to enhance the data science training on campus.

Best regards,

Hao Zhang

Hao Helen Zhang
Chair, Statistics and Data Science
GIDP

THE UNIVERSITY OF ARIZONA

NEW ACADEMIC PROGRAM – MAJOR
Supplemental Info Form

NOTE: This is being added to the proposal post Graduate Programs Executive Review Committee (GPERC) viewed and commented on the document. Below are their questions and the responses given by the proposing department/college.

1. *The projected enrollment numbers listed on the 2nd page are not consistent with the numbers listed later in the request. That should be an easy fix.*
   In the additional information, item X and in Appendix C both have

Three year projected enrollment			
	1st Year	2nd Year	3rd Year
Number of Students	30	60	75

   The number under the Faculty and Resources tab on the UA Add Acad Plan (Academic) online tool takes those numbers and adds 55, the projected size of the graduate population in the Department of Mathematics.

2. *I would like to have a better understanding of how the proposed MS in Data Science and Applied Statistics is different from the current GIDP's Statistics and Data Science program (offered at both MS and Ph.D levels). Both are interdisciplinary. Please provide a comparison table or some way to identify differences and similarities.*
   The GIDP Program is designed to that the Master's degree can serve as a pathway to a doctoral degree in Statistics and Data Science. Required coursework is focused on foundational theory and methodology with full semester courses on the theory of probability, theory of statistics, design of experiments and regression. The degree requires either a thesis or sufficiently high score on a written qualifying exam.

   The Professional Master's degree is terminal and does not prepare graduates for a doctoral priogram in Statistics and Data Science. While the Professional Master's degree has substantial mathematical and statistical prerequisites for admission, it is notably lower that the GIDP Master's degree. The target for this degree is working professionals in science and engineering. Consequently, coursework is focused more on the practical aspects of data science and applied statistics, e.g., advanced

programming, statistical computation, data visualization, and data management. It also encourages students to take courses in a domain science area – computational biology and earth science – that are not a part of the GIDP degree program.

The names of the programs mentioned above are so similar. Will prospective students be able to differentiate the two?
We will provide clear guidelines for each of the data science programs, the two mentioned above plus the degree in the iSchool and the Business Analytics Degree in the Eller School. We plan to put the office of the program coordinator for the Professional Master's degree next door to the GIDP coordinator so that we have consistent student advise.

3. *Courses with prefixes ATMO and HWRS need support letters from their respective departments*.
The ATMO and HWRS prefixes belong to the Department of Hydrology and Atmospheric Sciences. A letter is on file from this unit.