Minutes of the Graduate Faculty Council Meeting

Tuesday, December 10, 2013

**Members** (14): Andrew Storer (SFRES), Keat Ghee Ong (Biomed), Louisa Kramer (Geo), Kari Henquinet (PCorps), John Durocher (BioSci), Ashutosh Tiwari (Chem), Audrey Mayer (SocSci), Jiguang Sun (Math), Noel Urban (Non-Dept.Env), Mari Buche (Bus), Caryn Heldt (ChemEng), Andrew Swartz (Civ&Env), Warren Perger (Elec&Comp), Patty Sotirin (Rhet)

**Guests** (7): Jackie Huntoon (Grad Sch), Debra Charlesworth (Grad Sch), Nancy Byers-Sprague (Grad Sch), Jacquie Smith (Grad Sch), Amberlee Haselhuhn (GSG), Laura Brown (Comp Sci), Dan de Beaubien (IT), Josh Olson (IT)

1) Meeting called to order at 4:05 pm.

2) Review and approval of 11/05/13 meeting minutes with two amendments which will be updated and added to the GFC website.

3) Committee Reports:
   b. Thesis/Dissertation Review Committee: This committee has met and has a report. You will find the report on the handouts section of the GFC website (January 14, 2014 meeting).

4) Old Business:
   a. Rhetoric and Technical Communications Program Name Change (R. Strickland): In changing the name the key word “Rhetoric” has been maintained. To educators in the Humanities, this term implies “communication,” and signals the program’s commitment to understand communication in relation to its “historicity” and systemic functions. The second term—“Theory”—indicates the program’s focus on issues of the relationship between humans and their technologies. For scholars in the Humanities, the term invokes a tradition of scholarship concerned with the modern world’s changing relationships among individuals, our languages and social structures, and the physical environments. Networked environments and social media such as Facebook and Twitter are profoundly changing the ways people communicate in all areas of work, family and social life. These developments call for new ways of communicating that incorporate visual design with conventional text, and deploy various rhetorical strategies across different delivery platforms such as mobile phones and tablets. The fast-paced developments in digital media require the teaching of new skills, and new ways of teaching. The term “Theory” expresses the program’s commitment to explore and develop these methods and to prepare graduates to take them into their future classrooms and workplaces. The third term—“Culture”—reinforces the program’s emphasis on communication and social interaction. The term also refers to the expertise in areas such as diversity and globalization. Globalization is transforming our workplaces and our societies. Students who can recognize and understand cultural differences will be better equipped for the job market and for their future lives.

   • (Q): Was consideration given to propose this as a completely new program or spin-off?
   • (A): Yes, that was considered. After quite a bit of discussion and consideration it was determined that it made more sense to change the name.
   • (Q): Are there plans to change the curriculum?
   • (A): Yes, but that is a separate process.
   • **TO DO**: Please take the proposal (handouts section of the GFC website) back to your departments and bring feedback to the next GFC meeting. Please be prepared to vote.
a. Update on School of Technology’s Dual Degree Program: Geodesy and Remote Sensing (Dean Huntoon): There were some concerns passed on from the Curriculum Policy Committee. These concerns are being addressed. A dual degree proposal cannot be a way to establish a new degree. A dual degree program should be for the purpose of attracting new students. These programs are reviewed at a minimum of once every five years. The balance of revenue and student mobility is looked at carefully.

5) New Business:

a. Data Sciences Master’s Program Proposal (L. Brown/M. Buche): This proposal describes a plan for a new master’s degree program. The proposed Master of Science (MS) in Data Science will be the first non-departmental master’s degree at Michigan Tech. The MS in Data Science has three main objectives: i) to attract students from various disciplines who wish to learn the basics of data analysis, data science, and computing tools; ii) to teach students basic skills in communication and build their awareness of business contexts; and iii) to provide students the opportunity to gain domain specific skills that give them the ability to analyze large data sets, including Big Data. What the department feels is the real strength of this program is that it is multidisciplinary and the students will get the fundamental skills and be able to go much deeper into a particular domain which is unique in data science. There is a large demand for this type of skill set. The department is responding to industry need.

- (C): This will be the first non-departmental MS program at Tech. The Provost and Deans tasked Dean Huntoon with setting up a standardized framework for the administration, review, and oversight for all non-departmental programs. The administrative structure in the proposal has come from the new framework.
- (Q): Have the faculty lines and GA lines been approved and if the GA lines have been approved where is that money coming from?
- (A): Dean Huntoon’s understanding is that recommendations should be made about the lines which will carry through the approval process. Ultimately, the budget team will be approving the funds.
- (C): There are potential donors involved in this proposal as well.
- (C): The proposal should clearly state who is teaching each class and if it is additional teaching or are they going to get relieved of teaching other courses.
- (A): Most of the proposed courses were already in the works. They have gone through the binder process.
- (C): The above response should be stated in the proposal.
- (C): Mark Rouleau, a faculty member in Social Sciences, teaches an introductory course to computational social sciences. He may be somebody to reach out to and to potentially add his course to the curriculum.

- TO DO: Please take the proposal (handouts section of the GFC website) back to your departments and bring feedback to the next GFC meeting. Please be prepared to vote.


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c. Non-departmental/Interdisciplinary Graduate Programs (Dean Huntoon): The idea is that a graduate program director who is appointed by the Dean of the Graduate School manages the program on a day-to-day basis. The graduate program faculty is nominated by the graduate program steering committee, approved by relevant Chair/Dean, approved by Graduate School for adjunct faculty status. This gives them authority to serve as the primary advisor to the student. The Dean’s intent is to start meeting with the program leaders once a semester. In the handout section of the GFC website you will find the characteristics and governances of non-departmental/interdisciplinary programs.

- (C): It would be useful to know how many people apply and are accepted to these types of programs.
• **TO DO:** Please take the proposal (handouts section of the GFC website) back to your departments and bring feedback to the next GFC meeting. Please be prepared to vote.

d. IT Representatives to Address Issues/Concerns (D. de Beaubien/J. Olson): There have been concerns/questions about graduate student computing after the lab centralization including gradlab computing, information learning commons, cost of color printing, equipment purchase through IT, meeting the software needs of graduate students, and administrative access to computers. IT addressed those concerns via PowerPoint presentation. The presentation is posted on the GFC website. Any questions/concerns/comments should be forwarded to A. Storer for him to collate and pass on to IT. When the responses are collected from IT they will be posted on the GFC website.

6) Motion to adjourn at 5:03 pm.
December 10, 2013
(Last update: 12/12/13)

Handouts of the Graduate Faculty Council

Michigan Tech
Proposal for a New Non-Departmental Master of Science in Data Science

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Executive Summary

This proposal describes a plan for a new master’s degree program. The proposed Master of Science (M.S.) in Data Science will be the first non-departmental master’s degree at Michigan Tech. The M.S. Data Science has three main objectives: i) to attract students from various disciplines who wish to learn the basics of data analysis, data science, and computing tools; ii) to teach students basic skills in communication and build their awareness of business contexts; and iii) to provide students the opportunity to gain domain specific skills that give them the ability to analyze large data sets, including Big Data.

The M.S. program will be developed to adhere to national requirements for Professional Science Master’s (PSM) programs, where the emphasis is on advanced training in science and engineering, while simultaneously developing highly-valued business and communications skills. Once the M.S. program is approved at Michigan Tech it will be submitted to the national PSM oversight organization for accreditation as a PSM. A plan to offer the M.S. as an accelerated master’s will also be developed following approval of the program by Michigan Tech.

1 http://www.sciencemasters.com/
1. Background

The Internet has steadily moved from text-based communications to richer content, including interactive maps, images, videos, and most importantly metadata such as geolocation information and time and date stamps. High-speed communication networks such as 3G, 4G, and WiFi have enabled fast transmission of these storage-intensive data. The amount of data captured by e-health networks, telematics and telemetry devices for monitoring the location, movements, status of mobile units, for use in machine-to-machine and people-to-machine systems, social networks, environmental agencies, commercial and business agencies, and security agencies is exploding. In the year 2000, the amount of data stored in the world was about 800,000 petabytes (one petabyte = one million gigabytes). This amount is expected to reach 35 zettabytes (one million-million petabytes) by 2020. Twitter and Facebook, respectively, generate more than 7 terabytes of data each day. Advances in data storage and data-mining technologies make it possible to preserve increasing amounts of data generated directly or indirectly by users.

As we stand at a point where our economy is driven by Big Data, our data collecting abilities have far outpaced techniques to manage and analyze these data. Hence, enhanced capabilities in data analysis are needed to obtain valuable new insights from these captured data. Examples are sensor networks, big social data and social networks analysis, telephone call meta-data, military surveillance, medical records, imaging and video archives, large-scale e-commerce, astronomy, atmospheric science, genomics, biogeochemical, biological, and other complex and often interdisciplinary scientific research.

The field of data science has emerged as a response to increased data abundance in industry, science, and engineering. The National Consortium for Data Science\(^2\) (NCDS), a collaboration of industry and academic institutions, was formed to identify data science challenges, coordinate research priorities, to support the development of technical and ethical data standards policy, and to foster economic growth by launching a national strategic initiative to secure the U.S. as the world leader in data science.

The Big Data explosion needs data scientists and analysts able to interpret massive data sets. The lack of trained data scientists has meant that less than 5% of data are used effectively, according to the Forrester research firm\(^3\).

Data scientists primarily manage and analyze data, which requires computer science (CS), statistics, business, marketing, and communications skills. Traditional statistics training lacks the emphases on required CS and domain-specific skills, while traditional CS and engineering training lack emphases on the required statistical analyses skills. Furthermore, both lack acumen in business, marketing, and communications. Data analysis also requires expertise in the specific domain of the application (e.g., engineering, imaging and video analytics, social

\(^2\) [http://data2discovery.org](http://data2discovery.org)

\(^3\) [BIG DATA WILL HELP SHAPE YOUR MARKET’S NEXT BIG WINNERS](http://blogs.forrester.com/brian_hopkins/11-09-30-big_data_will_help_shape_your_markets_next_big_winners)
2. Justification and Estimated Market

A simple job search for “Data Scientist” today reveals thousands of job openings. The Bureau of Labor Statistics (BLS) forecasts a 19% growth in employment for computer and information research scientists by 2020. Numerous articles, studies, and blog postings warn of the shortage of Data Scientists, e.g., Information Week⁴; Fortune⁵; and EMC Data Science Study⁶. In 2011, McKinsey Global Institute published “Big data⁷: The next frontier for innovation, competition, and productivity,” citing a need for 140,000-190,000 data scientists in the U.S. alone, by 2018.

The program we are proposing will significantly increase the number of data scientists that Michigan Tech can offer to the workforce. Our M.S. program in Data Science will provide students with strong academic training in data analysis in a range of areas (e.g., physical sciences, geosciences, geoinformatics, bioinformatics, cheminformatics, environmental, social sciences, business and commerce) while at the same time introduce essential business acumen, communication and teamwork skills highly valued by industry and government. The minimum requirements listed in recent data scientist job postings include “strong communication and collaboration skills” (Groupon), “ability to communicate complex quantitative analysis in a clear, precise, and actionable manner” (Quicken Loans), and “expected to communicate their conclusions clearly to a lay audience” (CIA). The M.S. degree is not intended to be a stepping-stone towards a Ph.D.; rather, it is a stand-alone degree designed to prepare students for careers in industry and government.

The proposed program emphasizes data analytics from a general perspective, but the skills to be learned are applicable to a diverse range of areas, including business analytics, computer science and engineering, and informatics. To support the interdisciplinary nature of the Data Science program, applications from multiple areas will be included in the coursework.

The proposal Data Science program is in line with Michigan Tech strategic plan⁸ to “be a leader in creating solutions for society’s challenges through education and interdisciplinary endeavors that advance sustainable economic prosperity…”

⁴ Data Scientists: Meet Big Data's Top Guns
⁵ Data scientist: The hot new gig in tech
⁶ Data Science Revealed: A Data-Driven Glimpse into the Burgeoning New Field
⁷ Big data: The next frontier for innovation, competition, and productivity
http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation
⁸ STRATEGIC PLAN https://www.banweb.mtu.edu/pls/owa/strategic_plan2.p_display
3. Competitive Analysis

Established computer science, business analytics, and statistics master’s degrees and certificate programs already exist, both in the U.S. and abroad, and provide specializations in data mining and predictive analytics. However, despite interest and recognized need, there are as yet only a few master’s programs dedicated to data science in the U.S. Further, the existing programs have been designed around business data with a less domain-specific scientific focus. These master’s programs include Northwestern’s new M.S. in Analytics (2011), DePaul’s M.S. in Predictive Analytics (2010), University of San Francisco’s M.S. in Analytics (2012), LSU’s M.S. in Analytics (2011), Rutgers’s Professional Science Master’s (PSM) of Business and Science in Analytics (2012), and NCSU’s M.S. in Analytics (also a PSM program)(2007).

Finally, there is increased recognition by federal agencies that supporting Big Data research is important. For example, the National Institutes of Health (NIH) director, Dr. Francis Collins, recently convened a “Data and Informatics Working Group” that made several key recommendations aimed at fostering NIH sponsored research in Big Data. Other federal agencies have also signaled interest in Big Data research, including National Science Foundation, DARPA, Department of Energy, and Department of Defense.

4. Detailed Description of Master of Science in Data Science

i. Title:
Master of Science in Data Science

ii. Catalog description:

The non-departmental Data Science program at Michigan Tech provides a foundation for the emerging field of “Big Data” science, including the use of data mining, predictive analytics, cloud computing, and business skills, with a domain specific specialization in disciplines of science and engineering. The main threads of analytic techniques, programming practice, domain knowledge, business acumen, and communication skills are intertwined in this program.

The M.S. degree is designed to meet the needs of students and to adhere to the requirements for Professional Science Masters (PSM) programs. Students benefit from a PSM degree because it prepares them for careers in science and engineering that are highly sought after in industry, government, and nonprofit organizations, where workforce needs in data science are increasing. PSM graduates get advanced training in science and engineering without having to obtain a Ph.D., while simultaneously developing highly-valued business skills without having to obtain an MBA. The curricula for PSMs are based on

9 http://www.sciencemasters.com/
"Science Plus," where rigorous study in engineering, science, or mathematics is combined with skills-based coursework in management, policy, or law. In addition, PSM programs emphasize writing and communication skills and teamwork experience, with most requiring a “real-world” internship in an industry or public sector enterprise.

To comply with the PSM requirements, the M.S. program is grounded in science, technology, engineering, mathematics, computer science, and computing. It is designed to prepare students for a variety of careers that will fill the skill shortage in data science in industry, business, government, and non-profit organizations. This program prepares graduates for high-level careers in data science by combining advanced training in data analytics with an appropriate component of professional skills. In addition to the course work in data analytics and data management, the M.S. program will have a strong emphasis on skill areas such as written and oral communication, ethics, management, policy, entrepreneurship, and leadership. This program will incorporate an internship and/or an employer-sponsored project.

Entry into this program assumes basic knowledge in statistical and mathematical techniques, programming, and communications, obtained through a degree in business, science and engineering disciplines.

iii. Credit points:

The degree will be offered as coursework-only M.S. program that will require a minimum of 30 credits. A minimum of 18 credits applied toward the degree must be earned at the 5000-6000 level, and a maximum of 12 credits can be earned at the 3000-4000 level. Students earning the degree must adhere to all Graduate School policies.

iv. Course work:

The M.S. in Data Science requires 12 credits of required core courses and a minimum of six credits of approved Data Science electives. The remaining required credits can include up to maximum of six credits of approved foundational courses at the 3000-4000 level (Appendix I), plus domain specific courses (Appendix II).

It is expected that students seeking enrollment in this program will have sufficient foundational skills and aptitude in computer programming, statistical analysis, information systems and databases. The required foundational skills may have been obtained through formal academic qualifications or work experience. Students will receive advice regarding the expected level of foundational skills for incoming students and may be required to take specific foundational courses (Appendix I) as necessary to acquire the required level of foundational skills.

Students will be allowed to apply up to six credits of 3000-4000 level foundational skills courses (Appendix I) toward the M.S. Data Science degree. Additional courses (more than 6 credits) of foundational skills courses cannot be applied to the degree even though additional courses may be required for students to master necessary skills. Courses at the 1000 or 2000 level cannot be applied toward any graduate degree at Michigan Tech but may be

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necessary for students to take if they are lacking in a key skill.

Each student’s letter of offer of admission will clearly articulate the expectations for incoming students in the area of foundational skills in computer programming, statistical analysis, information systems and databases. Foundational skills can be developed through formal academic coursework, work experience, or a combination. Students will be encouraged to develop their foundational skills before coming to Michigan Tech to start the M.S. program in Data Science. They will be also advised of the availability of the low-level courses (1000 and 2000 level) and medium-level courses (3000 level) that they can take at Michigan Tech during the summer semester before they plan to begin the M.S. program in Data Science. After students matriculate in the program, their assigned advisors will continually monitor students’ progress to ensure that students are given all the necessary advice that they need to be successful in the program.

Coursework Summary

Core courses for M.S. Data Science (12 credits):
The four required core 3-credit courses focus on basic skills in data science analytics, data mining, and business analytics. These courses are:

- UN 5550 - Introduction to Data Science (3 credit points)\(^{11}\)
- MA 4790 - Predictive Modeling (3 credit points)
- CS 4821 / MA 4795 - Data Mining (3 credit points)
- BA 5200 - Information Systems Management and Business Analytics (3 credit points)\(^{12}\)

Foundational skills courses for M.S. Data Science (maximum of 6 credits at the 3000-4000 level):

A maximum of six credit hours of foundational skills courses (at the 3000-4000 level may be applied to the M.S. These courses will build skills necessary for successful completion of the M.S. Data Science. See Appendix I for a list of approved foundational skills courses.

Approved Data Science elective courses for M.S. Data Science (minimum of 6 credits):

At least 6 credit hours for the M.S. must be taken from the approved 3-credit Data Science elective courses below:

- CS 5841 / EE 5841 - Machine Learning (3 credits)\(^{13}\)
- CS 5491 - Cloud Computing (3 credits)\(^{14}\)

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\(^{11}\) New course to be designed for Fall 2014. This course will be administered by the office of Dean Graduate Studies, and executed by Data Science faculty across the campus.

\(^{12}\) Revision of the existing course BA 5200 - Strategic IS Management

\(^{13}\) New course to be designed for Spring 2015

\(^{14}\) New course to be designed for Spring 2015
● CS 5471 – Advanced Topics in Computer Security (3 credits)\textsuperscript{15}
● MA 5780 - Time Series Analysis and Forecasting (3 credits)\textsuperscript{16}
● BA 5740 - Managing Innovation & Technology (3 credits)
● PSY 5210 - Advanced Statistical Analysis and Design I (4 credits)
● FW 5083 - Bioinformatics Programming and Skills (3 credits)\textsuperscript{17}

Domain specific Data Science courses for M.S. program (maximum of 12 credits):
To complete the M.S. program in Data Science, the students must complete the remaining of
the required 30 credit hours through completion of approved domain-specific Data Science
courses (see Appendix II). Students may choose domain-specific courses from one or more
domains. Each student will consult with her/his advisor in order to determine the appropriate
mix of elective courses and domain-specific courses, given the student’s background,
interests, and career aspirations.

v.Online delivery:
Our goal is to have all the core data science courses and most approved data science
courses offered online by 2016. This would allow off-campus students to complete 12-18
credits of the M.S in Data Sciences online\textsuperscript{18}. Note that BA 5200 - Information Systems
Management and Business Analytics will be offered as an online course starting in 2014.
Additionally, the approved Data Science courses, CS 5841 / EE 5841 - Machine Learning
and CS 5491 - Cloud Computing, will be offered as online courses in 2016.

vi. Description of new or revised Data Science courses:

UN 5550 - Introduction to Data Science (new) (3 credit points)
This course provides an introduction to Big Data concepts, with focus on data management,
data modeling, visualization, security, cloud computing, and data science from different
perspectives: computer science, business, social science, bioinformatic, engineering, etc.
This course also introduces the tools for data analytics such as SPSS Modeler, R, SAS,
Python, and MATLAB. It involves two case study projects, each of which is integrated with
communication and business skills.

BA 5200 - Information Systems Management and Business Analytics (revision) (3
credit points)
This course is a restructuring of the existing course BA 5200 - Strategic IS Management to

\textsuperscript{15} New course to be designed for Spring 2015
\textsuperscript{16} Graduate version of MA 4780, to be offered as a split-level undergraduate/ graduate course. The
graduate version of this course contains additional theoretical material and substantial project work.
\textsuperscript{17} Graduate version of FW 4099, to be offered as a split-level undergraduate/ graduate course. The
graduate version of this course contains additional theoretical material and substantial project work.
\textsuperscript{18} This would also allow off-campus students to fully complete the Graduate Certificate in Data Sciences
with online offerings.
achieve a more acute focus on data analytics. The course incorporates experiential application of methods and analysis of business case studies focusing on contemporary issues in data analytics (i.e., Big Data) to include comprehension of business and organizational context, visualization and interpretation of results, reporting of outcomes from data analytics, evaluation of alternative techniques, and other current topics. Multiple online resources will be employed, including Teradata University. Students in this class will utilize open source software (e.g. Hadoop and NoSQL), developing skills applicable to industry. Ethical foundations and managerial constraints will be integrated throughout the course.

CS 5841 / EE 5841 - Machine Learning (new) (3 credit points)
This course will explore the foundational techniques of machine learning. Topics are pulled from the areas of unsupervised and supervised learning. Specific methods covered include naive Bayes, decision trees, support vector machines (SVMs), ensemble, and clustering methods.

CS 5471 - Advanced Topics in Computer Security (new) (3 credit points)
This course covers various aspects of producing trusted computer information systems. Topics may vary; network perimeter protection, host-level protection, authentication technologies, formal analysis techniques, and intrusion detection will be emphasized. Current systems will be examined and critiqued.

CS 5491 - Cloud Computing (new) (3 credit points)
This course provides an overview of the principles, methods, and leading technologies of cloud computing technologies. Topics include cloud computing concepts and architecture: Hadoop, MapReduce; standards; implementation strategies; Software as a Service (SaaS); Platform as a Service (PaaS); Infrastructure as a Service (IaaS); workload patterns and resource management; migrating to the cloud; and case studies and best practices. Students in this class will build their own cloud application using services from providers such as Amazon or IBM.

SS 5005 - Introduction to Computational Social Science (new) (3 credit points) (See Appendix II)
This course is an introduction to the use of computer simulation and modeling to understand social science phenomena. The course will provide an introduction to complexity theory as it applies to the methodological framework of Agent-Based Modeling. Students will be taught the fundamentals of model design including an introduction to standard simulation toolkits. Ultimately, students will be asked to apply what they have learned in this course to develop a pilot simulation study from design to implementation to model validation.

SAT 5600 - Web Application Development (new) (3 credit points) (See Appendix II)
This course provides an introduction to the building and administration of web applications.
Topics covered include Apache web server, Tomcat application server, HTML, cascading style sheets, JavaScript, JQuery, server side includes, server side application development, web services, SSL/TLS and authentication/authorization.

SAT 5002 - Application Programming Introduction (new) (3 credit points) (See Appendix II)

This course provides an introduction to application programming. It develops problem solving skills through the application of a commonly used high-level programming language. Topics include the nature of the programming environment, fundamentals of programming languages (e.g., programming constructs, data management, manipulation of simple data structures), structured programming concepts, object oriented programming concepts, desirable programming practices and design, debugging and testing techniques. Students will use the Java programming language to test programming concepts and to develop application programs.

5. Estimated Costs For Financial Evaluation

While hard to predict the exact figures, it is expected the program will have an initial enrollment of five in Fall 2014, with an increase to eight in Fall 2015. After accreditation as a PSM program it is expected that we will have an steady enrollment of 15 to 20 within five years.

To arrive at this estimation a combination of factors were considered; enrollment in other institutions in Data Science and PSM programs, enrollment in other M.S. programs in Michigan Tech, frequent recent requests from the industry for skills analytics (e.g., Kimberly-Clark), feedback from ECE EAC members, etc.

It is envisioned that the enrollment would primarily come from students who would otherwise not have come to MTU. However, feedback from several units across the University indicates to the likely popularity of the courses that are designed for Data Science in other existing programs.

The initial start up cost of this program is modest. The majority of courses in the Data Science program are based on existing courses in Mathematical Sciences, Computer Science, and the School of Business and Economics. However, the quality of the program is directly dependant on the ability of the core faculty to develop and continually improve the core and approved elective Data Science courses. To ensure long-term viability of the Data Science program at Michigan Tech, therefore, requires sufficient allocation of resources to support the core Data Science curriculum. The program requires additional resources for the following:

- One new faculty line to be used to attract a strong candidate with multi-disciplinary data science expertise who will be dedicated to the Data Science program. The new faculty will be primarily responsible for teaching of the core and Data Science courses in Data
Science program. Michigan Tech should consider this faculty line as a strategic investment in an important area for the university. A faculty search procedure will be proposed by the Data Science Executive Committee (Sec. 7), approved by the Dean of Graduate Studies, and recommended to the appropriate Department Chairs, Deans, and Provost. A joint appointment would be anticipated. The anticipated hire will also help Michigan Tech to enhance research expertise in the area of Data Science. We are in a position to start the program with the existing pool of faculty resources in the four units involved in the offering of core and approved elective Data Science courses, through the temporary diversion of resources. However, the program requires the hiring of one new faculty after the first year.

- Development of core course—UN5550 Introduction to Data Science. This course will be non-departmental; select faculty from Mathematical Sciences, Computer Science, and School of Business & Economics will have a leading role in the administration of this new course. Modest cost may be involved in providing faculty adequate preparation time. There is also need for resources to cover the cost associated with the external guest lectures.

- Development of approved Data Science courses, Machine Learning (CS5841/EECS5491) and Cloud Computing (CS5491). These courses have also been planned for inclusion in the Electrical & Computer Engineering and Computer Science M.S. programs. The program also requires revision of BA 5670 into IS Management and Business Analytics, in the School of Business and Economics, to make it suitable to the Data Science program. There will be also a new domain specific course in the Social Sciences—Introduction to Computational Social Science. Modest cost may be involved in faculty preparation time for the development of these new courses.

- Administration of the program by the Graduate School, extension to online delivery by Fall 2016, and PSM affiliation will incur some additional cost. We envision a ¼ to ½ line of administrative support when the program develops into its capacity of steady enrollment.

- Annual PSM membership, affiliation, and reaffiliation review fee of $1,500.

- Three graduate teaching assistant (GTA) lines are needed initially to help with the laboratory development and maintenance of the hardware and software tools necessary for the program. Specifically these GTAs will be used to assist with the instruction of core and approved elective Data Science courses listed in Section 4. It is envisioned that the students supported by these three GTA lines will be earning Ph.D. degrees in disciplines related to the Data Science program. The purpose of the GTAs is to support the offering of cutting-edge courses in order to allow affiliated faculty to maintain their active research programs. These lines will also help us to build our pool of research expertise in the area across the University. After the first three years of the project, the number of GTA lines allocated in support of the program may
be reduced to one if circumstances allows it.

- Student support through the Graduate Tuition Grant (GTG)\textsuperscript{19} which is designed to assist high-performing domestic students with unmet financial need. This program is already in existence and we expect to enhance the size of the pool of funding available to students by seeking external donations. We view fellowship and scholarship support for this program as important resources for getting this program started. There is often a time-lag between the start of a new program and being able to obtain external support for students in the program; hence, this initial investment in student support will fill that gap. We also plan to seek external funding for the following:
  - A fellowship for an outstanding Data Sciences M.S. candidate, to be named in honor of Professor Thomas Drummer who was instrumental in developing the Data Science program.
  - Several smaller scholarships for excellent students pursuing an M.S. in Data Sciences.

- The Office of Information Technology at Michigan Tech is fully supportive of this program. It has already installed all the tools and computing infrastructure that is needed for the Data Science program.

The resources of the Data Science program and the host departments will require continuous evaluation to ensure that the needs of each are being met in the future.

6. Planned Implementation Date

This program has an anticipated start in Fall semester, 2014. This program will be offered as a regular program. The program will be extended into an online program as soon as it is established and practical to do so. We envision a start date of Fall 2016 for the online delivery of core and approved elective courses.

7. Program Governance

Like other non-departmental and interdisciplinary programs at Michigan Tech, the Data Science program will be administered through the Graduate School, which will have overall responsibility and final oversight for the program. The program will have the following management structure.

- **Graduate Program Director**: The Director is appointed by the Dean of Graduate School for a period of three years. The Dean of the Graduate School will seek nominations for the Graduate Program Director position from the Graduate Program Executive Committee. The Graduate Program Director will report to the Dean of the

\textsuperscript{19}Graduate Tuition Grant, [http://www.mtu.edu/gradschool/admissions/financial/tuition-grant/](http://www.mtu.edu/gradschool/admissions/financial/tuition-grant/)
Graduate School and the Graduate Program Executive Committee. The Graduate Program Director will serve as the interim advisor for all incoming students until such time that each student identifies or is assigned a permanent advisor. The Graduate Program Director will meet with the Dean of the Graduate School and the Graduate Program Directors for other non-departmental and interdisciplinary graduate programs on a regular basis.

- **Graduate Program Executive Committee**: This committee is drawn from and elected by the membership of the Graduate Program Faculty. The committee will consist of three to five members that are representative of the diversity of programs and areas of interest of the Graduate Program Faculty. Members will serve for staggered five year terms. The Program Director serves as an ex-officio member of the Graduate Program Executive Committee. A staff member from the University IT Services will serve in a non-voting advisory capacity on the Graduate Program Executive Committee. This group will work with the Program Director to make day-to-day decisions regarding the program. This group will identify potential members of the Graduate Program Faculty and External Advisory Board and conduct voting in order to determine the membership of those bodies. The Graduate Program Executive Committee will provide leadership for the program and will organize and contribute to meetings of the External Advisory Board. Members of the Graduate Program Executive Committee will annually review the membership of the Graduate Program Faculty and External Advisory Board and recommendations for additions or removals will be made to the Dean of the Graduate School.

- **Graduate Program Faculty**: The faculty for this body is drawn from a wide range of units across the Michigan Tech campus community are affiliated with the Data Science program. These faculty members will have adjunct faculty status in the Data Sciences program and will be eligible to advise students who are seeking degrees in Data Sciences. Appointments to the Graduate Program Faculty will be made for terms of three-years duration, with the possibility of reappointment for multiple successive terms. Members of the Graduate Program Faculty will be expected to participate in Graduate Program meetings and events. Graduate Program Faculty may be elected to serve as a member of the Graduate Program Executive Committee, and upon this election may be nominated to serve as the Graduate Program Director. Graduate Program Faculty are encouraged to advise the Graduate Program Director on the direction of the Data Science program at Michigan Tech, the development of resources, and creation of opportunities for growth. Additionally, the Graduate

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20 We recognize that the term “adjunct” is not applied at Michigan Tech in the same way as it is used at other universities where it is often used to refer to non-permanent, frequently part-time faculty, who are not on the tenure-track. At Michigan Tech, the term “adjunct” is used to identify faculty members who are deemed eligible to be members of the faculty of a particular department or program. Adjunct faculty members are normally allowed to serve as the primary advisor to students in the department or program in which they hold adjunct status. Per Graduate School policy, adjunct faculty members are not allowed to serve as external members of graduate committees for students in the department or program in which they hold an adjunct appointment.
Program Faculty are encouraged to actively network with industry experts.

- **External Advisory Board**: This board is drawn from a key pool of experts from industry and academia operating in the forefront of Big Data science. This board will help ensure that the Michigan Tech Data Science program is abreast of industry needs. This board will act as an advocate for the program through its wide-reaching network. An External Advisory Board is a required component of all PSM (Professional Science Master’s) programs. Members of the External Advisory Board will serve staggered three year terms. Members will be allowed to serve multiple terms.

- **Tentative membership**: Appendix III list the tentative membership of three functional bodies for the Data Science program.
Appendix I: Foundational Skills Courses

Note that 2000 level courses listed here cannot be counted towards the requirement for M.S. in Data Science degree.

Mathematics Courses (Credits: 3)

- MA 3740 - Statistical Programming and Analysis

School of Business and Economics Courses (Credits: 3)

- MIS 2000 - IS/IT Management
- MKT 3600 - Marketing Research
- MIS 3100 - Business Database Management
- MIS 2100 - Introduction to Business Programming

Computer Science Courses (Credits: 3)

- CS 3425 - Database
- CS 2321 - Data Structures

School of Technology Courses (Credits: 3)

- SAT 3210 - DB Management
- SAT 3002 - Application Programming Introduction
- SAT 4600 - Web Application Development

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21 2000 level courses cannot be counted towards the M.S. in Data Science degree requirement.
22 2000 level courses cannot be counted towards the M.S. in Data Science degree requirement.
23 2000 level courses cannot be counted towards the M.S. in Data Science degree requirement.
24 New 3-credit point course to be designed for Fall 2014
25 New 3-credit point course to be designed for Spring 2015
Appendix II: Domain Specific Data Science Courses

Mathematics Courses (Credits: 3)

- MA 4710 - Regression Analysis
- MA 4720 - Design and Analysis of Experiments
- MA 4330 - Linear Algebra
- MA 5201 - Combinatorial Algorithms
- MA 5221 - Graph Theory
- MA 5401 - Real Analysis
- MA 5627 - Numerical Linear Algebra
- MA 5630 - Numerical Optimization
- MA 5701 - Statistical Methods
- MA 5741 - Multivariate Statistical Methods
- MA 5750 - Statistical Genetics
- MA 5761 - Computational Statistics
- MA 5791 - Categorical Data Analysis

Computer Science Courses (Credits: 3)

- CS 4425 - Database System
- CS 4471 - Computer Security
- CS 5321 - Advanced Algorithms
- CS 5331 - Parallel Algorithm
- CS 5441 - Distributed System
- CS/EE 5496 - GPU and Multi-core Programming
- CS 5631 - Data Visualizations
- CS 5760 - HCI Usability Testing
- CS 5811 - Advanced Artificial Intelligence
- CS/EE 5821 - Computational Intelligence

Department Computer Science may also consider developing new courses when appropriate or necessary in visual analytics, mobile applications and graduate software engineering service course.
School of Technology Courses (Credits: 3)

- SAT 5001 - Introduction to Medical Informatics
- SAT 5002 - Application Programming Introduction
- SAT 5121 - Introduction to Medical Sciences, Human Pathophysiology, Healthcare
- SAT 5141 - Clinical Decision Support and Improving Healthcare
- SAT 5161 - Data Warehousing and Business Intelligence
- SAT 5241 - Designing Security Systems
- SAT 5600 - Web Application Development
- SU 5010 - Geospatial Concepts, Technologies and Data
- SU 5045 - Geospatial Data Fusion

^New 3-credit point course to be designed for Fall 2014

^New 3-credit point course to be designed for Spring 2015

Electrical and Computer Engineering Courses (Credits: 3)

- CS/EE 5496 - GPU and Multi-core Programming
- EE 5500 - Probability and Stochastic Processes
- EE 5521 - Detection & Estimation Theory
- EE 5726 - Embedded Sensor Networks
- CS/EE 5821 - Computational Intelligence

Civil and Environmental Engineering Courses (Credits: 3)

- SSE 3200 - Web Based Services
- CE/SSE 4750 - Risk Analysis
- CE/SSE 4760 - Optimization and Decision-making
- CE 5740 - System Identification

School of Business and Economics Courses (Credits: 3)

- MIS 3100 - Business Database Management
- MIS 3400 - Business Intelligence
- EC 4200 - Econometrics
• BA 5610 - Business Process Management
• BA 5800 - Marketing, Technology, and Globalization

Geological and Mining Engineering and Sciences Courses (Credits: 3)
• GE 5150 - Advanced Natural Hazards
• GE 5195 - Volcano Seismology
• GE 5250 - Advanced Computational Geosciences
• GE 5600 - Advanced Reflection Seismology
• GE 5670 - Aquatic Remote Sensing
• GE 5870 - Geostatistics & Data Analysis

School of Forestry Courses
• FW 4099 - Programming Skills for Bioinformatics (Credits:3)
• FW 5084 - Data Analysis and Graphics Using R (Credits:2)
• FW 5089 - Tools of Bioinformatics (Credits:4)
• FW 5411 - Applied Regression Analysis (Credits:3)
• FW 5412 - Regression with the R Environment for Statistical Computing (Credits:1)
• FW 5540 - Advanced Terrestrial Remote Sensing (Credits:4)
• FW 5550 - Geographic Information Systems for Resource Management (Credits:4)
• FW 5555 - Advanced GIS Concepts and Analysis (Credits:3)
• FW 5556 - GIS Project Management (Credits:3)
• FW 5560 - Digital Image Processing: A Remote Sensing Perspective (Credits:4)

Social Science Courses
• SS 5005 - Introduction to Computational Social Science (Credits: 3)^

Department of Social Sciences may also consider developing new courses, when appropriate or necessary in computational social sciences with elements of social science theory, and land use modeling.

^New 3-credit point course to be designed for Fall 2014

Cognitive and Learning Sciences Courses
• PSY 5220 - Advanced Statistical Analysis and Design II (4 credit points)

Biological Sciences Courses
• BL 4470 - Analysis of Biological Data (Credits: 3)

Biomedical Engineering Courses
• BE 5550 - Biostatistics for Health Research (Credits: up to 4)

Department of Biomedical Engineering may also consider developing new courses, when appropriate or necessary in big data applications to human health. This course may be developed as a BE, BL, or KIP course.

Chemical Sciences Courses (Credits: 3)
• CH 4610 - Introduction to Polymer Science
• CH 5410 - Advanced Organic Chemistry: Reaction Mechanisms
• CH 5420 - Advanced Organic Chemistry: Synthesis
• CH 5509 - Transport and Transformation of Organic Pollutants
• CH 5515 - Atmospheric Chemistry
• CH 5516 - Aerosol and cloud chemistry
• CH 5560 - Computational Chemistry

Department of Chemistry may consider developing new courses when appropriate or necessary in bio-spectroscopy and cheminformatics

Physical Sciences Courses
• PH 4390 - Computational Methods in Physics (credits: 2)
• PH 4395 - Computer Simulation in Physics (credits: 3)
Appendix III: Tentative Membership of Data Science Bodies

Faculty Advisory Board Membership

- Asim Banskota (Forestry)
- Laura Brown (Computer Science)
- Mari W. Buche (School of Business & Economics)
- Jason Carter (Kinesiology)
- Sarah Green (Chemistry)
- Timothy Havens (Electrical and Computer Engineering/Computer Science)
- Guy Hembroff (School of Technology)
- Jacqueline Huntoon (Graduate School)
- Chandrashekhar Joshi (Biological Sciences)
- Robert Nemiroff (Physics)
- Saeid Nooshabadi (Electrical & Computer Engineering/Computer Science)
- Thomas Oommen (Geological & Mining Engineering & Sciences)
- Mark Rouleau (Social Sciences)
- Gowtham S (Information Technology Services)
- Ching-Kuang Shene (Computer Science)
- Allan Struthers (Mathematics)
- Raymond Swartz (Civil and Environmental Engineering)
- Hairong Wei (Forestry & Bioinformatics)

Graduate Executive Committee Membership

- Laura Brown (Computer Science)
- Mari W. Buche (School of Business & Economics)
- Timothy Havens (Electrical & Computer Engineering/Computer Science)
- Jacqueline Huntoon (Graduate School)
- Saeid Nooshabadi (Electrical & Computer Engineering/Computer Science)
- Gowtham S (Information Technology Services)
- Allan Struthers (Mathematics)

External Advisory Board Membership
• David Barnes (Program Director, Strategy and Emerging Internet Technologies, IBM)
• Tom Grebinski (Founder, Yotta Data Sciences)
• Lonne Jaffe (CEO of Syncsort)
• Jill Recla (Bioinformatics Analyst at The Jackson Laboratory)
• John Soyring (Soyring Consulting Services)
• John Wallin (Professor of Physics and Astronomy, and Director of the Computational Sciences Program at Middle Tennessee State University)
Proposal for a New Non-Departmental Master of Science in Data Science

Contacts: Laura Brown (Computer Science), Mari W. Buche (School of Business & Economics), Gowtham S (Information Technology Services), Timothy Havens (Electrical & Computer Engineering/Computer Science), Jacqueline Huntoon (Graduate School), Saeid Nooshabadi (Electrical & Computer Engineering/Computer Science), and Allan Struthers (Mathematics)

e-mail: datascience@mtu.edu

Executive Summary
This proposal describes a plan for a new Graduate Certificate in Data Science. This program will augment the proposal for a Master of Science (M.S.) in Data Science, and will be the first non-departmental graduate certificate program at Michigan Tech. Like its M.S. counterpart the graduate Certificate in Data in Science the has three main objectives: i) to attract students from various disciplines who wish to learn the basics of data analysis, data science, and computing tools; ii) to teach students basic skills in communication and build their awareness of business contexts; and iii) to provide students the opportunity to gain the basic skills that give them the ability to analyze large data sets, including Big Data.

Our goal is to have all the core data science courses and most approved data science courses offered online by 2016, which we note would allow off-campus students to fully complete the Graduate Certificate in Data Sciences with online offerings.
1. Background
The proposed Graduate Certificate is offered as subset of M.S. in Data Science and is offered to science and engineering graduates who wish to upgrade their qualification to be able to work in a profession with a primarily role to manage and analyze data.

2. Justification and Estimated Market
The program we are proposing will significantly increase the number of data scientists that Michigan Tech can offer to the workforce. The Graduate Certificate program in Data Science like its M.S. counterpart will provide students with strong academic training in data analysis in a range of areas (e.g., physical sciences, geosciences, geoinformatics, bioinformatics, cheminformatics, environmental, social sciences, business and commerce) while at the same time introduce essential business acumen, communication and teamwork skills highly valued by industry and government.

The proposed program emphasizes data analytics from a general perspective, but the skills to be learned are applicable to a diverse range of areas, including business analytics, computer science and engineering, and informatics. To support the interdisciplinary nature of the Data Science program, applications from multiple areas will be included in the coursework.

The proposal Data Science program is in line with Michigan Tech strategic plan1 to “be a leader in creating solutions for society's challenges through education and interdisciplinary endeavors that advance sustainable economic prosperity…”

3. Competitive Analysis
Established computer science, business analytics, and statistics master’s degrees and certificate programs already exist, both in the U.S. and abroad, and provide specializations in data mining and predictive analytics. However, despite interest and recognized need, there are as yet only a few programs dedicated to data science in the U.S. Further, the existing programs have been designed around business data with a less domain-specific scientific focus. These master’s programs include Northwestern’s new M.S. in Analytics, DePaul’s M.S. in Predictive Analytics, University of San Francisco’s M.S. in Analytics, LSU’s M.S. in Analytics, Rutgers’s Professional Science Master’s (PSM) of Business and Science in Analytics, and NCSU’s M.S. in Analytics (also a PSM program).

Finally, there is increased recognition by federal agencies that supporting Big Data research is important. For example, the National Institutes of Health (NIH) director, Dr. Francis Collins, recently convened a “Data and Informatics Working Group” that made several key recommendations aimed at fostering NIH sponsored research in Big Data. Other federal agencies have also signaled interest in Big Data research, including National Science

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1 STRATEGIC PLAN [https://www.banweb.mtu.edu/pls/owa/strategic_plan2.p_display](https://www.banweb.mtu.edu/pls/owa/strategic_plan2.p_display)
4. Detailed Description of Graduate Certificate in Data Science

i. Title:
Graduate Certificate in Data Science

ii. Catalog description:
The non-departmental Data Science program at Michigan Tech provides a foundation for the emerging field of “Big Data” science, including the use of data mining, predictive analytics, cloud computing, and business skills, with a domain specific specialization. The main threads of analytic techniques, programming practice, domain knowledge, business acumen, and communication skills are intertwined in this program.

The Graduate Certificate in Data Sciences provides the basic skills in data analytics, data management, business and communication skills. Entry into this program assumes basic knowledge in statistical and mathematical techniques, programming, and communications.

iii. Credit points:
Graduate Certificate in Data Science 15 credits (minimum)

iv. Course work:
In accordance with Senate policy, the requirements for the interdisciplinary Graduate Certificate in Data Sciences are a minimum 15 credits of coursework, including the required 12 credits of core courses and 3 credits of approved Data Science electives. All other requirements are per Senate proposals 11-10 and 4-11. Because this is an interdisciplinary certificate, a maximum of six credits can be earned at the 3000-4000 level.

Coursework Summary

Core courses for M.S. Data Science (12 credits):
The four required core 3-credit courses focus on basic skills in data science analytics, data mining, and business analytics. These courses are:

- UN 5550 - Introduction to Data Science (3 credit points)\(^2\)
- MA 4790 - Predictive Modeling (3 credit points)
- CS 4821 / MA 4795 - Data Mining (3 credit points)
- BA 5200 - Information Systems Management and Business Analytics (3 credit points)\(^3\)

\(^2\) New course to be designed for Fall 2014. This course will be administered by the office of Dean Graduate Studies, and executed by Data Science faculty across the campus.

\(^3\) Revision of the existing course BA 5200 - Strategic IS Management
Approved Data Science elective courses for M.S. Data Science (minimum of 6 credits):

The remaining 3 credit hours for the graduate certificate must be taken from the approved 3-credit Data Science elective courses that are as part of the M.S. program in Data Science as below:

- CS 5841 / EE 5841 - Machine Learning (3 credits)
- CS 5491 - Cloud Computing (3 credits)
- CS 5471 – Advanced Topics in Computer Security (3 credits)
- MA 5780 - Time Series Analysis and Forecasting (3 credits)
- BA 5740 - Managing Innovation & Technology (3 credits)
- PSY 5210 - Advanced Statistical Analysis and Design I (4 credits)
- FW 5083 - Bioinformatics Programming and Skills (3 credits)

Foundational Prerequisite Requirement:

It is expected that students seeking enrollment in this program will have sufficient foundational skills and aptitude in computer programming, statistical analysis, information systems and databases. The required foundational skills may have been obtained through formal academic qualifications or work experience. Students will receive advice regarding the expected level of foundational skills for incoming students and may be required to take specific foundational courses (Appendix I) as necessary to acquire the required level of foundational skills.

Each student’s letter of offer of admission will clearly articulate the expectations for incoming students in the area of foundational skills in computer programming, statistical analysis, information systems and databases. Foundational skills can be developed through formal academic coursework, work experience, or a combination. Students will be encouraged to develop their foundational skills before coming to Michigan Tech to start the graduate certificate program in Data Science. They will be also advised of the availability of the low-level courses (1000 and 2000 level) and medium-level courses (3000 level) that they can take at Michigan Tech during the summer semester before they plan to begin the M.S. program in Data Science. After students matriculate in the program, their assigned advisors will continually monitor students’ progress to ensure that students are given all the necessary advice that they need to be successful in the program. Appendix I provides a list of foundational courses.

v. Online delivery:

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4 New course to be designed for Spring 2015
5 New course to be designed for Spring 2015
6 New course to be designed for Spring 2015
7 Graduate version of MA 4780, to be offered as a split-level undergraduate/graduate course. The graduate version of this course contains additional theoretical material and substantial project work.
8 Graduate version of FW 4099, to be offered as a split-level undergraduate/graduate course. The graduate version of this course contains additional theoretical material and substantial project work.
Our goal is to have all the core data science courses and most approved data science courses offered online by 2016, which we note would allow off-campus students to fully complete the Graduate Certificate in Data Sciences with online offerings. Note that BA 5200 - Information Systems Management and Business Analytics will be offered as an online course starting in 2014. Additionally, the approved Data Science courses, CS 5841 / EE 5841 - Machine Learning and CS 5491 - Cloud Computing, will be offered as online courses in 2016.

vi. Description of new or revised Data Science courses (offered as part of M.S. in Data Science program):

UN 5550 - Introduction to Data Science (new) (3 credit points)
This course provides an introduction to Big Data concepts, with focus on data management, data modeling, visualization, security, cloud computing, and data science from different perspectives: computer science, business, social science, bioinformatic, engineering, etc. This course also introduces the tools for data analytics such as SPSS Modeler, R, SAS, Python, and MATLAB. It involves two case study projects, each of which is integrated with communication and business skills.

BA 5200 - Information Systems Management and Business Analytics (revision) (3 credit points)
This course is a restructuring of the existing course BA 5200 - Strategic IS Management to achieve a more acute focus on data analytics. The course incorporates experiential application of methods and analysis of business case studies focusing on contemporary issues in data analytics (i.e., Big Data) to include comprehension of business and organizational context, visualization and interpretation of results, reporting of outcomes from data analytics, evaluation of alternative techniques, and other current topics. Multiple online resources will be employed, including Teradata University. Students in this class will utilize open source software (e.g. Hadoop and NoSQL), developing skills applicable to industry. Ethical foundations and managerial constraints will be integrated throughout the course.

CS 5841 / EE 5841 - Machine Learning (new) (3 credit points)
This course will explore the foundational techniques of machine learning. Topics are pulled from the areas of unsupervised and supervised learning. Specific methods covered include naive Bayes, decision trees, support vector machines (SVMs), ensemble, and clustering methods.

CS 5471 - Advanced Topics in Computer Security (new) (3 credit points)
This course covers various aspects of producing trusted computer information systems. Topics may vary; network perimeter protection, host-level protection, authentication technologies, formal analysis techniques, and intrusion detection will be emphasized. Current systems will be examined and critiqued.
CS 5491 - Cloud Computing (new) (3 credit points)

This course provides an overview of the principles, methods, and leading technologies of cloud computing technologies. Topics include cloud computing concepts and architecture: Hadoop, MapReduce; standards; implementation strategies; Software as a Service (SaaS); Platform as a Service (PaaS); Infrastructure as a Service (IaaS); workload patterns and resource management; migrating to the cloud; and case studies and best practices. Students in this class will build their own cloud application using services from providers such as Amazon or IBM.

5. Estimated Costs For Financial Evaluation

The Graduate Certificate in Data Science program is a subset of M.S. in Data Science program, and does not incur any cost in addition and beyond the M.S. program. The approval of Graduate Certificate program must be subject to the approval of the M.S. program.

6. Planned Implementation Date

This program has an anticipated start in Fall semester, 2014. This program will be offered as a regular program. The program will be extended into an online program as soon as it is established and practical to do so. We envision a start date of Fall 2016 for the online delivery of this program.

7. Program Governance

Like other non-departmental and interdisciplinary programs at Michigan Tech, the Data Science program will be administered through the Graduate School, which will have the overall responsibility and final oversight for the program. The program will have the same management structure that governs the M.S. in Data Science program.
Appendix I: Foundational Skills Courses

Note that 2000 level courses listed here cannot be counted towards the requirement for M.S. in Data Science degree.

Mathematics Courses (Credits: 3)
- MA 3740 - Statistical Programming and Analysis

School of Business and Economics Courses (Credits: 3)
- MIS 2000 - IS/IT Management
- MKT 3600 - Marketing Research
- MIS 3100 - Business Database Management
- MIS 2100 - Introduction to Business Programming

Computer Science Courses (Credits: 3)
- CS 3425 - Database
- CS 2321 - Data Structures

School of Technology Courses (Credits: 3)
- SAT 3210 - DB Management
- SAT 3002 - Application Programming Introduction
- SAT 4600 - Web Application Development

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9 2000 level courses cannot be counted towards the M.S. in Data Science degree requirement.
10 2000 level courses cannot be counted towards the M.S. in Data Science degree requirement.
11 2000 level courses cannot be counted towards the M.S. in Data Science degree requirement.
12 New 3-credit point course to be designed for Fall 2014
13 New 3-credit point course to be designed for Spring 2015
Program Characteristics:

Inquiries:

- Forwarded to Graduate Program Director and Graduate Program Assistant

Applications:

- Initial processing by Graduate School (as for all programs)
- Forwarded to Graduate Program Director for review
- Graduate Program Assistant assists with processing
- Review conducted based on procedures developed by Graduate Program Director and Graduate Program Steering Committee and approved by relevant Chair(s)/Dean(s) and Graduate Dean
- Funding decisions made based on procedures developed by Graduate Program Director and Graduate Program Steering Committee and approved by relevant Chair(s)/Dean(s) and Graduate Dean

Admissions:

- Graduate Program Director responsible for final decisions
- Graduate Program Assistant assists with processing
- Graduate School issues official letter of admission (as for all programs)

Student Advising:

- Graduate Program Director serves as temporary advisor for incoming students
- Graduate Program Director and Graduate Program Steering Committee primarily responsible for program management with assistance of Graduate Dean and relevant Chair(s)/Dean(s) if necessary
- Graduate Program Steering Committee collaborates with Graduate Program Director to oversee day-to-day program management
- Graduate Program Steering Committee membership is representative of the academic home units of faculty members participating in the program
- Students reassigned to permanent advisor in home unit as soon as possible
- Students “live” (e.g., get mail, have office [if possible]) in same academic unit as advisor
- Students “count” toward enrollment in advisor’s home academic unit (where advisor has office and primary appointment)
- Graduate Program Directors meet as a group on a regular basis with Graduate Dean to promote communication/collaboration/continual improvement.
- Expectations for completion of milestones for degrees developed by Graduate Program Director and Graduate Program Steering Committee and approved by relevant Chair(s)/Dean(s) and Graduate Dean
• Graduate Program Assistant assists with all aspects of student support, ensuring appropriate level of enrollment (e.g., full-time), processing required forms, scheduling events, entering information into Banner (as for all programs)
• In cases of conflict, Graduate Program Director and Graduate Steering Committee address issues (as is done in other programs), with the Graduate School becoming involved when resolution at the program level is not possible

Curriculum:

• Core – goal of core is to develop commonly agreed upon required body of knowledge, facilitate cross-disciplinary communication and collaboration among faculty and students; highlight recent relevant research outcomes in relevant discipline(s).
  o Minimum of 1 regularly scheduled (can be online) course
  o Minimum of 1 seminar/journal course

• Additional courses:
  o Must conform to relevant rules for graduate programs at relevant level
  o Must promote interdisciplinary themes while providing opportunity to build students’ expertise in a particular area.

Changes to Curriculum or Program:

• Addressed through changes to Program policies and procedures (to be reviewed and approved by Graduate Dean in consultation with relevant Department Chair(s)/Dean(s)
• Addressed through Graduate School Binder Process
Grad Prog Director
- Rotating 3-year term

Grad Prog Asst
- In Prog Dir's unit

Graduate Program Steering Committee
- 3-5 member voting body; representation of departments/schools of participating faculty

Graduate Program Faculty
- Nominated by Graduate Program Steering Committee, approved by relevant Department Chair/Dean, approved by Graduate School for Adjunct Faculty Status in Program
- Authority to serve as primary advisor to students

All faculty supervised by relevant Department Chair/Dean

Graduate Program policies and procedures (written document, available on web) reviewed on 5-year basis by Graduate Dean. Review includes requests for input from relevant Department Chair(s)/Dean(s).

Graduate Program Director reports to Graduate Dean for program-related issues.

All non-departmental/interdisciplinary Graduate Program Directors will meet as a group on a regular basis with Graduate Dean to promote communication/collaboration/continual improvement.
Proposal to Change Degree Titles:
Current Title: PhD in Rhetoric and Technical Communication
Proposed Title Change: PhD in Rhetoric, Theory and Culture

1. General description and characteristics: This is a modification of the title to reflect the program's alignment with emerging trends of the discipline.

2. Related program in Michigan: PhD in Writing and Rhetoric at Michigan State University

3. Rationale: Over the past 40 years, Michigan Tech’s Humanities department has twice developed innovative programs that had broad national impact—we established the first “Writing across the Curriculum” (WAC) program in the late 1970s, and we established the nation’s first PhD degree in Rhetoric and Technical Communication (RTC) in the late 1980s. In each of these instances, we were in a better position to respond to changing conditions than other departments precisely because we are an interdisciplinary Humanities department in a STEM-focused research university. Now we are in a strong position to lead the profession once again, and this name change reflects that strength.

In changing our name we have retained the key word “Rhetoric.” To educators in the Humanities, this term implies “communication,” and signals our commitment to understand communication in relation to its “historicity” and systemic functions.

Our second term—“Theory”—indicates our program’s focus on issues of the relationship between humans and their technologies. For scholars in the Humanities, the term invokes a tradition of scholarship concerned with the modern world’s changing relationships among individuals, our languages and social structures, and our physical environments. Networked environments and social media such as Facebook and Twitter are profoundly changing the ways people communicate in all areas of work, family and social life. These developments call for new ways of communicating that incorporate visual design with conventional text, and deploy various rhetorical strategies across different delivery platforms such as mobile phones and tablets. The fast-paced developments in digital media require the teaching of new skills, and new ways of teaching. The term “Theory” expresses our commitment to explore and develop these methods and to prepare our graduates to take them into their future classrooms and workplaces.

Our third term—“Culture”—reinforces our emphasis on communication and social interaction. The term also refers to our expertise in areas such as diversity and globalization. Globalization is transforming our workplaces and our societies. Students
who can recognize and understand cultural differences will be better equipped for the job market and for their future lives.

In the late 1980s, the name “Rhetoric and Technical Communication” was a shot across the bow of traditional English and Communication graduate programs. It signaled our intention to prepare graduate students for an emerging but under-served sector of the academic marketplace. Now, there are 76 PhD programs that use “Composition” or “Technical Communication” in the titles. Nearly 70 of them are housed in English departments. Something that sets our program apart from these programs is our interdisciplinarity. We are the only department offering this kind of degree from a faculty that includes nationally recognized scholars of Rhetoric and Composition; Technical Communication; Communication; Culture and Media Studies; English; Linguistics; Modern Languages (Chinese, French, German and Spanish); and Philosophy. We have scholars working at the leading edge of technological change and globalization. And we have maintained our traditional strengths in Rhetoric, Composition Studies and Technical Communication. Our new name retains the initials “RTC” with the intention of emphasizing the continuity of the program. Just as the designation “Rhetoric and Technical Communication” was the herald of a significant movement twenty-five years ago, “Rhetoric, Theory and Culture” will mark our program's leadership in the discipline during the next twenty-five years.

4. Curriculum design: No change.
5. New course descriptions: Not relevant.
6. Additional resources: Requires no additional resources.
7. Accreditation requirements. No additional accreditation requirements.
8. Planned implementation date: The proposed change will be implemented in the 2014-2015 academic year.

Approved by vote of the Humanities faculty April 8, 2013.

Approved by Chair of the Humanities Department April 8, 2013.

Approved by College of Sciences and Arts Dean

Approved by Provost
November 7, 2013

Proposal to Change Degree Titles:

Current Title: MS in Rhetoric and Technical Communication

Proposed Title Change: MS in Rhetoric, Theory and Culture

1. General description and characteristics: This is a modification of the title to reflect the program’s alignment with emerging trends of the discipline.

2. Related programs in Michigan: MS in Writing and Rhetoric at Michigan State University

3. Rationale: Over the past 40 years, Michigan Tech’s Humanities department has twice developed innovative programs that had broad national impact—we established the first “Writing across the Curriculum” (WAC) program in the late 1970s, and we established the nation’s first PhD degree in Rhetoric and Technical Communication (RTC) in the late 1980s. In each of these instances, we were in a better position to respond to changing conditions than other departments precisely because we are an interdisciplinary Humanities department in a STEM-focused research university. Now we are in a strong position to lead the profession once again, and this name change reflects that strength.

In changing our name we have retained the key word “Rhetoric.” To educators in the Humanities, this term implies “communication,” and signals our commitment to understand communication in relation to its “historicity” and systemic functions.

Our second term—“Theory”—indicates our program’s focus on issues of the relationship between humans and their technologies. For scholars in the Humanities, the term invokes a tradition of scholarship concerned with the modern world’s changing relationships among individuals, our languages and social structures, and our physical environments. Networked environments and social media such as Facebook and Twitter are profoundly changing the ways people communicate in all areas of work, family and social life. These developments call for new ways of communicating that incorporate visual design with conventional text, and deploy various rhetorical strategies across different delivery platforms such as mobile phones and tablets. The fast-paced developments in digital media require the teaching of new skills, and new ways of teaching. The term “Theory” expresses our commitment to explore and develop these methods and to prepare our graduates to take them into their future classrooms and workplaces.

Our third term—“Culture”—reinforces our emphasis on communication and social interaction. The term also refers to our expertise in areas such as diversity and globalization. Globalization is transforming our workplaces and our societies. Students
who can recognize and understand cultural differences will be better equipped for the job market and for their future lives.

In the late 1980s, the name “Rhetoric and Technical Communication” was a shot across the bow of traditional English and Communication graduate programs. It signaled our intention to prepare graduate students for an emerging but under-served sector of the academic marketplace. Now, there are 76 PhD programs that use “Composition” or “Technical Communication” in the titles. Nearly 70 of them are housed in English departments. Something that sets our program apart from these programs is our interdisciplinarity. We are the only department offering this kind of degree from a faculty that includes nationally recognized scholars of Rhetoric and Composition; Technical Communication; Communication; Culture and Media Studies; English; Linguistics; Modern Languages (Chinese, French, German and Spanish); and Philosophy. We have scholars working at the leading edge of technological change and globalization. And we have maintained our traditional strengths in Rhetoric, Composition Studies and Technical Communication. Our new name retains the initials “RTC” with the intention of emphasizing the continuity of the program. Just as the designation “Rhetoric and Technical Communication” was the herald of a significant movement twenty-five years ago, “Rhetoric, Theory and Culture” will mark our program’s leadership in the discipline during the next twenty-five years.

4. Curriculum design: No change.
5. New course descriptions: Not relevant.
6. Additional resources: Requires no additional resources.
7. Accreditation requirements: No additional accreditation requirements.
8. Planned implementation date: The proposed change will be implemented in the 2014-2015 academic year.

Approved by vote of the Humanities faculty April 8, 2013.

Approved by Chair of the Humanities Department April 8, 2013.

Approved by College of Sciences and Arts Dean

Approved by Provost
IT Updates
GFC
Topics

- GradLab Computing
- Information Learning Commons (ILC) Update
- Cost of color printing for graduate students
- Purchasing of equipment through IT
- Meeting the software needs of graduate students
- Administrative access to computer
Current Centrally Funded Labs

<table>
<thead>
<tr>
<th>Building</th>
<th>Group Name</th>
<th>Dept</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Office Building</td>
<td>05-G005</td>
<td>SBE</td>
<td>5</td>
</tr>
<tr>
<td>DOW Environmental Sciences and Engineering</td>
<td>08-0211</td>
<td>GMES</td>
<td>11</td>
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<tr>
<td>DOW Environmental Sciences and Engineering</td>
<td>08-0853</td>
<td>CEE</td>
<td>10</td>
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<tr>
<td>Minerals and Materials Science</td>
<td>12-631A</td>
<td>MSE</td>
<td>5</td>
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<tr>
<td>U.J. Noblet Forestry Building</td>
<td>18-G036</td>
<td>FRES</td>
<td>7</td>
</tr>
<tr>
<td>R.L. Smith Mechanical Engineering Building</td>
<td>20-0707</td>
<td>ME</td>
<td>28</td>
</tr>
</tbody>
</table>
Need Help Finding a Seat?
Desktop/Office Grad Support

- Currently IT recycles 200-400 ex-lab machines
- Units are typically 4-6 years old
- Considered “Productivity Use” (Office/very light duty)
- Frequent support issues
- IT pays for grad office networking connection fees
- Device requirement for students in heavy discussion
Printing Information

9/1/2013 - 12/10/2013:
Husky-BW: 2,089,430 by 6,053 users (1,515 of these were from the "library" public login)
Husky-Color Student: 5,702 by 279 users (105 of these were from the "library" public login)
Husky-Color Non-Student: 4,551
Husky-Res: 31,143 by 478 users

9/2/2013 - 12/11/2012:
Husky-BW: 1,354,800 by 5,581 users
Husky-Color: 1,173,800 by 4,641 users
Estimated cost/year/student @ $112BW & $112 Color Pages per year
New Information Technology Procurement Policy

Michigan Tech's Purchasing Department announces the following new Information Technology (IT) Procurement Policy.

Information Technology Services (ITS) is responsible for maintaining the University network, servers, workstations, and peripherals to ensure that quality is maintained at reasonable cost. As such, procurement of all University IT resources and services is to be centrally managed by ITS regardless of the source of funding; all IT related purchases must be made following 2.2014.1 Procurement of Information Technology Equipment, Software, & Consumables Procedure. ITS manages the purchase of IT-related items in collaboration with the Purchasing Department, which has the final responsibility and authority for vendor selection and all purchasing decisions.

A centralized IT procurement procedure benefits Michigan Tech by providing:

- brand and model standardization where appropriate
- a campus-wide inventory of hardware and software to facilitate effective planning, maintenance, upgrades, and disposal
- pricing advantages obtained through volume purchasing and working with preferred vendors
- license compliance for software purchases
- hardware and software with a known “support state” at the time of purchase

Effective August 26, 2013 per 2.2014 Information Technology Procurement Policy, all IT resources and services must be procured through the Office of Information Technology. To make a purchase, please contact IT User Services at IT-help@mtu.edu or 487-1111.

For more information, please go to www.it.mtu.edu/procurement.
“Standardized” means

- Tested in Michigan Tech environment
- Warranty appropriate
- Established vendor support
- Common component
- Common consumables
Standardization in Progress for:

- Desktops
- Laptops/Tablets
- Printers
- Copiers
- University provided cell phones
Software available soon to all students:
Also, DreamSpark (198 Microsoft Apps) Currently available to most majors
Administrative Access

• System’s Administration By User (SABU)
  – Off domain
  – Multi-drive (Home Dir, etc.) via VPN only
  – No regular updates
  – “best effort” support
  – Responsible for all activity and security

• Working on new “Managed Desktop” program
Questions?
Graduate Faculty Council—Draft Agenda

December 10, 2013

NOTE: (all handouts connected to a single pdf file)

1. Review minutes of 11/05/13

2. Committee Reports:
   a. Research Only Mode
   b. Thesis/Dissertation Review Committee

3. Old Business:
   a. Rhetoric and Technical Communications Program Name Change (R. Strickland)
   b. Update on School of Technology's Dual Degree Program: Geodesy and Remote Sensing (Dean Huntoon)

4. New Business
   a. Data Science Master's Program Proposal (L. Brown/M. Buche)
   b. Data Science Graduate Certificate Program Proposal (L. Brown/M. Buche)
   c. Nondepartmental/Interdisciplinary Graduate Programs (Dean Huntoon)
   d. IT Representative to Address any Issues/Concerns (D. de Beaubien)