

Docket Item:

University Program Approval: Portland State University, Bachelor of Science (B.S.) in Data Science.

Summary:

Portland State University proposes a new degree program leading to a B.S. in Data Science. The statewide Provosts' Council has unanimously recommended approval. Higher Education Coordinating Commission (HECC) staff completed a review of the proposed program. After Analysis, HECC staff recommends approval of the program as proposed.

Staff Recommendation:

The HECC recommends the adoption of the following resolution:

RESOLVED, that the Higher Education Coordinating Commission approve the following program:

B.S., in Data Science at Portland State University.



Proposal for a New Academic Program

Institution: Portland State University

College/School: College of Liberal Arts & Sciences

Department/Program Name: Fariborz Maseeh Department of Mathematics and Statistics

Degree and Program Title: B.S. in Data Science

1. Program Description

- a. Proposed Classification of Instructional Programs (CIP) number.
30.7001 Data Science
- b. Brief overview (1-2 paragraphs) of the proposed program, including its disciplinary foundations and connections; program objectives; programmatic focus; degree, certificate, minor, and concentrations offered.

The proposed B.S. in Data Science degree is a multi-disciplinary program including courses from mathematics, statistics, computer science, and applications areas.

The objective of the program is, throughout the course of study, to build a mathematically and statistically rigorous foundation so that each graduate is able to make informed decisions on how to operate with numerical and network data (typically discrete but often of very large size); to - collect (read/write), visualize, approximate, optimize with respect to relevant cost functionals, make predictions/decisions and interpret them, all utilizing specialized software. A general goal is also to create awareness about the social implications of data bias/ethical conduct etc. when collecting, analyzing, and making decisions based on the data science methodologies that we teach.

To achieve these objectives, the program offers training, at a lower division level, in calculus, linear algebra, and computer science. Introduction to statistical methods, all requiring some basic programming skills (python, R, and/or MATLAB), is also taught as part of the program. In the Freshman Data Science Seminar guest lecturers will be introducing examples and case studies and discussing ethics and bias in Data Science.

The training at the upper division level includes specialized classes in statistics, large-scale data algorithms, computer science (including algorithms, SQL and Databases), optimization, and scientific computing for various hands-on data science applications, including health sciences and business. Students will be advised on relevant elective courses that address ethics and bias in data science studies, research, and applications.

- c. Course of study – proposed curriculum, including course numbers, titles, and credit hours.

The degree program requires a basic core of courses (61 credits) and elective courses (12-15 credits).

Requirements

Mth 251	Calculus I	4
Mth 252	Calculus II	4
Mth 253	Calculus III	4
Mth 261	Introduction to Linear Algebra	4
Mth 231	Data Science Seminar (new course)	2
CS 250	Discrete Structures I	4
Mth 343	Applied Linear Algebra	4
Stat 361	Intro to Statistical Methods (new course)	4
Stat 363	Statistical Computing and Data Visualization in R (new course)	4
Mth 271	Mathematical Computing	4
	or	
CS 161	Introduction to Programming and Problem-Solving	4
CS 350	Algorithms and Complexity	4
Stat 364	Modern Regression Analysis (new course)	4
Mth 371	Large-Scale Data Algorithms (new course)	4
Stat 387	Introduction to Statistical Learning (new course)	4
CS 486	Intro to Database Management Systems	4
Stat 409	Data Science Practicum	3

Additional Requirements chosen from Approved List of Electives:

Mth/Stat (two)	Approved 400-level Mth or Stat courses	6-7
Other (two)	Approved 300- or 400-level courses	6-8

Minimum Credit Hours: 73

- d. Manner in which the program will be delivered, including program location (if offered outside of the main campus), course scheduling, and the use of technology (for both on-campus and off-campus delivery).

The program will be offered on-campus and will follow the existing practices in the department of mathematics and statistics and the CS department. Classes from the approved list of elective courses in health sciences, business, and others will follow the practices of the involved departments.

- e. Adequacy and quality of faculty delivering the program.

The Fariborz Maseeh Department of Mathematics and Statistics is uniquely positioned (not only in PSU, but throughout Oregon) to offer this program because of the natural synergy of statistics and mathematics in the department complemented with the strong computational mathematics and statistics component already existing in the department. The computer science classes that are part of the core of this program are already taught in the CS department in the

Maseeh College of Engineering and Computer Science. There is sufficient capacity at this time to accommodate the students from the new program).

f. Adequacy of faculty resources – full-time, part-time, adjunct.

The program, in addition to already existing courses, has 6 new offerings, 3 of which are currently being taught with omnibus numbers (as 300-level undergraduate topics classes) for which we have the faculty in place. A 4th one will be offered by the new faculty hire (fall of 2019). Of the other two courses one is a seminar which will be driven mostly by guest lecturers to introduce students to the field of Data Science through real-life examples. To accommodate

Future investments will be considered based on enrollment and as budget allows.

g. Other staff.

The department has enough staff resources to launch the program. Future investments will be considered based on enrollment and as budget allows.

h. Adequacy of facilities, library, and other resources.

We have adequate resources in the library to support the program.

i. Anticipated start date.
Fall 2020

2. Relationship to Mission and Goals

a. Manner in which the proposed program supports the institution's mission, signature areas of focus, and strategic priorities.

The proposed data science program will prepare undergraduates who can boldly enter the 21st century workforce which is highly demanding in terms of skills and knowledge. Graduates will be competitive and have the potential to specialize in various areas (like health, business, information technologies) all of which are in high demand in the current and expected future job market.

The program is very well aligned with the PSU mission to serve the city and the state; has the ability to retain locally the graduates since not only major employers in Portland area and throughout Oregon, but start-ups as well, seek highly trained and skilled data science experts. The program is inclusive, open to all, offers equal access for learning, and through practicum and seminars, offers opportunities for research, scholarly work and service.

As stated in <https://www.pdx.edu/portland-state-university-mission>:

- (i) "We serve and sustain a vibrant urban region through our creativity, collective knowledge and expertise." - this is the goal of all programs at PSU, including data science.
- (ii) "We are dedicated to collaborative learning, innovative research, sustainability and community engagement." - this is embedded in various parts of the program such as the freshman data science seminar, the senior practicum and the project approach taken in some courses.

- (iii) "We educate a diverse community of lifelong learners" - because of its large number of areas of applicability data science is diverse by nature and it is here to stay and shape our future in all aspect of our life.
- (iv) "Our research and teaching have global impact" - certainly, data science qualifies for this type of research and global impact.

Our proposed program will educate and train future generations of experts - a local, regional and international diverse community in an interdisciplinary manner. Data science is one of the most innovative emerging disciplines with enormous impact on our everyday life. It is unimaginable to have future progress in any area of our daily life (from cell phone communications to our specialized area of work expertise- engineering, science, business, health, etc.) without being impacted by some aspects of data science.

- b. Manner in which the proposed program contributes to institutional and statewide goals for student access and diversity, quality learning, research, knowledge creation and innovation, and economic and cultural support of Oregon and its communities.

The quality is ensured by the qualification of the teaching faculty. They have a proven record for teaching undergraduate classes in mathematics, statistics and computer science. In addition, the tenure track faculty involved in the program have a strong record performing internationally recognized research in the areas of statistics, mathematics and computer science which ensures that the current-state-of-the-art is reflected in the teaching curricula. Last, but not least, the program will have an advisory board composed of industry experts in data science which will advise on trends and areas of application to keep the program current.

The emerging discipline of data science has its roots in the analysis of the enormous variety of large data sets being collected from the most diverse sources. At its core is the synergy of three disciplines - statistics, mathematics with emphasis on algorithms and computations, and computer science. Moreover, the areas of application of data science are quite varied and growing, reaching into most activities, from business applications to the health sciences. In business and industry applications range from internet and social media to sensor data captured by smart phones, security and environmental networks. In science, applications include techniques for drug delivery understanding, environmental data and improving healthcare. It is through examples from these various application areas (and many others), and projects founded in real-life problems that a diversity of viewpoints will be presented.

The teaching approaches include a variety of methods, from seminar discussions, to lectures, and group projects both large and small. A primary emphasis is placed on student discourse, which numerous educational studies have established as an effective strategy for supporting equity and inclusion in a diverse classroom. Throughout the program, the use of real-life data sets easily appeals to students with varied backgrounds, interests, and career goals. This variety and multimodal approach affords students with ample means to make key concepts in data science accessible, relevant, and personally meaningful.

Each component of the program benefits from the others. For example, a key component of the program is acquiring enough programming skills, and these are necessary for the core statistics and mathematics classes. To learn algorithms in linear algebra used in statistical/machine learning, modern regression, etc., you need solid mathematical thinking and concepts. Again, data science embodies a natural synergy of these three disciplines which enable each other. The varied learning styles of these disciplines complements each other.

- c. Manner in which the program meets regional or statewide needs and enhances the state's capacity to:
 - i. improve educational attainment in the region and state;
 - ii. respond effectively to social, economic, and environmental challenges and opportunities; and
 - iii. address civic and cultural demands of citizenship.

Data Science is an emerging discipline with growing demand from employers. Due to the strategic location of PSU where a majority of such employers is located and the quality of existing faculty in the department, we are in a unique position to respond to this growing demand. The structure of the program allows students the flexibility to explore and specialize in areas of applications of their interest. This will let the program adapt as industry demands shift from one area to another. Data gathering and the associated need to interpret and analyze it with the goal of making predictions and informed decisions, will continue to grow. The proposed program will address these needs, and hence be able to continuously bring in the state-of-the-art accomplishments in the discipline to our curricula by hiring new research-oriented faculty as the program grows.

To quote from the National Academies report on Data Science for Undergraduates: Opportunities and Options, "Data science is emerging as a field that is revolutionizing science and industries alike. Work across nearly all domains is becoming more data driven, affecting both the jobs that are available and the skills that are required. As more data and ways of analyzing them become available, more aspects of the economy, society, and daily life will become dependent on data." Typical data sets generated in a great variety of fields (from health sciences to business) are large, complex and often noisy. Extracting knowledge from such data sets requires sophisticated mathematical, statistical and computational techniques and algorithms. The proposed data science program will prepare undergraduates who can boldly enter the 21st century workforce which is highly demanding in terms of skills and knowledge. Graduates will be competitive and have the potential to specialize in various areas (like health, business, and information technologies) all of which are in high demand in the current and expected future job market.

The program is very well aligned with the PSU mission to serve the city and the state; has the ability to retain graduates locally since major employers and start-ups in the Portland area and throughout Oregon seek highly trained and skilled data science experts. The program is inclusive, open to all, offers equal access for learning, and through practicum and seminars, and offers opportunities for research, scholarly work and service. Our proposed program will educate and train future generations of experts - a local, regional and international diverse community in an interdisciplinary manner. Data science is one of the most innovative emerging disciplines with enormous impact on our everyday life. It is unimaginable to have future progress in any area of our daily life (from cell phone communications to our specialized area of work expertise- engineering, science, business, health, etc.) without being impacted by some aspects of data science. Data Science is an emerging discipline with growing demand from employers. Due to the strategic location of PSU where a majority of such employers is located and the quality and expertise of existing faculty in the department, we are in a unique position to respond to this growing demand. The structure of the program allows students the flexibility to explore and specialize in areas of applications of their interest. This will let the program adapt as industry demands shift from one area to another. Data gathering and the associated need to interpret

and analyze it with the goal of making predictions and informed decisions, will continue to grow. The proposed program will address these needs, and hence be able to continuously bring in the state-of-the-art accomplishments in the discipline to our curricula by hiring new research-oriented faculty as the

3. Accreditation

- a. Accrediting body or professional society that has established standards in the area in which the program lies, if applicable.

Not applicable.

4. Need

- a. Anticipated fall term headcount and FTE enrollment over each of the next five years.

We expect to begin with a minimum of 30 undergraduates students to start in the fall of 2020 and gradually increase the number to double in about five years.

- b. Expected degrees/certificates produced over the next five years.

Two classes graduated: first class of 30 degrees after the 4th year, and 30 more after the fifth year.

- c. Characteristics of students to be served (resident/nonresident/international; traditional/nontraditional; full-time/part-time, etc.).

We expect the initial cohort of students served will be mostly from the metropolitan area and mostly Oregon residents. We anticipate a mix of traditional and non-traditional students.

- d. Evidence of market demand.

Data Science in an emerging discipline with growing demand from employers. Due to the strategic location of PSU where a majority of such employers is located and the quality of existing faculty in the department, we are in a unique position to respond to this growing demand. The structure of the program allows students the flexibility to explore and specialize in areas of applications of their interest. This will let the program adapt as industry demands shifts from one area to another. Data gathering and the associated need to interpret and analyze it with the goal of making predictions and informed decisions, will continue to grow. The proposed program will address these needs, and hence be able to continuously bring in the state-of-the-art accomplishments in the discipline to our curricula by hiring new research-oriented faculty as the program grows. The program addresses long overdue demand, detailed in a market study report, and will contribute to the improved educational attainment in the region and state.

- e. If the program's location is shared with another similar Oregon public university program, the proposal should provide externally validated evidence of need (e.g., surveys, focus groups, documented requests, occupational/employment statistics and forecasts).

At the time the proposal was written, this would have been the only undergraduate program in data science with a solid foundation in mathematics, statistics and computer science to be offered by public universities in Portland and Oregon. However, the University of Oregon is proposing a B.A./B.S. in Data Science to begin in Fall 2020 and Oregon State University is proposing a B.S. in Biological Data Sciences to begin in Fall 2020.

- f. Estimate the prospects for success of program graduates (employment or graduate school) and consideration of licensure, if appropriate. What are the expected career paths for students in this program?

The proposed program can serve as a stepping stone for the planned data science graduate programs in the School of Business at PSU. A main performance indicator of the program would be the hiring of program graduates into business, industry and government (which the attached market study indicates is of high demand).

5. Outcomes and Quality Assessment

- a. Expected learning outcomes of the program.
 - **LO1: Core Knowledge and Reasoning.** Acquire sufficient mathematical, statistical, and computer science knowledge and develop respective reasoning skills to be able to correctly identify data analysis methods offered by the program in order to solve problems arising in typical data driven applications in broad areas in science, engineering, business and medicine.
 - **LO2: Technology and Computation.** Demonstrate proficiency in the core programming languages commonly used in data science (python, R, and SQL) in all of its components, i.e., be able to collect and store (read/write), visualize, approximate, optimize with respect to relevant cost functional, make informed predictions/decisions and interpret them, all utilizing specialized software. The latter involves basic knowledge and experience with the use of currently available state-of-the-art data science software technologies and/or being aware of their capabilities.
 - **LO3: Communication and Teamwork.** Be able to work as a part of a team, to communicate effectively to peers, as well as to people outside the discipline.
 - **LO4: Utilize Evolving Data Science Advances for Real-World Problem-Solving.** Be prepared to follow any new developments in data science theory and practice and be able to incorporate its evolving state-of-the-art in their work practice thus expanding their ability for better and wider real-world problem solving.
- b. Methods by which the learning outcomes will be assessed and used to improve curriculum and instruction.

The learning outcomes will be assessed in various ways. Direct measures of achievement include examinations and projects in individual courses. This will be particularly so for learning outcomes 1 and 2. The practicum course will address most notably learning outcome 3 and 4 as it takes the form of a culminating experience in the program. We also plan an exit survey to give to all students upon graduation to collect feedback on student satisfaction. Each year we will also do an assessment of one of the learning outcomes throughout the curriculum by collecting student work samples and projects and have a team of faculty evaluate them and give recommendations for refining and improving the specific courses.

Additional feedback that is expected to improve curriculum and instruction will come from an advisory board comprised by experts from business, industry, and government that are interested in hiring our future data science graduates.

- c. Nature and level of research and/or scholarly work expected of program faculty; indicators of success in those areas.

Research faculty will seek external funding from government agencies (e.g., NSF, NIH), as well as from industry. Indicators of success include also publications in specialized top tier (referred) journals, as well as presenting at conferences, including ones by invitation.

6. Program Integration and Collaboration

- i) Closely related programs in this or other Oregon colleges and universities.
- ii) Ways in which the program complements other similar programs in other Oregon institutions and other related programs at this institution. Proposal should identify the potential for collaboration.
- iii) If applicable, proposal should state why this program may not be collaborating with existing similar programs.
- iv) Potential impacts on other programs.

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The program is naturally integrated as a synergy between courses in mathematics and statistics and computer science which provides a natural basis for collaboration in the area of theory and practice of algorithms, machine/statistical learning. Also, based on a list of approved electives which involve health sciences and business, there are additional possibilities to engage in collaboration in these areas. We expect students in data science may also be able to complete a minor in a field of interest such as the health sciences with an appropriate selection of general elective courses.



Portland State University seeks the Oregon Higher Education Coordinating Commission approval to offer an instructional program leading to a B.S. in Data Science.

Program Description and Justification

1. Identify the institution, degree, and title of the program.

Portland State University
B.S. in Data Science

2. Describe the purpose and relationship of the proposed program to the institution's mission and strategic plan.

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specialized area of work expertise- engineering, science, business, health, etc.) without being impacted by some aspects of data science.

3. What evidence of need does the institution have for the program?

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4. Are there similar programs in the state? If so, how does the proposed program supplement, complement, or collaborate with those programs?

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All appropriate University committees and the Statewide Provosts Council have approved the proposed program. The Portland State University Board of Trustees approved the program on April 2, 2020.

Recommendation to the Commission

The Statewide Provosts Council recommends that the Oregon Higher Education Coordinating Commission authorize Portland State University to establish an instructional program leading to a B.S. in Data Science, effective fall 2020.

Institution: Portland State University
Program: BS in Data Science

Action: At the **May 7, 2020** meeting, the Statewide Provosts Council approved a new program for **PSU, BS in Data Science** to move forward to the Oregon Higher Education Coordinating Commission for its review and approval. The **PSU** Board of Trustees approved the **BS in Data Science** program at its **April 9, 2020** meeting.

Eastern Oregon University

Sarah Witte, provost

Approved
 Opposed
 Abstained



Oregon Health & Science University

Elena Andresen, interim provost

Approved
 Opposed
 Abstained



Oregon State University

Ed Feser, provost

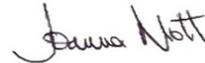
Approved
 Opposed
 Abstained



Oregon Tech

Joanna Mott, provost

Approved
 Opposed
 Abstained



Portland State University

Susan Jeffords, provost

Approved
 Opposed
 Abstained



Southern Oregon University

Susan Walsh, provost

Approved
 Opposed
 Abstained



University of Oregon

Patrick Phillips, provost

Approved
 Opposed
 Abstained



Western Oregon University

Rob Winningham, provost

Approved
 Opposed
 Abstained

