THE OHIO STATE UNIVERSITY
TRANSLATIONAL DATA ANALYTICS INSTITUTE

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Columbus, Ohio 43210
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April 10th, 2019

Dear Committee Members:

We write to direct your attention to changes made in response to feedback from the Graduate School/Council for Academic Affairs combined Curriculum Sub-Committee (GS/CAA) and the Graduate Council (GC) on the proposal for the Professional Science Master's in Translational Data Analytics (PSM-TDA).

1. On pages 14 and 15, we made the following changes under the "**Curriculum Overview**" heading:
    a) Clarified that we do not intend to offer exams to skip courses for any students with previous data analysis, statistics or design preparation at this time;
    b) Clarified that courses do have prerequisites and that those appear on the short form syllabi;
    c) Noted that all courses will be restricted in enrollment to PSM-TDA students and have verified that this appears on the short form syllabi;
    d) Clarified options to be considered for situations in which students fall off-cycle for personal circumstances or performance;
    e) Noted that we elected the 5000 level to mirror the naming convention of similar courses in ACCAD and the Departments of Computer Science and Engineering, Statistics, and Design.
2. We have clarified several details in the **"Formal Assessment Plan"** heading (page 20):
    a) Noted that five faculty comprising the PSM-TDA Faculty Advisory Committee will be the two-TDAI related faculty (TDAI Faculty Director and PSM-TDA Faculty Mentor) and the Chairs of GSC from the teaching departments. We also added language which allows for a faculty from the Graduate School to participate.
    b) Added that PSM-TDA student representation will be included in this board as a non-voting member.

Sincerely,

Raghu Machiraju, Ph.D.
Professor, Biomedical Informatics, Computer and Information Science, Pathology
Interim Faculty Director, Translational Data Analytics Institute

THE OHIO STATE UNIVERSITY
TRANSLATIONAL DATA ANALYTICS INSTITUTE

A Proposal for a Professional Science Master's Degree Program in Translational Data Analytics

Prepared by:

The Translational Data Analytics Institute

The Ohio State University

April 10. 2019

Vice Provost W. Randy Smith
Council on Academic Affairs
Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
Columbus, OH 43210

Dear Prof. Smith

Please find here an application from the Translational Data Analytics Institute (TDAI) related to the creation of a Professional Science Master's (PSM) degree in Translational Data Analytics. The decision to pursue offering the PSM degree in translational data analytics was reached after considerable discussion with our internal and external stakeholders, as it is an integral part of TDAI's outreach into the broader external community. The proposed degree leverages and expands critical, previously established partnerships between TDAI and the departments of Computer Science and Engineering, Design, Statistics and the Advanced Computing Center for the Arts and Design. The proposed PSM's focus in data science and analytics will incorporate design thinking, rendering it highly unique when compared to its competition. It should be noted that the proposed curriculum is modular and other disciplines can be included and the participation of a variety of other departments is welcome.

TDAI respectfully submits this proposal for consideration to both the Council of Academic Affairs and the Graduate School. We plan to welcome the first cohort of students in Fall 2020. We look forward to working with you and the Graduate School towards the successful consideration of this application.

Best Regards,

Raghu Machiraju
Interim Executive Director
Translational Data Analytics Institute

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I. EXECUTIVE SUMMARY

The groundwork for the Professional Science Master's (PSM) degree in Translational Data Analytics (TDA) was laid four years ago when the Translational Data Analytics Institute (TDAI) conducted an academic scan and gap analysis of graduate and professional offerings related to data science and analytics at The Ohio State University. In addition to these internal efforts, local and regional partners of the Institute have articulated high demand for additional data science programming. At two roundtable events in July 2017 and August 2018, potential employers from industry, government agencies and non-profit organizations provided valuable feedback on a draft curriculum and identified directions for further development. Roundtable participants expressed a clear demand for data scientists and analysts who are not only skilled with statistical methods and computing best practices, but also with the ability to "tell data stories". As a result, the first track of the proposed PSM degree embeds data science and analytics with design. This unique combination of data science with storytelling and visualization will differentiate Ohio State's offering from our competitors.

The proposed degree is built on partnerships between TDAI and the Colleges of Engineering and Arts and Sciences, as well as the Advanced Computing Center for Arts and Design (ACCAD). The departments of Computer Science and Engineering, Design, and Statistics will offer courses in the first specialization track planned, that of design and visualization. Contingent upon the success of this pilot, additional specializations tracks involving other Colleges will be considered in out years.

II. INTRODUCTION

The growth of data analytics creates a real imperative for The Ohio State University to lead in this field. *The proposal of the PSM program in Translational Data Analytics (PSM-TDA) represents an opportunity for The Ohio State University to produce leaders able to meet the challenges of the on-going seismic changes in the global economy.* The university has already taken a key step with the creation of the first interdisciplinary undergraduate major in data analytics at a major research institution (2014). Other premier institutions followed our example, responding to the unique and emerging needs of both academia and industry.

Despite the scale of the existing but disparate academic resources in data analytics, the university needs a clear plan for comprehensive offerings, based on local and national research and workforce needs, going beyond existing academic programming. This is urgent, as many other institutes have started degree offerings to meet the rapidly growing demand in the data analytics arena. Many of these institutes are seeing a burgeoning demand for viable degree programs from industry in their respective regions. The pressing need for an effort in this direction is underscored by the fact that one of the strongest recommendations issued at the First Data Science Leadership Summit held at Columbia University in March 2018 was to require universities to establish minimal requirements for a professional master's degree in data science. Further, Columbus 2020[1] reports that the Columbus region boasts 30 big data employers working across the analytics chain – from data capture and storage to deep analysis. This, coupled with more than 50 data centers in Central Ohio, means the region's increasing demand for deep

[1] Columbus 2020 report. "Big Data Spotlight." 2016.

analytical skills within business is vastly underserved. We have heard from several forums and institutional collaborators, including the Columbus Collaboratory, the region's demand is in part driven by large scale projects such as SmartColumbus and the presence of financial tech industry.

III. COMPETITIVE LANDSCAPE

Nationally, many of our peers are responding to similar regional, as well as global, demands. Every school in the Big Ten and at least seven universities in Ohio offer a degree or certificate program in data analytics at the undergraduate or graduate levels. Data analytics course offerings are also expanding at the graduate and professional levels. Programs began emerging as early as 2007 when North Carolina State University developed a graduate-level data analytics programs. The market continues to expand as universities realize the critical importance of data analytics to the wider economy. (See Appendix 1 for detailed analysis of market demand).

In 2017 the Institute commissioned two competitive landscape assessments: one from EduVentures and the other from the University's Business Intelligence Mapping Unit in the Industry Liaison Office. Highlights of both reports are summarized below in the *Overview of Competitors* section. Both reports have been included in Appendix 1 and Appendix 2, respectively. We have also included a 2017 report named *Investing in America's Data Science and Analytics Talent: The Case for Action* written jointly by PricewaterhouseCoopers (PWC) and the Business-Higher Education Forum (BHEF) in Appendix 3. Highlights are captured below in the *Novel Key Competitor Programs* section.

A. Overview of Competitors

EduVentures completed an assessment of data analytics master's programs in the US, and a detailed report can be found in Appendix 1. An assessment of academic programs in data science and analytics (DSA) was also conducted by the Business Intelligence & Mapping Unit (see Appendix 2), and for this analysis all areas of business analytics were intentionally excluded. This analysis identified 101 related graduate degrees offered by universities in the US. In 2014, Bowling Green State University was the first school in Ohio to offer a master's degree in analytics; Wittenberg University followed in 2016. While numerous employers in central Ohio have data analytics needs, there are few master's degree programs in DSA in the region. In this analysis, national academic programs were ranked based on various publication parameters; total awards by the National Science Foundation related exclusively to programs in data science; initiatives or Centers/Institutes in the DSA area; and/or offering bachelor's, master's and/or PhD programs in data analytics or statistics. Columbia University, Georgia Institute of Technology, University of California at Berkeley and Harvard University topped the rankings. With its degree offerings, funding and programs at the time of this analysis, Ohio State ranked 27th out of 30 universities.

B. Competitor Novel Programs

The 2017 report titled *Investing in America's Data Science and Analytics Talent: The Case for Action* by PwC and BHEF (see Appendix 3) discussed in detail the disconnect between academic training and industry skills required in DSA. The document specifically

highlighted four US universities – including Ohio State's - whose training programs in DSA begin to address this disconnect.

- "***The most effective programs apply data science to real-world problems.***" Here, the report uses the example of NC State's Advanced Institute for Analytics that has worked with >100 companies on multidisciplinary, eight-month student practicums.
- "***Employers want candidates with experience,***" as provided in year-long internships and co-ops through Northeastern University's Master of Data Science program.
- "***Educator-employer partnerships work best when the employer is aligned with the institutional mission and brand***." Ohio State's developing PSM-TDA program was highlighted due to our extensive partnering with private sector companies "on grants and academics…directed at using data science and analytics to reduce infant mortality in indigent urban neighborhoods, accelerate drug discovery to fight disease, and realize autonomous systems for transportation and agriculture." Regarding alignment with industry needs, the report also referenced Columbia University's Data Science Institute that was started to address local needs that would ultimately serve to "grow the local economy in New York City…Columbia structured its institute around multidisciplinary education, research, and outreach to industry."

North Carolina State University (NCSU) serves as the most suitable benchmark given our similarities in institutional makeup and prevailing enterprises in the region. The TDAI staff completed a comprehensive review of the program, the curriculum, and the job placement report of the class of 2017 (see Appendices 4, 5 and 6). Additionally, TDAI Faculty-in-Residence Dr. Dorinda Gallant (College of Education and Human Ecology, Department of Educational Studies) gained the following insights from Dr. Michael Rappa, the Director of the NCSU program, and these were considered in the design of our program.

- Focusing on academic programs will pave a path for research interactions with industry.
- Innovative and highly differentiated programs will yield dividends.
- Organizational innovation is necessary and should be attempted.
- Document success early and improvise in an agile manner.
- Interact with industry informally; listen and learn their business activities and how students we produce are benefiting them.
- Engage interested and expert faculty and empower them to be agile and innovative.
- Courses that are sum of topic threads will allow for creativity, flexibility, and adaptability.
- There is a need for a full-time person to oversee the degree program.

BHEF was also instrumental in helping TDAI and its campus partners to conceptualize and build out an experiential capstone project focused on real-world data analytics in collaboration with local community partners (see Appendix 10). This is a best practice, as evidenced by seven institutions of higher education offering data science programs with employer-engaged capstone experiences (Massachusetts Institute of Technology, North Carolina State University, Northwestern University, San Jose State University, Texas A&M University, University of Maryland, University of Washington). Representatives from these programs were interviewed to

gather insights into development and implementation of experiential learning aspects of their respective programs.

IV. PROGRESS TO DATE

Over the span of four years, a series of actions has been undertaken to investigate labor and academic student markets, provide information and gather feedback from students, faculty, university leadership, and the local industrial community. Figure 1 outlines the four phases of TDAI's deliberate and systematic approach to create a Professional Science Master's degree in translational data analytics.

During the academic year 2015-2016, TDAI conducted a comprehensive examination of data science and analytics or DSA-related academic programming at OSU (see Appendices 7, 8 and 9). Among the various recommendations to enhance data science and analytics training at OSU, the creation of a Professional Science Master's degree or the PSM in translational data analytics (TDA), or the PSM-TDA program, was accorded the highest priority. It was in fact, the former Dean of Graduate School, Prof. Scott Herness who alerted TDAI to the possibility of offering a PSM degree in data science and analytics. Subsequently, TDAI conducted quantitative, albeit general, market research through EduVentures to understand the labor market (for demand) and student market (for supply) of data analytics. In addition, TDAI organized a roundtable in July 2017 with local industry partners (see Appendix 10) and conducted a series of informational sessions with students and faculty to gather inputs for building a successful PSM.

In Spring 2018, TDAI actively developed learning objectives, a curriculum, and a tentative Advisory Board for the PSM. TDAI intends to submit the PSM proposal for consideration of approval to the Office of Academic Affairs and the Commission on Affiliation of PSM Programs during Spring 2019 and plans to welcome the first cohort of students in Fall 2020. TDAI is partnering with the departments of Computer Science and Engineering, Statistics, and Design, and with the Advanced Computing Center for the Arts and Design (ACCAD) to create the first version of the PSM program. The curriculum was designed collaboratively with all the four units. The following faculty participated: Prof. Spyros Blanas (Comp. Sci. & Eng.), Prof. Mary Ann Beecher (Design), Prof. YoonKyung Lee (Statistics), Prof. Matt Lewis (Design), Prof. Raghu Machiraju (Comp. Sci. & Eng.), Prof. Maria Palazzi (Design), Prof. Mario Peruggia (Statistics), Prof. Srini Parthasarathy (Comp. Sci. & Eng.), Prof. Rajiv Ramanth (Comp. Sci. & Eng.), Prof. Yvette Shen (Design), Prof. Han-wei Shen (Comp. Sci. & Eng.) and Prof. Joyce Zheng (Communications). The curriculum has been further refined based on feedback from the participants in the second employer roundtable held in August 2018.

The TDAI team has also met repeatedly with Vice Provost Randy Smith and relevant curriculum deans and department chairs across the campus. The topics discussed included: the proposed curriculum, the necessary oversight organization, the target audience, and the uniqueness of the proposed curriculum. The team also met frequently with Dr. Scott Herness to receive feedback and seek guidance. Appropriate approvals and guidance for the planning, design, and launch phases were obtained from a working group assembled by Vice Provost Smith and included the following faculty administrators: Prof. Christopher Hadad, Prof. Scott Herness, Prof. Stephen Fink, Prof. Waleed Muhanna and Prof. David Tomasko. Finally, presentations were made to the Council on Academic Affairs informing on the progress of the overall planning

process. Following Dr. Herness' departure, the team met with Alicia Bertone and other members of the Graduate School including Profs. Shari Speer and Jennifer Schlueter.

V. ACTIONS & ISSUES

Impact on specific groups/constituencies

Pending approval, the PSM program will be offered by the Graduate School in partnership with several academic units. The initial partnership involves three departments and one center: Computer Science and Engineering, Design, Statistics, and the Advanced Computing Center for Arts and Design. The offering rests on the contributions of our College partners in Arts and Sciences and Engineering. The Colleges and Departments involved are innovators, helping to develop an interdisciplinary program whose impact will extend beyond any single academic unit and presents significant opportunity to the University at large.

The PSM is targeting working professionals to enroll in the program on a part-time basis. The program is currently planned to be in-person. No online or hybrid instruction is currently planned. In this respect, the PSM offers needed continuing graduate education opportunities to professionals employed by local and regional businesses. The partnership between TDAI and these local businesses is a cornerstone of the proposed program and a valuable outreach to the OSU community-at-large.

Quality and academic integrity of the program will be guaranteed by the Commission on Affiliation of PSM Programs. This organization will oversee a peer-review process leading to affiliation and will periodically review the program and its achievements to ensure that the highest professional standards are maintained.

Internal programmatic changes: None anticipated.

Impact on outside participating units

In the initial stages of the build and launch of the PSM, the program will rely most heavily on the contributions of the two Colleges and four units identified above. Additional tracks will be considered. Some examples of these tracks could include decision sciences and geographical information systems. If implemented, their development will lead to an expansion of the PSM partnership to additional academic units. Ultimately, the PSM will establish itself as a focal educational venture, in line with the TDAI mission of fostering active collaborative engagement between the academic, scientific, and business communities.

Relationship with Existing OSU Programs

The curricular requirements of several graduate programs (i.e. in CSE, Stats, and Fisher) at OSU contain elements of data management and analysis. Typically, they aim to provide quantitative and analytical skills to accurately interpret domain-specific scientific literature, to design sound empirical studies, and to perform well-conceived statistical analyses. These programs serve traditional students engaged in comprehensive learning as opposed to serving a more limited pedagogical purpose. They do not serve to build the same skills as the PSM nor cater to the needs of working professional students which allow the enrollees to add competencies and skills to their portfolios.

There are four existing OSU graduate programs that are more closely related to the proposed PSM: the MS program offered by CSE, the MS and Master of Applied Statistics (MAS) programs offered by the Department of Statistics, and the Specialized Master's in Business Analytics (SMB-A) program available from the Fisher College of Business. However, the PSM-TDA program differs from all four. The CSE and Statistics MS degrees are based on curricula that emphasize rigorous technical training in their respective disciplines. They often represent an intermediate step in a student's path toward a PhD degree. However, to some in CSE they provide an entryway to positions in the computing industry and in applied statistics. The MAS and SMB-A degrees have a more applied focus. However, these degrees differ from the PSM-TDA in their distinct targeted student populations and learning outcomes. This is evidenced in the stated goals of each degree:

- MAS program: *"to prepare graduate students to enter positions in applied statistics in business, industry, and government."*
- SMB-A program: *to equip students "with an understanding of the science of data analytics and its implication for business innovation, productivity and growth."*

Given the inclusion of the special track on Design and Visualization, the proposed 33-credit-hours PSM degree will be one of a kind in DSA training in the world. Existing DSA programs have not included design thinking into the curriculum. This pedagogical approach will facilitate translation and application of data analytics into various application domains. The students of this program will not only be able to create sophisticated workflows for Big Data but will also be able to design viable user interfaces and tell compelling data stories. In closing, the stated goal of the proposed PSM-TDA degree program is "*to prepare professional students to be adept at conducting BIG DATA analysis at scale for improving enterprise productivity and profitability*".

VI. GENERAL REQUIREMENTS, CURRICULUM DESIGN, & LEARNING GOALS

A. GENERAL REQUIREMENTS

a) Requirements for admission

1. **Admission requirements of the Graduate School:** {Items below excerpted from section 2.2 of the 2018-2019 Graduate School Handbook: https://gradsch.osu.edu/handbook/all#2-2}.
   Admission Criteria. An applicant must submit documentation that demonstrates fulfillment of the following admission criteria or equivalent qualifications:
   a. an earned baccalaureate or professional degree in any subject from an accredited college or university by the expected date of entry.
   b. a minimum of a 3.0 cumulative grade-point average (CGPA) (on the 4.0 scale used at this university) in the last degree earned by the applicant relevant to the program of study. For international students, the CGPA is calculated on the home institution's grading scheme and the grade key on the transcript is then utilized to approximate an equivalent

US grade based on the educational system of that country. Information about the degree programs and grading systems for the top 50 sending countries can be found at the Graduate and Professional Admissions website (https://gpadmissions.osu.edu/secure/GP_resources/Resources/profile/).

c. prerequisite training that will enable the student to pursue the graduate program to which admission is sought
d. a minimum score of 550 on the old or a minimum score of 19 on each section of the new paper-based Test of English as a Foreign Language (TOEFL), 79 on the internet-based TOEFL, 82 on the Michigan English Language Assessment Battery (MELAB), or 7.0 on the International English Language Testing System (IELTS). This requirement applies only to an applicant from a country where the first language is not English, unless a bachelor's degree or higher was earned in an English-speaking country
e. Any exception to the above requirements will be considered on case-by-case basis.

2. **Additional admission requirements for the PSM-TDA program**:
   a. GRE General Test **or** 3 years of relevant professional experience is required.
   b. Applicants should have a minimum of 1-year of relevant professional experience.
   c. Students are expected to have completed courses that provide ample background in any of the following areas: computing, quantitative, and/or design/visualization skills at the undergraduate level or above from an accredited college or university by the expected date of entry.
   d. Students should have adequate experience with data analysis or work in a business field with a technology focus.
   e. Any exception to the above requirements will be considered on case-by-case basis.

The table below presents prototypical profiles of students who are envisioned to enroll in the proposed PSM-TDA program. If students do not fit the profiles indicated below but otherwise meet the minimum criteria above, they are encouraged to apply.

Profile	Degree Requirement	Bachelor's Degree	Professional Experience	Entrance Exam Requirement	Existing Skills/Expertise	Skills/Expertise Area to be Developed in PSM-TDA Program
1	BS	**DATA-STEM:** Engineering, Statistics, Mathematics, Computer Science	1-3 years	GRE (if needed).	Analytical/computing/ technical skills Foundational design/ visualization skills -Demonstrated logical thinking and problem-solving capabilities	Visualization/Design Business/Enterprise
2	BS, BA	**STEM:** Biology, Chemistry, Psychology	> 3 years	None	Basic foundational analytic and technical skills Basic to mid-level experience with data analysis Demonstrated logical thinking and problem-solving capabilities	Visualization/Design Business/Enterprise Computing skills
3	BA, BS	**NON-STEM:** Sociology, Humanities, Business, Finance, Communications, Design, Marketing	>3 years	None	Basic foundational computing, quantitative, and/or design/ visualization skills Basic to mid-level experience with data analysis or some experience working in a business field with a technology focus Demonstrated logical thinking and problem-solving capabilities	Visualization/Design Business/Enterprise Computing skills Analytical skills

b) Requirements for graduation

1. Graduation requirements of the Graduate School: {Items below excerpted from section 6.6 of the 2018-2019 Graduate School Handbook: https://gradsch.osu.edu/handbook/all#6-6}

a. submission of the Application to Graduate form to the Graduate School no later than the third Friday of the semester (or third Friday of summer term) in which graduation is expected
b. registration for at least three graduate credit hours during the autumn or spring semester or summer term in which graduation is expected
c. completion of a minimum of 30 graduate credit hours. Eighty (80) percent of those required credit hours must be completed at this university over a period of at least two semesters
d. graduate cumulative grade-point average of at least 3.0
e. receipt of final grades in the University Registrar's Office by the published deadline.
f. completion of the master's degree requirements established by the Graduate Studies Committee

2. Additional graduation requirements for the PSM-TDA:

a. Completion of all required coursework for the program (as outlined below) with a cumulative minimum GPA of 3.0 and minimum grade of B- in each course.
b. Satisfactory completion of a required capstone project.

B. CURRICULUM AND COURSE SYNOPSIS

Development of the Curriculum

During 2016-2017, the Translational Data Analytics Institute (TDAI) conducted a comprehensive examination of DSA-related academic programming at OSU. In addition, the TDAI held a roundtable with industry partners. Among the recommendations to make The Ohio State University a leader in DSA training, the creation of a Professional Science Master's degree (PSM) in translational data analytics (TDA) was accorded the highest priority. Subsequently, TDAI has conducted a series of information sessions with students, faculty, and industry partners to gather input for building a successful PSM-TDA program.

In early 2018, the TDAI team used this input to identify primary learning objectives and built a preliminary curriculum for the PSM program. The draft curriculum included three broad areas of study:

1. A set of foundational courses to acquire essential and applied skills in modern data analysis and computer science. The curriculum includes exposure to elements of common programing languages used in DSA applications.
2. A set of courses focusing on track-specific topics. In the initial phase of development of the PSM, the TDAI team has settled on a track that covers complementary aspects of data visualization. As the PSM program grows, we envision developing additional tracks focusing on other elements of DSA practice, such as decision science.
3. A set of courses and seminars incorporating experiential components within the PSM to focus on connecting students to community and business partners.

The principal partners working on the foundational and experiential components on campus have been the CSE and Statistics departments. The Advanced Computing Center for the Arts and Design (ACCAD) and the Design department have contributed mostly to the visualization track.

After preparing a draft curriculum, the TDAI managing team, in collaboration with BHEF, convened a second roundtable with TDAI's industry and local community partners. The focus of the second roundtable was principally to obtain feedback on the proposed curriculum and data visualization specialization. Additionally, the managing team desired to identify directions along which the curriculum could be modified and improved to better serve students and community partners.

This second roundtable involved 46 representatives from over 30 organizations, including industry, government, and nonprofit organizations. We believe this broad engagement with entities beyond industry demonstrates the potential and interest in our potential PSM offerings.

Relative to our community partners, TDA desired to explore where employers could best engage

in the program, define and outline effective applied learning experiences, and cultivate relationships between TDA and their organization for purposes of hiring and recruiting. Further, partners provided insight into skills gaps and workforce needs. The roundtable resulted in refinement of the curriculum to its current form as described in other parts of this proposal. The TDAI managing team was also better able to adjust course offerings and content to more precisely fit the profile and needs of the employers. Excitingly, the refined curriculum better differentiates the technical nature and goals of the proposed PSM-TDA program from those of other related programs at OSU. Specifically, the managing team added emphasis on business and ethical aspects of data analytics and added flexibility to connect the program to industry-specific domains. The roundtable discussion also helped the TDAI managing team to address logistic and educational requirements of the experiential components and capstone projects.

a) Curriculum overview

The general curriculum of the program is articulated around four major instructional modules:

- Five foundational courses addressing key computational and data analytics topics.
- Three core courses in data design and visualization for the first specialization. Future development of additional specialization tracks is envisioned, as dictated by the market need.
- A two-semester, capstone course sequence with a strong emphasis on experiential learning.
- Three multi-disciplinary seminars, focusing on data management, research methods and professional development.

As shown in the summary table below, the proposed PSM-TDA program can be completed in five semesters, part-time for a total of 33 credit hours. It is possible that some students may have received instruction in the salient topics of the program. However, the proposed curriculum is unique in that it incorporates design thinking into traditional topics of data analytics. We do not anticipate that many students will have received this unique combination of instruction. The emphasis of this program is also on practical and experiential learning which will make it attractive for students with a previous, more specialized data analysis or design background. At this point, we do not anticipate offering exams for students to skip courses based on previous experience.

Some courses have prerequisites and those have been noted on the compiled short form syllabi. All courses will be restricted in enrolment to only students in the PSM-TDA. The provided short form syllabi also note this as well.

Initial requirements to enter the degree program will be based on the named criteria under the section titled “Admission Criteria” within the proposal. No additional coursework will be required for entry. Prerequisites within this program only include satisfactory completion of coursework within the curriculum. When appropriate, we have named prerequisites which are required to progress on the short form syllabi provided.

All courses are lock-step, sequential and required. Courses may not be rearranged or moved. Situations where students fall out of sequence due to personal circumstances, performance or standing will be addressed on an individual basis. Some options include the following:

- The student may remain active in the program and enroll in the course the next time it's available. They may not progress until all prerequisites for the next courses are satisfied;
- The student will not continue in their original cohort, with the option to return the next time the course is offered to complete the remaining program as designed;
- The student may be offered an "incomplete" with an assigned deadline by which they would need to satisfactorily complete courses.

All courses will be taught at the graduate level with graduate level content. The courses sourced from ACCAD and Design already exist and are offered at the Graduate level. Specific sections will be offered to TDAI-PSM students under the GRADSCH numbering structure. The computing courses offered by the Department of Computer Science impart skills and knowledge on par with its regular offerings at the graduate level. Further, the emphasis on hands-on experiential learning has been incorporated into the PSM-TDA offerings. For courses taught by Statistics, course content is comparable in breadth and scope to that of courses already offered for graduate students from other departments seeking to build data analysis skills. Overall, all these courses justify their position as graduate level content in part because they integrate a broad set of concepts and incorporate substantial content into a condensed, rigorous curriculum. Additionally, they all have significant focus on experiential learning relevant to working professional students.

The 5000 level course numbers were selected to follow the numbering structure of similar courses in ACCAD and the Departments of Computer Science and Engineering, Design and Statistics. Additionally, because students will be coming from a variety of backgrounds and not just those with intense training in the principal disciplines, we believe the 5000 level is more appropriate.

In the table below, and the compiled short form syllabi, we have inserted tentative course numbers, subject to change. Some courses are being newly developed and may not yet have numbers for cross-listing. Upon formal approval of the course proposals, the courses will be assigned official GRADSCH numbers that follow an agreed upon taxonomy. The numbers of existing courses follow the numbering scheme of the teaching departments, with the departments' specific handles replaced by GRADSCH. The three multi-disciplinary 1-credit seminar courses will offer the stated themes. Their content will adjust based on the specific expertise and interest of the instructors of record and guest speakers invited from the partnering local community.

Y1-Fall	Y1-Spring	Y2-Summer	Y2-Fall	Y2-Spring
GRADSCH 5401: Data Analytics Foundations I, including R and Python (3c) **Teaching department:** STAT	**GRADSCH 5402:** Data Analytics Foundations II, including R and Python (3c) **Teaching department:** STAT	**GRADSCH 5620:** Practical Learning and Mining for Big Data (3c) **Teaching departments:** CSE + STAT (1.5 CH each)	**GRADSCH 5141:** Interactive Arts Media II: UI/UX (3c) **Teaching department:** ACCAD	**GRADSCH 5150:** Emerging Trends in Data Visualization (3c) **Teaching department:** ACCAD
GRADSCH 5621: Big Data Computing Foundations I: End-to-end workflows, incl. visualization (3c) **Teaching department:** CSE	**GRADSCH 5622:** Big Data Computing Foundations II: Scalable computing, data management (3c) **Teaching department:** CSE	**GRADSCH 5505:** Information Design (3c) **Teaching departments:** DESIGN+CSE	**GRADSCH 5911:** Practicum /Capstone I (3c) **Teaching department:** TBD	**GRADSCH 5912:** Practicum /Capstone II (3c) **Teaching department:** TBD
	GRADSCH 5625: Seminar I: Data governance (1c) **Teaching department:** TBD	**GRADSCH 5626:** Seminar II: Research methods (1c) **Teaching department:** TBD	**GRADSCH 5627:** Seminar III: Professional development (1c) **Teaching department:** TBD	
6 cr total	7 cr total	7 cr total	7 cr total	6 cr total

C. STUDENT LEARNING OUTCOMES

General Learning Goals of the PSM-TDA Degree

Upon graduation students will demonstrate:

1. **Knowledge of fundamental principles of computer science.** They will exhibit methodological understanding and experiential competency, enabling them to perform relevant workplace tasks such as: identifying common data sources and data structures; using information technology and programming environments to convey and retrieve information; and identifying processes and mechanisms commonly used to retrieve, assess, re-engineer, enrich, manipulate, visualize, and amalgamate data.
2. **Knowledge of fundamental principles of data analysis, statistical inference, and machine learning.** They will exhibit methodological understanding and experiential competency, enabling them to perform relevant workplace tasks such as: apply appropriate methods, models, and techniques from topics of data mining, learning methods, optimization, probability, statistics, and simulation to analyze data; generate explanations to answer the research and/or business questions under scrutiny; produce

predictions of future outcomes for the process under study. Critical thinking skills, acquired through coursework and experiential practice, enabling them to: ask relevant project-related questions; identify appropriate methodological approaches to produce useful answers; design methods to evaluate and assess validity of outcomes; evaluate requirements and specifications to recommend effective, analytics-based solutions.

3. **Translational competency**, enabling them to transfer, apply, and validate analytic methods and findings across domains. Also exhibit understanding of data governance obligations and challenges, as well as emerging legal and ethical issues with data analytics, including privacy and security best practices.
4. **Mastery of professional skills**, including interpersonal communication, designing and delivering presentations, teamwork, and leadership in diverse teams representing various organizational environments. They will exhibit mastery at communicating recommendations through effective storytelling, both orally and in the format of written reports, translating technical solutions to audiences with varied backgrounds.

Learning Goals of the Visualization Track

Students will demonstrate:

1. An ability to integrate artistic, methodological and experiential technical abilities for creating visual stories of data based upon a synthesis of interdisciplinary knowledge in the context of data usage in workplaces and enterprises.
2. A fundamental understanding of design principles that contribute to and enhance readability, legibility, aesthetics and visual comprehension allowing for the amplification of insights, and patterns inherent in the data and the placement of the insights into real-world contexts resulting in useful prediction of trends and events.
3. The application of foundational aspects of both user experience and human computer interaction design that enhances user understanding and use of data visualization to design user interfaces that are both meaningful and effective in a variety of workplace settings.
4. Proficiency in designing and implementing visual communication solutions of information and data analysis by resorting to practical knowledge of design, human-computer interaction, and visualization, and their skills in visual graphics programming for meaningful and contextual story telling.
5. The ability to evaluate and choose appropriate existing and emergent tools for visualization and interaction based on cognitive fit and background of users, analysis of workplace needs and platform.

VII. EXPERENTIAL COMPONENT/CAPSTONE

A key recommendation from both of TDAI's employer roundtables has been to incorporate high-quality, experiential learning into the PSM-TDA program to ensure industry relevancy. It also

serves as a critical bridge between a student's work experience and educational coursework. Therefore, the proposed PSM-TDA program will incorporate experiential activities throughout all its course offerings. Beginning with the foundation courses in data analytics and computing, and the subsequent course on practical learning, students will be exposed to realistic learning activities that emphasize the application of modern analytics tools to the solution of practical questions. This pedagogical framework will extend to the track-specific courses, in which the illustrative activities will concentrate on demonstrating how to construct and implement effective visualization methods in real-life settings.

The experiential elements of the program will culminate in a required two-semester Practicum/Capstone course sequence, for a total of six credit hours. A key element of the capstone experience will consist in the direct engagement of our community partners including employers from industry, government, and non-profits to formulate challenge questions. They will also provide data relevant to answer those questions. Collaborations with business partners will require they provide data with a challenge problem and financial support for the execution of the project. Among other things, this financial support will allow the PSM-TDA program to offer release time to faculty project advisors with specific domain knowledge to help supervise the projects. No deliverables will be expected of the students because the capstone project must be viewed as a learning experience rather than a consulting assignment. This approach has been successfully adopted by other programs on campus including Computer Science and Engineering, the Fisher College of Business for their degree offerings in business analytics and the Undergraduate Major in Data Analytics. Although the Multidisciplinary Capstone Program offered by the Department of Engineering Education imparts less experience in data analytics, several successful elements of that program will be eventually adopted. We draw upon all these programs as described below.

A. LOGISTICS

Practical organizational elements of the capstone experience will be as follows.

- Students will work in teams of suitable size (3 or more).
- Community partners will be recruited by the PSM-TDA Faculty Mentor, TDAI Managing Director and Program Coordinator.
- The community partners will present their projects to the students to pique their interest in the practical questions for which they need answers.
- The PSM-TDA Faculty Mentor will oversee the formation of teams and the project assignments.
- To foster a broader array of perspectives, students will not be generally assigned to projects involving their own employers. Exceptions to this general rule may be considered on a case-by-case basis.
- Each team will establish contact with a community partner supplying the problem and develop an ongoing partnership leading to a coherent, refined formulation of the problem and a satisfactory solution.
- In addition to the PSM-TDA Faculty Mentor, each team may be assigned a faculty project advisor with domain specific expertise (as needed). Typically, this faculty advisor will be

one of the TDAI affiliated faculty members, but non-affiliated faculty members will also be engaged.

- The PSM-TDA Faculty Mentor will monitor all projects to ensure that the learning experience has uniform requirements to guarantee academic integrity.

The OSU Office of Legal Affairs has developed a template for a proposed "Cooperative Agreement for Student Projects" between The Ohio State University on behalf of its Office of Sponsored Programs and the participating community partners. The Multidisciplinary Capstone Program of the Department of Engineering Education has used this working template to establish collaborative agreements for undergraduate capstone projects. TDAI will employ a similar set of documents to establish working relationships with various partners.

B. LEARNING GOALS

The learning goals of the capstone courses and of the capstone project are in concurrence with the general learning goals of the PSM-TDA degree, with special emphasis on translational competency and mastery of professional skills. Accordingly, in their capstone projects, the students will be expected to demonstrate mastery of soft skills, including design thinking and presentation capabilities, in addition to a keen familiarity with the required technical skills.

Specific assessment of the learning goals for the capstone experience will occur in conjunction with the assessment of general Learning Goals 3 and 4 for the PSM-TDA program (pg. 21). These are the learning goals most directly relevant to the students' experiential formative experience. The assessment process and rubric are described in detail later in Section VIII. The goals and their measurable learning outcomes are paraphrased herewith for ease of reference.

General Learning Goal 3: Translational competency.

The following *learning outcomes* are associated with Learning Goal 3:

1. Ability to transfer, apply, and validate analytic methods and findings across domains.
2. Competence in the best practices of the student's specialization track.
3. Knowledge of and ability to comply with data governance obligations and challenges, as well as understanding of emerging legal and ethical issues with data analytics, including privacy and security best practices.

General **Learning Goal 4:** Mastery of professional skills.

The following *learning outcomes* are associated with Learning Goal 4:

1. Level of interpersonal communication skills, including presentation design and delivery.
2. Propensity for teamwork and leadership in a diverse team representing various organizational environments.
3. Ability to communicate recommendations through effective storytelling, both orally and in the format of written reports, translating technical solutions to audiences with varied backgrounds.

C. PERFORMANCE EVALUATION

Performance evaluation of the students' performance in the capstone courses will be based on the following elements:

- Active and productive participation in the in-class activities and in the capstone project.
- Elaboration of mid-semester interim reports and final reports in each of the two capstone courses.
- Progress-report poster presentation at the end of the first semester.
- Final oral presentation at the end of the second semester.
- No deliverables for the companies will be expected.
- Project evaluation will be performed by the course instructor(s), PSM-TDA Faculty Mentor, and faculty advisor(s).
- The PSM-TDA Advisory Board members will observe the final presentations to assist with the overall evaluation of the quality of the degree program but will not be involved in the evaluation of the students' performance.

VIII. PROGRAM QUALITY ASSURANCE

The standards for program quality assurance will meet the OSU requirements for annual program assessment as follows:

1. The TDAI Faculty Director, the PSM-TDA Faculty Mentor and Program Coordinator will manage the annual assessment required by the Graduate School.
2. A formal assessment plan has been established and is described below. The learning goals of the PSM-TDA program inform the assessment plan. The plan includes procedures of data collection and analysis for the evaluation of student performance and the improvement of student learning outcomes.

A. FORMAL ASSESSMENT PLAN

The ensuing assessment plan is currently modeled after the assessment plans of the graduate programs in the Departments of Statistics from which it borrows structure and language. These assessment plans have been implemented successfully over the past several years and have produced valuable quantitative data that enables informative evaluation of the programs over time and suggest directions for improvement. We foresee that this general structure of the assessment plan will be similarly successful for the proposed PSM-TDA program. Since the PSM-TDA degree draws from several disciplines and programs, TDAI will include additional assessment elements as needed.

The PSM-TDA Faculty Mentor and Program Coordinator will be responsible for the overall assemblage and processing of the assessment data. The TDAI Faculty Director will lead the interpretation of the results and lead the preparation of the summaries of the annual assessment exercise. She/he will work closely with the PSM-TDA Faculty Mentor and Program Coordinator. Further, the PSM-TDA Faculty Mentor and Program Coordinator will work with TDAI's Managing Director, especially towards the accessibility and quality assessment of the

capstone material as it pertains to external outreach. This group (TDAI Faculty Director and Managing Director together with the PSM-TDA Faculty Mentor and Program Coordinator) forms the PSM-TDA Administrative Core Team. The other salient participants in the assessment are the PSM-TDA External Advisory Board (required by the PSM National Commissioning body) and the Directors of Graduate Studies in participating departments who will continuously work with the PSM-TDA Administrative Core Team. The PSM-TDA Administrative Core Team will be advised by a PSM-TDA Faculty Advisory Committee. The PSM-TDA Faculty Advisory Committee will be comprised of the TDAI Faculty Director or their designee, PSM-TDA Faculty Mentor, the Chairs of the GSC in the participating departments, and a faculty member from the Graduate School. One PSM-TDA student per cohort will be elected by their peers (or volunteer if not contested) to serve as non-voting members on the committee. The students will not be involved in any FERPA protected items if they are taken up by the Committee. The students will serve as liaisons between this team and the student body on issues relevant to their experience.

The PSM-TDA Faculty Advisory Committee will oversee the following activities (but not limited to):

- Devising guidelines or a handbook for the PSM-TDA.
- Admission requirements and selection of candidates
- Recruitment of M/P status faculty to serve as advisors for PSM-TDA students
- Curriculum requirements, course offerings and modifications
- Student petitions and other issues

General Learning Goals of the PSM-TDA Degree.

To reiterate, upon graduation, students will demonstrate:

1. **Knowledge of fundamental principles of computer science.**
2. **Knowledge of fundamental principles of data analysis, statistical inference, and machine learning.**
3. **Translational competency.**
4. **Mastery of professional skills**.

Assessment of Learning Goal 1: Knowledge of fundamental principles of computer science. The following *learning outcomes* are associated with Learning Goal 1:

1. Ability to identify common data sources and data structures.
2. Ability to use information technology and programming environments to convey and retrieve information.
3. Ability to implement the processes and mechanisms commonly used to retrieve, assess, re-engineer, enrich, manipulate, visualize, and amalgamate large scale data.

Assessment rubric:

The PSM-TDA program will directly assess students' achievement of the stated learning outcomes by scoring their performances on selected questions embedded in the final exam of the course *Big Data Computing Foundations II.* Appropriate questions addressing each learning outcome will be used. For each learning outcome, the course instructor will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the determination of the overall performance on the exam. The course instructor will be responsible for communicating the rating summaries and remarks to the PSM-TDA Program Coordinator.

Criterion: If at least 80% of the assessment ratings of students in the PSM-TDA program are in the "High Proficiency" or "Satisfactory Proficiency" categories, we will consider this as evidence of success in achieving Learning Goal 1.

Use of Data: Aggregated data for each learning outcome will be examined by the PSM-TDA Administrative Core Team on an annual basis. If the data do not meet our criteria or are otherwise disappointing, the team will explore possible remedies, including meeting with students directly to discuss their performance, making improvements in course content, and making improvements in course delivery and learning activities within courses.

Assessment of Learning Goal 2: Knowledge of fundamental principles of data analysis, statistical inference, and machine learning.

The following *learning outcomes* are associated with Learning Goal 2:

1. Ability to apply appropriate methods, models, and techniques to the analysis of data.
2. Ability to generate explanations to answer the research and/or business questions under scrutiny, to evaluate and assess the validity of outcomes, and to produce predictions of future outcomes for the process under study.
3. Ability to evaluate requirements and specifications to recommend effective, analytics-based solutions.

Assessment rubric:

The PSM-TDA program will directly assess students' achievement of the stated learning outcomes by scoring their performances on selected questions embedded in the final exam of the course *Data Analytics Foundations II.* Appropriate questions addressing each learning outcome will be used as in the assessment of Learning Goal 1. For each learning outcome, the course instructor will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the determination of the overall performance on the exam. The course instructor will be responsible for communicating the rating summaries and remarks to the PSM-TDA Program Coordinator.

Criterion: [same as for Learning Goal 1]

Use of Data: [same as for Learning Goal 1]

Assessment of Learning Goal 3: Translational competency.

The following *learning outcomes* are associated with Learning Goal 3:

1. Ability to transfer, apply, and validate analytic methods and findings across domains.
2. Competence in the best practices of the student's specialization track.
3. Knowledge of and ability to comply with data governance obligations and challenges, as well as understanding of emerging legal and ethical issues with data analytics, including privacy and security best practices.

The PSM-TDA program will directly assess students' achievement of the learning outcomes above by scoring each student on the student's capstone project (including the process leading to its completion and its oral presentation). For each learning outcome, the project evaluation will be performed by the capstone course instructor(s), PSM-TDA Faculty Mentor, and faculty advisor(s) with input from the community partner supplying the project. They will assess each student on the ordinal scale: "High Proficiency," "Satisfactory Proficiency," "Some Proficiency," or "Low Proficiency." This will be done separately from the overall determination of whether the student passes the capstone course and will usually be accompanied by additional remarks regarding the attainment or non-attainment of the learning outcome, which will be specific to the student's project topic. The PSM-TDAI Faculty Mentor will be responsible for communicating the rating summaries and remarks to the PSM-TDA Program Coordinator.

Criterion: If at least 80% of the above assessment ratings are in the "High Proficiency" or "Satisfactory Proficiency" categories, we will consider this as evidence of success in achieving Learning Goal 3 for our PSM graduates.

Use of Data: Aggregated data for each learning outcome will be examined by the PSM-TDA Administrative Core Team on an annual basis. If the data do not meet our criteria or are otherwise disappointing, the team will explore possible remedies, including meeting with students directly to discuss their performance, and improving the guidance that we give students in preparing the capstone project.

Assessment of Learning Goal 4: Mastery of professional skills.

The following *learning outcomes* are associated with Learning Goal 4:

1. Level of interpersonal communication skills, including presentation design and delivery.
2. Propensity for teamwork and leadership in a diverse team representing various organizational environments.
3. Ability to communicate recommendations through effective storytelling, both orally and in the format of written reports, translating technical solutions to audiences with varied backgrounds.

Assessment Rubric: [same as for Learning Goal 3]

Criterion: [same as for Learning Goal 3]

Use of Data: [same as for Learning Goal 3]

B. FURTHER ASSESSMENT AND EVALUATION

To evaluate the unique professional training nature of the program while aligning the program with other data analytics programs on campus, the following additional steps will be implemented.

a) The program will indirectly assess all the learning outcomes through an exit survey of all graduating students.
b) The program will record and analyze job placement data for all graduated students.
c) All assessment data will be shared and discussed annually with the program Advisory Board comprised of TDAI's Founding Partners and select representatives from chosen industry sectors. The board will also include faculty and advisors of existing data science programs. As needed, select OSU faculty will be invited to provide specific input.
d) Results and summaries of assessments will be shared with the Directors of Graduate Studies in each of the participating departments.
e) As part of the evaluation, informal benchmarking with other institutions will be conducted every five years.

C. EVALUATION OF INSTRUCTION

Evaluation of instruction will follow established OSU standards.

a) Faculty/Instructors associated with a TIU will be evaluated annually through a TIU review. The Chairpersons and Directors of Graduate Studies of participating departments will provide input on instruction and evaluate changes to content.
b) Faculty/Instructors not associated with any TIU (e.g., instructors hired directly by the TDAI) will be evaluated annually through a TDAI review led by the PSM-TDA Faculty Mentor.
c) At the end of each course, faculty will be evaluated by the enrolled students using standardized evaluation instruments followed across the University.

IX. UNIVERSITY APPROVALS

In progress.

X. CONSULTATIVE PROCESS

The following material was collected over the last 3 years to support the establishment of the graduate programs in data science and analytics.

A. During 2016-2017, TDAI conducted a comprehensive examination of DSA related academic programming at OSU. A long and a short version of the report are attached (see Appendices 7 and 8).
B. TDAI has conducted a market research through Eduventures to understand the labor market and student market of data analytics for our planned program (see Appendix 1).

C. TDAI organized two roundtables with TDAI's industry partners. A summary of the roundtables is attached (see Appendix 10).
D. TDAI has conducted a series of information sessions with students, faculty, and industry partners to gather inputs for building a successful PSM. Presentation slides from these information sessions are attached (see Appendix 9). Feedback from those who attended the meetings were positive. Suggestions were taken into consideration when developing the curriculum.

XI. COST ANALYSIS AND REVENUE SHARING MODEL

The proposed degree program is unique in many respects. The key issues to consider are:

- The TDAI will provide most of the logistic and administrative support but it is not an academic, degree-granting unit.
- The program is set up as a partnership between the departments of CSE, Statistics and Design in the Colleges of Engineering and Arts and Sciences. There is the possibility of future involvement of other academic units as more specializations are added to the program.
- The Graduate School has agreed to provide technical and administrative support.

For providing logistic and administrative support, TDAI has created the role of Internship and Student Programs Coordinator referred to as Program Coordinator throughout the proposal. Currently this position is filled by Mr. Joshua Roush who serves on the TDAI's staff. Further, it will also recruit a PSM-TDA Faculty Mentor who will oversee the academic content and the experiential aspects of the curricula. The Program Coordinator will interact with Faculty Mentor and TDAI's Faculty and Managing Directors. For all instructional matters, the Program Coordinator will work with the TDAI Faculty Director and the PSM-TDA Faculty Mentor. The Program Coordinator will work closely with the TDAI Managing Director on all matters of outreach and on discussions with our external and corporate partners. Please note that the PSM-TDA Faculty Mentor will be appointed in the imminent future.

TDAI is working with senior administration in the Colleges of Arts and Sciences, Engineering and the Graduate School and pertinent departments to create a 7-year model of projected revenues and costs. Under this proposed model, instructional costs are calculated based on a modular model of revenue sharing with the teaching colleges. The modular revenue sharing model assumes a current flat-rate compensation of $17,000 per credit hour taught (the number is subject to change). The Graduate School will collect revenues and distribute to the College that provides the instruction.

The individual departments and colleges will decide how to allocate their compensation. A possible example is as follows: A department commits to teaching three three-credit hour courses a year, generating $151,000 (subject to change) in instructional compensation. These funds could be used by the college to fund a tenure-track, clinical or lecturer faculty line.

This revenue model best suits the interdisciplinary nature of the program and better positions it for future expansion as additional partners become involved. This model will considerably simplify the task of welcoming additional partners.

Aggregate # of Students: We assume that 30 students will enroll each Fall in the 5-semester, part-time program. At steady state, there will be 60 students in the program in AU and SP and 30 students in SU. No attrition is currently accounted for.

Total Credit Hours: The program specifies a 33-credit hour requirement for a total of 990 credit hours taught each year.

Differential Fee: In addition to the tuition and subsidies collected, we intend to charge a differential fee for expenses.

Revenues are calculated distinguishing between **Total Revenues** and **Total Taxable Revenues.** Differential fee revenues are excluded from Total Taxable Revenues.

Instructional GTA's: We intend to employ GA teaching assistants to assist in instructional activities. Under the proposed model funding will go to the College/Department to fund a GTA.

Administrative Staff: This accounts for a 100% FTE PSM-TDA Faculty Mentor who will oversee teaching and supervising the experiential components of the program and a 50% FTE TDAI Program Coordinator.

Grad School and TDAI Tax: The graduate school and TDAI will assess a small tax (to be determined) only in the presence of a net profit.

General Supplies: Estimated costs for supplies needed to run the program (copying, advertising, etc.).

XII. ADDITIONAL RESOURCES

It is our goal that various participating units commit to providing curricular and instructional support as follows:

- Development and teaching of new courses.
- Adaptation and teaching of existing courses.
- Compensation models for TDAI and the participating Colleges and academic units for the provision of instructional, curricular, and administrative support.

To meet these requirements, TDAI will lead to define:

- Clear position descriptions and roles of the PSM-TDA Faculty Mentor, the likely recruitment of suitable candidate and her/his affiliation to participant departments. The affiliation (Computer Science, Statistics, Design, etc.) will be determined by the training and skill sets of chosen candidates.
- Curricular and Instructional support from departments. TDAI will work with Chairs and Graduate Chairs of participating departments for curriculum and instructional support.
  Operational and financial agreements between all participants. TDAI will enter into agreements regarding costs to all parties and institutionalize the above revenue sharing

model with all participating entities to. First it will create an agreement with the Graduate School for the administrative support of the PSM-TDA degree program. Further, TDAI and Graduate School will work administrations of participating colleges and units to create mechanisms of administrative and financial support. Appropriate agreements will be detailed in MOUs between TDAI and participating entities. It is also expected that, through tuition charges, the PSM-TDA program will provide a reliable revenue stream to TDAI and the various participating units, as per the blueprint in various MOUs. New resources committed to the TDA-PSM program will not interfere with the current pedagogical activities of the participating units if so deemed. Further, participating units will have freedom to recruit faculty of appropriate training and rank (clinical faculty, tenure track, instructors, etc.) per the market demands they operate with.

GRADSCH 5401: Data Analytics Foundations I

Syllabus

Teaching department: STAT 5401
Credit-hours: 3
Prerequisites: Good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description and Learning Outcomes:

The successful working professional engaged in modern, real world, data science must be able to extract useful information from data and use that information to address work-related challenges. Central to this endeavor is the focus on data-driven decision making under uncertainty. Data come from multiple sources and in all types of formats. Proficiency in identifying, sourcing, manipulating, and interpreting data is paramount.

This is the first course in a two-semester sequence comprised of two, 3 credit-hour courses focusing on R programing and data analysis using R. The sequence is intendent to be taken in parallel with the Big Data Computing Foundations sequence focusing on fundamental CS methods for data science.

Upon successful completion of the course, students will be able to:

1. Use the statistical programing language and software environment R and the companion integrated development environment RStudio to import, manipulate and visualize data
2. Clean the data and transform them into formats amenable to statistical analysis and visualization
3. Derive and interpret numerical and visual summaries of the data
4. Conduct application-driven, exploratory analyses that point in the direction of meaningful, application-specific structure in the data, and facilitate the separation of the information "signal" in the data from the "noise" reflecting pure randomness
5. Use their R programing skills to organize the data analysis steps into a streamlined, efficient workflow.
6. Perform basic programing tasks in R
7. Author effective summary reports of the performed analysis using R Markdown

Course Materials:

Textbook:

- Garrett Grolemund and Hadley Wickham (2017), *R for Data Science* (First Edition), O'Reilly; (https://r4ds.had.co.nz/)

Software:

- R (www.r-project.org)
- RStudio (www.rstudio.com)

Course Outline:

The outline is based on the assumption of 40 one-hour lectures and 2 one-hour midterms.

Lecture	Topic
1-3	Introduction and data visualization using R (Textbook Ch 2 and 3)
4-6	R coding basics and data transformations (Textbook Ch 4 and 5)
7-11	R scripts and introductory elements of exploratory data analysis; Workflow organization and RStudio projects (Textbook Ch 6, 7 and 8)
12	Midterm 1
13	Fundamental R data structures: Data frames and Tibbles (Textbook Ch 9-10)
14-15	Importing data into R and exporting data to file; Data types (Textbook Ch 11)
16-17	Organizing data into R (Textbook Ch 12)
18-21	Relational data in R (Textbook Ch 13)
22-24	String manipulation is R (Textbook Ch 14)
25-26	Factors in R (Textbook Ch 15)
27	Dates and time (Textbook Ch 16)
28	Midterm 2
29	Programing: Introduction and Pipes (Textbook Ch 17 and 18)
30-31	Programing: Functions (Textbook Ch 19)
32-33	Programing: Vectors (Textbook Ch 20)
34-36	Programing: Iterations (Textbook Ch 21)
37-38	Communication of results: Introduction and R Markdown (Textbook Ch 26 and 27)
39-40	Communication of results: Graphics for communication and R Markdown formats (Textbook Ch 28 and 29)

GRADSCH 5402: Data Analytics Foundations II

Syllabus

Teaching department: STAT 5402
Credit-hours: 3
Prerequisites: GRADSCH 5401 (Data Analytics Foundations I) + GRADSCH 5621 (Big Data Computing Foundations 1) and good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description and Learning Outcomes:

This is the second course in a two-semester sequence comprised of two, 3 credit-hour courses focusing on R programing and data analysis using R. The sequence is intendent to be taken in parallel with the Big Data Computing Foundations sequence focusing on fundamental CS methods for data science. The focus of this second course is on more advanced R programming, distribution theory via simulation methods, statistical modeling (A/B testing, ANOVA, multiple linear regression, logistic regression, multivariate analysis), and communication of results.

Building on the computational and interpretative skills developed in Data Analytics Foundations I, the students will explore formal, theoretically motivated frameworks for data analysis. The initial portion of the course will stress the use of simulation-based experimentation to teach the basic elements of distribution theory and develop a practical understanding of the sampling variability of estimators. The remainder of the course will cover specific modeling strategies for different types of data and will illustrate the data analysis strategies with examples drawn from real world applications.

Upon successful completion of the course, students will be able to:

1. Understand and quantify the sampling variability of data and parameter estimators under a variety of data generating mechanisms
2. Translate real world problems and scientific questions of interest into well-formulated inferential models for the available data.
3. Select the variables that are most useful to address the inferential task at hand
4. Use the inferential models developed in parts 2) and 3) to understand the problems of interest, provide answers to specific, domain-specific questions, and forecasts the values for future occurrences of the data
5. Assess and quantify the uncertainty in the conclusions drawn from the inferential tasks

Course Materials:

Textbook:

- Murray Aitkin, Brian Francis, John Hinde, and Ross Darnell (2014), *Statistical Modelling in R* (1st Edition), Oxford Statistical Science Series; (https://www.amazon.com/Statistical-Modelling-Oxford-Science/dp/0199219133)

Software:

- R (www.r-project.org)

- RStudio (www.rstudio.com)

Course Outline:

The outline is based on the assumption of 14 weeks with three one-hour lectures and 2 one-hour midterms.

Lecture	**Topic**
Week 1-3	Distribution theory and sampling distribution of estimators (Bernulli, Binomial, Normal, *t, F*)
Week 4-5	A/B testing (start with one sample problems leading to two sample problems for binomial and normal data)
Week 6-7	ANOVA (one and two-way, random effects)
Week 7-10	Multiple linear regression
Week 11-12	Logistic regression, Poisson regression
Week 13-14	Multivariate analysis

GRADSCH 5621 Big Data Computing Foundations I

Teaching department: CSE 5621
Credit-hours: 3
Prerequisites: Good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course description:

This is intended as a two-semester sequence comprised of two, 3 credit-hour courses focusing on use of Python and Javascript programing and tools/environments such as Hadoop and Scala. The sequence is to be taken in parallel with the sequence focusing on fundamental statistical data analytic methods. The successful working professional engaged in real world, problem-solving contexts must be able to construct schemas that locate data sources and scrape them, followed by practical workflows that ingest and clean data, extract useful information for exploration and visualization, and use that information to address work-related challenges. The course aims to teach students to construct programming-based, data-driven tools to facilitate context-aware problem to identify, source, manipulate, and interpret data to create workflows for a variety of data types and representations.

Course objectives:

1. Use the programing languages of Python and Javascript and the companion integrated development environment of Jupyter to import, manipulate and visualize data. Learn to interface with to other environments such as the R programming language and open-source software libraries and tools.
2. Learn to locate data sources and scrape data from collections and ingest them. Clean the data and wrangle or munge them into formats and representations amenable for further analysis and visualization. Become adept at constructing workflows to scrape and wrangle data for a variety of applications.
3. Learn to create high-utility and efficacious workflows using Python-based tools to extract summary information inherent in the data from a variety of applications.
4. Create high-information and useful Javascript/Java based tools that interface with the data analytic workflows to create meaningful and useful visualizations and in turn realize for the use of feedback loops to alter the data analysis in useful ways.
5. Conduct application-driven, exploratory analyses that use other contextual information including ontologies to contribute to problem solving and achieve true translation.
6. Author effective summary reports of the performed analysis using Jupyter notebooks.

Course Outline:

Assume 40 one-hour lectures and laboratory exercises
For planning purposes, I propose to follow the basic outline in the books listed at end of document. Projects and homework are just placeholders.

Lecture	Topic

Week 1	Introduction and case-studies of workflows from various applications and using data of various types.
Week 2	Python programming-I: Environments, toolkits incl. Jupyter, interfacing with other languages.
Week 3	Python programming-II: Rudimentary data structures, functions, file-processing for text and binary formats, and control flow. Locating data sources on the internet and data scraping using Python.
Week 4	Data wrangling and munging and data cleaning. First examples.
Week 5	Workflow Engineering - Types, construction, execution, etc.
Week 6	Python programming-III: Built-in data structures, functions, Numpy arrays, frames with pandas;
Week 7	Case Study I - String manipulation, workflows for unstructured textual and social media data using NLTK, bag-of-words, simple classifiers.
Week 8	Introduction to Javascript; Essential fundamentals and intro to D3.js.
Week 9	Word Clouds for text visualization; use of basic frequentist statistics and mapping visual attributes.
Week 10	Case Study II - Time Series analysis - moving averages, filtering, window-based data handling; visualization of univariate data;
Week 11	Case Study III - Tables and spatiotemporal maps; analysis and visualization;
Week 12	Case Study IV - Analysis and basic visualization of graphs
Week 13	Case Study V - Analysis and display of image data;
Week 14	Performance measurement of images

Texts:

1. Python for Data Analysis - Data Wrangling with Pandas, NumPy, and IPython, William McKinney, O'Reilly Media, October 2017. (An electronic version is available for online reading through the OSU Safari website)
2. JavaScript: The Definitive Guide, 6th Edition, David Flanagan, O'Reilly Media, May 2011. (An electronic version is available for online reading through the OSU Safari website)

GRADSCH 5622 Big Data Computing Foundations II

Teaching department: CSE 5622

Credit-hours: 3

Prerequisites: GRADSCH 5401 (Data Analytics Foundations I) + GRADSCH 5621 (Big Data Computing Foundations 1) and good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course description:

This course will emphasize the creation of scalable data organizations, expedient access to data and high-performance computing workflows, including cloud computing, for Big Data. Data structures and especially scalable data structures amenable to high performance computing will be a primary focus of the course. Data organization in the form of data warehousing and access to databases will be other salient topics. Finally, sufficient attention will be accorded to cloud computing including an introduction to systematic organization of data on cloud computing architectures. The emphasis will be more on the practical rather than foundational. The list of topics comprises an introduction to basic and advanced data structures; indexing techniques, including B-tree and hash-based indexing; fundamentals of query optimization; data partitioning and management and distributed task scheduling on the cloud.

Course objectives:

1. Mastery over fundamental concepts in indexing and optimization techniques, including B-trees, hash-based indexing and cardinality estimation.
2. Mastery of database organization and query optimization techniques
3. Competency with data warehousing techniques, including on-line analytical processing (OLAP)
4. Familiarity with distributed data management, including full and partial replication strategies, data partitioning, fault tolerance models and consistency tradeoff
5. Competency with distributed algorithms including Map-reduce, Spark, Hadoop and task scheduling in cloud environments
6. Exposure to current cloud-based data management technologies.

Course Outline:

Lecture	**Topic**
Week 1	Introduction to course and fundamentals of data management and cloud computing; review of programming environments. Use cases.
Week 2-5	Introduction to data structures; scalable data structures and use cases - B-trees, hash-based indexing and cardinality estimation.

Week 6-10	Database and data management techniques - queries and query optimization, data warehousing, on-line analytical processing (OLAP), and use cases.
Week 11-12	Cloud computing fundamentals, distributed algorithms and task scheduling in cloud environments including MapReduce, Spark, Hadoop.
Week 13-14	Current cloud-based data management technologies.

Texts

1. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey Ullman, 2014 http://www.mmds.org/.
2. Cloud computing for Engineering and Science , Ian Foster, Dennis B. Gannon, MIT Press,2017 - https://cloud4scieng.org/chapters/.
3. Fundamentals of Database Systems, Ramez Elmasri and Shamkant Navathe.Pearson Higher Education; 7th edition edition, 2016.
4. Data Center as a Computer, Luiz André Barroso, Jimmy Clidaras, Urs Hölzle, July 2013. (available at http://www.morganclaypool.com/doi/abs/10.2200/S00516ED2V01Y201306CAC024)
5. Learning Spark: Lightning-Fast Big Data Analysis, Matei Zaharia, Holden Karau, Andy Konwinski, Patrick Wendell, O'Reilly, 2015.(An electronic version is available for online reading through the OSU Safari website; https://spark.apache.org)
6. Data-Intensive Text Processing with MapReduce, Jimmy Lin and Chris Dyer, Morgan and Claypool, 2012. (Available https://lintool.github.io/MapReduceAlgorithms/MapReduce-book-final.pdf)

GRADSCH 5625 Data Governance

Cross-listed: CSE 5625

Credit-hours: 1

Prerequisites: GRADSCH 5401 (Data Analytics Foundations I) + GRADSCH 5621 (Big Data Computing Foundations 1) and good standing in the PSM-TDA. Course enrollment is restricted to graduate students enrolled in PSM-TDA program.

Course Description: Demonstrate the need for data governance. Emphasize the need to generate trust in data assets in typical projects and enterprises. Identify elements of good data governance. Discuss privacy and security in the context of data governance. Enumerate the advantages of robust and principled governance through the use of case studies.

Course Objectives: Upon successful completion of the course, students will be able to demonstrate:

1. Knowledge of and ability to comply with data governance obligations and challenges.
2. Knowledge of methods to ensure good and robust data governance for data analytics applications.
3. Understanding of emerging legal and ethical issues with data analytics, including privacy and security best practices.
4. Knowledge of use and assessment of metrics for evaluating data governance.

Course Schedule:

Module	**Module Description**
Introduction - 4 weeks	● Why govern data? ● What data should be governed? ● Drivers for data governance
Implementation - 4 weeks	● Selecting data; defining goals ● Data curation ● Standards/policies ● Technologies/methods/processes ● Privacy & security ● Measuring effective data governance
Legal and ethical issues - 3 weeks	● Examples from data analytic applications ● Resolution of issues
Case studies - 3 weeks	● Data analytic settings ● Problems and Challenges

	● Success stories

Course Materials

Readings - There is no required textbook for the course. A list of freely available readings will be posted to the course website.

GRADSCH 5620: Practical Learning and Mining for Big Data

Cross-listed: CSE 5624 + STAT 5620

Credit-hours: 3

Prerequisites: GRADSCH 5402 (Data Analytics Foundations II), GRADSCH 5622 (Big Data Computing Foundations II) + GRADSCH 5625 (Seminar 1: Data Governance) and good standing in PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description:

Building on the computational and interpretative skills developed in data analytics and computing foundations, students will explore practical ways to create data mining and machine learning workflows. The course will be divided into two modules. The first module will focus on practical and scalable data mining, while the second focuses on scalable machine learning. The focus is on building practical workflows that will teach enrolled students to mine associations, patterns, classify, and build recommendation systems for data and questions in the context of enterprises. Further, students will build both custom and public domain tools to infer from both machine and deep learning models and make predictions. The goals for this course are:

Course Objectives:

1. Students will gain mastery of knowledge discovery process; they will be able to formulate questions pertaining to associations and pattern mining and create workflows that can classify mine data in a scalable manner.
2. Students will gain familiarity with data structures for mining; students will be able to demonstrate scalable performance through sufficient knowledge of the underlying algorithms and methods in practical domains (e.g. manufacturing, market analysis, bioinformatics, etc.)
3. Students will understand the statistical learning framework, including core concepts such as loss, learning, and generalization; they will be able to judge when the framework is applicable and formulate real contextual problems from their enterprises within this framework.
4. Students will understand the rationale and algorithms behind statistical learning methods, and they will know the relative merits and limitations of these methods. Students will be able to quantitatively evaluate, validate and compare different statistical learning methods within the context of their enterprises and diagnose errors in a machine learning system.
5. Students will be able prioritize most promising directions of the project-at-hand; construct workflows with public-domain and custom tools for multitude of enterprise data; build machine learning systems in complex settings including when training and test sets are mismatched and obtain performance comparable to or surpass human-level performance.

Course Outline:

Assume 14 weeks with three one-hour lectures and 2 one-hour midterms.

Lecture	Topic
Module I: Week 1	Introduction to Data Mining; Frequent Pattern algorithms: Association Rule Mining, Sequential Pattern Mining; Use cases
Module I: Week 2-4	Mining Data Streams; Clustering continuous and categorical data; Classification Algorithms: Decision Tree Classification, Naive Bayesian Classification, A brief introduction to other classifiers; Recommendation Systems;
Module I: Week 5-7	Link Analysis (incl. Page Rank); Mining Social-Network Graphs; Scalable Data Mining with MapReduce and Hadoop. Use cases
Module II: Week 7-10	Statistical learning frameworks; Unsupervised vs. supervised learning; popular methods including regression-based (incl. LASSO), kernel methods, neural and deep learning networks; use cases
Module II: Week 11-12	Definitions of error/loss, learning, and generalization; bias vs. variance trade-offs; Cross-fold validation techniques with development/test and training data; addressing training and testing data mismatch; use cases
Module II: Week 13-14	Reinforcement, end-to-end learning, transfer learning. Deployment on multitude of data and context-driven evaluations.

Texts

1. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey Ullman, 2014 (Free material available at http://www.mmds.org/)
2. Machine Learning Yearning, Andrew Ng, http://www.mlyearning.org/ - A deeplearing.ai project, 2018 (Chapters available from author, Dr. Ng)
3. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurélien Géron, O'Reilly Media, 2017. (An electronic version is available for online reading through the OSU Safari website).
4. Learning Spark: Lightning-Fast Big Data Analysis, Matei Zaharia, Holden Karau, Andy Konwinski, Patrick Wendell, O'Reilly, 2015.(An electronic version is available for online reading through the OSU Safari website).
5. Data Mining, Charu Aggarwal, Springer, 2015. (Available online off SpringerLink)
6. An Introduction to Statistical Learning with Applications in R, James, Witten, Hastie, Tibshirani, Springer, 2013. (Freely downloadable PDF available at http://www-bcf.usc.edu/~gareth/ISL)
7. Murphy: Machine Learning: A Probabilistic Perspective, 2012, The MIT Press. (An electronic version is available for online reading through the OSU library website).

GRADSCH 5505: Information Design

Responsible department: DESIGN 5505 + CSE 5623

Credit-hours: 3

Prerequisites: GRADSCH 5402 (Data Analytics Foundations II), GRADSCH 5622 (Big Data Computing Foundations II) + GRADSCH 5625 (Seminar 1: Data Governance) and good standing in PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course description:

This course explores the relationship between data visualization and visual design. It presents programming skills and design strategies of how information and data can be structured and visualized in order to create effective communications and to stimulate viewer attention and engagement.

This is a project-based course that requires active student participation. Class sessions will be comprised of lectures, demonstrations, in-class activities, projects, presentations, discussions, and critique. An equal balance between theory and application will be expected. Students are expected to complete basic research, data collections, data filtering and analysis, discerning relationship and patterns, and finding the right tools and visual methods to create compelling interactive visual representations of data.

Course objectives:

Students will demonstrate:

1. Develop a fundamental understanding of design principles that contribute to and enhance readability, legibility, aesthetics and visual comprehension allowing for the amplification of insights, and patterns inherent in the data and the placement of the insights into real-world contexts resulting in useful prediction of trends and events.
2. The application of foundational aspects of both user experience and human computer interaction design that enhances user understanding and use of data visualization to design user interfaces that are both meaningful and effective in a variety of workplace settings.
3. Proficiency in designing and implementing visual communication solutions of information and data analysis by resorting to practical knowledge of design, human-computer interaction, and visualization, and their skills in visual graphics programming for meaningful and contextual story telling.

Information visualization:

- Tables, networks, and trees
- Interaction and manipulation: multiple views, facets and focus+context

Software:

- Python, Pandas, and Matplotlib

- Javascript and D3

Course schedule:

Week 1:	• Course overview
	• Visual queries and visual perception
	• Python data processing
	  ○ Language basics
	  ○ Python/Pandas

Week 2:	• Visual perception continued • Python data plotting with Matplotlib ○ Lab assigned

Week 3:	• Analysis of information
	• Visual variables
	• Javascript D3 - I
	  ○ HTML/CSS/SVG/D3
	  ○ Manipulation of DOM

Week 4:	• Design Elements and Design Principles

Week 5:	• Data abstraction, visualization marks and channels
	• Javascript D3 - II
	  ○ D3 data reading and processing
	  ○ D3 rendering
	  ○ D3 axis, scale, and transformation
	• Lab assigned

Week 6	Color Theories and Color Communications • Munsell color model • Color contrast • Interaction of colors

Week 7	• Task abstraction
	• Visualization of tables, networks, and trees
	• Javascript D3- III
	  ○ D3 layouts
	  ○ D3 interaction and transition

Week 8	• Symbols and icons • Pierce's theory of signs • Icons and metaphors
Week 9	• Typography and Grid Structure

	• Classification of type • Type hierarchy for communication • Layout design
Week 10	• Multidimensional visualization • Javascript D3 – IV • D3 advanced features
Week 11	• Final Project Proposal
Week 12-15	• In progress Final Projects
Week 16	• Final project presentations

GRADSCH 5626 Seminar in Research Methods

Credit-hours: 1

Prerequisites: GRADSCH 5402 (Data Analytics Foundations II), GRADSCH 5622 (Big Data Computing Foundations II) + GRADSCH 5625 (Seminar 1: Data Governance) and good standing in PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Faculty Instructor Department: TBD

Course Description & Objectives: This course will provide a high-level overview of general research methods that are common across many disciplines. Topics covered will range from formulating a research question to conducting specific analytical methodologies to writing/presenting results. Upon successful completion of the course, students will:

1. Be aware of ethical challenges that may arise during the research process and understand how to resolve.
2. Formulate a research question and conduct a literature review to understand the current knowledgebase.
3. Understand both qualitative and quantitative approaches to research, including design, sampling, data collection and analysis.
4. Be able to summarize research results in writing and via visualizations, and then present results to an informed audience.
5. Understand how to protect intellectual property.
6. Understand the publishing process.

Course Content:

Module	Topics
1: Research Process	• Research Process • Research Ethics and Integrity • Formulating Research Question • Conducting Literature Review (Primary and Secondary Research)
2: Quantitative Methods	• Quantitative Designs • Measurement Error, Reliability, Validity • Sampling and Data Collection • Analyzing Quantitative Data
3: Qualitative Methods	• Qualitative Designs • Collecting Qualitative Data • Analyzing Qualitative Data
4: Data Interpretation	• Interpreting Results • Visual Representations of Results • Writing a Research Report
5: Presenting Research	• Protecting Intellectual Property • Telling Your Research Story: Presenting Your Findings

Module	Topics
	• Publishing Process

Potential Textbook: (Topics above were taken in part from the reference indicated below.)

Introduction to Research Methods: A Hands-On Approach. SAGE Publications, Inc. Bora Pajo. 2018. ISBN: 9781483386959

GRADSCH 5141: Interactive Arts Media

Teaching department: ACCAD 5141

Credit-hours: 3

Prerequisites: GRADSCH 5620 (Practical Learning and Mining for Big Data) + GRADSCH 5505 (Information Design) + GRADSVH 5626 (Seminar II: Research Methods) and good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description:

Practice in methods for designing and crafting user experiences (UX) and user interfaces (UI) for applications that provide a cohesive, subjectively satisfying experience for the user. Contemporary methods and software to produce interactive application prototypes will be discussed and utilized. Additional course activities include cohort identification and conducting user testing and research.

Course objectives:

1. Demonstrate an applied understanding of the processes of concept development for an interactive mobile application
2. Gain exposure to the methods involved in designing and crafting a user interface that is both usable in a utilitarian sense but also provides a cohesive, subjectively satisfying experience
3. Demonstrate the ability to create an interactive prototype using wireframes and initiate a user test with subjects using the interactive prototype.
4. Learn technical skills surrounding the software required for usability and user experience
5. design and testing.

Course topics:

Week 1	Introduction to Interactive Media II and The Art and Science of User Experience and Usability Design
Week 2	Story Driven Design
Week 3	Story Driven Design and Theme Development
Week 4	Project 1 Due/Critique and Theme Development
Week 5	Usability Design
Week 6	Project 2 Due/Critique and Wireframe Development
Week 7	Using Software to Create Wireframes
Week 8	Creating Click---Through Prototypes
Week 9	Project 3 Due/Critique
Week 10	TBD
Week 11	Test Design
Week 12	Project 4 Due/Critique Test Design
Week 13	Project 5 Due/Critique and Recruiting for Tests

Week 14	Spreadsheets 101
Week 15	Documenting Tests and Creating Test Reports
Week 16	Project 6 Due/Critique

Course Methodology:

This course will emphasize hands--on experience and includes studio projects, demonstrations, reading, viewings, lectures, critiques. Students will explore design ideas of each project through video, and class time will be comprised of brainstorming ideas, working on creating time---based media and critiquing weekly deliverables.

Course Assignments and Value:

A1: Story and Persona Development = 10 points

A2: Proposal/Theme Development = 10 points

A3: High---Definition Wireframes = 15 points

A4: Click---Through Prototype = 15 points

A5: User Test Plan = 20 points

A6: User Test Report = 30 points

----------100 pts. Total

GRADSCH 5911: Capstone I

Cross-listed: CSE 5628, STAT 5911, DESIGN ####

Credit-hours: 3

Prerequisites: GRADSCH 5620 (Practical Learning and Mining for Big Data) + GRADSCH 5505 (Information Design) + GRADSVH 5626 (Seminar II: Research Methods) and good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description: Provide experiential training for students in data analysis with design thinking on non-trivial data. Require students to formulate data questions and create complete workflows. Place emphasis on teamwork, translational competency, and enhanced professional skills in data rich environments. Prepare students in the deployment and use of computing technology, the use of data analysis methods and the creation of user interfaces for data in the real world.

Course Objectives: Upon successful completion of the course, students will be able to demonstrate:

1. Ability to transfer, apply, and validate analytic methods and findings for given data.
2. Knowledge of and ability to comply with data governance obligations and challenges, as well as understanding of emerging legal and ethical issues with data analytics, including privacy and security best practices.
3. Level of interpersonal communication skills, including presentation design and delivery.
4. Propensity for teamwork and leadership in a diverse team with different skill sets and training.
5. Ability to communicate recommendations through effective storytelling, both orally and in the format of written reports, translating technical solutions to audiences with varied backgrounds.

In Capstone I, all students are provided non-trivial datasets which they will encode, analyze and visualize. The datasets will be chosen from a selection of popular open-source data that can be used to answer challenging questions with known solutions.

Topics:

- Introduction to data characteristics
- Data preparation
- Exploratory data analysis
- Visualization of data
- Computing workflows for data analysis
- Statistical modeling and analysis
- Model criticism and refinement
- Data analysis at scale
- Design principles for user interfaces

- Data storytelling
- Data ethics
- Problem identification
- Project scoping and planning
- Report writing
- Presentations

Course Schedule:

Module Duration	**Module Description**
Week 1	Course overview; Project guidelines; Team formation
Weeks 2-3	Data descriptions of datasets provided by external partners
Weeks 4-6	Problem identification & formulation for dataset A; Presentation I
Weeks 7-9	Problem identification & formulation for dataset B; Presentation II
Week 10	TBD
Weeks 11-13	Problem identification & formulation for dataset C; Presentation III
Week 14	Final Report; Preparing for Capstone II - Presentations for project

Course Materials

1. Readings - There is no required textbook for the course. A list of freely available readings will be posted to the course website.
2. Computing - The R programming language, Python and HTML/Javascript are available for use in the exercises.

Special equipment - Any necessary equipment for visualization will be made available

GRADSCH 5627 Seminar in Professional Development

Credit-hours: 1

Prerequisites: GRADSCH 5620 (Practical Learning and Mining for Big Data) + GRADSCH 5505 (Information Design) + GRADSVH 5626 (Seminar II: Research Methods) and good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Faculty Instructor Department: TBD

Course Description: During planning of the PSM-TDA program, industry partners and other government and non-profit employers indicated a need for soft skills development for their respective workforces. Thus, this seminar course is focused primarily on developing soft skills that are critical for success in business, as well as hard skills of project management. The content is divided into four modules: communications, project management, leadership and teamwork, and professionalism and work ethic.

Course Objectives: Upon successful completion of the course, students will be able to:

7. Communicate more effectively in writing and verbally. Understand how to use brevity and visualizations to enhance communications.
8. Understand basic project management, including four phases: initiation, planning, execution, and closure. Develop a project plan with associated scope, tasks, resources and schedule. Effectively lead a meeting to desired outcomes.
9. Understand what makes a high-performing team, as well as the value of diversity in that team. Gain exposure to team-building, coaching concepts, and managing upward. Apply these learnings in executing group project per the group project plan.
10. Understand and display professionalism and positive work ethic in the workplace.

Course Content:

Module	Weeks	Topic	Assessment
1	1-4	Communications • Written communications • Oral communications • Visual Communications /Presentations	• 1-page case study • Individual presentation
2	4-8	Project Management • Establishing project scope, budget, schedule • Running a meeting • Managing resources	Project plan
3	9-12	Leadership & Teamwork	• Case study analysis

		• High performing teams • Value of diversity • Team-building • Coaching • Managing upward	• Group project with presentation
4	13-14	Professionalism & Work Ethic	Final exam

Course Materials: (TBD. Select articles from *Harvard Business Review* and other sources.)

GRADSCH 5150: Emerging Trends in Data Visualization

Teaching department: ACCAD 5150
Credit-hours: 3
Prerequisites: GRADSCH 5141 (Interactive Arts Media) + GRADSCH 5911 (Practicum/Capstone 1) + GRADSCH 5627 (Seminar III: Professional Development), Good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description:
This course enables students to explore new and emerging visualization approaches, topics and trends in visualization research and their applications. Students will research, write about, create, and experience visualization trends.

Course objectives:

1. Examine and evaluate emerging approaches to visualization;
2. Describe the trends of visualization research and practice;
3. Facilitate, moderate, and participate in discussion on visualization research topics;
4. Articulate and analyze the factors that are prompting changes in visualization;
5. Apply new models to your own prototypes of future visualization possibilities

Course schedule:

1. Data Visualization: What's Next?
2. How Humans Interpret Graphics
3. Storytelling with Data
4. Data Collection
5. Mini-Presentation #1
6. Data Visualization for Products
7. Data and Natural Language Generation
8. Data Visualization for Social Good
9. Designing Virtual Reality Data Visualizations
10. Mini-Presentation #2
11. Animation and Interactivity in Data Visualization
12. Immersive, More Intuitive, and Richer Data-driven User Experiences
13. Information Visualization Research Projects that Would Benefit Practitioners
14. Prototyping Work Sessions
15. Final presentations and course wrap-up

GRADSCH 5912: Capstone II

Cross-listed: CSE 5629 STAT 5912, DESIGN ####

Credit-hours: 3

Prerequisites: GRADSCH 5141 (Interactive Arts Media) + GRADSCH 5911 (Practicum/Capstone 1) + GRADSCH 5627 (Seminar III: Professional Development), Good standing in the PSM-TDA program. Course enrollment is restricted to graduate students enrolled in the program.

Course Description: Provide a culminating experience for students through direct engagement with community partners who will formulate challenge questions and provide data. Place emphasis on teamwork, translational competency, and enhanced professional skills in data rich environments with added emphasis on processing of large data and interpretation of domain-relevant results. Illustrate the need for data storytelling through the deployment and use of scalable computing technology, the comprehensive use of basic and advanced data analysis, and the use of meaningful and enhanced user interfaces.

Course Objectives: Upon successful completion of the course, students will be able to demonstrate:

1. Ability to transfer, apply, and validate analytic methods and findings across domains.
2. Competence in the best practices of the student's specialization and of the data provider.
3. Knowledge of and ability to comply with data governance obligations and challenges, as well as understanding of emerging legal and ethical issues with data analytics, including privacy and security best practices.
4. Higher level of interpersonal communication skills, including presentation design and delivery.
5. Propensity for teamwork and leadership in a diverse team representing various organizational environments.
6. Ability to communicate recommendations through effective storytelling, both orally and in the format of written reports, translating technical solutions to audiences with varied backgrounds.

Topics:

- Advanced data analysis
- Visualization of large and complex data
- Scalable computing workflows for data analysis
- Statistical modeling and analysis at scale
- Design principles for user interfaces
- Data ethics
- Data storytelling and domain-relevant interpretation
- Problem identification
- Agile project planning, and execution
- Written and oral presentations

Course Schedule:

Module Duration	Module Description
Week 1	Course overview; Project recap per team from Capstone I
Week 2	Data descriptions of datasets provided by external partners
Weeks 3-5	Problem formulation and baseline workflow; Presentation I
Weeks 6-10	Modeling, scaling & visualization; Implementation 2; Presentation II
Weeks 11-13	Improve for interpretability; Implementation 3; Presentation III
Week 14	Final report and presentations.

Course Materials

1. Readings - There is no required textbook for the course. A list of freely available readings will be posted to the course website.
2. Computing - The R programming language, Python and HTML/Javascript are available for use in the exercises.
3. Special equipment - Any necessary equipment for visualization will be made available.