HIGHER EDUCATION COORDINATING COMMISSION
255 Capitol Street NE, Salem, OR 97310
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Docket Item:

University Program Approval: Oregon Institute of Technology, Bachelor of Science (B.S.) in Data Science

Summary:

Oregon Institute of Technology 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 Oregon Institute of Technology

Proposal for a New Academic Program

Institution: Oregon Institute of Technology
College / School: College of Health, Arts, and Sciences
Department / Program Name: Applied Mathematics Department
Degree and Program Title: B.S. Data Science

1 Program Description

a. Proposed Classification of Instructional Programs (CIP) number: 30.3001

Title: Computational Science

Definition: A program that focuses on the study of scientific computing and its application. Includes instruction in scientific visualization, multi-scale analysis, grid generation, data analysis, applied mathematics, numerical algorithms, high performance parallel computing, and numerical modeling and simulation with applications in science, engineering and other disciplines in which computation plays an integral role.

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.

Today, information is being produced and collected at an overwhelming pace, much faster than people are currently capable of analyzing it. The field of data science recently emerged in response to this deluge of ``big data.''

Students seeking a Bachelor of Science degree in data science at Oregon Tech will take their major courses in four departments: Applied Mathematics, Computer Systems Engineering Technology, Management and Geomatics. The major will be hosted by the Applied

Mathematics department. Program curriculum was developed following guidelines recently set out in the National Academy of Sciences Report *Data Science for Undergraduates: Opportunities and Options,* as well as an analysis of the skills required by jobs in industry. Students will gain extensive hands-on experience by completing a series of projects. In their junior year, students will work as part of team on a series of projects to apply material from previous classes. In their senior year, each student will work on an individual capstone project to develop a data driven solution for an outside group, such as a local business or national organization. After graduation, students will be ready for immediate employment as data scientists or for advanced coursework.

Given that data science is a young and rapidly changing field, we expect to develop concentrations and partner with other programs to create opportunities for dual majors that will meet industry's evolving needs after successfully running the proposed program for several years.

The program mission and objectives are below:

a. The mission of the Bachelor of Science in Data Science program at the Oregon Institute of Technology is to prepare students for professional practice or graduate school. A graduate will be prepared with the technical skills necessary to gain actionable insights from data, the ability to effectively communicate these insights as a member of an interdisciplinary team, and the necessary foundation in ethics, mathematics, and computer science to thrive in the evolving field of data science.

b. The following educational objectives are what faculty expects graduates to be able to accomplish a few years after the commencement of their careers and stem directly from the program mission. The alumni from the program should be:

    1) prepared for the professional practice of data science or acceptance into a graduate program,
    2) prepared with the necessary foundation in mathematics, statistics, and computer science in order to thrive in an evolving field,
    3) able to identify and incorporate ethical considerations in their work,
    4) able to identify, collect and analyze data necessary for actionable insights, and
    5) able to effectively communicate findings.

c. From the program educational objectives, stem a number of specific and measurable outcomes. Graduates of the program will possess:
    1) an ability to translate a real world question into mathematical language,
    2) an ability to design an efficient and cost-effective data collection strategy,

3) an ability to understand and apply ethical standards necessary in data collection, analysis, and storage,
4) an ability to organize a reproducible workflow with project documentation,
5) an ability to design, create, and manage data storage,
6) an ability to clean, impute, and structure features for modeling data,
7) an ability to produce sophisticated visualizations and quantitative summaries of data,
8) an ability to identify and quantify correlations and causal relations within a dataset,
9) an ability to optimize and validate predictive analytics,
10) an ability to effectively communicate findings in written or oral reports, and
11) an ability to work effectively as a member of diverse teams.

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

The proposed curriculum is below.

Freshman Year - Fall		
	Social Science Elective	3
STAT 201	Introduction to Data Science	4
WRI 121	English Composition	3
	Humanities Elective	3
	TOTAL:	13
Freshman Year - Winter		
	Social Science Elective	3
CST 116	C++ Programming I	4
GIS 134	Geographic Information Systems	3
WRI 122	Argumentative Writing	3
	Humanities Elective	3
	TOTAL:	16
Freshman Year - Spring		
MATH 251	Differential Calculus	4
	Social Science Elective	3
CST 126	C++ Programming II	4
SPE 111	Public Speaking	3
	TOTAL:	14

Sophomore Year - Fall		
MATH 252	Integral Calculus	4
	Lab Science Elective	4
CST 136	Object Oriented Programming with C++	4
WRI 227	Technical Report Writing	3
	TOTAL:	15
Sophomore Year - Winter		
MATH 254	Vector Calculus I	4
MATH 361	Statistical Methods I	4
	Lab Science Elective	4
MIS 275	Introduction to Relational Databases	3
	TOTAL:	15
Sophomore Year - Spring		
STAT 211	Data Science Methods	4
	Social Science Elective	3
SPE 221	Small Group and Team Communication	3
CST 211	Data Structures	4
	TOTAL:	14
Junior Year - Fall		
STAT 395	Junior Project I	4
MATH 465	Mathematical Statistics	4
MATH 362	Statistical Methods II	4
MATH 341	Linear Algebra I	4
	TOTAL:	16
Junior Year - Winter		
MATH 451	Numerical Methods I	4
STAT 396	Junior Project II	4
GIS 316	Geospatial Vector Analysis I	4
STAT 441	Statistical Machine Learning I	4
	TOTAL:	16
Junior Year - Spring		
MATH 342	Linear Algebra II	4
STAT 412	Regression and Time Series	4
STAT 442	Statistical Machine Learning II	4
STAT 397	Junior Project III	1
MIS 311	Introduction to Systems Analysis	3
	TOTAL:	16

Senior Year - Fall		
MIS 312	Systems Analysis I	4
CST 324	Database Systems and Design	4
STAT 495	Senior Project I	4
GIS 306	Geospatial Raster Analysis	4
	TOTAL:	16
Senior Year - Winter		
MATH 327	Discrete Mathematics	4
GIS 332	Customizing the GIS Environment I	4
STAT 496	Senior Project II	2
PHIL 331	Ethics in the Professions	3
or		
PHIL 342	Business Ethics	3
MIS 334	Business Analytics	3
	TOTAL:	16
Senior Year - Spring		
STAT 405	Advanced Methods in Data Science	4
STAT 497	Senior Project III	2
STAT 467	Spatial Statistics	4
WRI 350	Documentation Writing	3
or		
WRI 345	Science Writing	3
or		
WRI 327	Advanced Tech Writing	3
CST 475	Big Data Analysis	3
	TOTAL:	16
	Degree Total	183

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 proposed B.S. Data Science degree will be offered to students at the Klamath Falls campus. The program will be hosted by the Applied Mathematics department and advising for the degree handled by their faculty. Most of the courses required by the program are already being taught on this campus: new courses developed for the data science major will be scheduled around the existing courses. Some courses will require students to use computer labs to complete some assignments and projects. Students may also be asked to access a remote server to perform computations in one of the senior level courses.

e. Adequacy and quality of faculty delivering the program.

All courses in the program have been developed by existing faculty. The faculty currently in charge of these courses have proper academic qualifications (Master's degree or above in the subject matter they teach). Department members are required to have strong teaching evaluations, and many have undergone promotion, tenure, and post tenure review successfully. All faculty maintain professional development as expected of their roles in each department.

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

Any of the faculty in the Applied Mathematics department may teach required by the data science program in addition to faculty from the Computer Systems Engineering Technology, Geomatics and Management departments.

<u>Full-time faculty:</u>

Todd Breedlove
(1999) Professor, Computer Systems Engineering Technology
B.S. (1996) Oregon Institute of Technology
M.S. (1999) Southern Oregon University

Kenneth Davis
(2016) Assistant Professor, Applied Mathematics
B.A. (1981) Reed College
M.S. (1985) Portland State University
Ph.D. (1989) Washington State University

Dibyajyoti Deb
(2013) Associate Professor, Applied Mathematics
B.S. (2004) Chennai Mathematical Institute, India
M.S. (2006) Ph.D. (2010) University of Kentucky

Jeff Dickson, Associate Professor
(2010) Associate Professor, Management
B.S. (2006) Oregon Institute of Technology
M.B.A. (2012) Southern Oregon University

James P. Fischer
(1999) Professor, Applied Mathematics
B.S. (1989)
B.A. (1991) Humboldt State University
M.S. (1993) University of New Hampshire
Ph.D. (1998) Oregon State University

Tiernan Fogarty
(2002) Professor, Applied Mathematics
B.S. (1995)
M.S. (1997) Ph.D. (2001) University of Washington

David Hammond
(2013) Associate Professor, Applied Mathematics
B.S. (1999) Caltech
Ph.D. (2007) New York University, Courant Institute

Phil Howard
(2014) Assistant Professor, Computer Systems Engineering Technology
B.S., B.A. (1982) Central Washington University
Ph.D. (2012) Portland State University

Cristina Negoita
(2004) Professor, Applied Mathematics
B.A. (1995) University of Oregon
M.S. (2002) Ph.D. (2003) Arizona State University

Douglas Peter Overholser
(2018) Instructor, Applied Mathematics
B.S. (2006) Gustavus Adolphus College
Ph.D. (2013) University of California, San Diego

Rosanna Overholser
(2017) Assistant Professor, Applied Mathematics
B.S. (2006) California Polytechnic State University, San Luis Obispo
M.S. (2008) Ph.D. (2013) University of California, San Diego

Randall Paul
(2004) Professor, Applied Mathematics
B.A. (1989) Rice University
M.S.(1998) Ph.D. (1998) University of Texas at Austin

Joseph Reid
(2009) Associate Professor, Applied Mathematics
B.S. (2006) Western Oregon University
B.S. (2008) Oregon Institute of Technology
M.S. (2009) University of Washington
M.A.S. (2013) Penn State University
Certified gStat – American Statistical Association

John Ritter
(1996) Professor, Geomatics
B.A. (1976) University of California, Los Angeles
M.S. (1977) Ph.D. (1983) The University of Michigan

Lindy Stewart
(2016) Assistant Professor, Management
B.S. (2012) Oregon Institute of Technology
M.S. (2015) Boston University

Terri Torres
(2008) Professor, Applied Mathematics
B.S. (1981) Brigham Young University
M.S. (1994) Idaho State University
M.S. (2010) Bowling Green State University

g. Other staff.

The Applied Mathematics Department is supported by an Office Specialist 2 in Klamath Falls. No additional staffing will be needed to implement or support the program.

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

The Applied Mathematics department has two computer labs, one is an open lab space and the other designed for instruction. While the labs contain equipment sufficient for students to complete the required lab exercises in the data science program, we are considering replacing the computers in one lab to more easily support the use of computing in deep learning and are seeking grants to cover this cost – please refer to section 7b.

Using a summer creativity grant from our Provost, we recently purchased $500 of books on data science topics to supplement our existing collection. The library recently received a grant of $12,000 to train staff in data science techniques and update library resources in data science.

Coursework for the data science program in departments other than Applied Mathematics consists of existing classes and so adequate computing and library resources are already in place.

i. Anticipated start date.

We anticipate the B.S. in data science to begin in the Fall term of 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.

Data science is a new and fast-growing field with roots in computer science, mathematics, statistics, geomatics and management: its applications span many other fields, including engineering, healthcare, business and various technologies. Thus a data science program aligns well with Oregon Tech's mission of providing "statewide educational opportunities for the emerging needs of Oregonians" with "innovative and rigorous applied degree programs in the areas of engineering, engineering technologies, health technologies,

management, and the arts and sciences". The primary goal of a data science program should be to produce graduates who are cross trained in the foundational disciplines and who can apply these techniques to any of the fields mentioned above. This cross training spans the disciplines of management, mathematics, and engineering and will support data-driven decision making and, perhaps more importantly, to be able to design specialized solutions to data problems spanning many fields of study.

A data science program builds on Oregon Tech's signature areas of focus, including geomatics, computer science, healthcare and management. The mathematics department has a strong faculty of applied mathematicians and statisticians. Students enrolled in Oregon Tech's data science program will have the benefit of small student to faculty ratios and will be given many opportunities to learn by doing through junior and senior year projects, adding to Oregon Tech's "intimate, hands-on learning environment, focusing on application of theory to practice".

Oregon Tech's priority is to meet industry's need for skilled workers. Data science is a blossoming field with a combination of job titles and positions that these graduates could fill. Jobs range from research in science and medicine to technology jobs within companies in marketing and targeted advertising. Other jobs include self-automated learning systems (cars that drive themselves for example), governmental positions in data management and reporting. With an advanced degree, someone trained in data science could do research in a variety of fields including statistics, business/management, survey sampling, bioinformatics, and many others.

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.

By providing educational opportunities in Klamath Falls, Oregon Tech plays an important role in ensuring access to higher education to those would might otherwise not attend college. The relatively low cost of living in Klamath Falls, small student to faculty ratios and high expected return on investment of a degree from Oregon Tech will make it easier for a diverse group of people to work in the new field of data science. The proposed degree would allow Oregon Tech to stay at the cutting edge of employment needs and help met Oregon's need for qualified data-management and analysis professionals.

Due to the cross disciplinary origins of data science, much of the coursework in the proposed degree has already been developed and is currently used to train students in computer engineering, health informatics, geomatics, applied math and statistics: the success of Oregon Tech's graduates in these areas is evidence of the high quality of the proposed data science degree. Additionally, the high quality of the new coursework and overall structure of the proposed program can be seen through the curriculum development based on an analysis of data science skills most needed by industry and recent recommendations from the National Academies of Science.

Students in the proposed program will work on a variety of projects, generating new insights and adding to our collective knowledge. Projects could span many different fields, such as helping Animal Shelters identify the best way to match pets with owners, identifying the age structure of sea lion populations from aerial photographs, tracking rainforest deforestation (again from image processing), monitoring invasive species, tracking greenhouse gas emissions trends, identifying health trends in communities and the impact of interventions, and many others. Graduates of the data science program will be well equipped to process data and continue to gain new insights in whenever field they decide to work in.

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;

There are many job opportunities in data science, so we expect that the ability to get a degree in data science will encourage people in the region of Klamath Falls to pursue higher education. Klamath Falls has a lower cost of living compared to Portland and Seattle so offering the proposed B.S. in Data Science on Oregon Tech's campus may make a college degree more attainable for all Oregonians.

II. respond effectively to social, economic, and environmental challenges and opportunities; and

Our society has recently faced challenges in the form of data collection, use, and privacy: a data science program will add significantly to understand how data can be used to make decisions. For example, popular search engines will make decisions based on someone's browsing history which online advertisement would most likely result in a sale. Facebook recently generated controversy when news organizations reported that third parties were allowed to use methods from data science on networks of friends and private messages

sent on the site. It is important to have educational opportunities such as the proposed degree so that awareness of the power of data science methodologies grows.

Many fields are incorporating techniques from data science and it is increasingly being used to make decisions, either within companies or as part of technology: it is therefore necessary for Oregon's workforce to have exposure to the field of data science.

Data science combines traditional statistical methods with a computer's ability to process large volumes of data. By producing more data scientists, we can better analyze our environment. Oregon Tech's faculty with expertise in geomatics and environmental science will give graduates of the proposed program experience in applying methods of data science to environmental challenges.

III. Address civic and cultural demands of citizenship.

Technology can have an enormous impact on a culture, influencing the way information is exchanged, and giving rise to new opportunities. Data Science is the study of practical applications of mathematical and statistical principles to information collected or distributed through technology.

The proposed B.S. in data science goes beyond merely teaching technical skills required to analyze data and challenges students to consider civic and cultural demands. Each step of the workflow of a data scientist comes with ethical considerations, from data collection to analysis to reporting. The programs' heavy focus on practical applications through junior and senior year projects will provide a natural setting to discuss the civic and cultural ramifications of workflow choices.

3 Accreditation

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

At the present time, no accrediting body exists. The National Academy of Sciences has produced a set of suggested guidelines for an undergraduate degree in data science, which were followed in the development of the proposed program.

b. Ability of the program to meet professional accreditation standards. If the program does not or cannot meet those standards, the proposal should identify the area(s) in which it is deficient and indicate steps needed to qualify the program for accreditation and date by which it would be expected to be fully accredited.

Not applicable.

c. If the proposed program is a graduate program in which the institution offers an undergraduate program, proposal should identify whether or not the undergraduate program is accredited and, if not, what would be required to qualify it for accreditation.

Not applicable.

d. If accreditation is a goal, the proposal should identify the steps being taken to achieve accreditation. If the program is not seeking accreditation, the proposal should indicate why it is not.

We are not seeking accreditation because no accrediting body currently exists for data science programs.

4 Need

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

Data science programs at other universities appear to average between 2% and 4% of total enrollment in size, translating to approximately 40-80 students on the Klamath Falls campus. With the addition of dual major students, this could be 60-120 students in a four year period once the program is established (cohorts of 15 to 30 students, sufficient to justify courses).

We expect that high school students with an interest in mathematics and computer programming will be drawn to our program. Nontraditional students who see a high demand for and high salaries of data scientists may also be attracted to the program.

	2020-21	2021-22	2022-23	2023-24	2024-25
FTE =headcount	5	5	10	15	20

Table 1: Estimated 5-Year Enrollment of fulltime students over 5 years

b. Expected degrees produced over the next five years.

6- year graduation rate published by the state of Oregon is ~63%.

	2020-21	2021-22	2022-23	2023-24	2024-25
FTE = headcount	3	3	6	9	12

Table 2: Estimated Annual Graduations over 5 years

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

We expect that most students who come to the Klamath Falls campus for the proposed B.S. in data science will be full-time traditional students who are residents of Oregon. The program could accommodate part-time students as many of the existing courses are offered more than once a year, allowing for flexible pathways through required coursework.

Currently there is no B.S. in data science offered in Oregon and therefore the paths to transfer from two-year college or other four-year institution are uncharted. We plan to work with community colleges in Southern Oregon to develop a clear pathway for students to transfer into the data science. Because much of the coursework in a data science program comes from existing courses in computer science, management, applied mathematics and statistics, we expect that this route will be relatively easy to establish.

d. Evidence of market demand.

Salaries of data scientists are typically high, with Glassdoor.com reporting a median salary of $99,149 on July 6, 2018 for entry level workers. This number is likely higher than our graduates can expect as Glassdoor's dataset included workers with advanced degrees. We

did not find an external source for the median salary of a data scientist with only a BS degree, but expect starting salaries would range from $50,000 to $75,000. Structural Employment Gap is estimated between 140,000 and 190,000 jobs beyond the number of graduates produced for the 2016/2017 biennium.

During a one day examination of job advertisements for data scientists in July, we found 751 jobs for data scientists listed in Seattle, Portland, Reno and San Francisco. Throughout the summer, the number of postings in Portland ranged between 20 and 30.

A Google Trends analysis (see Figure 1 below) suggests that in the US, searches for "data science degree" are being as popular as searches for "mechanical engineering degree".

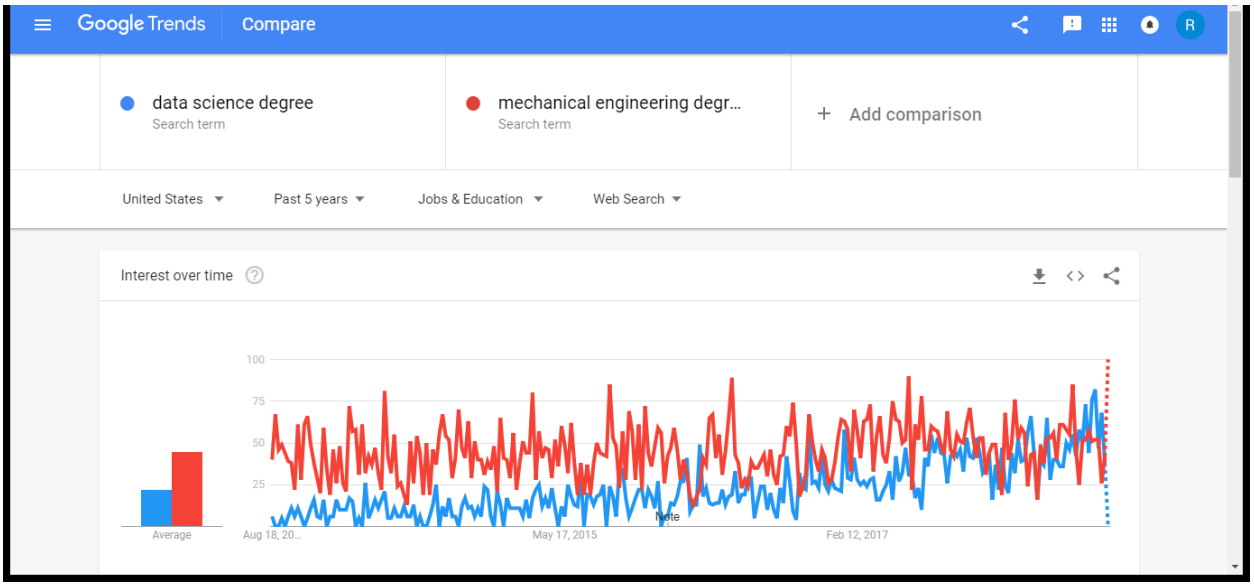

Figure 1: Google Trends analysis of the search popularity of the term "data science degree" (blue) vs. "mechanical engineering degree" (red). Notice that five years ago, there were almost no searches for data science, but within the last year the percentage of searches equals those for mechanical engineering. Note that these trends are for Google searches from the entire US, not just Oregon.

The job title of data scientist is new and not yet tracked by the Bureau of Labor Statistics (BLS). Although BLS does not have job projections for data scientists, the jobs of mathematician, statistician and software developer, applications are all in the top ten occupations with the estimated fastest growing rates in the US over the next 8 years with expected growth of over 30%.

OCCUPATION	GROWTH RATE, 2016-26	2017 MEDIAN PAY
Solar photovoltaic installers	105%	$39,490 per year
Wind turbine service technicians	96%	$53,880 per year
Home health aides	47%	$23,210 per year
Personal care aides	39%	$23,100 per year
Physician assistants	37%	$104,860 per year
Nurse practitioners	36%	$103,880 per year
Statisticians	34%	$84,060 per year
Physical therapist assistants	31%	$57,430 per year
Software developers, applications	31%	$101,790 per year
Mathematicians	30%	$103,010 per year
Physical therapist aides	29%	$25,730 per year
Bicycle repairers	29%	$28,390 per year
Medical assistants	29%	$32,480 per year
Genetic counselors	29%	$77,480 per year
Occupational therapy assistants	29%	$59,310 per year
Information security analysts	28%	$95,510 per year
Physical therapists	28%	$86,850 per year
Operations research analysts	27%	$81,390 per year
Forest fire inspectors and prevention specialists	27%	$37,380 per year
Massage therapists	26%	$39,990 per year

Last Modification: Friday, April 13, 2018
Figure. 2: BLS Occupational Outlook Fastest Growing Occupations

According to a survey from Gallup for the Business-Higher Ed Forum, 69% of employers expect to give preference to candidates with data science skills.

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).

Not applicable.

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?

As mentioned in 4.d, data science is a rapidly growing profession and we expect graduates will successfully find employment. They may have the job title of Data Scientist, or a related title as shown in Figure 3.

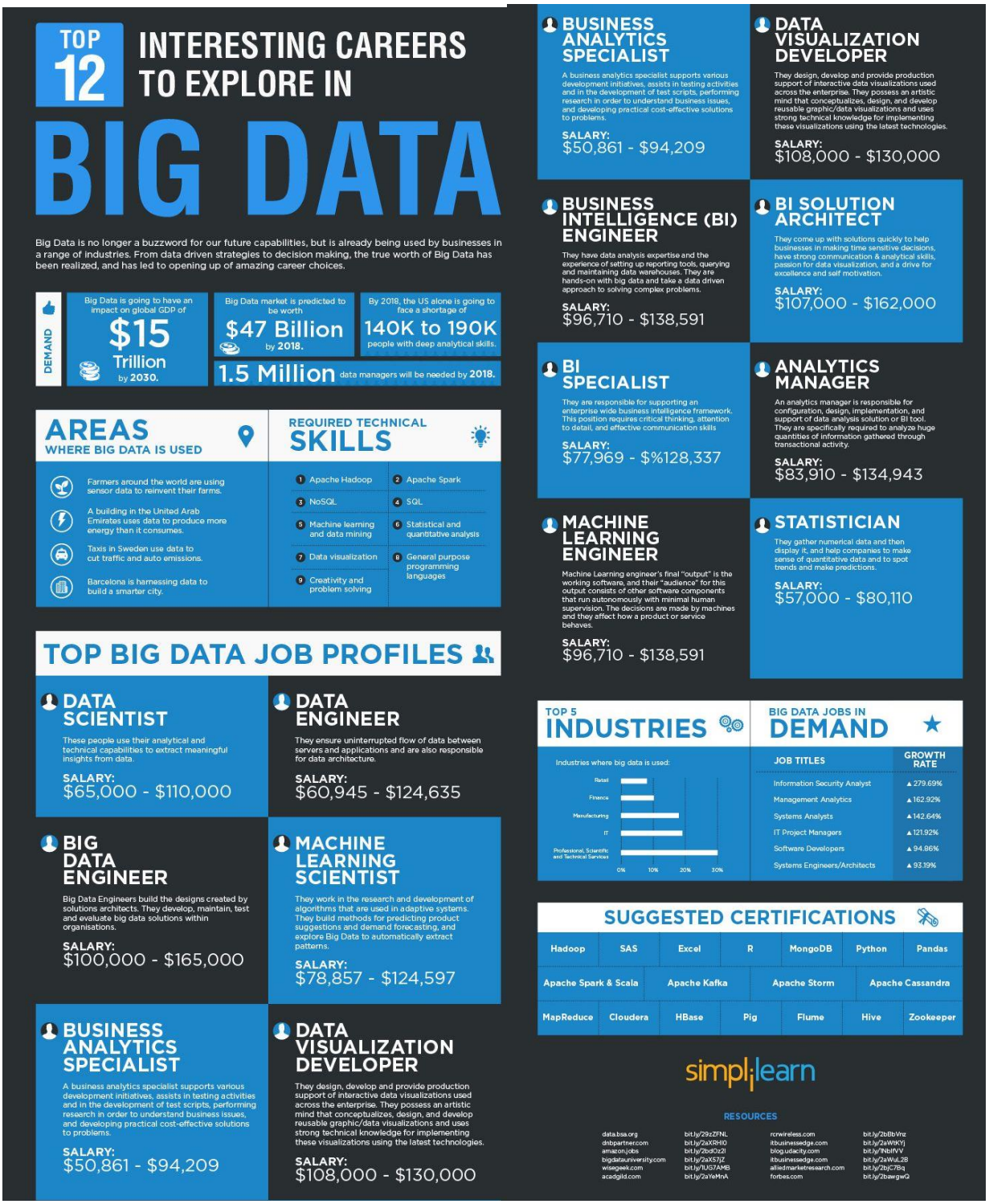

Figure 3: Job titles requiring data science. From https://cloudtweaks.com/wp-content/uploads/2016/09/Top-12-interesting-careers-to-explore-in-bigdata-2016-725px.jpg

5 Outcomes and Quality Assessment

a. Expected learning outcomes of the program.

In part, our curriculum was designed on an analysis of the skills listed in job advertisements for data scientists. By looking at current job postings, we were able to align our program with industry's needs (see figures 4 and 5 below). Discussions with hiring managers helped us understand the shortcomings of the education of current data scientists.

Figure 4: Word cloud of "desired skills" from 751 job advertisements for "data scientists" on Indeed.com. The jobs were located in Portland, Seattle, Reno and San Francisco and advertised on July, 2018. The size of each word corresponds to the number of times it appeared in the 751 advertisements.

Desired Skills	Python	Machine Learning	SQL	Hadoop	Java	Spark
% of job ads containing skill	42%	36%	27%	18%	15%	15%

Figure 5: Skills that appear in at least 15% of 751 job advertisements for data scientists. The most frequently requested skill was the ability to program in Python.

This analysis of the skillset required for a data scientist position along with the guidelines from the National Academy of Sciences informed the development of program level outcomes for the proposed B. S. in data science. These outcomes are shown in Table 3.

	Program Student Learning Outcomes
1	An ability to translate a real-world question into mathematical language
2	An ability to design an efficient and cost-effective data collection strategy
3	An ability to understand and apply ethical standards necessary in data collection, analysis, and storage.
4	An ability to organize a reproducible workflow with project documentation.
5	An ability to design, create, and manage data storage.
6	An ability to clean, impute, and structure features for modeling data.
7	An ability to produce sophisticated visualizations and quantitative summaries of data.
8	An ability to identify and quantify correlations and causal relations within a dataset
9	An ability to optimize and validate predictive analytics.
10	An ability to effectively communicate findings in written or oral reports.
11	An ability to work effectively as a member of diverse teams.

Table 3: Program Student Learning Outcomes for the proposed B.S. in Data Science. Outcomes will be assessed on a three-year cycle.

b. Methods by which the learning outcomes will be assessed and used to improve curriculum and instruction.

Program outcomes will be assessed using both direct and indirect methods.

Student exist surveys will be given to indirectly assess the program.

Program Student Learning Outcomes (PSLOs) will be assessed as shown in Table 3 in several key courses, primarily through student work collected in the junior and senior year project course sequence. Student work will be evaluated with respect to the PSLOs using a standard rubric. Faculty will gather each year at the beginning of the Fall term to assess the program.

Oregon Tech Essential Student Learning Outcomes (ESLOs) will be evaluated based on standard university processes.

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

Data science is a growing field with cross disciplinary origins. Thus, faculty teaching in the proposed B. S. in data science program will be expected to heavily invest in professional development.

6 Program Integration and Collaboration

a. Closely related programs in this or other Oregon colleges and universities.

There is not currently a bachelor's degree in data science being offered in Oregon. Similar programs are listed below:

Oregon State University
- Master of Science in Data Analytics
- Graduate Certificate in Data Analytics
- Master of Science, Master of Engineering or Ph.D in Computer and Electrical Engineering with a research area in Data Science

University of Oregon
- Bachelor of Science in Spatial Data Science & Technology

b. 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.

We expect that students enrolled in associate degree programs in computer science, engineering or mathematics will be able to easily transfer into the proposed B.S. in data science program as these students will have the required foundational courses in programming and mathematics and lower-division general education courses. We will pursue agreements and pathways with community colleges in Oregon that host such programs.

Students graduating from the proposed B. S. in data science program will have the foundational coursework necessary to enrolled in a variety of Master's programs, including those in computer science, statistics and data analytics. Graduates could also enroll in MBA programs. We expect that graduates may be attracted to OSU's M.S. in Statistics, Data

Analytics or Computer and Electrical Engineering program or OHSU's M.S. in Bioinformatics and Computational Biomedicine program, OHSU-PSU's M.S. in biostatistics program or PSU's M.S. in statistics program.

The proposed B.S. in data science will be hosted by the Applied Mathematics department, which also hosted a B.S. in applied mathematics. Besides sharing some coursework with this program, the proposed B.S. shares some coursework with B.S. programs in the Computer Systems Engineering Technology department. As the proposed B.S. in data science program matures, we will consider creating dual major programs with these programs. We will also consider developing various concentrations for the proposed B.S. in data science, for example in Geographic Information Systems, Renewable Energy Engineering, Environmental Sciences or Health Informatics as industry starts to expect specialization.

c. If applicable, proposal should state why this program may not be collaborating with existing similar programs.

Not applicable.

d. Potential impacts on other programs.

Data science is a new and rapidly growing field and it is possible some students may wish to change their major to data science as awareness grows. Since the data science program is similar in the first year to majors in the Computer Systems Engineering Technology department, we believe that these students are most likely to consider changing to the data science major. It is also possible that Applied Mathematics majors may wish to switch.

The all potentially impacted departments have all been consulted and are aware of potential increases in select courses within their curriculum (See Appendix C).

7 Financial Sustainability

a. Business plan for the program that anticipates and provides for its long-term financial viability, addressing anticipated sources of funds, the ability to recruit and retain faculty, and plans for assuring adequate library support over the long term.

Because much of the coursework for the proposed B.S. in data science program is from existing programs at Oregon Tech, minimal investment is needed to start the program. The proposed budget for the BS in data science has a breakeven point in the first year of running and returned profit of $181,701 after three years.

This budget calls for an initial investment in library resources, lab equipment (computers), and travel funds for the professional development of existing faculty. In the third year of the program, funds are allocated to hire an additional full-time math faculty member to support the addition of new upper division courses for the data science major and the junior and senior level project courses. Additionally, we allocate funds to hire a part-time faculty member to support additional sections of existing classes and one new course for the proposed B.S. in data science. Faculty will be recruited and retained following existing university processes.

The proposed budget provides minimal on-going support to the library to purchase print editions of relevant texts: we anticipate that the library's recently received grant of $12,000 for data science related spending and their current subscription to Safari Books will suffice for most student needs by giving access to ebooks. Please refer to Appendix D for a more detailed report of the library's readiness.

b. Plans for development and maintenance of unique resources (buildings, laboratories, technology) necessary to offer a quality program in this field.

Our technology requirements are similar to those to the recently proposed B.S. in Cybersecurity program. This program will be housed in the Management Department and will have one of the following three configurations:

(1.) On Premise + Public Cloud

Our ideal lab configuration offers direct hands-on experience with equipment onsite located within our own datacenter and can scale out to the public cloud (primarily Amazon Web Services via AWS Educate partnership). This configuration positions us best and provides visibility and presence. The On Premise component has the cost of maintenance and related software subscriptions on the existing hardware that was acquired with the initial cybersecurity grant. For the Public Cloud portion, we can tie direct student lab costs to the student taking the course using a model similar to a tech fee.

(2.) Public Cloud

Our second preference is a Public Cloud only option. In this configuration we solely utilize Public Cloud Infrastructure. We can accomplish this offering via Amazon

Web Services Educate partnership. Within this option, costs would be tied to student enrollment (i.e. we only need to provision the resources based on the number of students that we have enrolled). We can tie direct student lab costs to the student taking the course using a model similar to a tech fee (i.e. an "Extra Class / Course Fee").

(3.) On Premise

Our third preference is an on-premise lab. A lab which is solely on premise has some of the benefits outlined but is hindered by the inability to scale. This represents the highest overall cost in terms of capital outlay and maintenance costs.

Detail of Public Cloud:

The costs for Public Cloud services should be able to be contained within an extra class fee per class per student participating within the Cybersecurity degree. By having an "extra class fee" of $ 100, students will have the available resource budget on Amazon AWS to have on average 3 virtual machines for their labs running over the course of 10 weeks with the necessary utilization in terms of compute and storage hours.

To remain flexible and budget conscious we will work with our program directors, dean and related we will work diligently to bring cost under control and long term sustainable.

This equipment can also be leveraged by IT and HI degrees. Cross-utilization of laboratory equipment between Cybersecurity, IT, and HI programs results in high-utilization of existing resources. The programs together across all modalities the total students served would be approximately 250 (Cybersecurity, IT, HI, etc.).

Source: HECC Proposal for a New Academic Program
B.S. in Cybersecurity at Oregon Tech

We quote extensively from the proposed B.S. in Cybersecurity program because our choice of configuration will likely be the same. Our current plan is to have a combination of on-site computers (please refer to the budget for costs) and pay for access to a public cloud through a course fee for STAT 442. STAT 442 is the only course we anticipate having such a fee. If the Cybersecurity and Data Science programs can share access to a powerful computing cluster on site at Oregon Tech, then this option might become more attractive.

c. Targeted student/faculty ratio (student FTE divided by faculty FTE).

The target student/faculty ratio is generally 20:1, with the ratio for freshman courses being no more than 25:1 and senior courses no more than 15:1.

d. Resources to be devoted to student recruitment.

We will work with the Office of Academic Partnerships to create articulation agreements for transfer students. We will also work with the Offices of Strategic Enrollment Management and Admissions.

8 External Review

a. If the proposed program is a graduate level program, follow the guidelines provided in External Review of New Graduate Level Academic Programs in addition to completing all of the above information.

Not applicable.

APPENDIX

A. Approval to Proceed

B. Summary for OIT Curriculum Planning Commission

- **1. New Courses**
- **2. Program Narrative**
- **3. Curriculum Map**
- **4. General Education Requirements**

C. Documentation of communication

D. Library Resource Report

F. References

Appendix A: Approval to Proceed

Oregon TECH

Curriculum Proposal Cover Sheet
for New Degrees, New Degree Options, Significant Program Revisions, etc.

Approval to Proceed / Final Approval

Department: Applied Mathematics Program: Data Science

Submitter's Name: Rosanna Overholser Phone: 885-1475 Email: rosanna.overholser@oit.edu

Proposal submission date: 5/23/2018

Implementation requested for academic year:

Type of curriculum proposal:

- [x] New degree
- [ ] New degree option
- [ ] Significant program revision
- [ ] Curriculum change requiring additional funding, facilities or staff
- [ ] Minor
- [ ] Certificate
- [ ] Specialization
- [ ] Emphasis
- [ ] Other

Abstract of the proposed change:

Signatures below constitute **Approval to Proceed** in the curriculum proposal process:

Date: 5/16/18 Approved by: , Department Chair

Date: Approved by: , Dean

Date: 6/4/18 Approved by: , Provost

Signatures below constitute **Final Approval** of this proposal:

Date: Approved by: , Department Chair

Date: 12/12/18 Approved by: , Director of Assessment

Date: 1-8-19 Approved by: , Dean

Date: Approved by: , CPC

Date: Approved by: , Provost

Please note that the Department Chair's signature for Final Approval was submitted on a hard copy of this form.

Appendix B: Summary for OIT Curriculum Planning Commission

1. New Courses

Class Number and Name	**Cr.**
STAT 201 Introduction to Data Science	4-0-4
STAT 211 Data Science Methods	4-0-4
STAT 441 Statistical Machine Learning I	4-0-4
STAT 442 Statistical Machine Learning II	4-0-4
STAT 395 Junior Project I	4-0-4
STAT 396 Junior Project II	4-0-4
STAT 397 Junior Project III	1-0-1
STAT 405 Advanced Methods in Data Science	4-0-4
STAT 467 Spatial Statistics	4-0-4
STAT 495 Senior Project I	3-0-3
STAT 496 Senior Project II	3-0-3
STAT 497 Senior Project III	2-0-2
	41

RE: new courses with STAT prefix

BK **Ben Kintner <Ben.Kintner@oit.edu>**
2/18/2019 9:36 AM

To: Rosanna Overholser

Hi Rosanna,

I see that MATH 441 and MATH 442 are both available.

Thanks!
--Ben

Ben Kintner | Schedule Coordinator
Office of the Registrar
541-885-1314
Book a meeting with me!

Oregon TECH

From: Rosanna Overholser
Sent: Monday, February 18, 2019 8:10 AM
To: Ben Kintner <Ben.Kintner@oit.edu>
Subject: RE: new courses with STAT prefix

Hi Ben,

I got some feedback from CPC that I should have made STAT 311 and 312, Statistical Machine Learning I and II four hundred level courses, not 300 level. Could you please help me find 400 level numbers for those two courses?

Thank you!

Rosanna

From: Ben Kintner
Sent: Friday, November 9, 2018 12:55:37 PM
To: Rosanna Overholser
Subject: RE: new courses with STAT prefix

Hi Rosanna,

Sorry I didn't clarify the junior/ senior sequence. Yes 395, 396, 397 and 495, 496, 497 will work.

And here are a couple numbers that will work for these classes.

STAT 467 Spatial Statistics (400 level)

STAT 405 Advanced Methods in Data Science (400 level)

Let me know if you have any others.

Thanks!
--Ben

From: Rosanna Overholser
Sent: Friday, November 9, 2018 9:18 AM
To: Ben Kintner <Ben.Kintner@oit.edu>
Subject: Re: new courses with STAT prefix

Thank you for your prompt response, Ben.

The junior and senior project courses will each be a three course sequence, for example STAT 395 will be taken in fall, winter and spring and will be different in each term. So do we need a different number for each term, i.e. STAT 395, 396 and 397? Or how should I distinguish between the courses in the sequence?

One more request - could you also give numbers for

STAT xxx Spatial Statistics (400 level)

STAT xxx Advanced Methods in Data Science (400 level)

Thank you for your help,

Rosanna

From: Ben Kintner
Sent: Monday, November 5, 2018 3:51:46 PM
To: Rosanna Overholser
Subject: RE: new courses with STAT prefix

Hi Rosanna,

Here are STAT numbers that are not in use that should work for the corresponding classes.

STAT 201 Introduction to Data Science (freshman)

STAT 211 Data Science Methods (sophmore)

STAT 311 Statistical Machine Learning I (upper division)

STAT 312 Statistical Machine Learning II (upper division)

STAT 395 Junior Project (3 course sequence in junior year)

STAT 495 Senior Project (3 course sequence in senior year)

Let me know if you have any questions.

Thanks!
--Ben

2. Program Narrative

Degree Offered

Bachelor of Science in Data Science

Student Preparation and Admissions

Students must meet the standard OIT admissions requirements. Transfer students must arrange for official transcripts from each college and university attended to be sent to OIT.

3. Curriculum Map

	NEW CURRICULUM		
Prerequisite	Freshman Year - Fall		
		Social Science Elective	3
	STAT 201	Introduction to Data Science	4
WRI 115	WRI 121	English Composition	3
		Humanities Elective	3
		TOTAL:	13
	Freshman Year - Winter		
		Social Science Elective	3
MATH 111	CST 116	C++ Programming I	4
CE 203 or GIS 103 or co-req. CST 116	GIS 134	Geographic Information Systems	3
WRI 121	WRI 122	Argumentative Writing	3
		Humanities Elective	3
		TOTAL:	16
	Freshman Year - Spring		
MATH 112	MATH 251	Differential Calculus	4
		Social Science Elective	3
CST 116	CST 126	C++ Programming II	4
	SPE 111	Public Speaking	3
		TOTAL:	14
	Sophomore Year - Fall		
MATH 251	MATH 252	Integral Calculus	4
		Lab Science Elective	4
CST 126	CST 136	Object Oriented Programming with C++	4
WRI 122 and SPE 111	WRI 227	Technical Report Writing	3
		TOTAL:	15
	Sophomore Year - Winter		
MATH 252	MATH 254	Vector Calculus I	4
MATH 111	MATH 361	Statistical Methods I	4
		Lab Science Elective	4
	MIS 275	Introduction to Relational Databases	3
		TOTAL:	15

	Sophomore Year - Spring		
CST 126, MATH 252, (MATH 243 or MATH 361)	STAT 211	Data Science Methods	4
		Social Science Elective	3
SPE 111	SPE 221	Small Group and Team Communication	3
CST 136	CST 211	Data Structures	4
		TOTAL:	14
	Junior Year - Fall		
STAT 211 and co-req. of MATH 362	STAT 395	Junior Project I	4
MATH 254	MATH 465	Mathematical Statistics	4
MATH 361	MATH 362	Statistical Methods II	4
MATH 252	MATH 341	Linear Algebra I	4
		TOTAL:	16
	Junior Year - Winter		
CST 116 and MATH 252 and MATH 341	MATH 451	Numerical Methods I	4
MIS 275 and Math 362, co-req. of STAT 441	STAT 396	Junior Project II	4
GIS 134	GIS 316	Geospatial Vector Analysis I	4
(MATH 465 or MATH 361) and (MATH 254 or MATH 261 or MATH 341)	STAT 441	Statistical Machine Learning I	4
		TOTAL:	16
	Junior Year - Spring		
MATH 341	MATH 342	Linear Algebra II	4
MATH 362	STAT 412	Regression and Time Series	4
STAT 441 and MATH 451, co-req. of MATH 342	STAT 442	Statistical Machine Learning II	4
STAT 395 and STAT 396	STAT 397	Junior Project III	1
WRI 121	MIS 311	Introduction to Systems Analysis	3
		TOTAL:	16

	Senior Year - Fall		
CST 324 or MIS 275, and MIS 311	MIS 312	Systems Analysis I	4
CST 211	CST 324	Database Systems and Design	4
STAT 397	STAT 495	Senior Project I	4
GIS 134	GIS 306	Geospatial Raster Analysis	4
		TOTAL:	16
	Senior Year - Winter		
MATH 252 or junior standing	MATH 327	Discrete Mathematics	4
GIS 306 or MIS 116 or GIS 316	GIS 332	Customizing the GIS Environment I	4
STAT 495	STAT 496	Senior Project II	2
WRI 227	PHIL 331	Ethics in the Professions	3
	or		
WRI 122 and 3 cr. Hum Electives	PHIL 342	Business Ethics	3
MATH 361 and MIS 113 or MIS 275 or CST 324	MIS 334	Business Analytics	3
		TOTAL:	16
	Senior Year - Spring		
STAT 442, co-req. of STAT 467, and CST 211	STAT 405	Advanced Methods in Data Science	4
STAT 496	STAT 497	Senior Project III	2
GIS 332 and MATH 362	STAT 467	Spatial Statistics	4
WRI 227	WRI 350	Documentation Writing	3
	or		
WRI 123 or WRI 227	WRI 345	Science Writing	3
	or		
WRI 227	WRI 327	Advanced Tech Writing	3
CST 324	CST 475	Big Data Analysis	3
		TOTAL:	16
		Degree Total	183

4. **General Education Requirements**

The general requirements for a B.S. are met by the program in data science as outlined in the table below.

General Education Requirements Summary		
Communication: 18 Credits		
SPE 111	Public Speaking	3
SPE 221	Small Groups and Teams	3
WRI 121	English Composition I	3
WRI 122	English Composition II	3
WRI 227	Tech Report Writing	3
WRI 327 or WRI 345 or WRI 350	Advanced Tech or Science or Documentation Writing	3
		18
Humanities: 9 Credits		
PHIL 331 or 342	Ethics in the Professions or Business Ethics	3
	Humanities Electives	6
		9
Math / Science: 12 Credits		
MATH 251	Differential Calculus	4
MATH 252	Integral Calculus	4
	Lab Science Elective (BIO, CHE, GEOG, GEOL or PHY)	4
		12
Social Science: 12 Credits		
	Social Science Elective	3
	Social Science Elective	3
	Social Science Elective	3
	Social Science Elective	3
		12

BS Degree: 36 Credits in Mathematics and Science		
MATH 251	Differential Calculus	4
MATH 252	Integral Calculus	4
MATH 254	Vector Calculus I	4
MATH 361	Statistical Methods I	4
MATH 362	Statistical Methods II	4
MATH 341	Linear Algebra I	4
MATH 342	Linear Algebra II	4
MATH 451	Numerical Methods I	4
MATH 465	Mathematical Statistics	4
		36
Upper Division: 60 Credits		
MATH 327	Discrete Math	4
MATH 361	Statistical Methods I	4
MATH 362	Statistical Methods II	4
MATH 341	Linear Algebra I	4
MATH 342	Linear Algebra II	4
MATH 451	Numerical Methods I	4
MATH 465	Mathematical Statistics	4
STAT 412	Regression and Time Series	4
STAT 441	Statistical Machine Learning I	4
STAT 442	Statistical Machine Learning II	4
STAT 467	Spatial Statistics	4
STAT 405	Advanced Methods in Data Science	4
GIS 306	Geospatial Raster Analysis	4
GIS 316	Geospatial Vector Analysis I	4
GIS 332	Customizing the GIS Environment I	4

Appendix C: Documentation of Communication

a. Letter of Support Humanities Department

support for the data science major

Rosanna Overholser <Rosanna.Overholser@oit.edu>
11/30/2018 3:49 PM

To: Mark Neupert

Dear Prof. Neupert,

I'm an applied math faculty and we've recently finalized a curriculum map for a new BS in data science major. We are requiring the students to take either PHIL 331 or 342 but the choice of the rest of the gen ed requirements are left to the students.

Our estimated enrollements over the first three years of the program are 5, 5, and 10.

Is your department able to support these additional students?

Thank you,

Rosanna

b. Letter of Support Department of Management

RE: resources for data science program

Jeff Dickson <Jeff.Dickson@oit.edu>
11/8/2018 1:25 PM

To: Rosanna Overholser Cc: Sharon Beaudry

Rosanna,

We have capacity and support the additional students to the courses listed.

Thanks,

Jeff Dickson
Associate Professor
Program Director, Health Informatics
Program Director, Information Technology

Phone: 541-885-1857

Oregon TECH

Tech-Infused Business Degrees
Webpage
Facebook

From: Rosanna Overholser
Sent: Thursday, November 8, 2018 10:51 AM
To: Jeff Dickson <Jeff.Dickson@oit.edu>
Cc: Sharon Beaudry <Sharon.Beaudry@oit.edu>
Subject: resources for data science program

Hi Jeff and Sharon,

Jeff - thank your for your time yesterday - it was really helpful to talk with you and to see your course material.

I forgot to ask if your department would need any additional resources if data science students took your classes (I think MIS 285, 311, 312 and 334 should be required for all, some students might take others as electives). I've been planning for 5 students in year 1 (which is 2020 if all goes well), 5 in year 2 and 10 in year 3. Would you need to run any extra sections or purchase extra software licenses/computing power?

Thanks,

Rosanna

c. Letter of Support Computer Systems Engineering Technology

From: Todd Breedlove
Sent: Friday, November 30, 2018 12:37:31 PM
To: Rosanna Overholser
Subject: RE: support for the data science program

For the first two years, yes. The 10 might be a stretch but will make it work.

Todd

Todd Breedlove
Professor, Department Chair
Computer Systems Engineering Technology
Oregon Institute of Technology

From: Rosanna Overholser <Rosanna.Overholser@oit.edu>
Sent: Friday, November 30, 2018 12:19 PM
To: Todd Breedlove <Todd.Breedlove@oit.edu>
Cc: Phil Howard <Phil.Howard@oit.edu>
Subject: support for the data science program

Dear Todd,

We have recently finalized the curriculum map for a new major, data science, and are requiring students to take CST 116, 126, 136, 211, 324 and 475. Our estimated enrollments over the first three years are 5, 5, and 10 students.

Does your department have the necessary resources to support these additional students?

Thank you for your help,

Rosanna

d. Letter of Support Communication Department

Re: support for the data science program

VK

Veronica Koehn <Veronica.Koehn@oit.edu>
11/30/2018 4:19 PM

To: Rosanna Overholser

Hi Rosanna--

We can definitely make that work! The 10 was the most concerning to me, but we will have three years to work on that. We could handle an additional five right now, so I am sure that 5 will be fine next year and the year after.

Veronica

Veronica Koehn, Ph.D.
Associate Professor of Communication
Interim Chair of the Communication Department
Oregon Institute of Technology
Semon Hall 130
541-885-1677

From: Rosanna Overholser
Sent: Friday, November 30, 2018 3:41 PM
To: Veronica Koehn
Subject: Re: support for the data science program

Dear Veronica,

Please find the updated requirments below students for students in the new data science major:
WRI 121, 122, 227, 321, and 350 or 327 or 345
SPE 111, 321
Our estimated enrollments over the first three years are 5, 5, and 10 students.

Does your department have the necessary support for these additional students?

Thank you!

Rosanna

e. Letter of Support Geomatics Department

RE: support for data science major

JW

Jack Walker <Jack.Walker@oit.edu>
11/30/2018 12:27 PM

To: Rosanna Overholser Cc: John Ritter

Rosanna,

Yes, the Geomatics department can accommodate the additional students.
I submitted course prerequisite and corequisite changes to CPC to accommodate Data Science students taking GIS courses.

Thanks,
Jack Walker

Jack A. Walker, PLS
Professor and Chair
Department of Geomatics
Oregon Tech
3201 Campus Drive
Klamath Falls, OR 97601-8801
jack.walker@oit.edu
TEL 541.885.1511

From: Rosanna Overholser <Rosanna.Overholser@oit.edu>
Sent: Friday, November 30, 2018 12:17 PM
To: Jack Walker <Jack.Walker@oit.edu>
Cc: John Ritter <John.Ritter@oit.edu>
Subject: support for data science major

Dear Prof. Walker,

I'm an applied math faculty and we have recently finalized the curriculum map for a new major, data science, and are requiring students to take GIS 134, 306, 316 and 332. Our estimated enrollments over the first three years are 5, 5, and 10 students.

Does your department have the necessary resources to support these additional students?

Thank you for your help,

Rosanna

Appendix D: Library Resource Report

Oregon Tech Libraries Collection Review for Data Science Program
December 20, 2018
Karen Kunz

Background

The main goal of the Oregon Institute of Technology Libraries' collection development program is to support Oregon Tech's academic curriculum and degree programs. Librarians work with liaisons from each department to purchase materials required for existing and new courses or programs. However, the amount of money allocated for each department and program varies each year, depending on pressures on the library's budget from outside sources.

As the Applied Mathematics librarian liaison, I reviewed the library's resources for Data Science holdings along with related subject matter in all formats to prepare this collection review and recommendation about library resources needed to support a new program in Data Science. The following sections provide a summary of the library's related holdings and their associated costs.

Overview of the Oregon Tech Libraries Holdings:

<u>Books</u>

I searched library holdings for the following categories:

Python

- Beginning Python
- Advanced Python
- Python Analytics
- Python Machine Learning
- Python and Data Science
- Pandas, Data Visualization, NumPy, Web Scraping, etc.

Thanks to the Library's subscription to Safari eBooks, access to these topics is strong. However, this is a subscription and access to these eBooks will disappear if the subscription is stopped. In addition, the library has no control over the availability of publishers in this collection. Publishers can (and have in the past) remove their material from this collection. For that reason, I would suggest getting enough purchased (either print or eBook) material to provide basic support for this program. Purchasing 1-2 books in each subtopic should suffice. At the minimum, I would recommend getting:

- Python Data Science Handbook (59.99 – Print; 50.99 – 1 user)
- Python Machine Learning Cookbook ($34.63 – Print; $47.99 – 1/$71.99 – unlimited)
- Python for data analysis (42.99 – Print; $42.99 – 1 user)

Machine Learning

Once again, access to books on machine learning are primarily through eBook subscriptions. There are minimal current print books in the library's collection (none newer than 2006). Access can also be had through borrowing from regional libraries or through interlibrary loan but it is recommended that a few books on this subject be added.

Statistics/Data Analysis

Though the Library has enough general books on Statistics, books on Data Analysis are connected to specific disciplines such as health or transportation. There are adequate eBooks from the subscription eBook collections but it is recommended that some purchased (print or eBook) material on general data analysis be obtained.

Data Science

The Library has no purchased materials on data science. In addition to eBook collections and Summit borrowing, it is recommended that a few books be purchased.

Journals

The Library has a few journals on these topics (see Appendix) and there are several open access journals on Data Science topics. Research into other library's support of data science programs does not reveal much use of journals. However, if it is felt that it is necessary to have well regarded (high impact) journals available, the cost could range from $500 to $3500 per year.

Electronic Resources

The majority of support for Data Science programs from other libraries seems to be in providing data for students.

Databases/Datasets

The Oregon Tech library subscribes to ProQuest Statistical Abstract of the US which provides indexed tables on the social, political, and economic organization of the U.S. These tables are available for download in both XLS and PDF and show the source of the data. In addition, there are numerous federal sites that offer raw data (e.g. BLS, EPA, Census, Data.gov, NIH, etc.) and data repositories that allow for free access.

If it is felt that more access to data is required for this program, the following databases and data repositories are available at a price:

- Data-Planet (Sage)
    - *A very large dynamic repository providing access to massive amounts of statistical data combined with descriptive content and a robust suite of visualization, search, and analysis capabilities on a single platform. 16 subject categories*
- ProQuest Statistical Insight (~$2000)
    - *Index to US government, intergovernmental, and nongovernment publications*
- Social Explorer ($150/mo. <20 people)
    - *Hundreds of thousands of built-in data indicators related to demography, economy, health, politics, environment, crime and more. Free trial*

- Rand State Statistics ($0.154/FTE)
    - *More than 200 databases covering all 50 states. Free trial.*
- ProQuest Statistical Abstracts of the World (~$800)
    - *Approximately 50 countries*
- RDS TableBase
    - *Tabular data on companies, industries, products and demographics*
- Statista
    - *Market data, market research, market studies, consumer data. Business and industry data in 19 categories.*
- ICPSR: Inter-University Consortium for Political and Social Research ($2500)
    - *Requires membership ($2400/year)*

OIT Library Expenditures in Support of the Current Mathematics Program Curriculum:

The Library divides Mathematics purchases between those for general education material and those for the applied mathematics program. The applied mathematics programs does not have any library purchased journals or reference materials. Within the last 5 years, the library has spent $557 on books for this program. Within that same period of time, the Library spent $1040 on general education mathematics books.

Financial Summary Recommendations for the Library Support of a Data Science program

In general, using online collections, Summit borrowing, and Interlibrary Loan, the Oregon Tech Libraries are able to provide basic support for this program without additional purchases. However, since most of the books in this area are from an eBook subscription, I would recommend purchasing some basic and advanced material for assured access. A budget of $500 would probably provide 10 – 15 books to start. $100/year would allow for 2-3 books to be purchased each year.

The Libraries provide access to several journals in the areas applicable to Data Science. Should it be determined that access to a high-impact journal is desired, the cost would be in the thousands of dollars.

Finally, an area where the Libraries could provide significant help would be in access to data. Though we do have a subscription to the Statistical Abstract of the US, the information given is general in nature. More specific data might be required. Since raw data can be retrieved from many government sites for free (even if not easily), my suggestion would be to consider getting Statista whose data (market research and consumer data) is not easily found for free. Based on a quote from 2015, I would estimate the cost of this subscription to be between $2500 and $3000 – incorporating a 5% increase each year plus the increase of student FTE these past years.

Appendix F: References

HECC D4A Data Mart. (2017). Total Degree and Certificate Completion. Retrieved from https://www.oregon.gov/highered/research/Documents/Student/CC-completion-history.pdf

HECC Office of Research and Data. (2017). University Student Data. Retrieved from https://www.oregon.gov/highered/research/Pages/student-data-univ.aspx

Fastest Growing (n.d.). Retrieved from: https://www.bls.gov/ooh/fastest-growing.htm

BHEF and PwC (Business Higher Education Forum and PricewaterhouseCoopers). 2017. Investing in America's Data Science and Analytics Talent: The Case for Action. http://www.bhef.com/sites/default/files/bhef_2017_investing_in_dsa.pdf. Butler, D. 2013.

Institution: **Oregon Institute of Technology**
Program: **BS/ in Data Science**

Action: At the **June 6, 2019** meeting, the Statewide Provosts Council approved a new program for **Oregon Institute of Technology**, **BS – Data Science**, to move forward to the Oregon Higher Education Coordinating Commission for its review and approval. The **Oregon Institute of Technology** Board of Trustees approved the program at its **May 30, 2019** meeting.

Eastern Oregon University
Sarah Witte, provost
_X_ Approved
__Opposed
__Abstained

Oregon State University
Ed Feser, provost
_X_ Approved
__Opposed
__Abstained

Portland State University
Susan Jeffords, provost
_X_ Approved
__Opposed
__Abstained

University of Oregon
Jayanth Banavar, provost
_X_ Approved
__Opposed
__Abstained

Oregon Health & Science University
Elena Andresen, interim provost
_X_ Approved
__Opposed
__Abstained

Oregon Tech
Gary Kuleck, provost
_X_ Approved
__Opposed
__Abstained

Southern Oregon University
Susan Walsh, provost
_X_ Approved
__Opposed
__Abstained

Western Oregon University
Rob Winningham, provost
_X_ Approved
__Opposed
__Abstained