Executive Summary

Request for Authorization to Implement BS and BA in Statistics and Data Science

<table>
<thead>
<tr>
<th>Requested by</th>
<th>Department of Mathematics, College of Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIP Code</td>
<td>27.0503 Mathematics and Statistics</td>
</tr>
</tbody>
</table>

**Purpose of Program**

By merging modern data science approaches with a solid mathematical background and practical training, the statistics and data science major provides a curriculum that allows students to make significant contributions at the forefront of knowledge across the vast array of activities in government, education, and industry that rely on statistical thinking.

The focus of the undergraduate degree in statistics and data science program is on the mathematical and computational aspects of statistics and data science. Students will graduate knowing linear algebra and multivariate calculus, having experience in programming in two computer languages, grounding in the theoretical foundations of probability and statistics, and extending this knowledge to core areas like linear models and time series and application areas like finance and sports. The statistics and data science major will be available as a B.A. and B.S. degree-providing greatest flexibility for students wishing to pursue an additional major.

The major coursework will be identical for the two degrees; only the second language requirements and natural or laboratory science, and application course requirements will differ. The B.S. degree will be the natural choice for students planning to work in biostatistics, health/medical fields, engineering, and other fields where laboratory science experience is beneficial or required. Anticipate a significant group of statistics and data science majors to apply statistics by analyzing government data, social science research, banking, helping companies with market research for new products, or analyzing risk for insurance companies. The B.A. degree will provide greater emphasis on communication skills and less on science.

Job opportunities for graduates are extensive and cover any aspect of business, government, and industry that involves the issue of collection, model derivation and analysis, interpretation, explanation, and presentation of data. Possible careers include actuary, banking consultant, data analyst, healthcare analyst, market researcher, sports analyst, statistical engineer, underwriter, among others. Statistical training can be considered as a complement to many career choices that use intensive data analysis, presentation, and inference.

The BA and BS in Statistics and Data Science require 34 major units including a minimum of 21 upper division major units. BA and BS majors are required to complete 4 units of supporting coursework from Introduction to Computer Programming I (CSC 110) or Computational Thinking and Doing (ISTA 130). BA and BS majors are required to complete a minor. BS majors are required to complete one supporting lab science sequence from PHYS, CHEM, MCB/ECOL,
PSIO, or GEOS and 6 units of application coursework chosen from a list of options.

The key learning outcomes are:

- Be able to define mathematical and statistical terms precisely
- Recognize when arguments, especially formal statistical procedures and data visualization, are valid, and identify logical flaws
- Produce effective analyses from data using a variety of computational, mathematical, and statistical approaches
- Critically evaluate and extend statistical models drawn from current scientific literature
- Apply methods and concepts from coursework to analyze data based scientific problems
- Effectively communicate results

<table>
<thead>
<tr>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
<th>5th year</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 (13 BA)</td>
<td>80 (20 BA)</td>
<td>150 (38 BA)</td>
<td>240 (60 BA)</td>
<td>320 (80 BA)</td>
</tr>
<tr>
<td>20 NEW</td>
<td>50 NEW</td>
<td>100 NEW</td>
<td>160 NEW</td>
<td>213 New</td>
</tr>
</tbody>
</table>

Source(s) of Funding

BA and BS proposal, combined:

Anticipate needing 3 additional faculty and 2 long-term lecturers. Approximate 3 course releases to design and implement new courses.

Additional support needed:
- Academic Advisor
- Graduate Teaching Assistant needs are estimated to rise from 4 to 6 (at 0.5 FTE) over three year period

Funding sources:
- College tuition
- Reallocation of existing college funds
- College fund operational budget

Approvals:

<table>
<thead>
<tr>
<th>Approval</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABOR</td>
<td>2/8/18</td>
</tr>
<tr>
<td>Undergraduate Council</td>
<td>2/13/18</td>
</tr>
<tr>
<td>Graduate Council</td>
<td>N/A</td>
</tr>
<tr>
<td>CAAC</td>
<td>11/28/17</td>
</tr>
<tr>
<td>Provost’s Council</td>
<td></td>
</tr>
<tr>
<td>Faculty Senate</td>
<td></td>
</tr>
</tbody>
</table>
NEW ACADEMIC PROGRAM – REQUEST FORM

I. PROGRAM NAME, DESCRIPTION AND CIP CODE

A. PROPOSER’S NAME, TITLE, EMAIL AND PHONE NUMBER

Joseph Watkins, Chair, Statistics-GIDP
Professor, Applied Mathematics - GIDP
Professor, BIOS Institute
Professor, Mathematics
Professor, Genetics - GIDP

jwatkins@math.arizona.edu
520-621-5245

B. PROPOSED PROGRAM NAME AND DEGREE(S) TO BE OFFERED – Bachelor of Science Undergraduate Major in Statistics and Data Science; Undergraduate Minor in Statistics and Data Science (minor curriculum included in Appendix I).

C. CIP CODE – 27.0503 Mathematics and Statistics

D. DEPARTMENT/UNIT AND COLLEGE – Department of Mathematics, College of Science

Campus and Location Offering – indicate by highlighting in yellow the campus(es) and location(s) where this program will be offered.

UA South Campus
Sierra Vista
Douglas
Mesa
Pima CC East
Pinal County
Santa Cruz
UA Science and Tech Park

UA Main
Tucson
UA Downtown

Phoenix Biomedical Campus

UA Online
Online

Distance Campus
Chandler
Paradise Valley
Yuma
II. PURPOSE AND NATURE OF PROGRAM—describe the purpose and nature of your proposed program. Compare and contrast the purpose and nature of your proposed program to similar programs at two peer institutions. Complete the appropriate comparison chart to assist you. List of UA peer institutions can be found here. Comparison of additional relevant programs may be requested.

The centrality of statistical thinking to the advance of human knowledge is now accepted both by the public and by researchers from a broad range of endeavors. This viewpoint has become common wisdom in a world of big data. Indeed, following the 2013 International Year of Statistics, several Statistics professional societies convened a Future of Statistical Sciences Workshop. The report from this meeting makes the following observations:

Statistics can be most succinctly described as the science of uncertainty. While the words “statistics” and “data” are often used interchangeably by the public, statistics actually goes far beyond the mere accumulation of data. The role of a statistician is:

• To design the acquisition of data in a way that minimizes bias and confounding factors and maximizes information content
• To verify the quality of the data after it is collected
• To analyze data in a way that produces insight or information to support decision-making

These processes always take into explicit account the stochastic uncertainties present in any real-world measuring process, as well as the systematic uncertainties that may be introduced by the experimental design. This recognition is an inherent characteristic of statistics, and this is why we describe it as the “science of uncertainty,” rather than the “science of data.”

Data are ubiquitous in 21st-century society: They pervade our science, our government, and our commerce. For this reason, statisticians can point to many ways in which their work has made a difference to the rest of the world.

The focus of the Undergraduate Degree in Statistics and Data Science program will be on the mathematical and computational aspects of statistics and data science. The job opportunities for our graduates are extensive and cover any aspect of business, government, and industry that involves the issues of collection, model derivation and analysis, interpretation, explanation, and presentation of data. Our students will graduate knowing linear algebra and multivariate calculus, having experience in programming in two computer languages, grounding in the theoretical foundations of probability and statistics, and extending this knowledge to core areas like linear models and time series and application areas like finance and sports. The requirements for the degree will introduce our students to areas of application as well as an academic minor in any subject with opportunities that span many application disciplines as well as disciplines that are data driven, if they so choose. Because the use of data is broad and can complement many if not most disciplines, we will not restrict the choice of minors. (However, we will advise students to select a minor that best complements their life and career goals.)

To highlight the unique nature of the Undergraduate Degree Program in Statistics and Data Science, we contrast this program by describing the goals of other data driven undergraduate degree programs at the University of
Arizona. Consequently, we will make the direct comparisons with 1) the Probability and Statistics option for the Mathematics major, 2) the Computer Science Major, 3) the School of Information, 4) Management and Information Systems, and 5) Systems and Industrial Engineering. (Descriptions are adopted from Departmental webpages.)

1. **The Probability and Statistics option for the Mathematics major.** Students graduating under this option will have more experience in the abstract aspects of probability and statistics. They will see more advanced mathematics concepts in their real analysis (MATH 425A) and linear algebra (MATH 413) courses. Statistics students will have a much more data science-based curriculum, even in those courses with substantial theoretical underpinnings. Rather than exposure to mathematical proofs and ordinary differential equations, Statistics students will take a vector calculus/linear algebra-based foundations course (MATH 363) and statistical computing (NEW COURSE). Rather than the two 400-level mathematics courses above, Statistics students will be introduced to modern issues in data science, e.g. linear models and data mining along with elective courses that will complement their career goals.

2. **Computer Science.** Along with mathematics and statistics, computer science sits as a triad at the foundations of data science. The mathematical background of Computer Science BS students - calculus I and II, linear algebra, and discrete mathematics - are fundamental in working with the quintessentially discrete aspects of a computer. Upper division coursework is focused on topics, e.g., algorithms, databases, systems, software and programming, that have little overlap with upper division statistics courses. Because modern data science depends so much on the interaction of its foundational disciplines, we anticipate many students will study both statistics and computer science.

3. **School of Information.** ISchools have fundamental interest in the relationships between people, information, technology, and science. This is reflected in their five 100-level core courses and two 200-level eSociety courses for the BS in Information Science and Technology dealing with big data, programming, digital ethics, statistics, data analytics and the fundamental ideas in information science, all based on a mathematics background at the level of college algebra. Their mathematically intensive track has two linear algebra based courses - Bayesian methods and machine learning. These topics are a part of the Statistics and Data Science degree albeit with a more sophisticated mathematical and statistical background.

4. **Management Information Systems.** The undergraduate major in Management Information Systems is designed to prepare its graduates to have a solid grasp of business practices combined with an understanding of the role information systems play within organizations, determining how to use technology to solve business problems and provide effective strategies. The mathematics and statistics required for the degree is a business-oriented calculus course (MATH116) and a college algebra based statistics course.

5. **Systems and Industrial Engineering.** With a focus on engineering, Systems and Industrial Engineering undergraduates are exposed to a substantial amount of probability and statistics, beginning with an introductory probability and statistics course with a single variable calculus prerequisite (SIE 305). These students go on to take probability models (SIE 321), simulation modeling (SIE 431) and engineering experimental design (SIE 330R). Statistics students will have higher mathematics background, extensive experience with statistical software, and, depending on their choice of an academic minor, sophistication in one of the many disciplines that depend on modern statistics and data science.
We have letters of support for the degree in Statistics and Data Science from the administrative heads of Computer Science, the School of Information, Management Information Systems, and Systems and Industrial Engineering.

As with our undergraduate Mathematics major, the Statistics major will be available with either a B.A. or B.S. degree, providing the greatest possible flexibility for students who wish to pursue an additional major. A comparison chart for the two degrees is included in Appendix IV. The major course work will be identical for the two degrees; only the second language requirements and natural or laboratory science, and application course requirements will differ. The B.S. degree will be the natural choice for students planning to work in biostatistics, health/medical fields, engineering, and other fields where laboratory science experience is beneficial or required. We anticipate that many of these students will select minors or additional majors in areas of science or engineering, though they are not required to do so. We also anticipate a significant group of Statistics majors who will apply statistics very differently: analyzing government data (from census records to unemployment data), social science research (e.g. Bureau of Labor Statistics), banking, helping companies with market research for new products, or analyzing risk for insurance companies. A B.A. degree will provide less emphasis on science for these students. For those choosing a second major in a field like Economics, selection of the B.A. degree for both will make it easier to graduate in 4 years.

Students may choose to double major or double degree in Statistics and Mathematics, but would be expected to choose five 400-level courses for the Math major emphasis that are distinct from courses used in the Statistics major. Those courses in addition to the two distinct courses in the Math major core (MATH 323 and 355) would provide for 18 unique units - comparable to some other common double majors on campus.

The comparison to degree programs at peer institutions is in the next section.

III. **PROGRAM REQUIREMENTS** – list the program requirements, including minimum number of credit hours, required core, electives, and any special requirements, including subspecializations, subplans, theses, internships, etc. on the appropriate comparison chart. Use your completed comparison chart to explain how your requirements are: 1. similar and 2. unique from the compared public institutions.

<table>
<thead>
<tr>
<th>Program Name, subplan name (if applicable), degree, and institution</th>
<th>Statistics and Data Science BS Arizona (proposed)</th>
<th>Statistics BS University of Wisconsin</th>
<th>Statistical Science BS University of Minnesota</th>
<th>Mathematics (Probability &amp; Statistics subplan) BS Arizona</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently enrolled students</td>
<td>--</td>
<td>124</td>
<td>126</td>
<td>62</td>
</tr>
<tr>
<td>Description of major</td>
<td>By merging modern data science approaches with a solid mathematical background and practical training, the Undergraduate Degree in Statistics provides a curriculum that allows students to make significant contributions at the forefront of knowledge across the vast array of activities in government, education, and industry that rely on statistical thinking.</td>
<td>From: <a href="http://www.stat.wisc.edu/undergrad/undergraduate-major-statistics">http://www.stat.wisc.edu/undergrad/undergraduate-major-statistics</a></td>
<td>From: <a href="https://onestop2.umn.edu/pcas/viewCatalogProgram.do?programID=16280&amp;strm=1179&amp;campus=UMNTC">https://onestop2.umn.edu/pcas/viewCatalogProgram.do?programID=16280&amp;strm=1179&amp;campus=UMNTC</a></td>
<td>Students with skills in probability and statistics are in high demand in fields such as business analytics, biostatistics, big data, genomics, and actuarial science. Students who complete the probability and statistics emphasis leave UA very well prepared for a career as a statistician or actuary; however, the focus of this emphasis is to provide students with the mathematical depth and theoretical focus needed for graduate school in statistics. Students who may wish to earn a PhD in statistics should consider this emphasis rather than the Statistics major.</td>
</tr>
</tbody>
</table>
intensive data analysis, presentation, and inference.
A Master’s degree may be required for some careers.

<table>
<thead>
<tr>
<th></th>
<th>● Quantitative Analyst</th>
<th>● Research Analyst</th>
<th>● Researcher</th>
<th>● Social Scientist</th>
<th>● Statistician</th>
<th>● Risk Analyst</th>
<th>● Survey Researcher</th>
<th>● Software Engineer</th>
<th>● Teacher</th>
<th>● Statistical Consultant</th>
<th>● Statistician</th>
<th>● Survey Researcher</th>
<th>● Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>In most cases, positions aimed at “professional statisticians” require a Masters (or PhD) degree.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some fields require a graduate degree.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total units required to complete degree</th>
<th>120</th>
<th>120</th>
<th>120</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper -division units required to complete degree</td>
<td>42</td>
<td>60 intermediate/advanced</td>
<td>48</td>
<td>42</td>
</tr>
<tr>
<td>Foundation courses</td>
<td>English Composition</td>
<td>6 units</td>
<td>3-6 units</td>
<td>4 units</td>
</tr>
<tr>
<td></td>
<td>Foreign Language</td>
<td>BS: 2nd semester proficiency</td>
<td>BS: 3rd semester course</td>
<td>none</td>
</tr>
<tr>
<td>Math</td>
<td>3 units (part of major)</td>
<td>6 units (part of major)</td>
<td>Not specified (covered by major)</td>
<td>3 units (part of major)</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td>---------------------------------</td>
<td>-------------------------</td>
</tr>
</tbody>
</table>
| **General Education Requirements** | ● 2- Tier I 150 (INDV)  
 ● 2-Tier I 160 (TRAD)  
 ● 0-Tier I 170 (NATS)  
 ● 3 units-Tier II Arts  
 ● 1-Tier II Humanities  
 ● 1-Tier II Individuals and Societies  
 ● 0-Tier II Natural Sciences | ● 12 units- Humanities  
 (6 of the 12 must be in literature)  
 ● 12 units- Social Sciences  
 ● 12 units- Natural Sciences (must include 6 credits in biological science; and must include 6 credits in physical science) | Complete 3 units each:  
 ● Arts/Humanities  
 ● Historical Perspective  
 ● Literature  
 ● Social Science  
 Choose 4 (3 units each):  
 ● Civic Life & Ethics  
 ● Diversity & Social Justice  
 ● Environment  
 ● Global perspective  
 ● Tech & Society  
 Complete 4 units each (must include lab or field experience):  
 ● Biological Science  
 ● Physical Science | ● 2- Tier I 150 (INDV)  
 ● 2-Tier I 160 (TRAD)  
 ● 0-Tier I 170 (NATS)  
 ● 3 units-Tier II Arts  
 ● 1-Tier II Humanities  
 ● 1-Tier II Individuals and Societies  
 ● 0-Tier II Natural Sciences |
| **Pre-major? (yes/no). If yes, indicate coursework.** | no | no | no | no |
| **List any special requirements to declare or gain admission to this major (completion of specific coursework, minimum GPA, interview, application, etc.)** | none | Prospective majors are strongly recommended to have completed the following classes before declaring the major:  
 ● MATH 221 Calculus and Analytic Geometry 1  
 ● MATH 222 Calculus and Analytic Geometry 2  
 ● MATH 234 Calculus--Functions of Several Variables  
 ● STAT 302 Accelerated Introduction to Statistical Methods | Students must complete 1 course before admission to the program: Preparatory Course Complete STAT 3011 or STAT 3021 with a grade of C- or better in order to declare the Statistical Science B.S. program. | none |
<table>
<thead>
<tr>
<th>MAJOR REQUIREMENTS</th>
<th>Minimum # of units required in major</th>
<th>Minimum # of upper-division units required in the major</th>
<th>Minimum # of residency units to be completed in the major</th>
<th>Required supporting coursework (courses that do not count towards major units and major GPA, but are required for the major). Courses listed must include subject code, units, and title.</th>
</tr>
</thead>
</table>
|                     | 34                                   | 21-24                                                    | 18                                                       | One course from:  
  - CSC 110 Introduction to Computer Programming I (4 units)  
  - ISTA 130 Computational Thinking and Doing (4 units)  
  One lab science sequence selected from:  
  - PHYS 141 Introductory Mechanics (4 units) & either PHYS 142 Introductory Optics and Thermodynamics (3 units) or PHYS 241 Introductory Electricity |
|                     | (Does not include: 4 units programming, 8 units lab sci, 0-6 unique units application coursework) | 7-8 courses (students may transfer MATH 215 in to cover MATH 313) | 15 units in STAT subject, taken on campus | none |
|                     | 50                                   | 34                                                       | 50% of all upper-division coursework (3000 level or above); this is approx 15-23 units, depending on course selection | none |
|                     | (Includes: 3 units programming, 6 units MATH concentration OR 12 units Applied concentration) | (Includes 6 units MATH concentration OR 12 units Applied concentration) | | One course from:  
  - CSC 110 Introduction to Computer Programming I (4 units)  
  - ISTA 130 Computational Thinking and Doing (4 units)  
  - Equivalent (3-4 units)  
  One lab science sequence selected from:  
  - PHYS 141 Introductory Mechanics (4 units) & either PHYS 142 Introductory Optics and Thermodynamics (3 units) or PHYS 241 Introductory Electricity |
|                     | 63                                   | 30                                                       | 18                                                       | One course from:  
  - CSC 110 Introduction to Computer Programming I (4 units)  
  - ISTA 130 Computational Thinking and Doing (4 units)  
  - Equivalent (3-4 units)  
  One lab science sequence selected from:  
  - PHYS 141 Introductory Mechanics (4 units) & either PHYS 142 Introductory Optics and Thermodynamics (3 units) or PHYS 241 Introductory Electricity |
<p>|                     | (Does not include: 4 units programming, 8 units lab sci, 0-6 unique units application coursework) | 8 courses, including senior project (Units include 3 units for Senior Project; many courses are 4 units - this adds another 7 units to the total) | | |
|                     | 21-24                                | 7-8 courses (students may transfer MATH 215 in to cover MATH 313) | 18                                                       | |
|                     |                                       |                                                          |                                                          | |</p>
<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>and Magnetism (4 units)</td>
<td></td>
</tr>
<tr>
<td>- PHYS 161H Honors Introductory Mechanics (4 units) &amp; either PHYS 162H Honors Introductory Optics and Thermodynamics (4 units) or PHYS 261H Honors Introductory Electricity and Magnetism (4 units)</td>
<td></td>
</tr>
<tr>
<td>- CHEM 151 General Chemistry I (4 units) &amp; CHEM 152 General Chemistry II (4 units)</td>
<td></td>
</tr>
<tr>
<td>- CHEM 105A Honors Fundamentals of Chemistry (3 units) &amp; CHEM 106A Honors Fundamental Techniques of Chemistry (1 unit) &amp; CHEM 105B Honors Fundamentals of Chemistry (3 units) &amp; CHEM 106B Honors Fundamental Techniques of Chemistry (1 unit) these will be renumbered as 161/162 &amp; 163/164)</td>
<td></td>
</tr>
<tr>
<td>- MCB 181R Introductory Biology I (3 units) &amp; MCB 181L Introductory Biology Laboratory I (1 unit) &amp; ECOL 182R Introductory Biology II (3 - 5 units) &amp; ECOL 182L Introductory Biology II Lab (1 unit)</td>
<td></td>
</tr>
<tr>
<td>- PSIO 201 Human Anatomy and Physiology I (4 units) &amp; PSIO 202 Human Anatomy and Physiology II (4 units)</td>
<td></td>
</tr>
<tr>
<td>- Introductory Electricity and Magnetism (4 units)</td>
<td></td>
</tr>
<tr>
<td>- PHYS 161H Honors Introductory Mechanics (4 units) &amp; either PHYS 162H Honors Introductory Optics and Thermodynamics (4 units) or PHYS 261H Honors Introductory Electricity and Magnetism (4 units)</td>
<td></td>
</tr>
<tr>
<td>- CHEM 151 General Chemistry I (4 units) &amp; CHEM 152 General Chemistry II (4 units)</td>
<td></td>
</tr>
<tr>
<td>- CHEM 161 Honors Fundamentals of Chemistry (3 units) &amp; CHEM 163 Honors Fundamental Techniques of Chemistry (1 unit) &amp; CHEM 164 Honors Fundamental Techniques of Chemistry (1 unit)</td>
<td></td>
</tr>
<tr>
<td>- MCB 181R Introductory Biology I (3 units) &amp; MCB 181L Introductory Biology Laboratory I (1 unit) &amp; ECOL 182R Introductory Biology II (3 - 5 units) &amp; ECOL 182L Introductory Biology II Lab (1 unit)</td>
<td></td>
</tr>
<tr>
<td>- PSIO 201 Human Anatomy and Physiology I (4 units) &amp; PSIO 202 Human Anatomy and Physiology II (4 units)</td>
<td></td>
</tr>
<tr>
<td>- GEOS 251 Physical Geology (4 units) &amp;</td>
<td></td>
</tr>
</tbody>
</table>
- GEOS 251 Physical Geology (4 units) & either GEOS 302 Principles of Stratigraphy and Sedimentation (4 units) or 304 Structural Geology (4 units)

Six units of Application Course Work - see Appendix II for course list. Students completing a sequence in Honors Chemistry or in Physics will satisfy both the lab science and application courses.

either GEOS 302 Principles of Stratigraphy and Sedimentation (4 units) or 304 Structural Geology (4 units)

Six units of Application Course Work - see Appendix II for course list, which overlaps with the Math BS Application Course list. Students completing a sequence in Honors Chemistry or in Physics will satisfy both the lab science and application courses.

### Major requirements (list all required major coursework including major core, major electives, subplan core, subplan electives; courses count towards major units and major GPA). Courses listed must include course prefix, number, units, and title. Mark new coursework (New).

<table>
<thead>
<tr>
<th>Core:</th>
<th>Math:</th>
<th>Calculus:</th>
<th>Core:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- MATH 125 or 122A/B Calc 1 (3-5 units)</td>
<td>- MATH 221 Calculus and Analytic Geometry I (5 units)</td>
<td>- MATH 1271 Calculus I (4 units) or MATH 1371 CSE Calculus I (4 units) or MATH 1571H Honors Calculus I (4 units)</td>
<td>- MATH 125 or 122A/B Calc 1 (3-5 units)</td>
</tr>
<tr>
<td>- MATH 129 Calc 2 (3 units)</td>
<td>- MATH 222 Calculus and Analytic Geometry II (4 units)</td>
<td>- MATH 1272 Calculus II (4 units) or MATH 1372 CSE Calculus II (4 units) or MATH 1572H Honors Calculus II (4 units)</td>
<td>- MATH 129 Calc 2 (3 units)</td>
</tr>
<tr>
<td>- MATH 223 Vector Calc (4 units)</td>
<td>- MATH 234 Calculus--Functions of Several Variables (4 units)</td>
<td>- MATH 1272 Calculus II (4 units) or MATH 1372 CSE Calculus II (4 units) or MATH 1572H Honors Calculus II (4 units)</td>
<td>- MATH 223 Vector Calc (4 units)</td>
</tr>
<tr>
<td>- MATH 313 Intro to Linear Algebra (3 units) or 310 Applied Linear Algebra (3 units)</td>
<td>- MATH 340 Elementary Matrix and Linear Algebra (3 units) or MATH 341 Linear Algebra (3 units)</td>
<td>- MATH 2263 Multivariable Calculus (4 units) or MATH 2374 CSE Multivariable Calculus and Vector Analysis (4 units) or MATH 2573H Honors Calculus III (4 units)</td>
<td>- MATH 313 Intro to Linear Algebra (3 units)</td>
</tr>
<tr>
<td>- MATH 363 Intro to Stats (3 units)</td>
<td></td>
<td>- MATH 425A Real Analysis (3 units)</td>
<td></td>
</tr>
<tr>
<td>(new) MATH/STAT 375 Statistical Computing (3 units)</td>
<td>Statistics:</td>
<td>- MATH 464 Theory of Probability (3 units)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- STAT 302 Accelerated Introduction to Statistical Methods (3 units)</td>
<td>- MATH 466 Theory of Statistics (3 units)</td>
<td></td>
</tr>
<tr>
<td>(new) MATH 464 Theory of Probability (3 units)</td>
<td>- STAT 327 Learning a Statistical Language (1 unit)</td>
<td>Elective 1 (choose one):</td>
<td>Elective 2 (choose one):</td>
</tr>
<tr>
<td>(new) MATH 466 Theory of Statistics (3 units)</td>
<td>- STAT 333 Applied Regression Analysis (3 units)</td>
<td>- MATH 413 Linear Algebra (3 units)</td>
<td>- MATH 468 Stochastic Processes (3 units)</td>
</tr>
<tr>
<td>(new) MATH/STAT 467 Introduction to Applied Linear Models (3 units)</td>
<td>Linear Algebra: Take one of the following sequences (4-8 units). Students planning to minor in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(new) MATH/STAT 465 Intro to Data Science (3 units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Elective (choose one):
- MATH 367 Stat Methods in Sports Analytics (3 units)
- MATH 462 Financial Mathematics (3 units)
- MATH 468 Stochastic Processes (3 units)
- SIE 440 Survey of Optimization Methods (3 units)

Eventually, we would like to add more elective choices; some ideas:
- (new) MATH 4XX Actuarial Science (3 units)
- (new) MATH 4XX Survey Sampling (3 units)
- (new) MATH 4XX Time Series (3 units)

Statistics Electives (choose 9 units or more):
- STAT 349 Introduction to Time Series (3 units)
- STAT 351 Introductory Nonparametric Statistics (3 units)
- STAT 411 An Introduction to Sample Survey Theory and Methods (3 units)
- STAT 421 Applied Categorical Data Analysis (3 units)
- STAT 456 Applied Multivariate Analysis (3 units)
- STAT 461 Financial Statistics (3 units)
- STAT/M E 424 Statistical Experimental Design (3 units)
- Probability (choose one):
  - STAT/MATH 309 Introduction to Probability and Mathematical Statistics I (3 units)
  - or STAT 311 Introduction to Theory and Methods of Mathematical Statistics I (3 units)
  - or MATH/STAT 431 Introduction to the Theory of Probability (3 units)

Inference:
- STAT/MATH 310 Introduction to Probability and Mathematical Statistics II (3 units)

Mathematics should take Option 2.
- Option 1 CSCI 2033 Elementary Computational Linear Algebra (4 units)
- or Option 2 MATH 2243 Linear Algebra and Differential Equations (4 units)
- or Option 3 MATH 2373 CSE Linear Algebra and Differential Equations (4 units)
- or MATH 4242 Applied Linear Algebra (4 units)

Major Courses:
- STAT 3032 Regression and Correlated Data (4 units)
- STAT 3701 Introduction to Statistical Computing (3 units)
- STAT 4051 Applied Statistics I (4 units)
- STAT 4052 Applied Statistics II (4 units)
- STAT 5101 Theory of Statistics I (4 units)
- or MATH 5651 Basic Theory of Probability and Statistics (4 units)
- STAT 5102 Theory of Statistics II (4 units)

STAT Electives (choose 4 units or more):
- MATH 413 Linear Algebra (3 units)
- MATH 422 Advanced Applied Analysis (3 units)
- MATH 425B Real Analysis Several Variables (3 units)
- MATH 454 Ordinary Differential Equations & Stability Theory (3 units)
- MATH 456 Applied Partial Differential Equations (3 units)
- MATH 462 Financial Mathematics (3 units)
- MATH 468 Stochastic Processes (3 units)
- MATH 485 Mathematical Modeling (3 units)
- or 400-level MATH course approved by your math faculty advisor (3 units)
<table>
<thead>
<tr>
<th>Senior Concentration, available)</th>
<th>Select WRIT, CSCI, Methods list</th>
<th>STAT/COMP SCI 471 Introduction to Computational Statistics (3 units)</th>
<th>STAT 3501 Internship in Statistical Practice (1 unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STAT 479 Special Topics in Statistics (3 units)</td>
<td>STAT 5031 Statistical Methods for Quality Improvement (4 units)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STAT 575 Statistical Methods for Spatial Data (3 units)</td>
<td>STAT 5201 Sampling Methodology in Finite Populations (3 units)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STAT/B M I 641 Statistical Methods for Clinical Trials (3 units)</td>
<td>STAT 5401 Applied Multivariate Methods (3 units)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STAT 679 Special Topics in Statistics (3 units)</td>
<td>STAT 5421 Analysis of Categorical Data (3 units)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STAT 699 Directed Study (3 units)</td>
<td>STAT 5511 Time Series Analysis (3 units)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computer Programming (choose one):</td>
<td>STAT 5601 Nonparametric Methods (3 units)</td>
</tr>
<tr>
<td></td>
<td>● COMP SCI 200 Programming I (3 units)</td>
<td>● COMP SCI 200 Programming II (3 units)</td>
<td>STAT 5931 Topics in Statistics (3 units)</td>
</tr>
<tr>
<td></td>
<td>● COMP SCI 300 Programming II (3 units)</td>
<td>● COMP SCI 301 Introduction to Data Programming (3 units)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● COMP SCI 301 Introduction to Data Programming (3 units)</td>
<td>● COMP SCI 400 Programming III (3 units)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● COMP SCI 400 Programming III (3 units)</td>
<td>● COMP SCI 412 Introduction to Numerical Methods (3 units)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● COMP SCI/I SY E/MATH/STAT 525 Linear Programming Methods (3 units)</td>
<td>● COMP SCI/I SY E/MATH/STAT 525 Linear Programming Methods (3 units)</td>
<td></td>
</tr>
<tr>
<td>Other Electives (choose 10 units or less - 14 elective units needed between STAT and Other):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select either Math Concentration or Applied Concentration, 6-12 units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior Project, 1 course:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Math Concentration (select 6 units or more):
• MATH 319 Techniques in Ordinary Differential Equations (3 units)
• MATH 421 The Theory of Single Variable Calculus (3 units)
• MATH 443 Applied Linear Algebra (3 units)
• MATH/COMP SCI/STAT 475 Introduction to Combinatorics (3 units)
• MATH/COMP SCI 514 Numerical Analysis (3 units)
• MATH 521 Analysis I (3 units)
• MATH 522 Analysis II (3 units)
• MATH 541 Modern Algebra (3 units)
• MATH 605 Stochastic Methods for Biology (3 units)
• MATH 629 Introduction to Measure and Integration (3 units)
• MATH/I SY E/OTM/STAT 632 Introduction to Stochastic Processes (3 units)

Applied Concentration (select 12 units or more):

Select at least 12 units of coursework at the 300 level and higher in an area of application of statistical methods as

• STAT 4893W Consultation and Communication for Statisticians (3 units) (Fulfills upper-division writing intensive requirement)
<table>
<thead>
<tr>
<th>Internship, Practicum, Applied Course Requirements. (Yes/no. If yes, please describe.)</th>
<th>Yes; the BS requires at least 6 units of coursework that applies calculus or other concepts from the major to another field.</th>
<th>Yes, if Applied concentration is selected, Applied Courses are required. See Additional Requirements below.</th>
<th>No</th>
<th>Yes; the BS requires at least 6 units of coursework that applies calculus or other concepts from the major to another field.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Thesis or Senior Project Required (Yes/No)</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
| Additional Requirements (Please Describe.) | Electives are required to meet graduation unit requirements. Students may opt to add a second major to fill the extra units, which may fulfill the minor requirement. | Students select either a Mathematics concentration (minimum 6 units; course work similar to UA Probability & Statistics emphasis) or an Applied concentration (minimum 12 units; course work comparable to UA BS Application Course requirement or having a minor or 2nd major) | Students must complete four writing intensive courses; two must be upper-division, and one of the upper-division courses must be within the major. All incoming CLA freshmen must complete the First Year Experience course sequence (1 unit each semester for 2 semesters). Required courses for the major, minor or certificate in which a student receives a D grade (with or without plus or
In addition to the 2 peer institutions (University of Wisconsin and University of Minnesota), we have also included a comparison to our own Math major with the Probability and Statistics subplan, which we expect will shrink some, but will not disappear. We plan to keep this as a major in mathematics; while the new Statistics major is intended to prepare students to enter the workforce or some Master’s programs after graduation, the Math major with Probability and Statistics subplan covers the minimum requirements for entry to a Statistics PhD program. This option presently shares a core with six other subplans for the math major, and can have significant overlap with other options (applied math, economics and business, computer science). Thus, the goals of this version of the Math major, as described by our learning outcomes, align with other Math major options and are substantially different for the goals for the Statistics major. On the other hand, approximately half of our current and recent graduates do not take the senior level probability and statistic courses (especially Comprehensive and Mathematics Education). Not many in the Computer Science option choose prob/stat. Applied Math student often prefer one of the two other year long sequences - numerical analysis and differential equations.

We will address similarities and differences to our Math program below, after comparisons to our peer institutions.

1. Similarities to peers:

The undergraduate degree in Statistics at Arizona will be hosted by the Department of Mathematics. Arizona’s peers have their degrees in Statistics departments. This will lend a distinct flavor to the program that will take advantage of modern interactions among the mathematical sciences and their contributions to modern issues in statistics. Moreover, the University of Arizona has a long tradition of interdisciplinary approaches to education. This is already reflected in several of the present options in Mathematics - Business and Economics, Life Sciences, and Computer Science. The Undergraduate Program in Statistics provides exciting new opportunities for students to complement their core interest in mathematics and statistics with a wide selection in the choice of an academic minor. More specifically,

- All offer choice of BA or BS degree with Stats major. Wisconsin also offers a choice of BA or BS degree for a Mathematics major with concentration in Statistics, yet they also have a theoretical option for the statistics major that has a similar intention to the Probability/Statistics option for the Math major at Arizona.
- Wisconsin’s major requirements are the same regardless of choice of degree (BA or BS).
• All require Calc I & II and an intro programming course, usually offered by the Computer Science department. Minnesota requires a Statistical Computing course, as will Arizona.
• Many of the senior-level statistical courses are similar in content and quantity, including a year-long sequence in Mathematical Statistics, course work in Linear Models, and Electives.

2. Differences from peers:
• The unit totals appear to be quite different among the institutions above. However, we are not counting the introductory programming course, laboratory science, or application courses in the major itself. This highlights that the major GPA should reflect how the student is doing in the major coursework.
  Furthermore, as you will notice in the table above, many of Minnesota’s courses are 4 units, while most from Arizona and Wisconsin are 3 units. For this reason, comparing course counts is more helpful than comparing unit counts when looking at Minnesota’s program:

<table>
<thead>
<tr>
<th></th>
<th>Arizona BS in Statistics and Data Science</th>
<th>Minnesota BS in Statistical Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculus sequence</td>
<td>3 courses</td>
<td>3 courses</td>
</tr>
<tr>
<td>Linear algebra</td>
<td>1 course</td>
<td>1-2 courses</td>
</tr>
<tr>
<td>Major courses</td>
<td>6 courses</td>
<td>6 courses</td>
</tr>
<tr>
<td>STAT electives</td>
<td>1 course</td>
<td>1 course or more</td>
</tr>
<tr>
<td>Senior Project</td>
<td>n/a though STAT 465 is a project-based course</td>
<td>1 course</td>
</tr>
<tr>
<td>Programming</td>
<td>(1 course, not counted in major)</td>
<td>1 course</td>
</tr>
<tr>
<td>Other electives (MATH, CSCI, PUBH)</td>
<td>n/a - courses in these areas may be taken for a minor or second major</td>
<td>3 courses or less (together with STAT electives, total of 14 units)</td>
</tr>
</tbody>
</table>

• Arizona will not require that students complete any major coursework prior to declaring the major and will accept students at any point in the program. Minnesota does require at least one prerequisite course completed, and Wisconsin strongly recommends completion of several courses.
• Cécile Ané, Professor, Departments of Statistics and of Botany at the University of Wisconsin - Madison told us that a lot of their students declare the statistics major as an additional major late in the program. Offering a minor (which WI does not have) will give us an additional pipeline to reach students earlier. Students who start out in a minor and enjoy their minor courses can often be recruited into the major, as we have found with Mathematics.
• Minnesota’s BA and BS requirements are different. Our BS and BA major requirements will be identical.
• Minnesota’s BS requires some differential equations and a second course in linear algebra; Wisconsin does not, and we will not. The additional mathematics required for the BS at Minnesota enables students to take more courses in Mathematics as electives, to prepare for admission to graduate
Overall, Arizona students who need the abstract mathematics necessary for some graduate programs should select the Math major with Probability & Statistics emphasis (either BA or BS degree).

- **Non-MATH/STAT courses in the major:**
  - With one exception (SIE 440), we anticipate counting only MATH/STAT courses in the major. We moved our Computer Science course requirement out of the Math major starting in 2017, so it is now a supporting requirement. The Statistics major will mirror this, while Wisconsin and Minnesota include their introductory programming course and other non-MATH/STAT courses as part of the major.
  - Arizona will also require a minor for both the BA and BS. Students are Arizona have the option to choose course work similar to Wisconsin’s Applied concentration or Minnesota’s “Other Electives”. However, such choices differ in several ways:
    - Fewer units required (12 for Wisconsin, 6-11 maximum for Minnesota); a minor at the U of A requires at least 18 units.
    - Courses may be selected from multiple disciplines for these requirements at Wisconsin & Minnesota; a minor at the U of A usually focuses course work in a single discipline. For a Thematic minor, there must at least be a coherent theme to the course selection.
    - At UA, the minor courses do not count in our major GPA.
- Neither of the other schools offer a course to introduce Data Science - an important growing field that students are asking about.
- Wisconsin and Minnesota have more electives available than we anticipate initially, but this is to be expected for established programs.

1. **Similarities to UA Math major with Probability & Statistics subplan:**
   - Students may choose either BA or BS degree; major requirements are the same for both degrees. General Education requirements will be the same as for the corresponding degree with the Math major.
   - Supporting requirements are essentially the same: a programming course is required (CSC 110 or ISTA 130) for everyone; for the BS, students will complete a lab science sequence and application courses, the same as for our existing Math major, though the list of possible application courses is expanded, to allow for applications of statistics.
   - We expect that the application course requirement for the Statistics BS will prompt many students to select minors (or second majors) in these areas, which also happens with our Math BS. We feel that students benefit greatly from an interdisciplinary approach, and will continue to encourage students to pursue more than one major if they have interest in doing so. Of the 597 math majors in our current database, 294 have at least one additional major.

2. **Differences from UA Math major with Probability & Statistics subplan:**
   - They do not share the same core.
   - Students encounter statistics sooner (MATH 363) in the Statistics major. In the Math major, the more theoretical 400-level coursework in probability & statistics is required, and would be taken at least 1-2 semesters later than 363 could be.
   - Overall, the Statistics major is less theoretical, and more practical: the Math major requires completion of
o MATH 323 (Formal Mathematical Reasoning and Writing (3 units)
Description: Elementary real analysis as an introduction to abstract mathematics and
the use of mathematical language. Elementary logic and quantifiers; manipulations
with sets, relations and functions, including images and pre-images; properties of the
real numbers; supreme and infimum; other topics selected from cardinality, the
topology of the real line, sequence and limits of sequences and functions; the emphasis
throughout is on proving theorems.)
o and MATH 425A (Real Analysis of One Variable (3 units) Description: Continuity and
differentiation of functions of one variable. Riemann integration, sequences and series of
functions and uniform convergence.)
o also, MATH 413 (Linear Algebra (3 units) Description: Vector spaces, linear
transformations and matrices, determinants, eigenvalues and diagonalization, bilinear
forms, orthogonal and unitary transformations, Jordan canonical form.) will usually
be taken by students in the Probability and Statistics emphasis.

None of these theoretical, proof-intensive courses (323, 425A, 413) will be a part
of the Statistics major. Instead, students gain experience working with real data in
courses like MATH 363 and 367 (descriptions below, section A).

- The Math major with probability & statistics subplan will be the appropriate choice
for students who intend to pursue a PhD in areas like Statistics or Economics; the
Statistics major may be more useful as a terminal degree or as a background for a
variety of Master’s programs (e.g., computer science, systems engineering, law,
educational psychology, and sociology) and as a part of a double major or double
degree for those wishing to go on to advanced training in a variety of fields.

A. CURRENT COURSES AND EXISTING PROGRAMS -- list current courses and existing university programs
which will give strengths to the proposed program. If the courses listed belong to a
department that is not a signed party to this implementation request, obtain the department head’s
permission to include the courses in the proposed program and information regarding accessibility
to the course(s) for students in the proposed program. Include the course prefix, course number, number of units, title, and course description.

CSC 110 Introduction to Computer Programming I (4 units): Description: An introduction
to programming with an emphasis on solving problems drawn from a variety of domains.
Topics include basic control and data structures, problem solving strategies, and software
development tools and techniques. (The CS Department has said that it is fine to include
the course in the new major; they have capacity to increase enrollment in the
class and there should not be an issue including the students in this degree plan.)

ISTA 130 Computational Thinking and Doing (4 units): Description: An introduction
to computational techniques and using a modern programming language to solve current problems
drawn from science, technology, and the arts. Topics include control structures, elementary
data structures, and effective program design and implementation techniques. Weekly laboratory. (SISTA has said that they can accommodate our students.)

MATH 122A: Functions for Calculus (1 unit): Description: Elementary functions, their
properties, and uses in modeling. A graphing calculator is required for this course.
We recommend the TI-83 or TI-84 models. Calculators that perform symbolic manipulations,
such as the TI-89, Nspire CAS, or HP50g, cannot be used.
MATH 122B: First-Semester Calculus (4 units): Description: An introduction to first-semester calculus for engineering, science and math students, from rates of change to integration, with an emphasis on understanding, problem solving, and modeling. Topics covered include key concepts of derivative and definite integral, techniques of differentiation, and applications, using algebraic and transcendental functions. A graphing calculator is required for this course. We recommend the TI-83 or TI-84 models. Calculators that perform symbolic manipulations, such as the TI-89, Nspire CAS, or HP50g, cannot be used.

MATH 125: Calculus I (3 units) Description: An accelerated version of MATH 122B. Introduction to calculus with an emphasis on understanding and problem solving. Concepts are presented graphically and numerically as well as algebraically. Elementary functions, their properties and uses in modeling; the key concepts of derivative and definite integral; techniques of differentiation, using the derivative to understand the behavior of functions; applications to optimization problems in physics, biology and economics. A graphing calculator is required for this course. We recommend the TI-83 or TI-84 models. Calculators that perform symbolic manipulations, such as the TI-89, Nspire CAS, or HP50g, cannot be used.

MATH 129: Calculus II (3 units): Description: Continuation of MATH 122B or MATH 125. Techniques of symbolic and numerical integration, applications of the definite integral to geometry, physics, economics, and probability; differential equations from a numerical, graphical, and algebraic point of view; modeling using differential equations, approximations by Taylor series. A graphing calculator is required for this course. We recommend the TI-83 or TI-84 models. Calculators that perform symbolic manipulations, such as the TI-89, Nspire CAS, or HP50g, cannot be used.

MATH 223: Vector Calculus (4 units): Description: Vectors, differential and integral calculus of several variables.

MATH 310: Applied Linear Algebra (3 units) Description: Applications and methods of linear algebra emphasizing matrices and systems of equations, determinants, eigenvectors and eigenvalues. This course is an excellent introduction to linear algebra for students who are interested in a math minor. It does not satisfy requirements for the math major. Students who might be interested in the math major should consider taking Math 313. (Since MATH 310 requires completion of MATH 254, we anticipate that most Statistics majors will take 313. However, it is an option for them.)

MATH 313: Introduction to Linear Algebra (3 units): Description: An algorithmic approach to solving systems of linear equations transitions into the study of vectors, vector spaces and dimension. Matrices are used to represent linear transformations and this leads to eigenvectors and eigenvalues. The precise use of definitions plays an important role. Examinations are proctored. This course is required in the math major and prepares students to take Math 323. It is a prerequisite to the majority of the higher level courses in mathematics.

MATH 363: Introduction to Statistical Methods (3 units): Description: In Introduction to Statistical Methods, we shall be your previous knowledge of calculus and differential equations to consider the issues of collection, model derivation and analysis, interpretation, explanation, and presentation of data. Statistics is applicable to a wide variety of academic disciplines, from the natural and social sciences to engineering and the humanities.
MATH 367: Statistical Methods in Sports Analytics (3 units): This course will introduce students to the concept of sports analytics, with an emphasis on statistical inference and modeling while having the students focus on a semester long sports analytics project in partnership with a University of Arizona sports team. Engagement: Activity: Discovery, Competency: Interdisciplinarity. This course was developed with the Statistics undergraduate degree in mind.

MATH 462: Financial Math (3 units): The theory of interest, and its application to a wide variety of financial instruments. Emphasis on a direct-calculation approach to reaching numerical results. Topics include interest, annuities, loans, bonds, rates of return, stock valuation, buying and selling, and financial derivatives.

Initially, we intend to use the existing MATH 464 and 466 courses, but plan to create separate versions of these courses geared specifically at statistics major/minor students once the program has grown sufficiently (see also descriptions of new courses proposed below):

MATH 464: Theory of Probability (3 units): Description: Probability spaces, random variables, weak law of large numbers, central limit theorem, various discrete and continuous probability distributions.


SIE 440: Survey of Optimization Methods (3 units) Description: Survey of methods including network flows, integer programming, nonlinear programming and dynamic programming. Models development and solution algorithms are covered.

The host department, the Department of Mathematics, is a member of the School of Mathematical Sciences. The Interdisciplinary Programs in Applied Mathematics and in Statistics are also members of the School. As a consequence, undergraduate Statistics students will have ready access to faculty across 9 colleges who incorporate statistics into their academic life in a wide variety of ways.

In addition, students who are contemplating an undergraduate degree in mathematics (notably, with the probability/statistics option) or in statistics, or have the goal of an Accelerated Master’s Degree in Statistics can easily make changes in their academic goals among these choices with ease and little penalty in the time to graduation.

**B. Special conditions for admission to/declaration of this major-explain in detail the criteria to join this major, including GPA requirements, completion of courses prior to declaration, application process, interviews, etc. These conditions must be approved by faculty governance to be enforced.**

The Department of Mathematics has no special criteria for joining the major.
C. NEW COURSES NEEDED -- list any new courses which must be added to initiate the program; include a course prefix, course number, title, catalog description and number of units for each of these courses.

Initially, the degree program will require 3 new core upper division courses, Statistical Computing, Applied Linear Models, and a capstone course, Introduction to Data Science. As the program expands, we anticipate adding elective courses to the current list of electives. (Course numbers provisional.) At the outset, we will take advantage of the existing courses that Mathematics offers in the Theory of Probability and the Theory of Statistics (MATH 464 and MATH 466). However, the two populations of students (Statistics majors will their background in statistical models and computation and Mathematics majors with their background in mathematics proofs and differential equations) are sufficiently different to warrant new courses for Statistics majors in these areas.

MATH/STAT 375 Introduction to Statistical Computing – 3 units. (to begin in the Spring of 2019) Description: Basic computing skills including random variable generation, Monte Carlo integration, visualization, optimization techniques, resampling methods, Bayesian approaches, introduction to statistical computing environments (R and Python). Material will provide hands-on experience with real world problems.

MATH/STAT 467 Introduction to Applied Linear Models – 3 units (to begin in the Fall of 2019) Description: An applied undergraduate level course in multiple regression and analysis of variance for students who have completed a course in basic statistical methods. Emphasis is on practical methods of data analysis and their interpretation, using statistical software such as R. Course content includes model building, general linear hypothesis, residual analysis, leverage and influence, and basic experimental designs such as one-way and two-way anova, block designs and repeated measures. Some emphasis will be devoted to matrix representation of the general linear model and efficient computational techniques.

MATH/STAT 464s: Introduction to Mathematical Statistics I - 3 units (to begin in the Fall of 2020) Description: Axioms of probability, random variables and expectation, laws of large numbers, Monte Carlo and other simulation strategies, central limit theorem and the delta method, common families of distributions.


MATH/STAT 465 Introduction to Data Science – 3 units (to begin in the Spring of 2020) Description: This course aims to cover basic concepts and skills for learning from data, in order to find patterns and gain insights. A variety of tools and techniques for data cleaning, data management and processing, data exploration and visualization, data analysis and interpretation, will be introduced. Special emphasis will be on modern statistical learning methods, principles, and computational tools. Applications in bioinformatics, genomics, text mining, social networks, and medicine will be covered. The course topics include regression, classification, clustering, dimension reduction, and high dimensional analysis.
Individual Studies Courses:

STAT 199: **Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 199H: **Honors Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 293: **Internship** (1 - 10 units) Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or government establishment.

STAT 299: **Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 299H: **Honors Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 391: **Preceptorship** (1 - 6 units) Description: Specialized work on an individual basis, consisting of instruction and practice in actual service to a department, program, or discipline.

STAT 392: **Directed Research** (1 - 6 units) Description: Individual research under the guidance of faculty.

STAT 393: **Internship** (1 - 10 units) Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or government establishment.

STAT 399: **Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 399H: **Honors Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 491: **Preceptorship** (1 - 6 units) Description: Specialized work on an individual basis, consisting of instruction and practice in actual service to a department, program, or discipline.

STAT 492: **Directed Research** (1 - 6 units) Description: Individual research under the guidance of faculty.

STAT 493 Internship - 1 to 3 units Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment. Internship credit may be used to cover Application Course requirements for the BS.

STAT 498: **Senior Capstone** (1 - 3 units) Description: A culminating experience for majors involving a substantive project that demonstrates a synthesis of learning accumulated in the major, including broadly comprehensive knowledge of the discipline and its methodologies. Senior standing required.
STAT 498H: **Honors Thesis** (3 units) Description: An honors thesis is required of all the students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis.

STAT 499: **Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

STAT 499H: **Honors Independent Study** (1 - 5 units) Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.

**D. REQUIREMENTS FOR ACCREDITATION** -- *describe the requirements for accreditation if the program will seek to become accredited. Assess the eligibility of the proposed program for accreditation.*

There are no accreditation requirements.

**IV. STUDENT LEARNING OUTCOMES AND ASSESSMENT**

The Department of Mathematics adopted a set of Student Outcomes and Student Assessments in their 2016 Academic Program Review. The Outcomes and Assessment stated below are small adjustments to acknowledge that the undergraduate major is Statistics.

**A. STUDENT OUTCOMES** -- *describe what students should know, understand, and/or be able to do at the conclusion of this program of study. Note: student outcomes should be measurable.*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be able to define mathematical and statistical terms precisely</td>
<td>Gen Ed Learning Outcomes: Communicate Effectively</td>
</tr>
<tr>
<td>Recognize when arguments, especially formal statistical procedures and data visualization, are valid, and identify logical flaws</td>
<td>Gen Ed Learning Outcomes: Think Critically</td>
</tr>
<tr>
<td>Produce effective analyses from data using a variety of computational, mathematical, and statistical approaches</td>
<td>Gen Ed Learning Outcomes: Think Critically</td>
</tr>
<tr>
<td>Critically evaluate and extend statistical models drawn from current scientific literature</td>
<td>Gen Ed Learning Outcomes: Use Information Effectively</td>
</tr>
</tbody>
</table>
Apply methods and concepts from their coursework to analyze data based scientific problems

<table>
<thead>
<tr>
<th>BS Statistics and Data Science Curriculum Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses and Learning Activities</td>
</tr>
<tr>
<td>MATH 131 Introduction to Linear Algebra</td>
</tr>
<tr>
<td>MATH 36 Statistical Methods</td>
</tr>
<tr>
<td>Mathematical Statistics 375</td>
</tr>
<tr>
<td>STAT 66 Introduction to Mathematical Statistics I</td>
</tr>
<tr>
<td>STAT 490 Introduction to Mathematical Statistics II</td>
</tr>
<tr>
<td>STAT 495 Introduction to Data Science</td>
</tr>
</tbody>
</table>

Note that the following outcomes from the MATH 323 course in the Mathematics major core are not met with the Statistics and Data Science major:

- Construct proofs that follow directly from a definition
- Produce valid proofs using the techniques of mathematical induction, contradiction, contrapositive, and construction

In contrast, here are the existing outcomes for MATH 363, the core course that students take at a comparable time in their career (~4th semester).

- Have a clear understanding what statistical thinking is and how to integrate this with scientific procedures and quantitative modeling and
- Learn how to ask statistics experts productive questions, and how to implement their ideas using statistical software and other computational tools.

B. **STUDENT ASSESSMENT** -- provide a plan for assessing intended student outcomes 1) while students are in the program and 2) after they have completed the degree.
In addition to the usual course assessments and examinations, there are three points where we have agreed to assess these outcomes:

1) While students are in the program:
   - At the end of MATH 363, the core required introduction to statistical science class using a Rubric to be filled out by the instructor for each student based on student work through that semester. (This will check to see if the students is on track to meet the degree objectives.)

   At the end of MATH/STAT 466s, the final course in the theoretical foundations of statistics and data science using a Rubric to be filled out by the instructor for each student based on student work through that semester. (This speaks to the first three learning outcomes.)

   At the end of MATH/STAT 465, the capstone Data Science class taken by majors in Spring of their senior year using a Rubric to be filled out by the instructor for each student based on their work in modeling projects and the final competitive presentations that are judged by the faculty of the department. (This speaks to the final three learning outcomes.)

2) After completion of the degree:
   - Exit interviews and surveys including students’ self-assessment.

These rubrics are given in the Academic Program Review.

V. STATE’S NEED FOR THE PROGRAM

A. HOW DOES THIS PROGRAM FULFILL THE NEEDS OF THE STATE OF ARIZONA AND THE REGION?
   - Include an explanation of the process or source for arriving at all numbers used in this section
The need for such a program is well documented. Almost any industry that deals with large amounts of data will be in need of statisticians. Here is a table of possible opportunities in the state of Arizona.

<table>
<thead>
<tr>
<th>Finance</th>
<th>High Tech</th>
<th>Defense/Aviation</th>
<th>Medical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells Fargo</td>
<td>Arete</td>
<td>Boeing</td>
<td>Ventana</td>
</tr>
<tr>
<td>JP Morgan Chase</td>
<td>Ephibian</td>
<td>General Dynamics</td>
<td>Sanoifi</td>
</tr>
<tr>
<td>Bank of America</td>
<td>Go Daddy Group</td>
<td>Northrup Grummon</td>
<td>Accelerate Diagnostics</td>
</tr>
<tr>
<td>American Express</td>
<td>Honeywell</td>
<td>Raytheon</td>
<td>HTG Molecular</td>
</tr>
<tr>
<td>Discover</td>
<td>IBM</td>
<td>Sargent Aerospace</td>
<td>Tucson Medical</td>
</tr>
<tr>
<td>Citi</td>
<td>Intel</td>
<td>US Airways</td>
<td>Mayo Clinic</td>
</tr>
<tr>
<td></td>
<td>Motorola</td>
<td></td>
<td>Abrazo Health Care</td>
</tr>
<tr>
<td></td>
<td>Texas Instrument</td>
<td></td>
<td>Dignity Health</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Banner Health</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>Heavy Industry</th>
<th>Air Force Bases</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Districts</td>
<td>Caterpillar</td>
<td>Davis Montham AFB</td>
<td>Local</td>
</tr>
<tr>
<td>University of Arizona</td>
<td>Freeport McMoran</td>
<td>Luke AFB</td>
<td>State</td>
</tr>
<tr>
<td>Arizona State</td>
<td></td>
<td>Yuma MCAS</td>
<td>Federal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We solicited information from four of these businesses: Arete, Ephibian, Raytheon, and Ventana. John McLean, from Arete, describes “several areas where Arete would eagerly hire Statistics and Data Science graduates, I expect such graduates would have a wide variety of career choices available.” Lee LeClair at Ephibian states, “Our work … shares a common thread on the foundational knowledge of mathematics in general and Statistics in particular. It is gratifying to keep the UA at the forefront of the field and preparing graduates for an increasingly demanding workforce.” Jim Ranger Moore at Ventana adds that: “A source of undergraduates majoring in statistics who have already spent some time in Tucson, and may therefore be more likely to stay, would be a terrific resource for Ventana and an excellent opportunity for U of A undergraduates when they begin looking for employment.”

As our letters of support indicate, employers in the Tucson area have seen the need to recruit outside the University of Arizona to fill statistics and data science positions in their companies. In addition, Statistics Advanced Placement Teachers in the high schools have seen their students make a choice for postsecondary at other universities because the University of Arizona does not offer a major in statistics and data science. With 200,000 Advanced Placement students nationally, well over a thousand student make the Advanced Placement Exam in Statistics in Arizona. Thus, we see an increasing number of high school students who are aware of statistics as a career. We can market this degree through their high school instructors to attract students to the University of Arizona. Our advisors frequently speak to students who enjoyed their high school statistics course, and are interested in pursuing the subject in college.

At present the only other Statistics undergraduate degree in the state is at the West Campus of Arizona State University - not the main Tempe campus, where it would be accessible to a large and diverse population of students, as noted in section V below. Moreover, students at the University of Arizona (as opposed to ASU West) will have opportunities that come with study at a research intensive university. The opportunities are too
numerous to mention, with many specialized subject specific programs or program that foster access by underrepresented groups. The Undergraduate Biology Research Program and the NASA Space Grant Program are two large long standing examples of engaging undergraduate students in research. Moreover, engineering students must take a senior design course. All of these endeavors are enhanced by have coursework in statistics and data science.

To place this in a national context, the This is Statistics website (maintained by the American Statistical Association) published an article on October 1, 2015 an article entitled More Students Earning Statistics Degrees, But Not Enough To Meet Surging Demand for Statisticians. This report remarks that “2013 to 2014 … marks 15 consecutive years the number of undergraduates in statistics has risen, increasing by more than 300% since the 1990s. For comparison, the number of undergraduates earning science and engineering degrees grew by 72% over the same period.” (See the growth in the plot below prepared by the National Center for Educational Statistics.)

Moreover, at least 12 of the 16, Arizona Board of Regents approved peer institutions have a Statistics (or closely related data science) undergraduate degree. The ten in Statistics are the University of California-Davis, University of California-Los Angeles, University of Florida, University of Illinois at Urbana-Champaign, University of Iowa, Michigan State University, University of Minnesota-Twin Cities, Pennsylvania State University-Main Campus, University of Washington-Seattle Campus, and University of Wisconsin-Madison. University of North Carolina at Chapel Hill offers a Mathematical Decision Sciences major. Ohio State University-Main Campus offers a Data Analytics major.

1. Is there sufficient demand for the program? Provide student data indicating demand.
Presently we have approximately 70 students who have declared the Mathematics undergraduate major under the Probability/Statistics option. A sizable (but really unknowable) fraction of these students plus some from the Math majors under the Applied Mathematics option will choose to take the Statistics undergraduate major. In addition, we have seen an increase in interest among freshmen and sophomores for the Accelerated Master’s Degree in Statistics, some of whom may either choose the undergraduate Stat degree either as a terminal degree or as preparation for the Master’s Degree.

Several other academic units are undergoing discussions to take advantage of this new major and minor. The Department of Ecology and Evolutionary Biology are presently requiring MATH 363 for their bioinformatics track and likely will encourage students to take MATH/STAT 375, Introduction to Statistical Computing. The Department of Molecular and Cellular Biology is initiating a Biology of Big Data track that depends on courses in the Statistics and Data Science undergraduate. Biostatistics is undergoing discussions to develop strategies that will bring graduates in Statistics to the many graduate programs in the health sciences that can benefit from these population of students and are considering either applications or elective courses that will introduce Stat students to these opportunities.

We received general and sometimes enthusiastically expressed support from several department head, program chairs, and school directors - Astronomy, Chemistry & Biochemistry, Computer Science, Economics, Geosciences, Management Information Systems, Material Sciences, Physics, Physiology, School of information, School of Natural Resources and the Environment, and Systems & Industrial Engineering.

To have a look at the estimates for demand from a national perspective, we note that the degrees conferred among the 10 peer institutions has essentially quintupled in the last 6 years from a mean of 14 in 2010 to a mean of 70 in 2016. As of 2016, this growth shows no signs of abating. A table showing the number of degrees awarded is provided below.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of California-Davis</td>
<td>24</td>
<td>32</td>
<td>55</td>
<td>53</td>
<td>54</td>
<td>60</td>
<td>110</td>
<td>388</td>
</tr>
<tr>
<td>University of California-Los Angeles</td>
<td>13</td>
<td>20</td>
<td>30</td>
<td>50</td>
<td>66</td>
<td>71</td>
<td>127</td>
<td>377</td>
</tr>
<tr>
<td>University of Florida</td>
<td>16</td>
<td>30</td>
<td>29</td>
<td>32</td>
<td>41</td>
<td>41</td>
<td>51</td>
<td>240</td>
</tr>
<tr>
<td>University of Illinois at Urbana-Champaign</td>
<td>26</td>
<td>30</td>
<td>62</td>
<td>67</td>
<td>91</td>
<td>111</td>
<td>143</td>
<td>530</td>
</tr>
<tr>
<td>University of Iowa</td>
<td>3</td>
<td>9</td>
<td>9</td>
<td>11</td>
<td>25</td>
<td>23</td>
<td>22</td>
<td>102</td>
</tr>
<tr>
<td>Michigan State University</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>11</td>
<td>18</td>
<td>23</td>
<td>22</td>
<td>90</td>
</tr>
<tr>
<td>University of Minnesota-Twin Cities</td>
<td>17</td>
<td>28</td>
<td>52</td>
<td>50</td>
<td>57</td>
<td>66</td>
<td>106</td>
<td>376</td>
</tr>
<tr>
<td>Pennsylvania State University-Main Campus</td>
<td>8</td>
<td>23</td>
<td>20</td>
<td>33</td>
<td>45</td>
<td>51</td>
<td>39</td>
<td>219</td>
</tr>
<tr>
<td>University of Washington-Seattle Campus</td>
<td>9</td>
<td>15</td>
<td>31</td>
<td>32</td>
<td>30</td>
<td>37</td>
<td>25</td>
<td>179</td>
</tr>
<tr>
<td>University of Wisconsin-Madison</td>
<td>16</td>
<td>11</td>
<td>27</td>
<td>27</td>
<td>38</td>
<td>42</td>
<td>59</td>
<td>220</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>sum</td>
<td>137</td>
<td>201</td>
<td>323</td>
<td>366</td>
<td>465</td>
<td>525</td>
<td>704</td>
<td>2721</td>
</tr>
<tr>
<td>mean</td>
<td>13.7</td>
<td>20.1</td>
<td>32.3</td>
<td>36.6</td>
<td>46.5</td>
<td>52.5</td>
<td>70.4</td>
<td>272.1</td>
</tr>
<tr>
<td>standard deviation</td>
<td>7.63</td>
<td>10.2</td>
<td>18.6</td>
<td>18.3</td>
<td>21.5</td>
<td>26.3</td>
<td>46.6</td>
<td>141</td>
</tr>
</tbody>
</table>
We do see signs of this upturn at the University of Arizona. Before 2010, about one fourth of our graduating majors completed the Probability/Statistics senior sequence, MATH 464/466. Around 2013, this number had jumped to about one half and has stayed constantly at that level. At that same time, we began to offer MATH 363, Introduction to Statistical Methods. Within a couple of years, this course quickly moved to ~35 students per semester with nearly all of them Mathematics minors (and a few Math majors).

In 1997, the College Board began offering an Advanced Placement Exam in Statistics. The number of students have grown from 7,667 in that first year to 206,563 in 2016. The growth shows no sign of abating. (See plot below.)

![Number of students taking the AP Statistics Exam](image)

2. What is the anticipated student enrollment for this program? Complete the following table. How did you arrive at these numbers?

Based on the table of our peers, we anticipate the following student enrollments. These are designed to take us to a steady state of 80 Statistics degrees per year. The table is based on a ramping up of 20, 30, and 50 new students in the first three years. This may be a modest assessment with the number of majors easily exceeding this amount. The second row values represent a net increase to the Mathematics Department and does not include those current math majors who switch to the Statistics Degree.

<table>
<thead>
<tr>
<th>Year</th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2023</td>
<td>20</td>
<td>30</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>2024</td>
<td>30</td>
<td>40</td>
<td>60</td>
<td>130</td>
</tr>
<tr>
<td>2025</td>
<td>40</td>
<td>50</td>
<td>70</td>
<td>160</td>
</tr>
<tr>
<td>2026</td>
<td>50</td>
<td>60</td>
<td>80</td>
<td>190</td>
</tr>
<tr>
<td>2027</td>
<td>60</td>
<td>70</td>
<td>90</td>
<td>220</td>
</tr>
</tbody>
</table>

5-YEAR PROJECTED ANNUAL ENROLLMENT

29
<table>
<thead>
<tr>
<th></th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>4th Year</th>
<th>5th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Majors</td>
<td>50 (37 BS) 20 NEW</td>
<td>80 (60 BS) 50 NEW</td>
<td>150 (112 BS) 100 NEW</td>
<td>240 (180 BS) 160 NEW</td>
<td>320 (240 BS) 213 NEW</td>
</tr>
</tbody>
</table>

These number are higher than Minnesota and Wisconsin and may in large part be due to the fact that these institutions have required or recommended courses for entry to the major.

3. **What is the local, regional and national need for this program? Provide market analysis data or other tangible evidence of the need for and interest in this program.** 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 during the next three years.

In a 2011 report, McKinsey Global Institute stated a “significant constraint on realizing value from Big Data will be a shortage of talent, particularly of people with deep expertise in statistics and machine learning,” and predicted a potential shortage in the U.S. of 140,000 to 190,000 workers with deep analytical skills by the year 2018. This “deep understanding” calls for a statistics undergraduate program supported by a rigorous background in mathematics, notably calculus and linear algebra, and in computation.

The *This is Statistics* article continues quoting data from the Bureau of Labor Statistics that “total employment for statisticians has grown from 28,000 positions in 2010 to 85,000 in 2014. In addition, the Bureau “projects job growth for statisticians will increase 27% between 2012 and 2022, outpacing the projected 11% rate for all other occupations.”

We surveyed existing Math majors, Math minors, and students enrolled in MATH 363 about their level of interest in a Major or Minor in Statistics and Data Science. The response was quick and positive. We had 10 responses within 10 minutes. Of the 141 responses received up, we have the following table of counts for the interest in a major or minor (a 1 indicates “Not interested at all’; a 5 indicates “Very interested”).

The final row gives the maximum value of each student’s response.
This is admittedly a self selected group, with those highly interested more likely to respond. Nevertheless, the response is strongly favorable to have a major and minor in Statistics and Data Science. It also indicates a 3 to 1 interest in the BS compared to the BA. This is consistent with the current situation in mathematics.

4. **Beginning with the first year in which degrees will be awarded, what is the anticipated number of degrees that will be awarded each year for the first five years? Complete the following table. Explain anticipated attrition rates.**

<table>
<thead>
<tr>
<th>PROJECTED DEGREES AWARDED ANNUALLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Year (2020)</td>
</tr>
<tr>
<td>Number of Degrees</td>
</tr>
</tbody>
</table>

Sophomores transferring majors next spring at the end of the sophomore year can graduate in the Spring, 2020. Similarly, freshmen can graduate in Spring, 2021. In latter years, we will have a mix of students choosing the Statistics major as a net increase and those who would have previously chosen the Mathematics major but now are selecting Statistics. We will recruit through Statistics Advanced Placement teachers and can anticipate that new arrivals to the University of Arizona will come because of the new Statistics and Data Science undergraduate degree and the opportunities for employment in Arizona. The attrition rate in Mathematics (below 2%) is too low to be taken into account for these projections.

**IV. APPROPRIATENESS FOR THE UNIVERSITY** -- **Explain how the proposed program is consistent with the UA mission and strategic direction. Why is the UA the most appropriate location within the Arizona University System for the proposed program? Explain how this proposed program is consistent with the College strategic plan. Refer to the website [here](http://neversettle.arizona.edu/) regarding UA’s mission and strategic plan.**

The University of Arizona has given its Strategic Plan for the years 2013 to 2018 through the *Never Settle* document. (See [http://neversettle.arizona.edu/](http://neversettle.arizona.edu/)) *Never Settle* outlines the University’s strategic priorities from the perspective of **engaging, innovating, partnering, and synergy**. Faculty members participating in the Undergraduate Program in Statistics are central in the development of innovative new curricula using the most modern methods of delivery and to the establishment of key industry partnerships, especially in education, health sciences, STEM, and cultural competence. They will also provide essential technical interdisciplinary training so that our students become highly sought for individuals for the many aspects of the modern enterprise that take on grand challenges through data intensive initiatives. This is a core mission of a land grant university like the University of Arizona. Moreover, the Center for Recruitment and Retention of Mathematics Teachers in the School of Mathematical Sciences, is well positioned to play a key role in bridging from K-12 students and their education communities to the University in preparing young students for the greatly expanding roles that data analysis play in nearly every aspect of life and work.
Key statements from the *Never Settle* Strategic Plan

**Engaging**
3. Provide students with a dynamic educational experience.
4. Graduate individuals who will be sought out by the best employers and postgraduate programs.

**Innovating**
1. Promote core strengths to address grand challenges.
2. Expand opportunities for interdisciplinary collaboration.

**Partnering**
1. Better adapt our land-grant mission for the 21st century, including a global strategy.
2. Expand, develop, and sustain community and industry partnerships, locally and globally, via innovative programs.
3. Increase capacity in critical and emerging fields such as education, health sciences, STEM, and cultural competence.
4. Align output with workforce and knowledge needs, in our region and around the world.

**Synergy**
1. Elevate interdisciplinary collaborations.
2. Expand global connections and deepen regional roots.

V. **EXISTING PROGRAMS WITHIN THE ARIZONA UNIVERSITY SYSTEM**

A. **ARIZONA UNIVERSITY SYSTEM** – list all similar programs at the same academic level (Bachelor's, Master's, Doctoral) currently offered in the Arizona University System. Use the table below. Additional rows may be added, as needed.

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Degree Type</th>
<th>Number of Students Enrolled</th>
<th>LOCATION University &amp; Site</th>
<th>PROGRAM ACCREDITATION? YES/NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASU - Statistics BS</td>
<td>BS</td>
<td>121</td>
<td>ASU, West Campus</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

Curricular Affairs (and the Graduate College for graduate programs) will determine if you are required to complete additional comparison charts to discuss the ways in which the proposed program differs from University of Arizona programs.
Note: ASU has both a Mathematics major with concentration in Statistics (Tempe campus) and a Statistics major (West campus). The West Campus at ASU had an enrollment of 3,663 as of Fall 2016 - just 5.1% of ASU’s total enrollment at all Metropolitan campuses of 71,946. ASU reported 850 Mathematics majors (all concentrations) for 2016-17. Their major enrollments should be considered in context of the campus at which each major is available.

<table>
<thead>
<tr>
<th>Program Name, subplan name (if applicable), degree, and institution</th>
<th>Statistics and Data Science BS Arizona (proposed)</th>
<th>Statistics BS Arizona State University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently enrolled students</td>
<td>--</td>
<td>121</td>
</tr>
<tr>
<td>Description of major</td>
<td>By merging modern data science approaches with a solid mathematical background and practical training, the Undergraduate Degree in Statistics provides a curriculum that allows students to make significant contributions at the forefront of knowledge across the vast array of activities in government, education, and industry that rely on statistical thinking.</td>
<td>From <a href="https://newcollege.asu.edu/statistics-degree">https://newcollege.asu.edu/statistics-degree</a>: Statisticians collect, analyze and interpret data from experiments and surveys. Their work is critical in helping individuals and organizations better understand the information contained in the data. Emphasizing the practical application of statistics, this program builds upon the foundation of mathematics and computing to study concepts in theoretical and applied statistics. Students must select one focus area and complete a minimum of nine credit hours (three courses) from that focus area. The focus area courses are in addition to the General Studies requirements. Students should consult with an academic advisor in the School of Mathematical and Natural Sciences before enrolling in any focus area course.</td>
</tr>
</tbody>
</table>
| Target Careers | ● Actuary  
● Banking consultant  
● Consulting statistician  
● Data analyst  
● Data engineer  
● Database administrator  
● Financial planner  
● Healthcare analyst  
● Market researcher  
● Risk analyst  
● Statistical computing  
● Survey designer  
● Software engineer  
● Sports analyst  
● Statistical engineer | From [https://newcollege.asu.edu/statistics-degree](https://newcollege.asu.edu/statistics-degree):  
● Actuaries  
● Business Teachers, Postsecondary  
● Clinical Data Managers  
● Clinical Research Coordinators  
● Survey Researchers  
● Natural Sciences Managers  
● Mathematical Science Occupations, All Other  
● Mathematicians  
● Mathematical Science Teachers, Postsecondary  
● Statisticians |
- Underwriter

Statistical training can be considered as a complement to many career choices that use intensive data analysis, presentation, and inference.

A Master’s degree may be required for some careers.

<table>
<thead>
<tr>
<th>Total units required to complete degree</th>
<th>120</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper -division units required to complete degree</td>
<td>42</td>
<td>45</td>
</tr>
</tbody>
</table>

### Foundation courses

<table>
<thead>
<tr>
<th>English Composition</th>
<th>6 units</th>
<th>6 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Language</td>
<td>BS: 2nd semester proficiency</td>
<td>none</td>
</tr>
<tr>
<td>Math</td>
<td>3 units (part of major)</td>
<td>6 units MA &amp; CS (part of major)</td>
</tr>
</tbody>
</table>

### General Education Requirements

- 2- Tier I 150 (INDV)
- 2-Tier I 160 (TRAD)
- 0-Tier I 170 (NATS)
- 3 units-Tier II Arts
- 1-Tier II Humanities
- 1-Tier II Individuals and Societies
- 0-Tier II Natural Sciences

Core areas: MA/CS (see Math above), HU, SB, L, SQ/SG:
- 12 units combined; at least 6 units from one of the areas:
  - Social-Behavioral Sciences (SB)
  - Humanities, Arts and Design (HU)
- 3 units Literacy and Critical Inquiry (L)
- 8 units Natural Science:
  - At least 4 units Quantitative (SQ);
  - The other 4 units may be SQ or General (SG)

Three awareness areas (may also satisfy a core area):
- Cultural Diversity in the U.S. (C)
- Global Awareness (G)
- Historical Awareness (H)

### Pre-major? (yes/no). If yes, indicate coursework.

- no

### List any special requirements to declare or gain

- none

- none
admission to this major
(completion of specific coursework, minimum GPA, interview, application, etc.)

<table>
<thead>
<tr>
<th>MAJOR REQUIREMENTS</th>
<th>Minimum # of units required in major</th>
<th>Minimum # of upper-division units required in the major</th>
<th>Minimum # of residency units to be completed in the major</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34</td>
<td>21-24</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>(Does not include: 4 units programming, 8 units lab sci, 0-6 unique units application coursework)</td>
<td>7-8 courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(students may transfer MATH 215 in to cover MATH 313)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>57</td>
<td>27</td>
<td>12</td>
</tr>
</tbody>
</table>
| Required supporting coursework (courses that do not count towards major units and major GPA, but are required for the major). Courses listed must include subject code, units, and title. | One course from:  
- CSC 110 Introduction to Computer Programming I (4 units)  
- ISTA 130 Computational Thinking and Doing (4 units)  
- Equivalent (3-4 units)  
One lab science sequence selected from:  
- PHYS 141 Introductory Mechanics (4 units) & either PHYS 142 Introductory Optics and Thermodynamics (3 units) or PHYS 241 Introductory Electricity and Magnetism (4 units)  
- PHYS 161H Honors Introductory Mechanics (4 units) & either PHYS 162H Honors Introductory Optics and Thermodynamics (4 units) or PHYS 261H Honors Introductory Electricity and Magnetism (4 units) | none |
- CHEM 151 General Chemistry I (4 units) &
  CHEM 152 General Chemistry II (4 units)
- CHEM 105A Honors Fundamentals of
  Chemistry (3 units) & CHEM 106A Honors
  Fundamental Techniques of Chemistry (1
  unit) & CHEM 105B Honors Fundamentals of
  Chemistry (3 units) & CHEM 106B Honors
  Fundamental Techniques of Chemistry (1
  unit)
- MCB 181R Introductory Biology I (3 units)
  & MCB 181L Introductory Biology
  Laboratory I (1 unit) & ECOL 182R
  Introductory Biology II (3 - 5 units) & ECOL
  182L Introductory Biology II Lab (1 unit)
- PSIO 201 Human Anatomy and Physiology I
  (4 units) & PSIO 202 Human Anatomy and
  Physiology II (4 units)
- GEOS 251 Physical Geology (4 units) &
  either GEOS 302 Principles of Stratigraphy
  and Sedimentation (4 units) or 304 Structural
  Geology (4 units)

Six units of Application Course Work - see
Appendix II for course list.

<table>
<thead>
<tr>
<th>Major requirements (list all required major coursework including major core, major electives, subplan core, subplan electives; courses count towards major units and major GPA). Courses listed must include course prefix, number, units, and title. Mark new coursework (New).</th>
<th>Core:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- MATH 125 or 122A/B Calc I (3-5 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 129 Calc 2 (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 223 Vector Calc (4 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 313 Intro to Linear Algebra (3 units)</td>
</tr>
<tr>
<td></td>
<td>or 310 Applied Linear Algebra (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 363 Intro to Stats (3 units)</td>
</tr>
<tr>
<td></td>
<td>- (new) MATH/STAT 375 Statistical Computing (3 units)</td>
</tr>
<tr>
<td></td>
<td>- (new) MATH 464s Intro to Mathematical Stats I (3 units)</td>
</tr>
<tr>
<td></td>
<td>- (new) MATH 466s Intro to Mathematical Stats II (3 units)</td>
</tr>
<tr>
<td></td>
<td>- (new) MATH/STAT 467 Introduction to Applied Linear Models (3 units)</td>
</tr>
<tr>
<td></td>
<td>- (new) MATH/STAT 465 Intro to Data Science (3 units)</td>
</tr>
<tr>
<td>Elective (choose one):</td>
<td>ACO 101: Introduction to Computer Science (MA) (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 367 Statistical Methods in Sports Analytics (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 462 Financial Mathematics (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 468 Stochastic Processes (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MAT 270: Calculus with Analytic Geometry I (4 units)</td>
</tr>
<tr>
<td></td>
<td>- MAT 271: Calculus with Analytic Geometry II (4 units)</td>
</tr>
<tr>
<td></td>
<td>- MAT 272: Calculus with Analytic Geometry III (4 units)</td>
</tr>
<tr>
<td></td>
<td>- MAT 343: Applied Linear Algebra (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 280: Probability &amp; Statistics for Researchers (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 315: Statistical Computing (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 281: Statistical Analysis for Researchers (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 310: Design and Analysis of Experiments (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 311: Regression and Time Series analyses (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 421: Probability (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 427: Mathematical Statistics (3 units)</td>
</tr>
<tr>
<td></td>
<td>- STP 485: Statistics Capstone (3 units)</td>
</tr>
<tr>
<td>Upper Division Statistics Elective (6 units) choose from:</td>
<td>Focus Area Electives choose 9 units from:</td>
</tr>
<tr>
<td></td>
<td>- STP 450: Nonparametric Statistics</td>
</tr>
<tr>
<td></td>
<td>- STP 451: Quality Improvement</td>
</tr>
<tr>
<td></td>
<td>- STP 452: Multivariate Statistics</td>
</tr>
<tr>
<td></td>
<td>- STP 460: Categorical Data Analysis</td>
</tr>
<tr>
<td></td>
<td>- ACO 201: Data Structures and Algorithms (CS) (3 units)</td>
</tr>
<tr>
<td><strong>Internship, Practicum, Applied Course Requirements.</strong> <em>(Yes/no. If yes, please describe.)</em></td>
<td>*<em>Yes; the BS requires at least 6 units of coursework that applies calculus or other concepts from the major to another field.</em></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Senior Thesis or Senior Project Required</strong> <em>(Yes/No)</em></td>
<td><strong>no</strong></td>
</tr>
<tr>
<td>*<em>Additional Requirements (Please Describe.)</em></td>
<td><strong>Electives are required to meet graduation unit requirements. Students may opt to add a second major to fill the extra units, which may fulfill the minor requirement.</strong></td>
</tr>
<tr>
<td><strong>MINOR (Please specify if optional or required)</strong></td>
<td><strong>required</strong></td>
</tr>
</tbody>
</table>

Some of ASU’s Focus Area Electives (CHM 113 and 116) would transfer to UA to cover the Supporting Laboratory Science requirement in our BS degree programs (CHEM 151 and 152 General Chemistry I and II).

Some of ASU’s Focus Area Electives (namely, the Mathematical Structures course - MAT 300 and their Advanced Calculus I - MAT 371) would be taken by ASU students in the Statistics major who intend to pursue a PhD in Statistics. Theses courses transfer as MATH 323 (Formal Mathematical Reasoning and Writing) and MATH 425A (Real Analysis of One Variable) at the University of Arizona, and will not be a part of the Statistics major here.
However, as described above, they are fundamental to the Mathematics major with Probability and Statistics subplan.

VI. EXPECTED FACULTY AND RESOURCE REQUIREMENTS

A. FACULTY

1. Current Faculty – list the name, rank, highest degree, primary department and estimation of the level of involvement of all current faculty members who will participate in the program. Attach a brief vita for each faculty member listed.

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
<th>Highest Degree</th>
<th>Primary Department</th>
<th>Current FTE</th>
<th>Level of committed Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joseph Watkins</td>
<td>Professor and Chair, Statistics GIDP</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (2 courses/yr)</td>
<td>50%</td>
</tr>
<tr>
<td>Ning Hao</td>
<td>Assistant Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>66.7%</td>
</tr>
<tr>
<td>Tom Kennedy</td>
<td>Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>33.3-66.7%</td>
</tr>
<tr>
<td>Kevin Lin</td>
<td>Associate Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>16.7-33.3%</td>
</tr>
<tr>
<td>Robert Maier</td>
<td>Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>0.51 (3 courses/2 yrs)</td>
<td>16.7-33.3%</td>
</tr>
<tr>
<td>Matti Morzfeld</td>
<td>Assistant Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (2 courses/yr)</td>
<td>25%</td>
</tr>
<tr>
<td>Yue (Selena) Niu</td>
<td>Assistant Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>66.7%</td>
</tr>
<tr>
<td>Doug Pickrell</td>
<td>Associate Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>16.7% (but open to increasing)</td>
</tr>
<tr>
<td>Walter Piegorsch</td>
<td>Professor &amp; Director, Statistical Research and Education</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (0.5 for Math; 3 courses/2 yrs)</td>
<td>33.3%</td>
</tr>
<tr>
<td>Sunder Sethuraman</td>
<td>Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>33.3%</td>
</tr>
<tr>
<td>Janek Wehr</td>
<td>Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>16.7%</td>
</tr>
<tr>
<td>Helen Zhang</td>
<td>Professor</td>
<td>PhD</td>
<td>Mathematics</td>
<td>1 (3 courses/yr)</td>
<td>33.3%</td>
</tr>
</tbody>
</table>
2. Additional Faculty -- Describe the additional faculty needed during the next three years for the initiation of the program and list the anticipated schedule for addition of these faculty members.

The commitment above reflects the Department’s interest in the Degree Program. As a way to maintain a well integrated faculty, the tradition in Mathematics is for professors to continue to teach a variety of courses throughout their careers. Thus, having current faculty teaching Statistics Major’s courses at a high level will create need for instructors in the courses they had previously taught. This gap will be met by having our newly hired faculty teach the type of broad portfolio of courses that are enjoyed by the rest of the faculty.

We anticipate needing 3 additional faculty and two long-term lecturers. One of these lecturers will be responsible for low level statistics courses. The second instructor, who will be required to have an advanced degree in statistics or related field, will be hired to teach some of the 300-level courses. Regular faculty generally teach 3 courses per year. We will also need to provide approximately 3 course releases to design and implement the three new courses. After 3 years, the first set of freshman will not have completed the Bachelor’s degree, so we expect increases in years 4 and 5 before reaching a steady state.

<table>
<thead>
<tr>
<th>COURSE</th>
<th>Year 3</th>
<th>Steady state</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 363</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>MATH 375</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>MATH 464</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>MATH 466</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>MATH 467</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>MATH 465</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>electives</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>13</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>

The Math Department has hiring authority and plans to hire faculty, including some to support this program.

3. Current and Projected Major headcount – give the current and projected (next three years) headcount of your undergraduate and graduate students enrolled in your existing degree/major programs. Add rows to the table, as needed.

<table>
<thead>
<tr>
<th>Program name(s)</th>
<th>Current enrolled</th>
<th>Year 1 Projected</th>
<th>Year 2 Projected</th>
<th>Year 3 Projected</th>
</tr>
</thead>
<tbody>
<tr>
<td>(include subplans, if applicable)</td>
<td>headcount</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (no subplan selected)</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (COMPREH)</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (COMSCI)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (ECBUS)</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (GEN)</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (LIFESC)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (PROBSTAT)</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA (MATHTEACH)</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (no subplan selected)</td>
<td>144</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (COMP)</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (COMPSCI)</td>
<td>76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (ECONBUS)</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (GENERAL)</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (LIFESC)</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (PROSTAT)</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBS (MTEACH)</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHBA/BS total</td>
<td>592</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Current and Projected Faculty FTE—give the present and projected (next three years) Faculty FTE in the department or unit in which the proposed program will be offered (include all instructional faculty).

<table>
<thead>
<tr>
<th>Current Faculty FTE</th>
<th>Year 1 Projected</th>
<th>Year 2 Projected</th>
<th>Year 3 Projected</th>
</tr>
</thead>
<tbody>
<tr>
<td>111.86 including instructional faculty, post-docs, etc.</td>
<td>112.86</td>
<td>114.86</td>
<td>116.86</td>
</tr>
</tbody>
</table>

Tenured and tenure-track faculty account for 57.62 of the current FTE. The Current FTE also includes Post-Docs (17.5). Projections above include some hires for this program, and others for existing programs. Projections do not include non-tenure track hires and does not take into account retiring faculty.

B. **LIBRARY**

1. Acquisitions Needed -- Describe additional library acquisitions needed during the next three years for the successful initiation of the program.

No additional resources needed.

C. **PHYSICAL FACILITIES AND EQUIPMENT**

1. Existing Physical Facilities -- Assess the adequacy of the existing physical facilities and equipment available to the proposed program. Include special classrooms, laboratories, physical equipment, computer facilities, etc.
We have some office space for faculty/staff. No special classrooms, laboratories, physical equipment needed.

Courses for the program would use centrally-scheduled classrooms.

2. **Additional Facilities Required or Anticipated** -- *Describe physical facilities and equipment that will be required or are anticipated during the next three years for the proposed program.*

Newly recruited regular faculty will be given a start up package. The Statistics program will use office space for students, staff, and faculty. We are likely to need additional space for tutoring.

D. **OTHER SUPPORT**

1. **Other Support Currently Available** -- *Include support staff, university and non-university assistance.*

The Math Center will coordinate advising and activities for the Statistics major and minor programs. Existing Math Center staff:

- Jason Aubrey: Director, Math Center & Assistant Professor, Mathematics
- Laurie Varecka: Assistant Director, Math Center
- Michelle Ort: Academic Advisor
- Nellie F Rios: Administrative Assistant

We also currently have assistance from Tharini Wijeweera, Senior Academic Advisor II, in the College of Science; she provides General Education advising for our majors. Depending on the advisor/student ratio, we may need to continue to utilize this support from the college.

The Math Department’s Academic Office will assist students with enrollment and placement issues, as they do for all math students now (not just math majors).

The Math Department’s Undergraduate Committee will oversee curriculum decisions.

The needs of the Statistics Undergraduate Program will generally be accommodated by the existing infrastructure of the Department of Mathematics.

2. **Other Support Needed, Next Three Years** -- *List additional staff needed and other assistance needed for the next three years.*

We will need an additional Academic Advisor to support the Statistics undergraduate programs. Enrollments above the median projection will necessitate additional support in Advising and Business.

Graduate Teaching Assistant GTA needs are estimated to rise from 4 to 6 (at 0.5 FTe) over the three year period of this proposal. For Year 1, the GTAs will assist in MATH/STAT 363 taught in moderate size sections of 50 to 60,
assistance in developing and piloting MATH/STAT 375 which is likely to have a weekly session in a computer laboratory, with student work facilitated by the GTA, and instruction on elementary statistics to cover teaching release for course development by faculty. In Year 2, we will need an additional GTA for the expanded enrollment in the 300 level courses. For Year 3, we will need an additional GTA for the Data Science capstone course.

VII.   FINANCING

A.   LIST SUPPORTING FUNDS FROM OUTSIDE SOURCES.

No outside funding is anticipated. We do expect the program to bring new students and tuition to the College of Science and to the University of Arizona, so that it will pay for itself.

B.   BUDGET PROJECTIONS FORM – Complete the budget projection form describing the current departmental budget and estimating additional costs for the first three years of operation for the proposed program. Please note that these costs for each year are incremental costs, not cumulative costs. Include in this budget the anticipated costs for support for instruction, administration of the program, graduate students, marketing, the support discussed in Section VI-D.2, and any other costs that will be needed.

VIII.  OTHER RELEVANT INFORMATION

A.    Diversity and Inclusion- how will you recruit diverse students and faculty to this program?

1.    Students:

The Math Center already has mechanisms in place to recruit diverse students to existing programs; it will be natural to include discussion of the Statistics and Data Science major within the existing framework, and recruit into both programs at the same time.

Calculus Workshop: The Calculus summer workshop was originally designed to increase the representation of underrepresented minority students in the mathematics major. With the addition of a major in Statistics and Data Science in our department, we expect to expand recruitment to the new major as well. The five-day summer calculus workshop prepares students for their first calculus class in college by highlighting productive study skills and building a support network. Students also receive individual academic advising where they are encouraged to add a mathematics minor, or consider the mathematics major; in future, the Statistics and Data Science minor and major will also be included as possible options during these advising sessions. During the summer workshop students are grouped based on their calculus course they are registered for in the Fall semester. They engaged in group problem solving with topics from the prerequisite course and their future calculus course. As part of the workshop, students also engaged in five critical consciousness conversations about race, gender, and STEM. The curriculum for the conversations was designed in collaboration with the
Dean of Students on Diversity and Inclusion office. Two conversations were held during the five-day workshop, two in the fall semester, and the final session in early spring semester. The conversations served two goals. First they aimed to empower students with language and tools to make sense of and navigate any racialized and gendered experiences they might come across in being a STEM major. The conversations were also opportunities for students to check in about their first semester in college and their calculus course. Topics for the conversations included students’ hopes and fears about their first semester, STEM network, and stereotype threat and management.

**Minority Recruiting/Advising:** Recruitment, advising and support of underrepresented minority students is one of the core concerns of the Math Center.

Dr. Aubrey, the Director of the Math Center, is a member of the Committee on Minority Participation in Mathematics of the Mathematical Association of America, and he regularly attends conferences and professional development workshops which are primarily focused on recruitment and support of underrepresented minority students. He recently attended the 2017 Field of Dreams Conference. This conference is the primary meeting of the National Alliance for Doctoral Studies in the Mathematical Sciences, whose primary goal is to increase the number of doctoral degrees in the mathematical sciences among groups that have been traditionally underrepresented in those fields. As another example, in summer 2016 he attended the “Workshop for Mentors of Undergraduate Mathematics Research by Minority Students” at the Park City Mathematics Institute.

Increasing the number of underrepresented minority students in our undergraduate degree programs is one of Dr. Aubrey’s main concerns as Director of the Math Center, and efforts to effect this are evident in the long-time work of the Math Center. Three examples are our recruitment operations, our advising program, and our summer calculus workshop.

The Math Center has an extensive recruitment operation, which includes outreach every year to all incoming freshmen, and outreach every semester to students who enroll in our courses numbered 129 and above, outreach to mathematically successful transfer students, and outreach to students who perform well in Math 122A. We also reach out to students who for whatever reason were previously on our radar, but do not enroll in a math course in a given semester. As part of the semester recruitment effort, we email those students who have demonstrated success in their past math courses. This often involves some judgement about who to contact and who not to contact. When it comes to underrepresented minority students, we always aim to err on the side of casting a wide net when reaching out to students.

Once we recruit a student into our department, the next task is to ensure that they get excellent advising. We can guarantee that students get quality advising and the attention they need from our professional advisors, but we are careful about choosing faculty advisors for our underrepresented minority students. In particular, the Math Center has implemented an advising program for underrepresented minority Math majors to provide additional support to these students, and plans to extend this program to include students majoring in Statistics and Data Science. These students are assigned to specific Faculty Advisors who will be proactive about scheduling advising appointments with them, encouraging them to create resumes, apply for research opportunities, and more.
A final example of the Math Center’s efforts at recruiting, advising, and supporting underrepresented minority students takes place during our summer calculus workshop mentioned above, when participating students are set-up with appointments with Dr. Aubrey for mentoring, advising, and possible recruiting.

**Outreach:** As part of the American Statistical Association Biometrics Section initiative, “Developing the Next Generation of Biostatisticians,” graduate students in biostatistics and statistics from the University of Arizona (UA) carried out an outreach project to increase awareness of careers in statistics and promote a college education in statistics among underrepresented students in upper-level math classes in southern Arizona high schools.

Based on the ASA’s “This is Statistics” program, graduate students gave 35-minute presentations focused on careers in statistics, ideal steps to pursue an education in statistics, and personal experiences involving statistics. (from [http://magazine.amstat.org/blog/2016/10/01/statistics-as-a-career/](http://magazine.amstat.org/blog/2016/10/01/statistics-as-a-career/))

Thus, validated material is in place for bringing awareness of statistics as a career and for recruiting undergraduate students from underrepresented groups. We will continue to use this presentation material and current graduate students. In addition, we will provide a slide presentation and narrative to high schools suitable for presentation by high school faculty.

2. **Faculty:**

In August, 2017, the Department of Mathematics experienced a change in leadership with Professor Douglas Ulmer beginning his tenure as Department Head. Doug and College of Science Dean Joaquin Ruiz have agreed on the broad outlines of a hiring plan that will provide sufficient faculty to cover the needs of the new undergraduate degree in Statistics and Data Science. Even more recently, in September, 2017, the University released its *Guidebook for Implementing and Practicing Inclusive Excellence*. Under this new leadership, the Department is in the beginning stages of a strategic plan for faculty hiring. This *Guidebook* will play a major role in framing this planning process.

B. **Websites for information:**

**Statistics as a Career**
More Students Earning Statistics Degrees, But Not Enough To Meet Surging Demand for Statisticians, *This is Statistics* October 1, 2015
http://thisisstatistics.org/more-students-earning-statistics-degrees-but-not-enough-to-meet-surge-demand-for-statisticians/

A Peek into the Largest, Fastest-Growing Undergraduate Statistics Departments
*Amstat News*, February 1, 2015
http://magazine.amstat.org/blog/2015/02/01/undergraduatedeppts_feb2015/

*Amstat News* A Peek into the Largest, Fastest-Growing Undergraduate Statistics Departments
Statistics Bachelor’s degrees awarded by year and institution:


Big data: The next frontier for innovation, competition, and productivity McKinsey Global Institute, May 2011

AP Data – Archived Data 2016 College Board,
https://research.collegeboard.org/programs/ap/data/archived

Minnesota Statistical Science BS and Statistical Practice BA
https://onestop2.umn.edu/pcas/viewCatalogProgram.do?programID=16280&strm=1179&campus=UMNTC
https://onestop2.umn.edu/pcas/viewCatalogProgram.do?programID=16260&strm=1179&campus=UMNTC

Wisconsin BS and BA in Statistics
http://guide.wisc.edu/undergraduate/letters-science/statistics/statistics-bs/#requirementstext
http://guide.wisc.edu/undergraduate/letters-science/statistics/statistics-ba/#requirementstext

Wisconsin BS and BA in Mathematics
http://guide.wisc.edu/undergraduate/letters-science/mathematics/mathematics-bs/#requirementstext
http://guide.wisc.edu/undergraduate/letters-science/mathematics/mathematics-ba/#requirementstext

ASU Campus Enrollment Data, Fall 2016
https://uoia.asu.edu/sites/default/files/asu_facts_at_a_glance_-_fall_2016_final_0.pdf

ASU Mathematics Major enrollment, May 2017
https://asunow.asu.edu/20170503-awards-ceremony-celebrates-outstanding-achievements-students-school-mathematical-and

ASU BS in Statistics
https://newcollege.asu.edu/statistics-degree

ASU Mathematics major with Statistics concentration
https://math.asu.edu/content/mathematics-statistics

Undergraduate Degree Programs at the University of Arizona

Mathematics http://math.arizona.edu/academics/undergrads
C. Letters of support:

We include letters of support from the following departments/schools offering courses included in this proposal:

- Astronomy
- Biomedical Engineering
- Chemistry/Biochemistry
- Civil Engineering and Engineering Mechanics
- Computer Science
- Ecology & Evolutionary Biology
- Economics
- Electrical & Computer Engineering
- Epidemiology
- Geosciences
- Materials Science and Engineering
- Molecular and Cellular Biology
- Neuroscience and Cognitive Science
- Optical Sciences
- Physics
- Physiology
- Planetary Sciences
- School of Animal and Comparative Biomedical Sciences
- School of Information
- School of Natural Resources and the Environment
- Soil, Water and Environmental Science
- Systems & Industrial Engineering

Letters have been promised from the following departments offering proposed supporting course work:

- Aerospace & Mechanical Engineering
- Agricultural & Biosystems Engineering
- Geography
- Hydrology & Atmospheric Sciences
- Sociology
We asked Chemical and Environmental Engineering about including some courses; they now wish to discuss further with us.

Support Letters:

**Statistics Community**
DeAnna McDonald, Statistics Advanced Placement Instructor, University High School, Tucson, Arizona
Josh Tabor, Statistics Advanced Placement Instructor, Canyon del Oro High School, Tucson, Arizona

**University Community**
Edward Bedrick - Professor of Biostatistics, Department of Epidemiology and Biostatistics
Sue Brown - Professor and Head, Department of Management Information Systems
Bryan Heidorn - Professor and Director, School of Information (also approving supporting courses)
Todd Proebsting - Professor and Head, Department of Computer Science (also approving supporting courses)
Young-Jun Son - Professor and Head, Department of Systems and Industrial Engineering (also approving supporting courses)

**Industry**
Bonnie Lefleur, CDx Program Lead, HTG Molecular Diagnostics - Pending
Lee LeClair, Chief Technology Officer, Ephibian
John McLean, Chief Technology Officer, Arete Associates
Alan Mense, Principal Engineering Fellow Chief Statistician, Raytheon Missile Systems
Jim Ranger-Moore, Senior Director, Biostatistics and Data Management Ventana Medical Systems, Inc.
Appendix I - Minor in Statistics and Data Science

Total units required: 18-19
Upper-division units required: 6-9**

Calculus I:
- MATH 122A: Functions for Calculus (1 unit)
  AND MATH 122B: First-Semester Calculus (4 units)
- OR MATH 125: Calculus I (3 units)

Calculus II & III:
- MATH 129: Calculus II (3 units)
- MATH 223: Vector Calculus (4 units)*

Linear Algebra - Complete 1**:
- MATH 310: Applied Linear Algebra (3 units)
- MATH 313: Introduction to Linear Algebra (3 units)

Intro to Statistics:
- MATH 363: Introduction to Statistical Methods (3 units)

Elective - Complete 1 (3 units):
- MATH 367: Sports Analytics (3 units)
- (new) MATH/STAT 375 Statistical Computing (3 units)
- MATH 462: Financial Math (3 units)
- MATH 464s***: Theory of Probability (3 units)
- MATH 493 Internship (3 units) - with approval from advisor
  Additional elective options to be added.

*A 3 unit transfer course deemed sufficiently equivalent may fulfill this requirement; at least 18 units will be required in the minor.

**Transfer credit for MATH 215 - Introduction to Linear Algebra is also acceptable for this requirement; students using 215 to complete this requirement are not expected to complete additional upper-division units for the minor. Thus, 6-9 upper-division units are required.

***We will eventually need to add a new version of MATH 464 (perhaps with a new number) with a different focus to accommodate the background of statistics majors/minors.

Students may request the minor using our online form; any advisor may add the minor for their students.
### Appendix II - U of A BS STAT/MATH Application Course List

See Section III. - PROGRAM REQUIREMENTS (Comparison Chart), Required supporting coursework section

<table>
<thead>
<tr>
<th>Application Course Requirement:</th>
<th>Statistics &amp; Data Science Major - 6 units of non-math course work with prerequisite or corequisite of at least Calculus 1 or Statistics. Students may choose from:</th>
</tr>
</thead>
</table>
| Math Major - 6 units of non-math course work with prerequisite or corequisite of at least Calculus 1. Students may choose from: | *Permission letter promised  
**Permission pending |
| • ABE 201 Introduction to Biosystems Engineering (2 units), | • ABE 201 Introduction to Biosystems Engineering (2 units), |
| • ABE 284 Biosystems Thermal Engineering (3 units), | • ABE 284 Biosystems Thermal Engineering (3 units), |
| • ABE 428 Control of Erosion Processes (3 units), | • ABE 423 Biosystems Analysis+Dsgn (3 units), |
| • ABE 481A Engineering of Biological Processes (3 units), | • ABE 428 Control of Erosion Processes (3 units); |
| • ABE 481B Cell and Tissue Engineering (3 units); | • ACBS 313 Prin Anml Genetic System (3 units); |
| • ASTR 250 Fundamentals of Astronomy (3 units); | • *AME 472 Reliability Engineering (3 units); |
| • ATMO 421C Physical Climatology: Mechanisms of Change (3 units), | • ASTR 250 Fundamentals of Astronomy (3 units); |
| • ATMO 436A Fundamentals of the Atmospheric Sciences (3 units), | • *ATMO 421C Physical Climatology: Mechanisms of Change (3 units), |
| • ATMO 469A Air Pollution I: Gases (3 units), | • *ATMO 436A Fundamentals of the Atmospheric Sciences (3 units), |
| • ATMO 469B Air Pollution II: Aerosols (3 units); | • *ATMO 469A Air Pollution I: Gases (3 units), |
| • BIOC 462A Biochemistry (4 - 5 units), | • *ATMO 469B Air Pollution II: Aerosols (3 units); |
| • BIOC 462B Biochemistry (4 - 5 units), | • BIOC 462A Biochemistry (4 - 5 units), |
| • BIOC 463A Biochemical Laboratory Techniques (4 units), | • BIOC 462B Biochemistry (4 - 5 units), |
| • BIOC 466 Biochemistry of Nucleic Acids (4 units); | • BIOC 466 Biochemistry of Nucleic Acids (4 units); |
| • BME 481B Cell and Tissue Engineering (3 units); | • BME 481B Cell and Tissue Engineering (3 units); |
| • CE 214 Statics (3 units); | • CE 214 Statics (3 units); |
| • CHEE 201 Elements of Chemical Engineering I (3 units), | • CHEM 161 Honors Fundamentals of Chemistry (3 units), |
| • CHEE 201I Elements of Chemical Engineering I-Computational Lab (1 unit), | • CHEM 162 Honors Fundamentals of Chemistry (3 units), |
| • CHEE 202 Elements of Chemical Engineering II (4 units), | • CHEM 325 Analytical Chemistry (2 units), |
| • CHEE 301A Chemical Engineering Lab I (1 unit), | • CHEM 326 Analytical Chemistry Laboratory (2 units), |
| • CHEE 481A Engineering of Biological Processes (3 units), | • CHEM 404A Inorganic Chemistry (3 units), |
| • CHEE 481B Cell and Tissue Engineering (3 units); | • CHEM 480A Physical Chemistry (3 units), |
| • CHEM 161 Honors Fundamentals of Chemistry (3 units), | • CHEM 480B Physical Chemistry (3 units); |
| • CHEM 162 Honors Fundamentals of Chemistry (3 units), | • CSC 345 Analysis of Discrete Structures (4 units), |
| • CHEM 325 (to be added Fall 2018) Analytical Chemistry (2 units), | • CSC 422 Introduction to Parallel and Distributed Programming (3 units), |
| • CHEM 326 (to be added Fall 2018) Analytical Chemistry Laboratory (2 units), | • CSC 433 Computer Graphics (3 units), |
| • CHEM 404A Inorganic Chemistry (3 units), | • CSC 436 Software Engineering (3 units), |
| | • CSC 437 Geometric Algorithms (3 units), |
| | • CSC 445 Algorithms (3 units), |
- CHEM 480A  Physical Chemistry (3 units),
- CHEM 480B  Physical Chemistry (3 units),
- CHEM 481  Biophysical Chemistry (3 units),
- CSC 345  Analysis of Discrete Structures (4 units),
- CSC 422  Introduction to Parallel and Distributed Programming (3 units),
- CSC 433  Computer Graphics (3 units),
- CSC 436  Software Engineering (3 units),
- CSC 437  Geometric Algorithms (3 units),
- CSC 445  Algorithms (3 units),
- CSC 453  Compilers and Systems Software (4 units),
- CSC 460  Database Design (3 units),
- CSC 477  Introduction to Computer Vision (3 units),
- CSCV 345  Analysis of Discrete Structures (4 units),
- ECE 381A  Introductory Electromagnetics (4 units),
- ECE 429  Digital Signal Processing (3 units),
- ECOL 302  Ecology (4 units),
- ECOL 447  Introduction to Theoretical Ecology (3 units),
- ECOL 496N  Non-Linear Dynamics of Biological Systems (2 - 4 units),
- ECON 332  Intermediate Macroeconomics (3 units),
- ECON 361  Intermediate Microeconomics (3 units),
- ENGR 211C  Engineering Science Module - Statics (1 unit),
- ENGR 211P  Engineering Science Module - Engineering Economics (1 unit),
- ENV 420  Environmental Physics (3 units),
- ENV 470  Soil Physics (3 units),
- GEOG 463  Economic and Environmental Input-Output Analysis (3 units),
- GEOS 322  Introduction to Geophysics (3 units),
- GEOS 356  Petrology (4 units),
- GEOS 419  Physics of the Earth (3 units),
- GEOS 432  Introduction to Seismology (3 - 5 units),
- GEOS 434A  Introduction to Exploration Seismology (3 units),
- GEOS 440  Geodynamics (3 units),
- GEOS 469  Seismic Data Processing (3 units),
- GEOS 479  Introduction to Climate Dynamics (3 units),
- HWRS 421  Water Resources Systems Planning and Management (3 units),
- HWRS 431  Hydrogeology (4 units),
- HWRS 460A  Watershed Hydrology (4 units),
- ISTA 352  Images: Past, Present, and Future (3 units),
- ISTA 421  Introduction to Machine Learning (3 units),
- MCB 315  (to be added Fall 2018) Key Concepts in Quantitative Biology (4 units),
- MCB 480  Introduction to Systems Biology (3 units),
- MSE 345  Thermodynamics (4 units),
- MSE 404  Optical Spectroscopy of Materials (3 units),
- MSE 453  Compilers and Systems Software (4 units),
- MSE 460  Database Design (3 units),
- MSE 477  Introduction to Computer Vision (3 units),
- ECE 381A  Introductory Electromagnetics (4 units),
- ECE 429  Digital Signal Processing (3 units),
- ECOL 302  Ecology (4 units),
- ECOL 447  Introduction to Theoretical Ecology (3 units),
- ECON 332  Intermediate Macroeconomics (3 units),
- ECON 361  Intermediate Microeconomics (3 units),
- ENGR 211C  Engineering Science Module - Statics (1 unit),
- ENV 420  Environmental Physics (3 units),
- ENV 470  Soil Physics (3 units),
- *GEOG 463  Economic and Environmental Input-Output Analysis (3 units),
- GEOS 322  Introduction to Geophysics (3 units),
- GEOS 356  Petrology (4 units),
- GEOS 419  Physics of the Earth (3 units),
- GEOS 432  Introduction to Seismology (3 - 5 units),
- GEOS 434A  Introduction to Exploration Seismology (3 units),
- GEOS 440  Geodynamics (3 units),
- GEOS 469  Seismic Data Processing (3 units),
- GEOS 479  Introduction to Climate Dynamics (3 units),
- *HWRS 421  Water Resources Systems Planning and Management (3 units),
- *HWRS 431  Hydrogeology (4 units),
- *HWRS 449  Statistical Hydrology (3 units),
- *HWRS 443A  Risk Asmnt for Environment Sys (3 units),
- *HWRS 460A  Watershed Hydrology (4 units),
- ISTA 321  Data Mining and Discovery (4 units),
- ISTA 350  Programming for Informatics Applications (4 units),
- ISTA 421  Introduction to Machine Learning (3 units),
- ISTA 450  Artificial Intelligence (3 units),
- MCB 315  Key Concepts in Quantitative Biology (4 units),
- MCB 416A  Stat Bioinfo+Genomic Anl (3 units),
- MCB 480  Introduction to Systems Biology (3 units),
- MSE 345  Thermodynamics (4 units),
- MSE 404  Optical Spectroscopy of Materials (3 units),
- MSE 415  Transport Phenomena and Kinetics in Materials Processing (4 units),
- NSCS 344  Modeling the Mind (3 units),
- OPTI 201R  Geometrical and Instrumental Optics I (3 units),
- PHYS 140  Introductory Mechanics (3 units),
- PHYS 141  Introductory Mechanics (4 units),
- PHYS 142  Introductory Optics and Thermodynamics (3 units),
- MSE 415 Transport Phenomena and Kinetics in Materials Processing (4 units);
- OPTI 201R Geometrical and Instrumental Optics I (3 units);
- PHYS 140 Introductory Mechanics (3 units),
- PHYS 141 Introductory Mechanics (4 units),
- PHYS 142 Introductory Optics and Thermodynamics (3 units),
- PHYS 143 Introductory Optics and Thermodynamics (2 units),
- PHYS 161H Honors Introductory Mechanics (4 units),
- PHYS 162H Honors Introductory Optics and Thermodynamics (4 units),
- PHYS 240 Introductory Electricity and Magnetism (3 units),
- PHYS 241 Introductory Electricity and Magnetism (4 units),
- PHYS 261H Honors Introductory Electricity and Magnetism (4 units);
- PSIO 303 (to be added Fall 2018) Integrative Cellular Physiology (3 - 4 units),
- PSIO 472 Quantitative Modeling of Biological Systems (3 units);
- PTYS 407 Chemistry of the Solar System (3 units);
- PTYS 411 Geology and Geophysics of the Solar System (3 units);
- SIE 250 Introduction to Systems & Industrial Engineering (3 units),
- SIE 265 Engineering Management I (3 units);
- WSM 460A Watershed Hydrology (4 units);
- or courses approved by your academic advisor

- PHYS 143 Introductory Optics and Thermodynamics (2 units),
- PHYS 161H Honors Introductory Mechanics (4 units),
- PHYS 162H Honors Introductory Optics and Thermodynamics (4 units),
- PHYS 240 Introductory Electricity and Magnetism (3 units),
- PHYS 241 Introductory Electricity and Magnetism (4 units),
- PHYS 261H Honors Introductory Electricity and Magnetism (4 units);
- PSIO 303 (to be added Fall 2018) Integrative Cellular Physiology (3 - 4 units),
- PSIO 472 Quantitative Modeling of Biological Systems (3 units);
- PTYS 407 Chemistry of the Solar System (3 units);
- RAM 456A Rangeland Inventory and Monitoring (4 units);
- RNR 417 Geographic Information Systems for Natural and Social Sciences (3 units),
- RNR 473 Spatial Analysis+Modeling (3 units);
- SIE 250 Introduction to Systems & Industrial Engineering (3 units),
- SIE 265 Engineering Management I (3 units)
- SIE 422 Decision Making under Uncertainty (3 units)
- SIE 496 Information Analytics and Decision-Making in Engineering (3 units);
- **SOC 476 Rsch & Analysis of Health Data (3 units);
- STAT 493 Internship (1-3 units);
- WFSC 444 Wildlife Ecol, Cnsvr, Mgmt (4 units);
- WSM 460A Watershed Hydrology (4 units);
- or courses approved by your academic advisor
Appendix III - Minnesota BA & BS Other Electives List

See Section III.  PROGRAM REQUIREMENTS (Comparison Chart), Major coursework section

Electives
For the BA: Take a total of 11 units, at least 5 units of which must be listed as STAT Electives (see table); up to 6 units may be selected from the list below.
For the BS: Take a total of 14 units, at least 4 units of which must be listed as STAT Electives (see table); up to 10 units may be selected from the list below.

Other Electives
BA: Take at most 6 units from the following:
BS: Take at most 10 units from the following:

- CSCI 2011 Discrete Structures of Computer Science (4 units)
- CSCI 2011H Honors Discrete Structures of Computer Science (4 units)
- CSCI 2021 Machine Architecture and Organization (4 units)
- CSCI 2041 Advanced Programming Principles (4 units)
- CSCI 3003 Introduction to Computing in Biology (3 units)
- CSCI 3081W Program Design and Development [WI] (4 units)
- CSCI 4011 Formal Languages and Automata Theory (4 units)
- CSCI 4041 Algorithms and Data Structures (4 units)
- CSCI 4041H Algorithms and Data Structures (4 units)
- CSCI 4061 Introduction to Operating Systems (4 units)
- CSCI 4131 Internet Programming (3 units)
- CSCI 4211 Introduction to Computer Networks (3 units)
- CSCI 4511W Introduction to Artificial Intelligence [WI] (4 units)
- CSCI 4611 Programming Interactive Computer Graphics and Games (3 units)
- CSCI 4707 Practice of Database Systems (3 units)
- CSCI 4950 Senior Software Project (3 units)
- CSCI 4970W Advanced Project Laboratory [WI] (3 units)
- CSCI 5103 Operating Systems (3 units)
- CSCI 5105 Introduction to Distributed Systems (3 units)
- CSCI 5106 Programming Languages (3 units)
- CSCI 5115 User Interface Design, Implementation and Evaluation (3 units)
- CSCI 5117 Developing the Interactive Web (3 units)
- CSCI 5125 Collaborative and Social Computing (3 units)
- CSCI 5143 Real-Time and Embedded Systems (3 units)
- CSCI 5161 Introduction to Compilers (3 units)
- CSCI 5211 Data Communications and Computer Networks (3 units)
- CSCI 5221 Foundations of Advanced Networking (3 units)
- CSCI 5231 Wireless and Sensor Networks (3 units)
- CSCI 5271 Introduction to Computer Security (3 units)
- CSCI 5302 Analysis of Numerical Algorithms (3 units)
- CSCI 5304 Computational Aspects of Matrix Theory (3 units)
- CSCI 5403 Computational Complexity (3 units)
- CSCI 5421 Advanced Algorithms and Data Structures (3 units)
- CSCI 5451 Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3 units)
- CSCI 5461 Functional Genomics, Systems Biology, and Bioinformatics (3 units)
- CSCI 5471 Modern Cryptography (3 units)
- CSCI 5481 Computational Techniques for Genomics (3 units)
- CSCI 5511 Artificial Intelligence I (3 units)
- CSCI 5512 Artificial Intelligence II (3 units)
- CSCI 5521 Introduction to Machine Learning (3 units)
- CSCI 5523 Introduction to Data Mining (3 units)
- CSCI 5525 Machine Learning (3 units)
- CSCI 5551 Introduction to Intelligent Robotic Systems (3 units)
- CSCI 5552 Sensing and Estimation in Robotics (3 units)
- CSCI 5561 Computer Vision (3 units)
- CSCI 5607 Fundamentals of Computer Graphics I (3 units)
- CSCI 5608 Fundamentals of Computer Graphics II (3 units)
- CSCI 5609 Visualization (3 units)
- CSCI 5611 Animation & Planning in Games (3 units)
- CSCI 5707 Principles of Database Systems (3 units)
- CSCI 5708 Architecture and Implementation of Database Management Systems (3 units)
- CSCI 5715 From GPS and Virtual Globes to Spatial Computing (3 units)
- CSCI 5801 Software Engineering I (3 units)
- CSCI 5802 Software Engineering II (3 units)
- MATH 2283 Sequences, Series, and Foundations (3 units)
- MATH 3283W Sequences, Series, and Foundations: Writing Intensive [WI] (4 units)
- MATH 4065 Theory of Interest (4 units)
- MATH 4067W Actuarial Mathematics in Practice [WI] (3 units)
- MATH 4151 Elementary Set Theory (3 units)
- MATH 4152 Elementary Mathematical Logic (3 units)
- MATH 4281 Introduction to Modern Algebra (4 units)
- MATH 4428 Mathematical Modeling (4 units)
- MATH 4512 Differential Equations with Applications (3 units)
- MATH 4567 Applied Fourier Analysis (4 units)
- MATH 4603 Advanced Calculus I (4 units)
- MATH 4604 Advanced Calculus II (4 units)
- MATH 4707 Introduction to Combinatorics and Graph Theory (4 units)
- MATH 5067 Actuarial Mathematics I (4 units)
- MATH 5068 Actuarial Mathematics II (4 units)
- MATH 5075 Mathematics of Options, Futures, and Derivative Securities I (4 units)
- MATH 5076 Mathematics of Options, Futures, and Derivative Securities II (4 units)
- MATH 5165 Mathematical Logic I (4 units)
- MATH 5166 Mathematical Logic II (4 units)
- MATH 5248 Cryptology and Number Theory (4 units)
- MATH 5251 Error-Correcting Codes, Finite Fields, Algebraic Curves (4 units)
- MATH 5285H Honors: Fundamental Structures of Algebra I (4 units)
- MATH 5286H Honors: Fundamental Structures of Algebra II (4 units)
- MATH 5335 Geometry I (4 units)
- MATH 5336 Geometry II (4 units)
- MATH 5345H Honors: Introduction to Topology (4 units)
- MATH 5378 Differential Geometry (4 units)
- MATH 5385 Introduction to Computational Algebraic Geometry (4 units)
- MATH 5445 Mathematical Analysis of Biological Networks (4 units)
- MATH 5447 Theoretical Neuroscience (4 units)
- MATH 5467 Introduction to the Mathematics of Image and Data Analysis (4 units)
- MATH 5485 Introduction to Numerical Methods I (4 units)
- MATH 5486 Introduction To Numerical Methods II (4 units)
- MATH 5525 Introduction to Ordinary Differential Equations (4 units)
- MATH 5535 Dynamical Systems and Chaos (4 units)
- MATH 5583 Complex Analysis (4 units)
- MATH 5587 Elementary Partial Differential Equations I (4 units)
- MATH 5588 Elementary Partial Differential Equations II (4 units)
- MATH 5615H Honors: Introduction to Analysis I (4 units)
- MATH 5616H Honors: Introduction to Analysis II (4 units)
- MATH 5652 Introduction to Stochastic Processes (4 units)
- MATH 5654 Prediction and Filtering (4 units)
- MATH 5705 Enumerative Combinatorics (4 units)
- MATH 5707 Graph Theory and Non-enumerative Combinatorics (4 units)
- MATH 5711 Linear Programming and Combinatorial Optimization (4 units)
- PUBH 3415 Introduction to Clinical Trials Online (3 units)
- PUBH 6420 Introduction to SAS Programming (1 units)
- PUBH 6431 Topics in Hierarchical Bayesian Analysis (1 units)
- PUBH 6432 Biostatistical Methods in Translational and Clinical Research (1 units)
- PUBH 6470 SAS Procedures and Data Analysis (3 units)
- PUBH 7415 Introduction to Clinical Trials (3 units)
- WRIT 3562W Technical and Professional Writing [WI] (4 units)
- CSCI 4203 Computer Architecture (4 units)
  or EE 4363 Computer Architecture and Machine Organization (4 units)
- CSCI 4921 History of Computing [TS, HIS] (3 units)
  or HSCI 4321 History of Computing [TS, HIS] (3 units)
- CSCI 5204 Advanced Computer Architecture (3 units)
  or EE 5364 Advanced Computer Architecture (3 units)
# Appendix IV - Comparison Chart for Proposed BA & BS in Statistics and Data Science

<table>
<thead>
<tr>
<th>Program Name, subplan name (if applicable), degree, and institution</th>
<th>Statistics and Data Science BS Arizona (proposed)</th>
<th>Statistics and Data Science BA Arizona (proposed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently enrolled students</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Description of major</td>
<td>By merging modern data science approaches with a solid mathematical background and practical training, the Undergraduate Degree in Statistics provides a curriculum that allows students to make significant contributions at the forefront of knowledge across the vast array of activities in government, education, and industry that rely on statistical thinking.</td>
<td>By merging modern data science approaches with a solid mathematical background and practical training, the Undergraduate Degree in Statistics provides a curriculum that allows students to make significant contributions at the forefront of knowledge across the vast array of activities in government, education, and industry that rely on statistical thinking.</td>
</tr>
</tbody>
</table>
| Target Careers | • Actuary  
• Banking consultant  
• Consulting statistician  
• Data analyst  
• Data engineer  
• Database administrator  
• Financial planner  
• Healthcare analyst  
• Market researcher  
• Risk analyst  
• Statistical computing  
• Survey designer  
• Software engineer  
• Sports analyst  
• Statistical engineer  
• Underwriter  

Statistical training can be considered as a complement to many career choices that use intensive data analysis, presentation, and inference. | • Actuary  
• Banking consultant  
• Consulting statistician  
• Data analyst  
• Data engineer  
• Database administrator  
• Financial planner  
• Market researcher  
• Risk analyst  
• Statistical computing  
• Survey designer  
• Sports analyst  
• Statistical engineer  
• Underwriter  

Statistical training can be considered as a complement to many career choices that use intensive data analysis, presentation, and inference. |
<table>
<thead>
<tr>
<th><strong>use intensive data analysis, presentation, and inference.</strong></th>
<th><strong>A Master’s degree may be required for some careers.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total units required to complete degree</strong></td>
<td><strong>120</strong></td>
</tr>
<tr>
<td><strong>Upper -division units required to complete degree</strong></td>
<td><strong>42</strong></td>
</tr>
<tr>
<td><strong>Foundation courses</strong></td>
<td></td>
</tr>
<tr>
<td><strong>English Composition</strong></td>
<td><strong>6 units</strong></td>
</tr>
<tr>
<td><strong>Foreign Language</strong></td>
<td><strong>BS: 2nd semester proficiency</strong></td>
</tr>
<tr>
<td><strong>Math</strong></td>
<td><strong>3 units (part of major)</strong></td>
</tr>
<tr>
<td><strong>General Education Requirements</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pre-major? (yes/no). If yes, indicate coursework.</strong></td>
<td><strong>no</strong></td>
</tr>
<tr>
<td><strong>List any special requirements to declare or gain admission to this major (completion of specific coursework, minimum GPA, interview, application, etc.)</strong></td>
<td><strong>none</strong></td>
</tr>
<tr>
<td><strong>MAJOR REQUIREMENTS</strong></td>
<td></td>
</tr>
</tbody>
</table>

57
<table>
<thead>
<tr>
<th>Required supporting coursework (courses that do not count towards major units and major GPA, but are required for the major). Courses listed must include subject code, units, and title.</th>
<th>Minimum # of units required in major</th>
<th>Minimum # of upper-division units required in the major</th>
<th>Minimum # of residency units to be completed in the major</th>
</tr>
</thead>
</table>
| One course from:  
- CSC 110 Introduction to Computer Programming I (4 units)  
- ISTA 130 Computational Thinking and Doing (4 units)  
One lab science sequence selected from:  
- PHYS 141 Introductory Mechanics (4 units) & either PHYS 142 Introductory Optics and Thermodynamics (3 units) or PHYS 241 Introductory Electricity and Magnetism (4 units)  
- PHYS 161H Honors Introductory Mechanics (4 units) & either PHYS 162H Honors Introductory Optics and Thermodynamics (4 units) or PHYS 261H Honors Introductory Electricity and Magnetism (4 units)  
- CHEM 151 General Chemistry I (4 units) & CHEM 152 General Chemistry II (4 units)  
- CHEM 105A Honors Fundamentals of Chemistry (3 units) & CHEM 106A Honors Fundamental Techniques of Chemistry (1 unit) & CHEM 105B Honors Fundamentals of Chemistry (3 units) & CHEM 106B Honors Fundamental Techniques of Chemistry (1 unit) (these will be renumbered as 161/162 & 163/164)  
- MCB 181R Introductory Biology I (3 units) & MCB 181L Introductory Biology Laboratory I (1 unit) & ECOL 182R Introductory Biology II | 34 | 21-24 (students may transfer MATH 215 in to cover MATH 313) | 18 |
| One course from:  
- CSC 110 (4 units) Introduction to Computer Programming I  
- ISTA 130 (4 units) Computational Thinking and Doing | 34 | 21-24 (students may transfer MATH 215 in to cover MATH 313) | 18 |
Methods

SIE

MATH

Analytics

Data

Introduction

Statistics

Probability
coursework

Statistical

Major requirements
(list all required major coursework including major core, major electives, subplan core, subplan electives; courses count towards major units and major GPA). Courses listed must include course prefix, number, units, and title. Mark new coursework (New).

<table>
<thead>
<tr>
<th>Major requirements</th>
<th>Core:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- MATH 125 or 122A/B Calc 1 (3-5 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 129 Calc 2 (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 223 Vector Calc (4 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 313 Intro to Linear Algebra (3 units) or MATH 310 Applied Linear Algebra (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 363 Intro to Stats (3 units)</td>
</tr>
<tr>
<td></td>
<td>- <strong>(new)</strong> MATH/STAT 375 Statistical Computing (3 units)</td>
</tr>
<tr>
<td></td>
<td>- <strong>(new)</strong> MATH 464s Theory of Probability (3 units)</td>
</tr>
<tr>
<td></td>
<td>- <strong>(new)</strong> MATH 466s Theory of Statistics (3 units)</td>
</tr>
<tr>
<td></td>
<td>- <strong>(new)</strong> MATH/STAT 467 Introduction to Applied Linear Models (3 units)</td>
</tr>
<tr>
<td></td>
<td>- <strong>(new)</strong> MATH/STAT 465 Intro to Data Science (3 units)</td>
</tr>
<tr>
<td>Elective (choose one):</td>
<td>- MATH 367 Stat Methods in Sports Analytics (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 462 Financial Mathematics (3 units)</td>
</tr>
<tr>
<td></td>
<td>- MATH 468 Stochastic Processes (3 units)</td>
</tr>
<tr>
<td></td>
<td>- SIE 440 Survey of Optimization Methods (3 units)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- MATH 125 or 122A/B Calc 1 (3-5 units)</td>
</tr>
<tr>
<td>- MATH 129 Calc 2 (3 units)</td>
</tr>
<tr>
<td>- MATH 223 Vector Calc (4 units)</td>
</tr>
<tr>
<td>- MATH 313 Intro to Linear Algebra (3 units) or MATH 310 Applied Linear Algebra (3 units)</td>
</tr>
<tr>
<td>- MATH 363 Intro to Stats (3 units)</td>
</tr>
<tr>
<td>- <strong>(new)</strong> MATH/STAT 375 Statistical Computing (3 units)</td>
</tr>
<tr>
<td>- <strong>(new)</strong> MATH 464s Theory of Probability (3 units)</td>
</tr>
<tr>
<td>- <strong>(new)</strong> MATH 466s Theory of Statistics (3 units)</td>
</tr>
<tr>
<td>- <strong>(new)</strong> MATH/STAT 467 Introduction to Applied Linear Models (3 units)</td>
</tr>
<tr>
<td>- <strong>(new)</strong> MATH/STAT 465 Intro to Data Science (3 units)</td>
</tr>
</tbody>
</table>

Elective (choose one):
- MATH 367 Stat Methods in Sports Analytics (3 units)
- MATH 462 Financial Mathematics (3 units)
- MATH 468 Stochastic Processes (3 units)
- SIE 440 Survey of Optimization Methods (3 units)
Eventually, we would like to add more elective choices; some ideas:

- **(new)** MATH 4XX Actuarial Science (3 units)
- **(new)** MATH 4XX Survey Sampling (3 units)
- **(new)** MATH 4XX Time Series (3 units)

<table>
<thead>
<tr>
<th>Internship, Practicum, Applied Course Requirements. (Yes/no. If yes, please describe.)</th>
<th>Yes; the BS requires at least 6 units of coursework that applies calculus or other concepts from the major to another field.</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Thesis or Senior Project Required (Yes/No)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Additional Requirements (Please Describe.)</td>
<td>Electives are required to meet graduation unit requirements. Students may opt to add a second major to fill the extra units, which may fulfill the minor requirement.</td>
<td>Electives are required to meet graduation unit requirements. Students may opt to add a second major to fill the extra units, which may fulfill the minor requirement.</td>
</tr>
<tr>
<td>MINOR (Please specify if optional or required)</td>
<td>required</td>
<td>required</td>
</tr>
</tbody>
</table>
Biographical Sketch

Ning Hao

(a) Professional Preparation

<table>
<thead>
<tr>
<th>Institution</th>
<th>Major</th>
<th>Degree (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peking University,</td>
<td>Mathematics</td>
<td>BS (2003)</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stony Brook University</td>
<td>Mathematics</td>
<td>PhD (2009)</td>
</tr>
</tbody>
</table>

(b) Appointments

Position
Assistant Professor, Department of Mathematics, University of Arizona 2013 -
Member, Graduate Interdisciplinary Program in Statistics, University of Arizona 2010 -
Visiting Assistant Professor, Department of Mathematics, University of Arizona 2010 - 2013

(c) Products

(i) Five Products Most Closely Related to the Proposed Project


(ii) Five Additional Products

3. Hao, N. and Zhang, H.H. A Note on High Dimensional Linear Regression with Interactions, to appear *The American Statistician*.
(d) Synergistic Activities


2. Contributions to publicly accessible statistical software: R packages SaRa, modSaRa, RAM and SCPALDA.


4. Organize and chair invited sessions for domestic and international conferences.
Thomas G. Kennedy  
Department of Mathematics, University of Arizona, Tucson, AZ 85721

A. Professional Preparation  
University of Virginia  
Mathematics  
Ph.D., 1984  
Indiana University  
Mathematics  
M.A., 1981  
California Institute of Technology  
Mathematics  
B.S., 1977

B. Appointments  
1995-present  
Professor, Mathematics Department, U. of Arizona  
1996-present  
Professor, Physics Department, U. of Arizona  
2008-2014  
Associate Head for the Mathematics Graduate Program, U. of Arizona  
1998-1999  
Acting Head for the Applied Mathematics Graduate Program, U. of Arizona  
1988-1995  
Associate Professor, Mathematics Department, U. of Arizona  
1986-1989  
NSF Mathematical Sciences Post-doctoral Research Fellowship  
1985-1988  
Assistant Professor, Physics Department, Princeton University  
1984-1985  
Instructor, Physics Department, Princeton University

C. Products relevant to proposed research  
Links to electronic versions of these publications may be found on the PI’s website:  
[http://math.arizona.edu/~tk/](http://math.arizona.edu/~tk/)

Five products most closely related to proposed project  
1. K. Haller, T. Kennedy, Absence of renormalization group pathologies near the critical  
095219 (2012).  
4. T. Kennedy, Conformal invariance of the 3D self-avoiding walk, Phys. Rev. Lett. 111, 
165703 (2013).  
5. T. Kennedy, The Smart Kinetic Self-Avoiding Walk and Schramm-Loewner Evolution, 

Five other significant products  
1. T. Kennedy, Long range order in the anisotropic quantum ferromagnetic Hasebell  
2. J. Affleck, T. Kennedy, E. Lieb, H. Tasaki, Valence-bond ground states in isotropic  
3. T. Kennedy, Monte Carlo tests of SLE predictions for the 2D self-avoiding walk, Phys. 
4. T. Kennedy, A fast algorithm for simulating the chordal Schramm-Loewner evolution, 
5. T. Kennedy, G. Lawler, Lattice effects in the scaling limit of the two-dimensional self-  
avoiding walk, Fractal Geometry and Dynamical Systems in Pure and Applied Mathematics II: 
D. Synergistic Activities
1. Algorithm development/computer code: The code for the fast algorithm the PI has
developed to compute the Loewner driving function of curves in the plane has been shared with
several researchers at other institutions. The code for the fast algorithm the PI has developed to
simulate SLE was released under the GNU General Public License and is available on the PI’s
website.
2. The “Bridge Group”: The bridge group, which was named after bridges in self-avoiding
walks and SLE, consisted of undergraduates, graduate students and the PI. It was started in
September 2008 and met weekly during the academic year until the spring of 2012 to discuss
research problems in self-avoiding walks and SLE. The members at various times included
graduate students Ben Dyhr, Michael Gilbert, Jinning Jiang, John Kerl and Shane Passon, and
undergraduates Howard Cheng, Daniel Cross, Di Fu, Sean Howe, Xiaoying Jia, John Lawrence,
Marco Lopez, Gabriel Moreno and Jing Wei Zhang.

E. Collaborators and Other Affiliation:
Collaborators:
Michel Bauer, Physique Théorique, CEA, Saclay, France
Denis Bernard, Ecole Normale Superieure, Paris, France
Tony Guttmann, Department of Mathematics and Statistics, University of Melbourne
Gregory Lawler, Departments of Mathematics and Statistics, University of Chicago
Graduate Advisor:
David Brydges, Mathematics Department, University of British Columbia
Postdoctoral Sponsor:
Elliott Lieb, Mathematics and Physics Departments, Princeton University
Thesis advisor for:
Jinning Jiang, Ph.D., Mathematics, University of Arizona, 2015
Michael Gilbert, Ph.D., Mathematics, University of Arizona, 2013
Ben Dyhr, Ph.D., Mathematics, University of Arizona, 2009
Karl Haller, Ph.D., Applied Mathematics, University of Arizona, 1998
Martin Pokorny, Ph.D., Applied Mathematics, University of Arizona, 1992
Postdoctoral Sponsor: none
Kevin K. Lin

Education
Massachusetts Institute of Technology Mathematics S.B. 1996
Massachusetts Institute of Technology Computer Science S.B. 1997
Massachusetts Institute of Technology EECS M.Eng. 1997
University of California, Berkeley Mathematics Ph.D. 2003

Experience
2015 - Member, Graduate Interdisciplinary Program in Cognitive Science
2014 - Member, Graduate Interdisciplinary Program in Statistics
2013-2014 Visiting Scientist, Lawrence Berkeley National Laboratory and Visiting Scholar, Dept. of Mathematics, University of California, Berkeley
2013 - Associate Professor of Mathematics, University of Arizona
Fall 2009 Research Fellow, Statistical and Applied Math. Sci. Institute (SAMSI)
2008 Member, Program in Applied Mathematics
2007-2013 Assistant Professor of Mathematics, University of Arizona
2003-2007 NSF Postdoctoral Fellow and Courant Instructor Courant Institute of Mathematical Science, New York University

Synergistic Activities, Honors and Awards
2012 - Steering Committee, Program in Applied Mathematics, University of Arizona
2012 - Editorial Board, Journal of Computational Dynamics
2003-2007 NSF Postdoctoral Fellowship
1999-2003 Fannie and John Hertz Foundation Fellowship

Selected publications
David Lyttle, Brian Gereke, Kevin K. Lin, and Jean-Marc Fellous (2013) Spatial scale and place field stability in a grid-to-place cell model of the dorsoventral axis of the hippocampus, Hippocampus 23, 729-744
Peter Balint, Kevin K. Lin, and Lai-Sang Young (2010) Ergodicity and energy distributions for some boundary driven integrable Hamiltonian chains, Communications in Mathematical Physics 294, 199-228
Kevin K. Lin and Lai-Sang Young (2008) Shear-induced chaos, Nonlinearity 21, 899-922
Rob Maier

A. Professional Preparation
Rutgers University Mathematics Ph.D. 1983
California Institute of Technology Physics M.S. 1980

B. Appointments
2001 – Professor of Mathematics and Physics, University of Arizona, Tucson, AZ
1998 – 2001 Associate Professor of Mathematics and Physics, University of Arizona
1994 – 1998 Associate Professor of Mathematics, University of Arizona
1988 – 1994 Assistant Professor of Mathematics, University of Arizona
1986 – 1988 Visiting Assistant Professor of Mathematics, University of Arizona
1983 – 1986 Instructor, Department of Mathematics, University of Texas at Austin

C. Publications
5 publications most closely related to the proposed project (all single-authored)

5 other significant publications

D. Synergistic Activities
- 2006-2008. Co-organized three Special Sessions at sectional meetings of the American Mathematical Society (AMS), titled “Special Functions and Orthogonal Polynomials” and “Algorithmic Probability and Combinatorics,” with attendees including physicists and applied mathematicians, in addition to pure mathematicians.

Co-edited the resulting refereed proceedings volume, now being published by the AMS in its Contemporary Mathematics series.
- 1996-present. Authored and served as maintainer of the GNU plotting utilities package, the centerpiece of which is a subroutine library for exporting 2-D graphics in many graphics file formats, from C and C++ programs. It is distributed by the Free Software Foundation, at the URL: http://www.gnu.org/software/plotutils.

E. Collaborators & Other Affiliations
(a) Collaborators and Co-Editors
Research collaborators (last five years). None
Co-editors (current and last two years). Diego Dominici (SUNY), Manuel Lladser (U. Colorado), Marni Mishna (Simon Fraser U.), Andrew Rechnitzer (U. British Columbia).

(b) Graduate and Postgraduate Advisors

(c) Thesis Advisor and Postgraduate-Scholar Sponsor
Former Ph.D. students. Michael Peralta (Texas Instruments).
Matthias Morzfeld  
Department of Mathematics  
University of Arizona  
Tucson, Arizona, 85721  
mmo@math.arizona.edu  http://math.arizona.edu/~mmo

(a) Professional Preparation
Technical University Darmstadt (Germany) Mechanical Engineering B.Sc. 2007
University of California, Berkeley Mechanical Engineering M.Sc. 2009
University of California, Berkeley Mechanical Engineering Ph.D. 2011
Lawrence Berkeley National Laboratory Mathematics Postdoctoral Fellow 2011–2012
University of California, Berkeley Mathematics Postdoctoral Fellow 2012–2013

(b) Appointments
2015 – present  Assistant Professor  Mathematics, University of Arizona
2013, 2014  Visiting Professor  Institute de Physique du Globe de Paris, France

(c) Publications
(i) Closely related publications

(ii) Other significant publications

(d) Synergetic Activities
(i) Conference and Seminar Organization


(ii) Graduate student advising


Insoon Yang, Electrical Engineering and Computer Science, University of California, Berkeley (2013–2015). Topic: path integral control. This led to a conference paper.

(iii) Undergraduate student advising


(iv) Journal Refereeing


(v) Fellowships and awards

Robert F. Steidel Memorial Fund in Mechanical Engineering, UC Berkeley (2011); Graduate Researcher Travel Grant, German Academic Exchange Service (DAAD) (2010); Outstanding Graduate Student Instructor Award, Graduate Division, UC Berkeley (2008); Exceptional Prelim Award, Mechanical Engineering, UC Berkeley (2008); Undergraduate Research Grant, DAAD (2006–2007); Undergraduate Research Travel Grant, DAAD (2004–2005).

(e) Collaborators and Other Affiliations


(ii) Graduate and Postdoctoral Advisors: A.J. Chorin (UC Berkeley/LBNL, postdoctoral), F. Ma (UC Berkeley, graduate)

(ii) Thesis Advisor and Postgraduate-Scholar Sponsor: None.
Yue Niu

Education
Peking University  Statistics  B.A.  2004

Experience
2009-  Assistant Professor, Mathematics, University of Arizona
2009-  Member, Graduate Interdisciplinary Program in Statistics
2009 -  Postdoctoral Associate, Yale University

Synergistic Activities, Honors and Awards
Refereeing: Annals of Applied Statistics; Annals of Statistics; Biometrics; Canadian Journal of
Statistics; Journal of the American Statistical Association; Journal of Computational and
Graphical Statistics; PLOS ONE; Statistica Sinica; Statistics and Its Interface.
AWM-NSF Travel Grant, 2012

Selected publications


Niu, Y. S., Hao, N. and An, L. (2011) Detection of rare functional variants using group ISIS,

Niu, Y. S. and Zhang, H. (2012) The Screening and Ranking Algorithm to Detect DNA Copy

Hao, N., Niu, Y. S. and Zhang, H. (2013) Multiple change-point detection via a screening and
ranking algorithm, Statistica Sinica, 23 (2013), 1533-1572.
DOUG PICKRELL

0.1. Education.
   Ph.D. in Mathematics, University of Arizona, 1984
   B.S. in Mathematics, University of Arizona, 1975

0.2. Employment.
   (Assistant, Associate) Professor of Mathematics, University of Arizona, 1986-present
   Visiting Positions:
      UC Berkeley, 2014-2015,
      Mittag-Leffler Institute, Fall 1998,
      Yale University 1989-1990
   N.S.F. Postdoctoral Fellowship, 1989-1992
   Gibbs Instructor, Yale University, 1984-1986
   Mathematics/Engineering, Hughes Aircraft, Culver City, CA 1979-1981

0.3. Selected Publications.
   1. (with Angel Chavez) Werner's measure on self-avoiding loops and welding, SIGMA (2014)
   2. Loops in SU(2) and factorization, J. Funct. Anal. 260 (2011)
Walter W. Piegorsch

Education
Colgate University  Mathematics  B.A., magna cum laude  1979
Cornell University  Statistics  M.S.  1982
Cornell University  Statistics  Ph.D.  1984

Experience
2006-  Professor, Mathematics, Univ. of Arizona
2010-  Member, GIDP in Applied Mathematics (Affiliate Member, 2006-2010), Univ. of Arizona
2007-  Member, GIDP in Statistics (Chair, 2007-2012), Univ. of Arizona
2007-  Director, Statistical Research & Education, BIO5 Institute, Univ. of Arizona
2007-  Professor, Public Health, Univ. of Arizona
2007-  Professor, Agricultural & Biosystems Engineering, Univ. of Arizona
2004-2006  Senior Scientific Member, South Carolina Cancer Center
1996-2006  Professor, Statistics, Univ. of South Carolina (Associate Professor, 1993-1996)
1998-2002  Director of Undergraduate Studies, Statistics, Univ. of South Carolina
1998-2002  Adjunct Professor, Biostatistics, Univ. of North Carolina
1988-1993  Adjunct Associate Professor, Statistics, North Carolina State Univ.
1984-1993  Mathematical Statistician, U.S. National Institute of Environmental Health Sciences

Synergistic Activities, Honors and Awards
2012-  Member, Editorial Board, John Wiley & Sons WileyStatsRef: Statistics Reference Online
2010-  Editor-in-Chief, Environmetrics (Editor, 2009; Associate Editor, 1992-2008)
2010-2016  Accredited Professional Statistician (PStat®), American Statistical Association
2006-2008  Joint Editor, Journal of the American Statistical Association, Theory & Methods Section
(Joint editor-elect, 2005; Associate Editor, 1996-2004)
2004  Chairman, American Statistical Association Section on Statistics and the Environment (Past-Chair, 2005; Chair-elect, 2003)
2002-2005  Council Member, International Biometric Society
2000-2004  Member, Board of Scientific Counselors, U.S. National Toxicology Program
1997-2004  Associate Editor, Biometrics
1997-1999  Vice-Chair, American Statistical Association Council of Sections Governing Board
1995-1996  Secretary, International Biometric Society/ENAR
1995  Fellow, American Statistical Association
1995  Member (by election), International Statistical Institute
1994  Chairman, Joint Program Committee, Joint Statistical Meetings, Toronto, Canada
1993  Distinguished Achievement Medal, American Statistical Association Section on Statistics and the Environment

Selected publications
Sunder Sethuraman

Education
Stanford University  Mathematics  BS  1990
New York University  Mathematics  PhD  1995

Experience
2011 -  Professor, Mathematics, University of Arizona
2008 - 2011  Professor, Mathematics, Iowa State University
2002 - 2008  Associate Professor, Mathematics, Iowa State University.
1998 - 2002  Assistant Professor, Mathematics, Iowa State University.
1996 - 1998  Visiting Assistant Professor, Mathematics, University of Minnesota.
1995 - 1996  Post-Doc, Mathematics, ETH-Zentrum (Zürich)

Synergistic Activities, Honors, and Awards
2009  Lambert Prize for pure mathematics, Department of Mathematics, Iowa State University.
2002-2011  Associate Editor for Statistics and Probability Letters
2013  -  Associate Editor for Rocky Mountain J. Math.
2014  -  In organizing committee of Frontier Probability Days conference
2001  -  In organizing committee of Ames Weekend Workshop on Particle Systems
2009 - 12 lectures given in conferences

Graduate and Postdoctoral Advisors
Graduate:  Varadhan, S.R.S. (New York)
Postdoctoral:  Sznitman, A.-S. (ETH-Zürich).

Thesis Advisor
PhD advisor:  Z. Dietz (Hamilton College)
  D. Kontoyiannis (co-adv. with G. Lieberman) (Georgia Southern U.)
  J. Choi (co-adv. with M. Askenovic) (Syracuse U.)
MS advisor:  Eric Blabac (Statistics) (SAP Software)
  Max Wimmer (Mathematics) (U. Regensburg, Finance)
Current MS graduate student:  Derick Bishop (U. Arizona)
Current PhD graduate student:  Erik Davis (U. Arizona)
  Doron Shahar (U. Arizona)
former graduate students + 3 current graduate student advised.

Selected Publications (after 2009)
Joseph C. Watkins
Professor - Department of Mathematics, Member of Interdisciplinary Programs on Applied Mathematics, Statistics, and Genetics and the Bio5 Institute

a. Professional Preparation
University of Tennessee Mathematics B.A. 1974
University of Tennessee Mathematics M.A. 1976
University of Wisconsin Mathematics M.S. 1978
Freie Universität Berlin Mathematics Wissenschaftlicher Mitarbeiter, 1980
University of Wisconsin Mathematics Ph.D. 1982
University of British Columbia Mathematics Postdoctoral Fellow, 1982-1985
University of Minnesota, Institute for Mathematics and its Applications Postdoctoral Fellow, 1985

b. Appointments:
2007- Present, Professor, Mathematics, University of Arizona
1996-2007, Associate Professor, Mathematics, University of Arizona
1982-1996, Visiting Assistant Professor, Mathematics, University of Arizona
1986-1992, Assistant Professor, Mathematics, University of Southern California
1987, Senior Research Fellow, Northwestern University

c. Publications

d. Synergistic activities
i) Interdisciplinary research – co-Principal Investigator of National Science Foundation funded projects in the programs on Biocomplexity and Human and Social Dynamics. Investigators come from anthropology, genetics, and mathematics.

ii) Interdisciplinary graduate training. Member of Graduate Interdisciplinary Programs in Applied Mathematics, in Statistics and in Genetics. Member of Executive Committee and Vice Chair for Interdisciplinary Programs in Statistics.

iii) Interdisciplinary high school education. Director – Native American Summer Institute. The Institute serve the Pascua Yaqui Tribe and the Tohono O’odham Nations by inviting 24 high school students to spend 3 weeks at the University of Arizona involved in a interdisciplinary curriculum in mathematics, biology, and economics. (1996-2006)

iv) Service to the mathematics community. Chair – Human Rights of Mathematicians Committee.

v) Service to the educational aspects of the profession. Executive Committee Member – Howard Hughes Medical Institute Biomath Consortium, dedicated to fostering inter-institutional collaboration in the development of interdisciplinary undergraduate education in mathematics and biology (2006-2008)

e. Collaborators and Other Affiliations:

i) Collaborators and co-authors (last 4 years):
- W. Ardika – Fakultas Sastra, Universitas Udayana, Denpasar, Bali, Indonesia
- W. A. Arthawiguna – Blaii Penelitian dan Pengkajian Teknologi Pertanian, Denpasar, Bali, Indonesia
- Michael Bamshad, Lynn Jorde – University of Utah
- Murray C. Cox – Massey University, New Zealand
- Xavier Didelot – University of Oxford
- Sean S. Downey – University College, London
- M. Merrwether – Binghamton University
- Alan Redd – University of Kansas
- John Schoenfelder – University of California, Los Angeles
- Herawati Sudoyo – Eijkman Institute, Indonesia
- S. P. K. Surata – Mhasraswati University, Bali, Indonesia
- Jesse E. Taylor – Arizona State University
- Jeffery D. Wall – University of California, San Francisco

ii) Graduate Advisor – Thomas G. Kurtz, University of Wisconsin
Postdoctoral Advisor – John B. Walsh, University of British Columbia (emeritus)

iii) Graduate Students advised:
- Silvia Henbach – California State University, Los Angeles
- Wolfgang Rolke – University of Puerto Rico, Mayaguez
- Kevin Anderson – Carlisle Consulting, Minneapolis, Minnesota
- D. Brian Walton – James Madison University
- Sergei Pond – University of California, San Diego
- Shih-Chieh Liao – Taiwan National University
- Joseph Stover – University of California, Santa Barbara

Postdoctoral Trainees advised; Last 5 years:
- Jai Ling Dai – University of the Pacific

In total 6 masters’ students, 6 doctoral students, 4 postdoctoral students advised.
Janek Wehr

CHRONOLOGY OF EDUCATION
Department of Mathematics, Warsaw University: 1977-1982
Master of Science: 1982
Major field: Mathematics

Department of Mathematics, Rutgers University: 1985-1989
Doctor of Philosophy: 1989
Major field: Mathematical Physics

CHRONOLOGY OF EMPLOYMENT
1982-1985 Teaching assistant, Department of Mathematics, Warsaw University
1986-1989 Teaching assistant, Department of Mathematics, Rutgers University, New Brunswick, NJ
1989-1991 Visiting member, School of Mathematics, Institute for Advanced Study, Princeton, NJ
1991-1997 Assistant professor, Department of Mathematics, University of Arizona, Tucson, AZ
1991-1992 Instructor, Department of Physics, Princeton University, Princeton, NJ (on leave from the University of Arizona)
1999-2000 Visiting professor, Interdisciplinary Center for Mathematical and Computer Modeling, Warsaw University, Warsaw, Poland (on leave from the University of Arizona)
2007-2008 Associate professor, Department of Mathematics, University of Arizona, Tucson, AZ
2006-2007 Visiting professor, Institute for Optical Sciences (ICFO), Castelldefels, Spain and Visiting scientist, Physics Laboratory, École Normale Supérieure, Lyon, France (on leave from the University of Arizona)
2008-2015 Professor, Department of Mathematics, University of Arizona
2014 Visiting scientist, Physics Laboratory, École Normale Supérieure, Lyon, France and Visiting professor, Department of Physics, Bilkent University, Ankara, Turkey (on leave from the University of Arizona)
2013 Visiting member, Mathematical Sciences Research Institute, Berkeley CA

SYNERGISTIC AND OUTREACH ACTIVITIES
1. Development of a graduate course in mathematical physics at the University of Arizona and teaching it three times (in 2004, 2007 and 2010).
3. Extensive graduate teaching at the University of Arizona (39 graduate courses taught during 20 years).
4. Graduate advising: 6 students graduated with Ph. D. degrees.
5. Undergraduate advising: counseling about 15 mathematics majors at any given time since 1993.
6. Designing and teaching a probability and statistical thinking course for Tucson school teachers (Fall of 2010) as a part of the Arizona Teacher Initiative program.
7. "At random: the wonderful world of probabilities"—a talk for general public in the Science Cafe series, Tucson, Arizona, followed by an article in “Arizona Daily Star”.

HONORS AND AWARDS

COLLABORATORS, ADVISERS AND ADVISEES:

Graduate and postdoctoral advisers: Tadensz Ba-laban, Michael Aizenman, Thomas Spencer, Elliott Lieb.

Dissertation advisees: Jung Woo, Thomas LaGatta, David Herzog, Michael Bishop, Scott Hottovy, Austin McDaniel, Soon Hoe Lim (current), Dustin Keys (current).
Hao Helen Zhang

Education
Peking University Mathematics B.A. 1996
University of Wisconsin Statistics Ph.D. 2002

Experience
2014- Member, Graduate Interdisciplinary Program in Statistics
2011-2014 Associate Professor, Mathematics, University of Arizona
2008-2011 Associate Professor, Department of Statistics, North Carolina State University
1986-1992 Assistant Professor, Department of Statistics, North Carolina State University

Synergistic Activities, Honors and Awards
2015 Fellow, American Statistical Association (ASA)
2015 Elected Member, International Statistical Institute (ISI)
2007 CAREER Award, National Science Foundation (NSF)
2008- Associate Editor – Journal of the American Statistical Association (JASA)
2012- Associate Editor – Journal of Computational and Graphical Statistics (JCGS)
2015- Editor, Stat
2008-2014 Associate Editor, Biometrics
2015- COWIS-Gertrude Cox Scholarship Committee, ASA
2015- Executive Board, Caucus for Women in Statistics
2013- Council of Sections Representative, Section on statistical learning and data mining, ASA

Selected Grants
2013-2016 Flexible modeling for high-dimensional data. NSF DMS-1309507 (PI)
2007-2013 NSF CAREER Award, DMS-0643293. (PI)
2012-2013 Computational approaches to feature selection for massive data. NSA H98230-12-1. (PI)
2007-2011 Flexible statistical methods for biomedical data. NIH R01 CA083848 (Co-PI)
2007-2014 CSUMS: NCSU computation for undergraduates in statistics. NSF DMS-0703392 (Co-PI)

Selected publications
October 20, 2017

University of Arizona
Mathematics Department

To Whom It May Concern,

University High School would like to express its support for the opportunity for students, through the creation of a new Bachelors’ degree in Statistics and Data Science at the University of Arizona, to earn a degree in an emerging and important field right here at home.

Currently, when students hope to pursue a degree in statistics, they must consider matriculation at a university other than the U of A. This new degree will increase options for those students who do elect to study here as well as provide additional incentives for students to remain.

When such a degree program is approved, we would be happy to provide interested students with the degree plan as well as facilitate in-person recruitment efforts by members of the department.

Yours Sincerely,

Leiba Schuneman             DeAnna K. McDonald
Leiba Schuneman             DeAnna McDonald
Mathematics Department Chair AP Statistics Teacher

Joel Bacalia
Joel Bacalia
Assistant Principal, Curriculum and Instruction

25 Advanced Placement Course Offerings • 62 Flinn Foundation Scholars
676 National Merit Finalists • 434 National Merit Scholars
21 Varsity-level Athletic Teams • Student Clubs For All Interests
October 13, 2017

To Whom It May Concern,

We are writing this letter to strongly support the creation of a Statistics and Data Science degree for undergraduates at the University of Arizona.

At Canyon del Oro High School in Oro Valley, we have between 50 and 60 students taking AP Statistics each year. Many of those students fall in love with the subject and consider pursuing a major or minor when they go to college. In particular, several students have become interested in the subject as a result of an outreach program from graduate students in the statistics program at UA. For the last two years, Ph.D. students have spoken to my classes about the value of studying statistics and the research they are conducting as part of their studies. Here is a link to an article in an American Statistical Association magazine highlighting these talks: http://www.stat.u.arizona.edu/Statistics/Online%20Activities/stat-grads-

After our students express interest in studying statistics in college, it is with disappointment that we inform them that the University of Arizona does not currently offer such an option. As a result, these students either look to other universities or consider other majors. This is frustrating to us as teachers and fans of the U of A!

The proposed course of study is rigorous and the emphasis on data science reflects best practices as described by the American Statistical Association. It also makes it easier for us to go back to college and get a second degree.

We strongly encourage you to add this degree at the University of Arizona.

Sincerely,

Josh Test
AP Statistics Teacher
2011 Arizona Teacher of the Year Finalist

Dr. Nina Godlewski
Math Department Chair

Scanned by CamScanner
November 6, 2017

Joe Watkins, Ph.D.
Professor of Mathematics
Director, GIDP in Statistics
Department of Mathematics
University of Arizona

Joe:

I am writing in support of your efforts to create an undergraduate program in Statistics and Data Science at the University of Arizona. There are a number of compelling reasons why this program should exist. First, many level I research institutions in the United States have separate degree programs in Statistics, including undergraduate majors. As Statistics is distinct from Mathematics, clarity in degree branding is very important, especially given the tremendous demand for quantitative scientists with expertise in statistical methods and data science, a demand that does not broadly extend to mathematics. Having a separate, new degree program will allow students greater flexibility in their choice of courses to fulfill the major, and thus to better position themselves for later opportunities. As I believe we have an obligation to the taxpayers of the state of Arizona to provide degree programs that are responsive to market demands (among other things), I view the relatively small investment needed to get this program going as a great opportunity to provide our constituents sound academic training that will lead to marketable degrees and ultimately high-paying professional positions.

As the Graduate Program Director of Biostatistics in the Mel and Enid Zuckerman College of Public Health, I also view your program as providing great training for advanced study in either statistics or biostatistics. As I have a B.A. in Statistics from SUNY at Buffalo, I can attest that my undergraduate degree coupled with sound mathematical training positioned me to apply and be accepted into many top graduate programs in Statistics. Without a doubt, that undergraduate degree in Statistics helped me get to where I am today, I enthusiastically support for attempts to bring the same opportunities to students at Arizona.

Sincerely,

Edward J. Bedrick

Edward J. Bedrick, Ph.D.
Professor of Biostatistics
Department of Epidemiology and Biostatistics
Mel and Enid Zuckerman College of Public Health
University of Arizona

Arizona’s First University – Since 1885
October 23, 2017

Joseph Watkins  
Department of Mathematics  
University of Arizona

Dear Dr. Watkins,

This is a letter of support for the proposed Bachelor’s in Statistics and Data Science being proposed by the Department of Mathematics. I have reviewed the program specifications and I believe that the program is timely and a necessary addition to our undergraduate offerings at the University of Arizona. In this age of big data and sophisticated analytical tools permeating all spheres of business and social life, more training in statistics and data-related topics will only improve our graduates’ success rates in the long run.

This degree is significantly different from anything we offer in MIS. In fact, I can imagine encouraging our majors who are seeking a non-Eller concentration to investigate this program as the quantitative skills will dovetail nicely with the business and computing skills of our program.

We support the Department of Mathematics’ plans to launch this degree.

Sincerely,

Susan A. Brown  
McClelland Professor and Department Head of Management Information Systems
14 October 2017

Joe Watkins, PhD
Department of Mathematics
University of Arizona
617 N Santa Rita Ave
Tucson, AZ 85721

Subject: Undergraduate Statistics and Data Science Degree at the University of Arizona

Dear Joe,

During my thirty-five year career in ocean remote sensing research, I was often confronted with challenging technical problems that required a strong foundation in Statistics. As CEO and CTO of Artec Associates, I was constantly on the lookout for new talent with a deep understanding of statistics. I was fortunate to find many outstanding Math, Physics, and Engineering graduates; however, in most cases their knowledge of statistics was rather shallow. What Artec needed then, and still needs today, are graduates with a much deeper understanding of statistical principles and methods.

Artec's technical problems include "classical" Bayesian detection and estimation theory applied to problems of high dimensionality. In addition to the statistical methods, a firm grounding in computational techniques is required to make such problems tractable. The proposed program in Statistics and Data Science would prepare students to make significant contributions to these challenging problems.

A second class of problems at Artec is concerned with predictive analytics. One example is using patient's medical histories to predict future hospitalizations. Such predictive techniques would allow early interventions to improve patient outcomes. A strong grounding in Data Science, as covered by the proposed degree, would prepare students for a broad range of problems in predictive analytics.

While I have described several areas where Artec would eagerly hire Statistics and Data Science graduates, I expect such graduates would have a wide variety of career choices available. Conversely, lack of such a program leaves an unfulfilled gap in the hiring needs of many institutions. Given such a need, and the outstanding capability of the University of Arizona faculty to implement such a program, I wholeheartedly endorse the development of a new undergraduate degree program in Statistics and Data Science.

Sincerely,

[Signature]

John W. McLean, PhD
Consultant (former CEO and CTO of Artec Associates)
3537 N. Camino Seco
Tucson, AZ 85749
We are excited to learn that the University of Arizona Department of Mathematics is launching an undergraduate degree in Statistics.

Companies in all industries and researchers in every area of scientific study are awash in data. Making sense of that data comes, ultimately, from Statistics. While various computer disciplines also come into play, the basis of measuring what is real in an ocean of data comes down to Statistics. Predictive analytics, simulations, and modelling are all shaped by Statistics.

Ephibian is a Tucson based technology company that works in many industries and research areas. While our focus is on the applied use of technology, statistics and data analysis underpin many of our core efforts.

Our work in the fields of medicine, insurance, finance, defense, space, education, telecommunications, cybersecurity, and others share a common thread of reliance on the foundational knowledge of mathematics in general and Statistics in particular. It is gratifying to see that the UA recognizes this need and is working to keep the UA at the forefront of the field and preparing graduates for an increasingly demanding workforce.

So we are happy that the University of Arizona recognizes the importance of Statistics with this new undergraduate program and we celebrate the award of the UA-TRIPODS by the National Science Foundation.

Kind Regards,

Leonard Le Clair
Chief Technology Officer
Ephibian Inc.
To: Professor Joseph C. Watkins, Ph.D.
Professor of Mathematics, Applied Mathematics, Genetics, BIO5 Inst.
Chair, Statistics GIDP
1064 E. Lowell St., Blcg. ENR2, Rm. S321
University of Arizona
Tucson, AZ

The University of Arizona and Raytheon Company have had an enduring and beneficial relationship for many years. We have always appreciated and continue to appreciate the University's strong ongoing commitment to partner with us and to serve the needs of Arizona industry.

Of the approximately 12,000 employees at our Tucson Missile Systems headquarters, about 2,000 gained their degrees from the University of Arizona. It is difficult to predict exactly how many statistics graduates we would hire each year but certainly in areas such as reliability and mission assurance, program development and cyber IT we use statistical analyses. It is always useful if your graduates also have strong skills modeling and simulation and introductory cyber IT background. Year after year, the University is our largest single source of new hires into Raytheon Missile Systems and adding an undergraduate program in statistics should increase the pool of talent from which we can select.

We depend upon the University's nationally renowned programs to keep us and our domestic and international customers at the forefront edge of today's latest technologies. Over the years, the University has successfully adapted its academic programs to the changing needs of our business, and I want to draw your attention to the fact that the present Statistics Certificate established by the Mathematics Department GIDP has fulfilled an important need for advanced statistics education for our engineers. RMS is very appreciative. There is now a new opportunity for further cooperation and coordination between our company and the University. We wholeheartedly support this new initiative.

Allan T. Menae, Ph.D., PhE, CRE
Principal Engineering Fellow
Chief Statistician
Raytheon Missile Systems
Andrew C. Comrie  
Senior Vice President for Academic Affairs and Provost  
University of Arizona  
Tucson, AZ 85719

Dear Dr. Comrie,

I am writing this letter in support of the effort being made at the University of Arizona to establish an undergraduate major and minor in statistics. Offering these opportunities to students would directly benefit them, as well as the job market and society they will join. I will present three of the largest benefits I see from my perspective as an administrator at Ventana Medical Systems, as a long-practicing statistician, as a former U of A professor for 18 years, and as a responsible citizen.

I will start with the narrowest focus, which is benefit to local companies like Ventana. We have a challenging time hiring outside talent to Tucson for a variety of reasons, with the result that the U of A has been a significant pipeline for us, with many of my best employees being former Wildcats. Of course, since there is not yet a statistics undergraduate degree, they are a combination of MS, MPH, and PhD students from the Statistics GIDP and the College of Public Health. While advanced degrees are important for some of our more challenging work, there are also a great many tasks for which graduate degree holders are somewhat overqualified. A source of undergraduates majoring in statistics who have already spent some time in Tucson, and may therefore be more likely to stay, would be a terrific resource for Ventana and an excellent opportunity for U of A undergraduates when they begin looking for employment. Any of those students continuing into a graduate program first would be even more qualified than their peers who have a less rigorously statistical background, further enhancing employment opportunities upon graduation.

Casting more broadly, in my department of nearly 40 people, almost 80% of my biostatisticians are foreign-born. There is a critical shortage of US-born statisticians that has had a strong adverse impact across industry. Although it has been possible to import statisticians from other countries, it is not at all clear in the current political climate whether this will continue to be possible in the future to the extent that it is now. Industry, government, and academia will all profit by a strengthening of our domestic production of statistical talent.
Entirely aside from consideration of labor markets and job opportunities, and indeed of whether a statistics minor or major undergraduate would go on to be employed as a statistician per se, there is great value in providing such opportunities for students in the modern world. We face an unprecedented amount of information of highly uneven quality. Systematically teaching students the skills necessary to understand and interpret not only the information itself, but also the validity of that information, is critical if we are to maintain an educated electorate that can contribute to the stability of our democratic society.

For all of these reasons, implementing the requested undergraduate statistics major and minor would serve students well, the job market well, and our society well. I strongly recommend that you support this endeavour.

Please do not hesitate to contact me if you would like to discuss this further.

Sincerely,

James Ranger-Moore, PhD
Senior Director, Biostatistics and Data Management
Ventana Medical Systems, Inc.
520-241-8843
jim.ranger-moore@roche.com
# BUDGET PROJECTION FORM

Name of Proposed Program or Unit: **Major in Statistics and Data Science**

<table>
<thead>
<tr>
<th>METRICS</th>
<th>1st Year 2018 - 2019</th>
<th>2nd Year 2019 - 2020</th>
<th>3rd Year 2020 - 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net increase in annual college enrollment UG</td>
<td>30</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Net increase in college SCH UG</td>
<td>624</td>
<td>1,425</td>
<td>2,964</td>
</tr>
<tr>
<td>Net increase in annual college enrollment Grad</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Net increase in college SCH Grad</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Number of enrollments being charged a Program Fee</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>New Sponsored Activity (MTDC)</td>
<td>0.00</td>
<td>0.00</td>
<td>100,000.00</td>
</tr>
<tr>
<td>Number of Faculty FTE</td>
<td>1.00</td>
<td>3.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>

## FUNDING SOURCES

### Continuing Sources
- UG RCM Revenue (net of cost allocation) 239,652.00 519,925.00 1,075,532.00
- Grad RCM Revenue (net of cost allocation)
- Program Fee RCM Revenue (net of cost allocation)
- F and A Revenues (net of cost allocations) 100,000.00
- UA Online Revenues
- Distance Learning Revenues
- Reallocation from existing College funds (attach description)
  - Faculty
  - GRAs 80,000.00 100,000.00 120,000.00
  - Instructor 40,000.00 100,000.00 100,000.00
- Other Items (attach description)

**Total Continuing** 359,652.00 819,925.00 1,720,532.00

### One-time Sources
- College fund balances - Operational Budget 15,000.00 15,000.00 15,000.00
- Institutional Strategic Investment

(Net gain in majors only; will likely have similar number of Stat minors)
<table>
<thead>
<tr>
<th>Gift Funding</th>
<th>35,000.00</th>
<th>75,000.00</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total One-time</strong></td>
<td>15,000.00</td>
<td>50,000.00</td>
</tr>
<tr>
<td><strong>TOTAL SOURCES</strong></td>
<td>374,652.00</td>
<td>869,925.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXPENDITURE ITEMS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Continuing Expenditures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>100,000.00</td>
<td>325,000.00</td>
<td></td>
</tr>
<tr>
<td>Instructors/Lecturers</td>
<td>40,000.00</td>
<td>100,000.00</td>
<td>100,000.00</td>
</tr>
<tr>
<td>Other Personnel (Academic Advisor)</td>
<td>45,000.00</td>
<td>45,000.00</td>
<td>45,000.00</td>
</tr>
<tr>
<td>Employee Related Expense</td>
<td>27,200.00</td>
<td>78,400.00</td>
<td>150,400.00</td>
</tr>
<tr>
<td>Graduate Assistantships</td>
<td>80,000.00</td>
<td>100,000.00</td>
<td>120,000.00</td>
</tr>
<tr>
<td>Graduate ERE</td>
<td>10,400.00</td>
<td>13,000.00</td>
<td>15,600.00</td>
</tr>
<tr>
<td>Graduate Tuition</td>
<td>45,944.00</td>
<td>57,430.00</td>
<td>68,916.00</td>
</tr>
<tr>
<td>Other Graduate Aid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations (materials, supplies, phones, etc.)</td>
<td>15,000.00</td>
<td>15,000.00</td>
<td>15,000.00</td>
</tr>
<tr>
<td>Additional Space Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Items (attach description)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Continuing</strong></td>
<td>263,544.00</td>
<td>508,830.00</td>
<td>839,916.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>One-time Expenditures</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction or Renovation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start-up Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library Resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Items (attach description)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total One-time</strong></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

| **TOTAL EXPENDITURES**    | 263,544.00 | 508,830.00 | 839,916.00 |
| **Net Projected Fiscal Effect** | 111,108.00 | 361,095.00 | 970,616.00 |
New academic program request BS statistics and data science

IX. REQUIRED SIGNATURES:

Managing Unit Administrator: Douglas Ulmer
(name and title)

Managing Administrator’s Signature: ___________________ Date: 10/18/17

Managing Unit Administrator:
(name and title)

Managing Administrator’s Signature: ___________________ Date:

Managing Unit Administrator:
(name and title)

Managing Administrator’s Signature: ___________________ Date:

Dean’s Signature: ___________________ Date: 10/18/17

Dean’s Signature: ___________________ Date:

All programs that will be offered through distance learning must include the following signature. The signature of approval does not indicate a commitment to invest in this program. Any potential investment agreement is a separate process.

Joel Hauff, Associate Vice President of Student Affairs & Enrollment Management/Academic Initiatives and Student Success

Signature: ___________________ Date:

All programs that will be offered fully online must include the following signature: The signature of approval does not indicate a commitment to invest in this program. Any potential investment agreement is a separate process.

Vincent Del Casino Jr., Vice Provost for Digital Learning and Associate Vice President of Student Affairs & Enrollment Management

Signature: ___________________ Date:

Note: In some situations signatures of more than one unit head and/or college dean may be required.
MEMORANDUM

DATE: December 7, 2017

TO: Dr. Joseph C. Watkins, Professor & Chair, Statistics GIDP
    Laurie Varecka, Assistant Director, Math Center

FROM: Kitt Farrell-Poe, PhD
      Professor and Head
      Agricultural & Biosystems Engineering Department

RE: ABE courses supporting proposed Statistics and Data Science Bachelor of Science program

The ABE department supports the proposed new major in Statistics and Data Science. Thank you for including the following ABE courses in your list of approved courses: ABE 201, ABE 284, ABE 423, and ABE 428. I do not foresee any problems regarding accessibility of your students to any of the listed courses. We hope your new program is a success and look forward to collaborating with you in this new program and in future endeavors.
Date: October 23, 2017

To: Dr. Joseph C Watkins, Professor and Chair, Statistics-GIDP
Laurie Varecka | Assistant Director, Math Center

From: Dr. André-Denis Wright, Director, School of Animal and Biomedical Sciences

Subject: Statistics and Data Science

This is to formally express our support of the proposed new major in Statistics and Data Science. Thank you for including ACBS 313 Principles of Animal Genetic Systems (3 units) in some of the proposed program's supporting requirements. I do not foresee any problems regarding accessibility to the course for students in your proposed program. We hope your new program is a success and look forward to collaborating with you on future endeavors.
Date: October 23, 2017

To: Pamela Coonan, Senior Director, Academic / Curricular Affairs

From: Marcia Rieke, Associate Head, Department of Astronomy

Re: Use of ASTR 250 for Statistics and Data Science Major

Action: In support of the new degree

Copy: Buell Jannuzi, Department Head, Astronomy; Joseph Watkins, Statistics-GIDP Chair; Laurie Varecka, Assistant Director, Math Center; Yancy Shirley, Astronomy Undergraduate Director

This memo indicates our formal support of the Statistics and Data Science major that would be housed in the Mathematics Department. The course “Fundamentals of Astronomy” (ASTR 250) would be offered to give students background in astronomy to help understand the large datasets generated in astronomy such as those that will come from the Large Synoptic Survey Telescope. We have recently switched from teaching this course only in the fall semester to offering it in both the fall and spring semesters so we have enough capacity to teach these extra students although we may need to request larger classrooms than currently used. We do not anticipate any extra costs associated with statistics students taking this course.
November 14, 2017

Pamela Coonan  
Executive Director  
Academic/Curricular Affairs  
University of Arizona  
RE: Statistics and Data Science Bachelors of Arts and Science

Dear Pamela Coonan,

This letter is to formally express our support of the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science, housed in the Department of Mathematics.

We do not anticipate any negative impacts from the BS or BA in Statistics and Data Science.

We anticipate consistently offering the following courses as a support course for this degree:

BME 481B (spring only)

Students are required to meet all pre-requisites prior to enrolling. They may be required to take courses not required for the Statistics and Data Science major in order to enroll.

Sincerely,

Arthur F. Gmitro, Ph.D.  
Professor and Head Department of Biomedical Engineering  
Professor of Medical Imaging and Optical Sciences
October 20, 2017

Pamela Coonan  
Executive Director  
Academic/Curricular Affairs  
University of Arizona

RE: Statistics and Data Science Bachelors of Arts and Science

Dear Pamela Coonan,

This letter is to formally express our support of the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science, housed in the Department of Mathematics.

We do not anticipate any negative impacts from the BS or BA in Statistics and Data Science. Due to overlap with other majors, it may become possible for students to more easily earn multiple majors and minors.

We anticipate consistently offering the following courses for this degree:

- CHEM 151 General Chemistry I (Fall, Spring, and Summer)  
- CHEM 152 General Chemistry II (Fall, Spring, and Summer)  
- CHEM 161 & CHEM 163 Honors Fundamentals & Techniques of Chemistry (Fall)  
- CHEM 162 & CHEM 164 Honors Fundamentals & Techniques of Chemistry (Spring)  
- BIOC 462A Biochemistry (Fall)  
- BIOC 462B Biochemistry (Spring)  
- BIOC 466 Biochemistry of Nucleic Acids (Spring)  
- CHEM 404A Inorganic Chemistry (Spring)  
- CHEM 480A Physical Chemistry (Fall & Spring, Fall only effective Fall 2018)  
- CHEM 480B Physical Chemistry (Spring only, effective Spring 2018)  
- CHEM 325 Analytical Chemistry (Fall and Spring)  
- CHEM 326 Analytical Chemistry Laboratory (Fall and Spring)

Students are required to meet all pre-requisites prior to enrolling. They may be required to take courses not required for the Statistics and Data Science major in order to enroll.

Sincerely,

Roger L. Miesfeld, Ph.D.  
CBC Department Head  
Director, Industry Associates Program
To: Laurie Varecka, Asst. Director, Math Center

From: Kevin Lansey, Department Head, Dept. of CEEM

Date: 1 November 2017

RE: Inclusion of CE 214, Engr. 211C and Engr. 211I as options in Statistics and Data Science Major

Our department is agreeable to the prospect of students in the proposed Statistics and Data Science major to take the courses noted above given that they have the proper prerequisites as defined in the course catalog. No requirement will be imposed on these students to be part of the College of Engineering or our department.

Our department is responsible for these CE and Engr classes and providing their instructors. We currently have space in the classes to accommodate additional students and have adequate resources to support a higher demand if necessary.
October 10, 2017

MEMORANDUM TO: Pamela Coonan, Executive Director, Academic & Curricular Affairs
FROM: Todd Proebsting
REGARDING: Support for proposed BA and BS in Statistics and Data Science

This is to formally express Department of Computer Science support of the proposed Department of Mathematics Bachelor of Arts and Bachelor of Science Statistics and Data Science degrees.

We do not anticipate any negative impact on course enrollment or demand from the proposed degrees and find it may be beneficial for students to double major in computer science and statistics and data science, in both the BA and BS degrees.

We approve the inclusion of CSC 110 – Introduction to Computer Programming I in the proposed BA and BS degrees. We also approve the following courses as options for applications in the proposed BS degree:

- CSC 345 – Analysis of Discrete Structures
- CSC 422 – Introduction to Parallel and Distributed Programming
- CSC 433 – Computer Graphics
- CSC 436 – Software Engineering
- CSC 437 – Geometric Algorithms
- CSC 445 – Algorithms
- CSC 453 – Compilers and Systems Software
- CSC 460 – Database Design
- CSC 477 – Introduction to Computer Vision

We anticipate the SCH revenue for these courses will cover our costs of delivery.
November 27, 2017

TO: Pamela Coonan, Executive Director, Academic & Curricular Affairs
FR: Jeffrey W. Jacobs, Department Head, Aerospace and Mechanical Engineering (AME)
RE: In support of Statistics and Data Science Bachelor of Science Degree

This is to formally express AME’s support of the proposed Statistics and Data Science Bachelor of Science Degree housed in the College of Science, Mathematics Department.

We do not anticipate a negative impact on the Department of Aerospace and Mechanical Engineering’s degree programs or the Department of Mathematics’ Bachelor of Science Degree in Statistics and Data Science. We believe this will have a positive impact allowing for further collaboration between the two departments/colleges.

AME anticipates delivering one course for this degree (AME 472 – Reliability Engineering) and the revenue generated through RCM for this course will support the costs associated with the delivery.

Cc: file
November 14, 2017

Pamela Coonan  
Executive Director  
Academic/Curricular Affairs  
University of Arizona  

RE: Statistics and Data Science Bachelors of Arts and Science  

Pamela Coonan,  

The Department of Mathematics is requesting the use of ECE 429 and 381A as supporting coursework for the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science. The Electrical and Computer Engineering Undergraduate Studies Committee has unanimously voted to allow the use of ECE 429 and ECE 381A in this proposed degree program.  

If you need further information, please do not hesitate to contact me.  

Sincerely,  

Hal Tharp  

Associate Department Head  
Department of Electrical and Computer Engineering
November 2, 2017

Pamela Coonan  
Executive Director, Academic/Curricular Affairs  
University of Arizona

Dear Pamela Coonan,

This letter is to formally express the support of the Department of Economics for the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science, housed in the Department of Mathematics.

The Department of Economics would be pleased to have students in these new degree programs select Economics as their minor or second major (requiring ECON 332 and ECON 361) for their degree requirements. In our view, classes such as ECON 332, Intermediate Macroeconomics, and ECON 361, Intermediate Microeconomics, would be excellent complements to the other technical requirements for the new degrees. While students who are not official Economics majors are not able to register for ECON 332 and 361 during the University’s Priority Registration period, space is often available for other students to be able to enroll in these two classes.

Sincerely,

Andreas Blume  
Department Head  
McClelland Professor of Economics
Date: November 6, 2017

To: Pamela Coonan, Executive Director, Academic/Curricular Affairs

From: Michael Worobey, Department Head and Louise Foucar Marshall Science Research Professor

Re: Support for Statistics and Data Science B.S. and B.A. Degrees

Dear Pamela,

This letter is a formal expression of support for the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science, housed in the Department of Mathematics.

We do not anticipate that these new degree programs will have a negative impact on the B.S. or B.A. in Ecology and Evolutionary Biology, B.S. in Biology, or B.S. in Bioinformatics, and believe this collaboration between EEB and Math has the potential to be beneficial for both departments. Therefore, the following ECOL courses are permitted to be included in the proposed programs’ supporting requirements:

- ECOL 182R Introductory Biology II Lecture (offered Fall, Spring, SSI, SSII; Instructor/s: TBA)
- ECOL 182L Introductory Biology II Lab (offered Fall, Spring, SSI, SSII; Instructor/s: TBA)
- ECOL 302 Ecology (offered Fall; Instructor/s: Judith Bronstein, Katrina Dlugosch)
- ECOL 447 Introduction to Theoretical Ecology (offered every other Fall; Instructor: Peter Chesson)

We expect that we will be able to accommodate additional students in the courses listed above, and that the SCH revenue generated will cover our cost of delivery.

Sincerely,

Dr. Michael Worobey
Department Head
Louise Foucar Marshall Science Research Professor
Ecology and Evolutionary Biology
November 16, 2017

Laurie Varecka,
Assistant Director, Math Center
Department of Mathematics
The University of Arizona

Dear Ms Varecka,

I am writing in support of your efforts to create an undergraduate program in Statistics and Data Science at the University of Arizona. In an era of big data, it is important to provide students with the skills to both conduct analyses on existing data sets and also to understand their context and how they may be applied to answer questions of relevance to different communities.

As the undergraduate program director in Epidemiology, I fully support the development of this program. We received a request to include EPID 479 as a potential selective for your curriculum and I feel it would be an appropriate course to provide context on health issues that may benefit from big data analysis. While this course does not have a heavy analytical component, the instructor indicated that students will be exposed to relevant health questions and will learn about data sources and analytical techniques through the papers that are read in the course.

Please feel free to contact me to discuss further details about this course.

Sincerely,

Kacey C. Ernst, PhD
Associate Professor
Undergraduate Program Director
Department of Epidemiology and Biostatistics
Mel and Enid Zuckerman College of Public Health
University of Arizona
This is to formally express our support of the proposed Statistics and Data Science Bachelor of Science degree, housed in the Mathematics Department of the College of Science. We do not anticipate a negative impact on the degrees offered by the School of Geography and Development. We anticipate delivering one course for this degree: GEOG 463 Economic and Environmental Input-Output Analysis (3 units). We do not anticipate any increased cost of delivery.

Sincerely,

Greg Barron-Gafford
Associate Professor and Associate Director for the School of Geography & Development
University of Arizona
Tucson, AZ 85721, USA
www.barrongafford.org
520.548.0388
18 October 2017

To: Pamela Coonan, Senior Director, Academic / Curricular Affairs
From: Peter Reiners, Head, Department of Geosciences
Re: Support for new major in Statistics and Data Science

We support the proposed new major in Statistics and Data Science and we will be pleased to accommodate students in the following courses (as well as any other Geos courses) to support their pursuit of this degree:

GEOS 251 Physical Geology
GEOS 302 Stratigraphy and Sedimentology
GEOS 304 Structural Geology
GEOS 322 Introduction to Geophysics
GEOS 356 Petrology
GEOS 419 Physics of the Earth
GEOS 432 Earthquake Seismology
GEOS 434A Exploration Seismology
GEOS 440 Geodynamics
GEOS 469 Seismic Data Processing
GEOS 479 Introduction to Climate Dynamics

We do not anticipate any negative impacts from the BS or BA in Statistics and Data Science. Students are required to meet all pre-requisites for Geosciences classes prior to enrolling. They may be required to take courses not required for the Statistics and Data Science major in order to enroll.

Sincerely,

Peter W. Reiners
Professor and Department Head
October 17, 2017

Pamela Coonan, Senior Director
Academic/Curricular Affairs

Dear Pamela,

This is to formally express our support of the proposed new major in Statistics and Data Science offered by the Department of Mathematics in the College of Science.

We anticipate delivering the following three courses for this degree:

MCB 315 – Key Concepts in Quantitative Biology
MCB 416A – Statistical Bioinformatics and Genomic Analysis
MCB 480 – Introduction to Systems Biology

We anticipate that the SCH revenue for these courses will cover our costs of delivery.

Sincerely,

Joyce Schroeder
Professor and Head

MCB 181R and MCB 181L also approved for use as lab science courses.
To: Pamela Coonan  
Executive Director  
Academic/Curricular Affairs  
University of Arizona

From: Pierre A. Deymier  
Professor and Head, Dept. of Materials Science and Engineering  
University of Arizona  
Tucson AZ 85721

Re: Statistics and Data Science Bachelors of Arts and Science

Dear Pamela Coonan,

This letter is to formally express my Department’s support of the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science, housed in the Department of Mathematics.

We anticipate consistently offering the following courses that you are being considered as supporting courses for the proposed bachelor programs:

MSE 345 Thermodynamics (4 units)  
MSE 404 Optical Spectroscopy of Materials (3 units)  
MSE 415 Transport Phenomena and Kinetics in Materials Processing (4 units)

Students are required to meet the pre-requisites prior to enrolling in these courses. Subsequently, they may be required to take courses not required for the Statistics and Data Science bachelors in order to enroll.
Re: NSCS 344

Dear Laurie,

We’re delighted by your interest in our course, NSCS 344 – Modeling the Mind, as an option to fulfill part of the supporting-courses requirement for your proposed major in Statistics and Data Science. We’ve checked with the instructor who believes it completely possible to accommodate students from the proposed major.

NSCS 344 has recommended, but not required, pre-requisites of statistics and introductory programming. The course is open for any undergraduate to enroll, with no restrictions. Currently, the course is only offered in the spring; we see no likelihood of changing the frequency or semester in the near-term future.

Yours,

Lynne A. Oland, PhD
Research Professor
Associate Head, Dept of Neuroscience
Director, Undergraduate Program in Neuroscience and Cognitive Science
9 November 2017

To: Laurie Varecka, Assistant Director, Math Center  
FROM: John Koshel, Associate Dean for Academic Programs  
RE: Supporting course for degree program

We would be elated to include OPTI 201R – Geometrical and Instrumental Optics I as a supporting course for the B.S. in Statistics and Data Science major that is being proposed. This course is the introductory course for the Optical Sciences and Engineering (OSE) undergraduate degree, thus the perquisites are limited to introductory Math (124 or 125; and 129), Physics (141), and MSE (110) courses. We require that students have received at minimum a grade of C in each of the prerequisite courses. There is no concern at this time in the increased class sizes if students from your proposed new major take this course or others from the OSE curriculum. You indicated in your request that students in this program may consider a minor or second major in the supporting program. You may learn more about a B.S. in Optical Sciences and Engineering at this [link]. You may learn more about an undergraduate minor in Optics at this [link].† Note that the B.S. OSE degree is joint between the College of Optical Sciences and the College of Engineering, thus Engineering procedures must also be followed. We look forward to the development of your new major and your students learning more about the field of optics. If you should have any questions, do not hesitate to contact me.

Cheers,

[Signature]

* BS in OSE: [http://www.optics.arizona.edu/academics/degree-programs/bachelor-science-optical-sciences-and-engineering](http://www.optics.arizona.edu/academics/degree-programs/bachelor-science-optical-sciences-and-engineering)

† Minor in Optics: [http://www.optics.arizona.edu/academics/undergraduates](http://www.optics.arizona.edu/academics/undergraduates)
November 3, 2017

Pamela Coonan
Executive Director
Academic/Curricular Affairs
University of Arizona

RE: Statistics and Data Science Bachelors of Science

Dear Pamela Coonan,

This letter is to express our support of the Bachelor of Science degree in Statistics and Data Science proposed by the Department of Mathematics.

We permit the inclusion of the following courses for use in the proposed major, and foresee no issues with accessibility for students in the major:

PHYS 140
PHYS 141
PHYS 142
PHYS 143
PHYS 161H
PHYS 162H
PHYS 240
PHYS 241
PHYS 261H

Students are required to meet all prerequisites prior to enrolling.

Sincerely,

[Signature]

Sumit Mazumdar
Department Head and Professor of Physics
October 30, 2017

Dear Pam,

The Department of Physiology is supportive of the use of Human Anatomy and Physiology (PSIO 201 and 202) as part of the curriculum for the proposed Statistics and Data Science degree. In addition, we also support the use of Quantitative Models of Biological Systems (PSIO 472) as an elective in this proposed degree. Integrative Cellular Physiology (PSIO 303) is also a good option for students who choose to pursue a double degree in Physiology and Statistics and Data Science.

Please let us know if you have any questions.

Sincerely,

Claudia Stanescu, Ph.D.
Assistant Professor (Educator Scholar)
Director, Physiology Undergraduate Program
(520) 621-2795

Nick Delamere, Ph.D.
Professor
Chair, Department of Physiology
(520) 626-6425
DATE: October 23, 2017

TO: Pamela Coonan  
Executive Director, Academic/Curricular Affairs

FROM: Timothy D. Swindle

RE: PTYS courses (407 and 411) for Statistics and Data Science major

This is to express departmental support for use of PTYS 407 as a supporting course to fulfill the degree requirement for applications in a math/statistics context. However, after review and consideration of the course syllabi for PTYS 411, I cannot recommend use of PTYS 411 for the Statistics and Data Science major. PTYS 411 does not include enough statistical content to merit inclusion in the major curriculum.

Please contact me should you have any questions or concerns.

PTYS 407: Chemistry of the Solar System. Abundance, origin, distribution, and chemical behavior of the chemical elements in the Solar System. Emphasis on applications of chemical equilibrium, photochemistry, and mineral phase equilibrium theory. Suggested prerequisites: CHEM 152, MATH 129, and PHYS 132 or their equivalents. PTYS 407 is equivalent to CHEM 407 (not cross-listed).
October 30, 2017
Joseph Watkins
Professor Mathematics and Chair of Statistics GIDP
Department of Mathematics
University of Arizona
617 N. Santa Rita Ave.
P.O. Box 210089
Tucson, AZ 85721-0089 USA

Dear Dr. Watkins,

This is a letter of support for the proposed Undergraduate Statistics and Data Science Degree. I have reviewed the New Academic Program – Implementation Request for the new program and I believe that the program is both timely and would provide an excellent education for the students. Data Science in many forms is a critical skill needed in many sciences, business and professions.

There is no conflict with School of Information programs and opportunities for synergy. We are eager to welcome students from the Statistics and Data Science Degree into our relevant courses. We agree with your assessment about courses in the School of Information that would enrich education for these majors. These include ISTA 130 Computational Thinking and Doing; ISTA 321 Data Mining and Discovery; ISTA 350 Programming for Informatics Applications; ISTA 421 Introduction to Machine Learning; and ISTA 450/550 Artificial Intelligence. We regularly welcome students from other majors into our classes and will adjust offerings according to demand. Other class that your students might be interested in may include ESOC 214 – Intro to Data Science

We look forward to future collaboration to identify possible electives that could be offered in the program.

Sincerely,

P. Bryan Heidorn
Director, School of Information
MEMORANDUM

DATE: November 3, 2017

TO: Pamela Coonan, Senior Director, Academic / Curricular Affairs

FROM: Young-Jun Son,
Department Head of Systems and Industrial Engineering

RE: Undergraduate Major in Statistics and Data Science and Undergraduate Minor in Statistics and Data Science

COPY: Joseph Watkins, Professor, Mathematics, Chair, Statistics-GIDP

This is to express our support of the proposed 1) Undergraduate Major in Statistics and Data Science and 2) Undergraduate Minor in Statistics and Data Science, housed in the Department of Mathematics.

For the Undergraduate Major in Statistics and Data Science, Dr. Watkins and I agreed that the following five (5) Systems and Industrial Engineering (SIE) courses will be part of the degree program (either “elective” or “Applications courses”), and SIE will allow the students in the Undergraduate Major in Statistics and Data Science program to take them:

- Elective:
  SIE 440: Survey of Optimization Methods

- Applications courses:
  SIE 250: Introduction to Systems and Industrial Engineering
  SIE 265: Engineering Management I
  SIE 422: Decision Making under Uncertainty
  SIE 496: Information Analytics and Decision-Making in Engineering

If there is any question about this memorandum, please feel free to contact me.
MEMORANDUM

DATE: 13 November 2017

TO: Laura A. Varecka, Dept of Mathematics

FROM: John L. Koprowski, Associate Director

SUBJECT: Support for a Major in Statistics & Data Science

We are pleased to hear the good news about a proposal for a Major in Statistics and Data Science and support the effort. The following courses would be acceptable courses to include from the curriculum of Natural Resources-based disciplines, each of which addresses quantitative approaches to real-world challenges:

- WFSC 444
- WSM 460A.
- RAM 456A.
- RNR 417 and 473 (RNR 417 is a prerequisite for RNR 473)

Again, we are in strong support of this sorely needed major that will have wide reaching effects across the physical, biological and social sciences.
November 17, 2017

Dr. Pamela Coonan
Executive Director, Academic/Curricular Affairs
University of Arizona

Dear Pam,

This letter is to formally express the support of the School of Sociology for the proposed Bachelor of Science and Bachelor of Arts degrees in Statistics and Data Science, housed in the Department of Mathematics.

The School of Sociology agrees to grant the Statistics and Data Science majors enrollment in our SOC/CHS 476 Research & Analysis of Health Data as one of the many options offered in both of the BS/BA degrees. While students who are not official SOC/CHS majors are not eligible to register for SOC/CHS 476 during the University's Priority Registration period, space is often available for other students to enroll in our course during open enrollment.

Sincerely,

Albert J. Bergesen
Professor and Director, School of Sociology
Professor, School of Government and Public Policy (by courtesy)
Professor, McGuire Center for Entrepreneurship (by courtesy)
Phone: 520-621-3303
Email: albert@email.arizona.edu
Fax: 520-621-9875
MEMORANDUM

DATE: October 23, 2017

TO: Pam Coonan, Senior Director, Curricular Affairs

FROM: Jon Chorover, Professor and Head

RE: Use of ENVS 420 and ENVS 470 towards B.S. program in Statistics and Data Science

On behalf of the Department of Soil, Water and Environmental Science, I hereby approve the use of SWES Courses, ENVS 420 Environmental Physics and ENVS 470 Soil Physics, as supporting coursework requirement for the proposed Bachelor of Science degree program in Statistics and Data Science.

Students will have access to enrollment during their Priority Registration period and during open registration. Currently, there are no restrictions on enrollment.

ENVS 420 Environmental Physics has a course requisite of MATH 125 Calculus I and concurrent registration of PHYS 102 Introductory Physics I. ENVS 470 Soil Physics has course requisites of ENVS 200 Introduction to Soil Science, and PHYS 103 Introductory Physics II, and concurrent registration of MATH 125 Calculus I.