

YORK UNIVERSITY

Schulich School of Business

Master of Management in Artificial Intelligence (MMAI)

Program Proposal

January 31, 2019

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1. Introduction

1.1. Brief Statement of the Program

The proposed Master of Management in Artificial Intelligence (MMAI) program is designed to prepare individuals to seek and obtain meaningful employment in artificial intelligence (AI)-related management positions, whether in private, public or non-profit organizations.

AI-related fields include, but are not limited to: data science, machine learning, visualizations, natural language understanding, intelligent robotics, knowledge representation, reasoning and management, intelligent agents, human computer interfaces, and recommendation systems.

The MMAI addresses a growing need in post-graduate management education for programs that train students in the task of managing the design and implementation of practical AI-related solutions and technologies. The objective of the MMAI is to produce such graduates. The proposed program is not based on any existing Master of Management in Artificial Intelligence. Rather, the program will be designed from the ground up. Program-level learning outcomes (see section 5 in this document and **Appendix A** for a detailed list of learning outcomes and goals) have been developed based on input from leading academics in the field of management and AI as well as potential employers from the private sector, government and the non-profit and social sectors. Curriculum structure and course contents have been developed to achieve these learning outcomes ensuring that our MMAI students acquire the knowledge and skills required to succeed as managers in business and non-profit organizations or as entrepreneurs. These include strategic thinking, managerial decision making, AI technologies, design techniques and ethics in AI. The MMAI's program structure, which includes a unique 2-term integrative hands-on consulting project, will ensure that the program is differentiated from competing programs (see section 3.2 below for details on program differentiation).

In addition to meeting the quality standards of the Schulich School of Business, York University and the province of Ontario, the MMAI has been designed to fulfill the standards set out by the Vector Institute (Vector) under the heading "1000AIMs." Vector's 1000AIMs initiative was established to support the province of Ontario's goal to produce 1000 graduates annually in the field of AI within five years.

Thus, in sum, the MMAI is a professional degree program in the management of artificial intelligence. The degree focuses on strategic thinking, managerial decision making, AI technologies, design techniques and ethics in AI. The objective is to produce well-rounded managers who have the potential to become leaders in AI-management.

1.2. Endorsed Fields of Study

N/A

1.3. Method Used to Develop the Program

The program has been designed by a Schulich-based task force established by Dean Horvath. The task force obtained input from all relevant subject matter disciplines within Schulich, from prospective students, and from potential employers in a wide range of sectors.

To develop the learning outcomes and curriculum content the task force conducted interviews with management practitioners in industry and government, with consultants, and with industry associations. In addition, the task force used detailed job descriptions developed by expert panels from The Vector Institute for Artificial Intelligence to fully understand the emerging trends in AI and the expected knowledge requirements for graduates aspiring to enter careers in AI-related fields. Finally, in designing the program's goals and curriculum the task force consulted the Vector Institute's 1000AIMs guidelines released April 5th, 2018 for recognized AI-related master's programs.

The learning outcomes in turn informed which courses are needed to provide future graduates with the required knowledge and skills. The program's draft curriculum was discussed again with potential employers for a last round of input in order to validate the program design.

1.4 Faculty in which the Program is Housed

The program will be housed in the Schulich School of Business.

2. General Objectives of the Program

2.1. Brief Overview

The Schulich School of Business proposes to establish a Master of Management of Artificial Intelligence (MMAI) program to prepare students with the necessary skills and knowledge to obtain entry-level management positions in business or other types of organizations (e.g., nonprofit organizations, governmental bodies, or entrepreneurial start-ups) upon graduation. The overall objective of the program is as follows:

The Master of Management of Artificial Intelligence program provides specialized education in the management of AI. The program emphasizes managerial and technical skills needed to leverage emerging AI technologies for the generation of insights and solutions to challenges organizations face in rapidly changing business and policy environments. Students are challenged to consider both theoretical and applied perspectives of management and AI-technologies. While teaching hands-on skills necessary for initial employment, the overarching goal of the program is to create managerially competent, creative thinkers that have the potential to become thoughtful leaders in a world of rapid technological change.

The program is designed primarily for students who have recently graduated from a non-business degree program such as science, engineering, liberal arts, and applied arts. In addition, the program may attract some individuals who have worked in other fields of business and wish to add management of AI to their skill set.

We aspire to graduate individuals from the MMAI program that:

- are intellectually curious and prepared for continuous learning;
- exhibit leadership and/or entrepreneurial qualities;
- are effective communicators and can lead teams;
- are able to use cutting-edge AI techniques;
- are well versed in methods of management;
- are able to effectively manage AI-projects; and
- are conscious of his/her own and the organization's ethical and social responsibilities.

The program will achieve these objectives over the course of three terms of full-time study and the completion of 45 credits. The program is structured to facilitate the acquisition of AI and management knowledge and skills over these three terms. A key component of the program is the integration of the acquired knowledge through a capstone community-involved experiential learning project (the so-called AI Consulting Project, or AICP). This project will take place during the 2nd and 3rd terms. During the AICP students will make extensive use of the newly developed Schulich Deloitte Visual Cognitive Analytics Lab.

2.2. Alignment with University and Faculty Missions

This program will support the University's goals as outlined in the 2015-2020 UAP as follows:

- *Academic Quality and Student Success.*
The proposed Master of Management in Artificial Intelligence program is specifically designed to provide a professional managerial education to high-performing post-secondary graduates as well as qualified individuals who are currently working but eager to augment their skill set. The Schulich School of Business is recognized worldwide as a leader in management education. The proposed Master of Management in Artificial Intelligence program not only draws from existing expertise but also brings into the classroom world-class instructors from outside the School ensuring that graduates from the program are at the leading edge of AI management knowledge and practice.
- *Enhanced Quality in Teaching and Learning and Internationalization.*
The program will be open to eligible applicants from all recognized universities worldwide, thereby enhancing achievement of York University's internationalization objective. As with Schulich's other specialized Master programs as well as the MBA, we expect a substantial number of applications to come from individuals outside Canada.

The program will feature the highest quality in teaching and learning. Instructors

will be selected from Schulich's tenure stream faculty and highly experienced industry experts thus ensuring first-rate teaching. In addition, this program offers cutting-edge experiential learning. Similar to Schulich's other programs, this program will use high impact teaching practices throughout all three terms. In particular, the two-term Artificial Intelligence Consulting Project (AICP) offers a unique learning experience to students in the program (for details on the AICP see Appendix B and H). As such, the University's goals of pedagogical innovation and a high-quality student experience are addressed.

- *Enhanced Community Engagement.*

The program's learning outcomes have been informed by extensive input from the professional community. In addition, AICP is community-involved. During the last two terms, students will work with organizations to help them analyze and solve real-live problems in a hands-on fashion.

University Goals

This program aligns with York University's Strategic Mandate Agreement on many fronts. The program's innovative combination of management and technology training drives York's aspiration for unique learning experiences. The two-term Artificial Intelligence Consulting project creates a truly innovative student experience. This project offers students an opportunity to apply theories and concepts to a real-world company problem under the supervision of experts from academia, business and non-business organization. Based on applied research this project makes an impact in the community, one solved problem at a time. Furthermore, the MMAI is supported in material ways by strategic partnerships with community members. For example, central to the learning experience of the students is their use of the innovative Deloitte Schulich Cognitive Analytics and Visualization Lab. The lab and in extension the student projects are supported by a world-class data scientist. Both, the lab and the data scientist are financed in partnership with Deloitte. Finally, York University's Strategic Mandate Agreement identifies business as an area of both strength and growth. This new program aims to contribute to this growth at the graduate level. By providing a net addition to the University's Masters complement, it will help the University to address its goal of enhanced graduate studies, research intensification and reaching the masters- level enrolment target.

Faculty Goals

The Schulich School's academic plan calls for the School to be global, innovative, and diverse. The Master of Management in Artificial Intelligence program exhibits all these attributes. The program introduces graduate-level management education to individuals who are academically highly qualified but lack managerial knowledge and experience, and offers this preparation to a diverse group of students of widely varying backgrounds, nationalities and work experience levels. At the same time, the program furthers the Faculty's shared goals of pedagogical innovation in terms of optimized, outcome-oriented curriculum design and the use of experiential, community-involved, and high impact teaching practices. It helps the Faculty round out its offering of direct-entry programs in core and emerging management areas and implement its pipeline model of continuing education that spans from an undergraduate degree to a specialized master's degree to a senior leadership degree (MBA) or PhD.

3. Need and Demand

3.1. The Rise of Artificial Intelligence as a Management Concern

Due to the confluence of recent technological breakthroughs and societal changes, Artificial Intelligence – e.g., deep learning, machine learning, natural language processing – has become an increasingly important focus for research and practice in fields such as computer science, information systems and management studies among others.

Over the next 15 years, Artificial Intelligence will transform the private and public sphere (Internet, media, mobile-based assistance systems, electronic voting, autonomous transportation, voice guidance systems, medical care, etc.) as well as business (FinTech, AI-enabled marketing, intelligent healthcare, intelligent logistics systems, smart manufacturing, process automation, smart cities, smart energy, etc.). Some companies have begun to adopt AI in their digital transformation projects, thereby fundamentally changing how value chains are configured and managed. Indeed, with businesses expected to be the main driver of AI adoption and investment over the next decade, the need for individuals that combine management skills and knowledge of advanced AI applications will continue to increase.

3.2. Similar Artificial Intelligence Programs Offered Elsewhere

In recent years, several top business schools in North America and Europe have introduced master's-level programs for the emerging field of AI. While some have a similar positioning as the proposed Schulich Master of Management of AI, others emphasize technological training rather than management skills. In Ontario Queen's University's Smith School of Business has launched a master-level program in the Management of AI (see Appendix D). However, the proposed MMAI program is different from existing programs by focusing equally on the managerial and the technical training of the student.

The Queen's University's Master of Management in Artificial Intelligence program takes 12 months to complete, and it limits its AI technology training to Data Science and Business analytics applications. The Schulich MMAI covers a much wider range of AI-related techniques. While a more limited focus on techniques makes sense for the Queen's program, which aspires to help graduates obtain decision support positions in the private and public sector, the Schulich program aspires to prepare students for a much wider range of jobs in all functional areas of the organization. In addition to data science and business analytics, Schulich MMAI students obtain knowledge in deep learning, numerical analysis, visualization and other advanced AI applications. Therefore, we do not consider the Queen's program as a direct competitor to the proposed Schulich MMAI. Indeed, the Queen's MMAI much more closely resembles the Schulich Master of Business Analytics, which also has a strong focus on data science and analytics methods, such as forecasting and decision modelling, while lacking training in advanced AI techniques.

In the US, the schools with the most similar programs to the MMAI are David Eccles School of Business at the University of Utah, Rutgers University Business School, University of Maryland's Robert H. Smith School of Business, and New York University's Stern School of Business (for details on the similarities with, and differences between, their respective programs and the proposed MMAI see Appendix D).

In sum, the most significant differentiator of the MMAI is the deliberate combination of its strong focus on developing management skills and its provision of significant training in a broad range of AI-related technologies. The culmination of this blend of management and technology training is the 2-term integrative consulting project. Our most immediate competitor, the Smith School of Business program, does not offer such an immersive and extended experiential learning component. In addition, while a few of the very best programs in the US offer a similar level of experimental and integrative learning, most of the US-based programs and none of the Canadian programs do.

3.3. The Need for Artificial Intelligence Programs

Over the past two decades, the AI industry has undergone a period of significant, if not revolutionary, expansion. Through the rapid proliferation of the Internet and other digital technologies, AI researchers now have an unparalleled level of data on all processes and operations of the organization as well as on consumers and markets. Furthermore, organizations and managers are looking to find ever new ways of gathering, analyzing and utilizing data often in real-time.

This rapid technological change has created growth and new job opportunities in the Management of Artificial Intelligence field. The Canadian government's Occupational Projection System predicts robust job growth for computer and information systems managers (see NOS Code 0213). Indeed, recognizing the looming gap between supply and demand, the province of Ontario aggressively pursues plans to increase the number of graduates in (AI)-related master programs over the next few years. The Vector Institute and its public and private partners will play a major role in meeting the demand for AI-talent. Jordan Jacobs, Co-founder & Member of the Vector Institute Board of Directors states: "An informal survey of companies in Toronto and the surrounding area found that local companies want to hire thousands of machine learning PhDs and master's graduates in the next five years. This number is far greater than the number of graduates per year in all of Canada and that helped to validate the idea to create the Vector Institute." The MMAI program will train such graduates and thereby help fill the gap between supply and demand of AI-related skills.

Further evidence for the need of IT-talent in general and AI-trained graduates in particular is the fact that the average hourly wage for AI-related jobs grew faster than the overall average wage growth. A lack of supply of qualified experts drives up wages and salaries. Over the 2014-2016 period, employment in AI increased faster than the average of all occupations. For Computer and information systems managers, over the period 2017-2026, new job openings (arising from expansion demand and replacement demand) are expected to total 32,500. In short, demand for AI-trained managers will be high.¹

¹ See Marr, B. (2018, June 25). "The AI Skills Crisis And How To Close The Gap." Access online at <<https://www.forbes.com/sites/bernardmarr/2018/06/25/the-ai-skills-crisis-and-how-to-close-the-gap/#22cdbc4931f3>>

4. Program Content and Curriculum

4.1. Program Requirements and Courses

The MMAI will require the completion of fourteen required courses, totaling 45 credits over three terms of full-time study. Students will also be required to complete a mandatory pre-start program. Figure 1 below presents an overview of the program structure.

The pre-start program will consist of the satisfactory completion of online course modules in Calculus, Computer Science, and Statistics offered by Udemy. The program commits to covering the Udemy fees for the required modules. The requirement for any or all Udemy modules may be waived if the student has taken subject courses in their previous studies as verified by their official transcripts. Students will also take a 3-day pre-start business fundamentals bootcamp in Marketing, Accounting and Finance.

The proposed coursework includes a real-world 6.00-credit capstone project called the Artificial Intelligence Consulting Project (AICP) that spans two terms (roughly 8 months in duration). During the AICP, students will solve a significant business problem by applying pertinent management techniques and Artificial Intelligence approaches. While much of the work during the AICP will happen at the new Schulich Deloitte Cognitive Analytics and Visualization Lab, students will also spend time at the client site (i.e., businesses, social sector and government organizations), interacting with various stakeholders including line managers, technicians, customers and suppliers.

All general program requirements currently in force for Schulich's 3-term master's degrees (including promotion and graduation requirements) will apply to this program as well. A copy of the handbook can be found at schulich.yorku.ca/graduate-handbook.

Figure 1. Master of Management in Artificial Intelligence Program Structure

Master of Management in Artificial Intelligence (MMAI)			
Pre-Program	Term 1 (Fall)	Term 2 (Winter)	Term 3 (Summer)
Mandatory completion of 3 Udemy ® online courses	SB/MMAI 5000 3.00* Artificial Intelligence Fundamentals	SB/MMAI 5040 3.00* Business Applications of Artificial Intelligence I	SB/MMAI 5090 3.00* Business Applications of Artificial Intelligence II

Calculus	SB/MGMT 6300 3.00 Case Analysis and Presentation Skills	SB/MBAN 5140 3.00 Visual Analytics and Modelling	SB/MMAI 5500 3.00* Applications of Neural Networks & Deep Learning in Business
Statistics	SB/MMAI 5100 3.00* Database Fundamentals	SB/MMAI 5300 3.00* Numerical Analysis	SB/MMAI 5400 3.00* Natural Language Processing
Computer Science	SB/MMAI 5200 3.00* Algorithms for Business Analysis	SB/ORGS 6350 3.00 Managing Change	SB/ORGS 6500 3.00 Interpersonal Managerial Skills
	GS/PHIL 5340 3.00 Ethics of AI	SB/MMAI 6050** Consulting Project 1	SB/MMAI 6050** Consulting Project 2

* = New Course

** = MMAI 6050 6.00 spans Terms 2 and 3.

4.2. Courses

The program consisting of 14 required courses will run over three consecutive terms starting in September (see Figure 1; course descriptions are provided in **Appendix B**).

Of the fourteen required courses, four are existing masters-level courses. The other ten courses are unique to the Master of Management in Artificial Intelligence. The Ethics of AI course (GS/PHIL 5340) was developed especially for the MMAI program by the Philosophy department at York under the leadership of Canada Research Chair professor Regina Rini.

The courses will provide students with essential business knowledge and skills in the first term, including business communication and teamwork, basic artificial intelligence, and essential research and analytics skills. In the Winter and Summer terms, students will gain more advanced and specific knowledge in artificial intelligence as they study topics such as visualization, conversational systems, autonomous agents, natural language processing, big data, and deep learning. In addition, students will acquire problem-oriented management skills in the Winter and Summer terms as part of the consulting project and the course Business Applications of AI II.

Course scheduling was carefully considered in the design of the program. Courses that teach students fundamentals of artificial intelligence and analytics are taught in the first two terms. The program contains an experiential Artificial Intelligence consulting project (AICP) that spans terms 2 and 3. In term 2, students will define the projects with their clients, collect and analyze relevant qualitative and quantitative data, and develop management-driven Artificial Intelligence solutions to meet concrete business needs. In term 3 the student teams will implement their solutions, thus managing an entire Artificial Intelligence project from planning to

implementation.

The coursework that students complete before and during the AICP will enable them to choose from and apply appropriate artificial intelligence and management methods. Therefore, the consulting project will provide students with a truly integrative learning experience that offers both unique insights into the challenges and opportunities of creating an AI-driven business solution and a more confident entry into the workplace.

Students must enroll as full-time students. The total program can be completed in one year (3 terms). Students must complete the program within four years of entering.

4.3. Course Level

All courses are at the graduate level.

4.4. Program Overview

A program overview is provided in **Appendix A**.

5. Program Learning Outcomes and Assessment

5.1. Learning Outcomes

The MMAI program's learning outcomes were developed through extensive discussion with Schulich faculty members, industry experts, and graduates of the Schulich School of Business who currently work in related positions. Complete details on the expected learning outcomes are enclosed in **Appendix A**. **Appendix C** offers a detailed curriculum map that indicates which courses support a specific learning outcome. Importantly, the program level learning outcomes have been mapped against the Vector Institute's 1000AIMs guidelines for Complementary AI-related Master's Programs².

² <https://vectorinstitute.ai/wp-content/uploads/2018/04/1000aims-guidance-and-appendices-9apr18.pdf>

5.2. Program Learning Outcomes:

**Schulich School of Business
Master of Management in Artificial Intelligence (MMAI)
Program-Level Learning Outcomes**

Graduates of the MMAI Program are able to:

1. Core Business AI Understanding

1.1 Describe the key components of the artificial intelligence (AI) field, including search heuristics, knowledge representation, automated planning, agent-based systems, machine and deep learning, and probabilistic reasoning

1.2 Connect key AI components to the cornerstones of modern business management

2. Critical Thinking and AI Applications

2.1 Analyze the application of AI technologies for business problems, including knowledge management, information retrieval, decision support systems, natural language processing, process automation, personalization and visualizations

2.2 Design, implement, evaluate, and refine AI technologies for solving business problems

2.3 Understand and analyze the trade-offs between computational complexities and business benefits in applying different AI techniques and models

2.4 Apply strategic thinking skills for managerial decision making

3. Professional Communication

3.1 Deliver a clear, effective and engaging oral presentation appropriate for both technical and non-technical audiences

3.2 Prepare a clear, effective and engaging written report appropriate for both technical and non-technical audiences

3.3 Apply appropriate strategies to work effectively in interdisciplinary teams

4. Ethical Behaviour & Social Responsibility

4.1 Identify the ethical and societal implications of AI and its applications in business

4.2 Describe, analyze, and devise solutions for ethical and social issues that arise in the application of AI in business

5.3. Achieving the Program Learning Outcomes

Based on many (and always ongoing) conversations with our key stakeholders, such as practitioners, consultants, researchers, students and alumni, there is a substantial and ever-growing need for individuals that can take a business problem and manage all the processes required to develop an AI-driven solution to the problem. The skill set required by such an individual can therefore not be limited to cutting edge knowledge of AI technologies. Rather, the individual that businesses, government organizations and the social sector will need combines technology know-how with the skill set of a manager. Therefore, this program aspires to teach both the ability to design, evaluate, refine and implement practical AI technologies and solutions in a business context and the ability to manage a team, communicate effectively with business clients and demonstrate the highest ethical standards in business.

The Master of Management in Artificial Intelligence program has been designed to help students achieve both of these objectives with 18 credits dedicated to AI techniques and up to 27 credits allocated for the acquisition of AI management skills.

To achieve the proposed learning outcomes, the MMAI program has put a strong emphasis on experiential learning. Throughout the program, project-orientated teaching will be used to convey key technological components for AI applications such as machine learning as well as managerial capabilities ranging from presentation skills to strategic thinking and teamwork (e.g., MGMT 6300 Case Analysis and Presentation Skills).

The critical hands-on experience of a live project will be delivered via the AICP, where students are required to manage an entire cycle of preparing, applying and evaluating AI-based solutions to an organizational problem. Students work with businesses, non-profit and governmental organizations as well as entrepreneurial start-ups.

5.4. Assessment of Learning Outcomes

The grading and assessment process will be that used in other Schulich master's programs. Overall course grades will be based on the student's performance on the various elements of the course, including written assignments, case analyses, team work, presentations, examinations (mid-term tests and final examinations), and their contribution to class participation and learning.

Assignments, exercises or exams will also serve to assess the achievement of the learning outcomes. The program task force, the AD Academic and Academic Affairs Officer have worked together to map each learning outcome onto an assessment objective in a course delivered in the program. Please see the program's curriculum map in **Appendix C** for courses in which learning outcomes will be assessed.

The program has established a detailed assurance of learning (AoL) plan for the purposes of demonstrating and documenting students' performance levels with respect to the program's expected learning outcomes and DLEs. Each program-level learning outcome will be measured by an individually completed final assessment embedded in particular courses throughout the curriculum (see a list of final assessments in Appendix C). Student performance on these final assessments will be assessed against pre-established performance benchmarks, conveyed through the use of rubrics where appropriate. Certain rubrics, such as those designed to measure

'soft-skills'-related outcomes (e.g., presentation, reflection and teamwork skills) will be implemented program-wide to provide a consistent definition of program-level expectations as well as a well-scaffolded, formative approach to the development and measurement of core skills throughout the curriculum. A sample program-wide rubric for the assessment of presentation and teamwork skills (Outcome 3.3) is included in Appendix C.

Documentation of students' performance levels with regard to learning outcomes will be performed through Schulich's new learning management system, Canvas. This system offers robust learning outcome functionality in which outcomes can be set and aligned at both the course and program levels, and assessments can be aligned to outcomes through the use of course-specific or program-wide grading rubrics. The grading of student work in Canvas results in the automatic collection and compilation of data on student progress and allows for the tracking and reporting of performance levels to support the enhancement of curriculum and teaching, the identification of at-risk students, and reporting requirements for accreditation processes. The performance data will serve as the basis of the program's assurance of learning plan, enable evidence-based decision-making with regards to the identification of gaps in student performance in relation to the expected learning outcomes and enable the 'closing of the loop' on its curricular improvement initiatives undertaken to address these gaps.

5.5. Normal Program Length

The normal program length is three terms of full-time study, as indicated by the program structure in Figure 1. A course load of five courses per term is typical for all full-time students in Schulich masters' programs and is achievable for the vast majority of students. The course load, by design, aligns with similar professional master programs in the Schulich School of Business.

5.6. Delivery Modes

The program is in-person and course-based. The nature of the coursework varies, depending on the expected learning outcomes for each course. Students will engage in various types of experiential learning throughout the program, including case analysis, laboratory exercises, team work, working with technologies and data sets, as well as outreach and assistance to external organizations. The program also includes a two-term, community-based AI consulting project that helps students integrate their newly acquired technical and managerial skills in a real-world setting.

6. Admission Requirements

6.1. Program Admission Requirements

The minimum admission requirements are as follows:

- An undergraduate degree from a recognized postsecondary institution with a

- minimum B+ average in the last two full years (or equivalent) of academic work.
- Work Experience is not required, but internships or prior work experience is recommended.
- Graduate Management Admission Test (GMAT) or Graduate Record Examination (GRE)
 - Acceptable scores on all measures of the GMAT or GRE
 - To send your scores for these tests to us please use the following codes: GMAT code Z75-X8-87 or GRE code 5697
- Proof of English language proficiency if prior studies were not completed in English: TOEFL (iBT): 100 with minimum component scores of 23 or IELTS: 7.0 overall with minimum component scores of 6.5.
- A supplementary application form that shows strong evidence of leadership ability.
- Two letters of recommendation. It is recommended that one of these should be from a professor.

6.2. Alternative Requirements

N/A.

7. Resources

7.1. Areas of Faculty Strength and Expertise

One of Schulich's greatest strengths is the wide breadth of knowledge and experience of its faculty, which includes specialists in all areas of management in every type of organization as well as those who are experienced in the field of management of artificial intelligence.

The Schulich School of business is one of the very few business schools that has in-house experts in areas such as data governance and engineering, knowledge discovery, information retrieval, intelligent agent, managerial strategy, sustainability, ethics, and business and the environment, which facilitate a wide range of the curriculum components, such as database fundamentals, numerical analysis, visual analytics and modeling, machine learning, and natural language processing.

The resources for this program will largely be drawn from the resource base of the Schulich School (see Appendix E). Most courses will be taught by faculty members of the Operations Management and Information Systems (OMIS) area (tenure stream and contract), who possess expertise in general management as well as artificial intelligence. OMIS members also teach in Schulich's other masters programs and are responsible for teaching and supervising OMIS PhD students. In addition, the program will be enriched by experts in the ethics of AI from the Philosophy Department at York University, who designed and will teach a unique Ethics of AI course.

7.2. Role of Retired and Contract Instructors

Contract instructors play an essential role in the Schulich School of Business. All our contract instructors are highly experienced professionals and recognized experts in their respective fields of practice. These instructors bring real-world experience into the classroom to enrich lectures,

case analyses, assignments, projects, presentations, and students' performance in the "real world" of management.

Contract instructors will be employed where advisable, likely predominantly from the pool of qualified instructors already teaching at Schulich. As expert in their fields of specialization, such as machine learning, natural language processing and business applications of AI, contract instructors are very good at imparting practice-rich knowledge, which is in line with the goal of this master program. Other reasons for employing part-time instructors could be sabbatical coverage.

Retired professors also are valuable teaching resources due to their long experience and insight, but they are not expected to take a significant teaching role.

7.3. Laboratory Facilities/Equipment

The program will make use of the brand new Schulich Deloitte Cognitive Analytics and Visualization Lab, which stems from the partnership between the Schulich School of Business and Deloitte, a global leader in the field of business analytics and AI. The lab will be supported by leading data scientist Hjalmar Turesson to foster advances in the visualization and interpretation of big data. The new lab and position have been established as part of a joint commitment to nurturing tomorrow's leading talent in the field and to elevate data analytics in Canada. The Lab will be housed within Schulich's future Centre of Excellence in Business Analytics, one of several Centres of Excellence to be located in the School's new \$50-million Rob and Cheryl McEwen Graduate Study & Research Building, opening November 2018. The approximately 800-square-foot lab will support teaching and research goals, as well as explore advances in predictive analytics, natural language processing, machine learning, analytics design and visualization, and data-based story-telling.

MMAI students will use the lab to complete the AI Consulting Project, the program's capstone integrative course in which students undertake a comprehensive AI-related project for an organization (the "client" site). Over the course of eight months, real client data will be ingested into the lab platform, and students will perform data cleansing, verification and QA, and uncover insights using advanced analytics methods and visualization tools. The lab also brings the challenges faced by real companies (sponsor organizations) into the MMAI classroom, delivering deep insights and innovative ideas to drive business forward through advanced analytics, AI and visualization solutions. Using predictive and prescriptive advanced analytics methods, actionable insights can be derived from these data to equip organizations with a unique competitive advantage. The lab will also combine statistical methods, computational intelligence, decision-making enabled by machine learning, and traditional symbolic AI to maximize AI's impact on analytical initiatives. More information on the Schulich Deloitte lab can be found at <https://dschulichlab.ai/how-it-works/>.

7.4. Space

Given the expected initial size of the program, space constraints are not an issue. The program will be housed in the newly constructed Rob and Cheryl McEwen Graduate Study & Research Building, which will add 3 large classrooms and 4 seminar rooms to the number of existing classrooms already available. The Deloitte lab is situated adjacent to these classrooms as are 8 small group breakout rooms where teams can prepare their group assignments. With the addition of the new building, space will not be a concern for the program for the foreseeable future.

7.5. Support Services

The primary support services will be the library, information technology, career services and student and enrolment services, all of which are already in existence at Schulich and serve its other 11-degree programs. We anticipate the possibility of needing one additional career advisor and an additional academic recruiter. These resources may be shared with the Master of Business Analytics (MBAN). The program will also rely on the strength of its Advisory Board Network and professional network of faculty members. Combined these networks bring together a substantial set of companies who will deliver high quality real-world AI-projects to the program for the AICP course.

7.6. Financial Support and Supervisory Capacity

As this is not a research-based program, no special financial support will be provided other than the financial aid and scholarships that are generally available to Schulich masters-level students. Similarly, there is no need for research supervisors.

7.7. Enrolment Projections

We expect that the first cohort (in Fall 2019) will attract 25 students. First year enrolment will be capped at 50 students. This enrolment target is reasonable and achievable, as evidenced by the success of Schulich's other direct-entry master's programs (e.g., the Master of Management started with an inaugural class of 50 students in Fall 2016 and the Master of Marketing drew a class of 53 in its first year). The expected steady-state maximum enrolment target is one full class (up to 55 students), with a potential to add a second cohort over time.

7.8. Support Statements and Consultations

Please see the Dean's resource statement (**Appendix F**) and the library statement (**Appendix G**). The proponents have consulted extensively with Schulich faculty. In addition, the Schulich AD Academic has undertaken extensive consultation with the faculty of science and with the Lassonde School of Engineering. Both faculties have provided letters of support of the proposed program (see below). In addition, the Schulich AD Academic has integrated feedback from FGS APPC and the external review process. This section will be updated as consultations progress.

Appendix A

Master of Management in Artificial Intelligence (MMAI) Program Overview

Program Overview

The proposed Master of Management in Artificial Intelligence (MMAI) program is designed to prepare individuals to seek and obtain meaningful employment in artificial intelligence (AI)-related management positions, whether in private, public or non-profit organizations.

AI-related fields include, but are not limited to: data science, machine learning, visualizations, natural language understanding, intelligent robotics, knowledge representation, reasoning and management, intelligent agents, human computer interfaces, and recommendation systems.

The MMAI addresses a growing need in post-graduate management education for programs that train students in the task of designing, evaluating, refining and implementing practical AI-related solutions and technologies. The objective of the Master in Management of AI (MMAI) is to produce such graduates. The proposed Schulich MMAI program is not based on any existing Master of Management in Artificial Intelligence. Rather, the program will be designed from the ground up. Program-level learning outcomes (see below) have been developed based on input from leading academics in the field of management and AI as well as potential employers from the private sector, government and the non-profit and social sectors. Curriculum structure and course contents have been developed to achieve these learning outcomes ensuring that our MMAI students acquire the knowledge and skills required to succeed as managers in business and non-for-profit organizations or as entrepreneurs. The MMAI's program structure, which includes a unique 2-term integrative consulting project, will ensure that the program is highly differentiated from competing program (see section 3.2 below for details on program differentiation).

In addition to meeting the quality standards of the Schulich School of Business, York University and the province of Ontario, the MMAI has been designed to fulfill the standards set out by the Vector Institute (Vector) under the heading "1000AIMs." Vector's 1000AIMs initiative was established to support the province of Ontario's goal to produce 1000 graduates annually in the field of AI within five years.

The MMAI is a professional degree program in the management of artificial intelligence. The degree focuses on strategic thinking, tactical decision making, design techniques and ethics in AI. The objective is to produce well-rounded managers who have the potential to become leaders in AI-management.

The program will achieve these objectives over the course of three terms and the completion of 45 credits. The program is structured to facilitate the acquisition of AI and management knowledge and skills over these three terms. A key component of the program is the integration of the acquired knowledge through a capstone community-involved experiential learning project (the so-called AI Consulting Project, or AICP). This project will take place during the 2nd and 3rd terms. During the AICP students will make extensive use of the newly developed Schulich Deloitte Visual Cognitive Analytics Lab.

Schulich School of Business
Master of Management in Artificial Intelligence (MMAI)
Program-Level Learning Outcomes

1. Core Business AI Understanding

1.1 Describe the key components of the artificial intelligence (AI) field, including search heuristics, knowledge representation, automated planning, agent-based systems, machine and deep learning, and probabilistic reasoning

1.2 Connect key AI components to the cornerstones of modern business management

2. Critical Thinking and AI Applications

2.1 Analyze the application of AI technologies for business problems, including knowledge management, information retrieval, decision support systems, natural language processing, process automation, personalization and visualizations

2.2 Design, implement, evaluate, and refine AI technologies for solving business problems

2.3 Understand and analyze the trade-offs between computational complexities and business benefits in applying different AI techniques and models

2.4 Apply strategic thinking skills for managerial decision making

3. Professional Communication

3.1 Deliver a clear, effective and engaging oral presentation appropriate for both technical and non-technical audiences

3.2 Prepare a clear, effective and engaging written report appropriate for both technical and non-technical audiences

3.3 Apply appropriate strategies to work effectively in interdisciplinary teams

4. Ethical Behaviour & Social Responsibility

4.1 Identify the ethical and societal implications of AI and its applications in business

4.2 Describe, analyze, and devise appropriate solutions for ethical and social issues that arise in the application of AI in business

Admission Requirements

The minimum admission requirements are as follows:

- An undergraduate degree from a recognized postsecondary institution with a minimum B+ average in the last two full years (or equivalent) of academic work.
- Work Experience is not required, but internships or prior work experience is recommended.
- Proof of English language proficiency if prior studies were not completed in English: TOEFL (iBT): 100 with minimum component scores of 23 or IELTS: 7.0 overall with minimum component scores of 6.5.
- A supplementary application form that shows strong evidence of leadership ability.
- Two letters of recommendation, at least one of which should be from a professor.
- Work Experience is not required, but strong internships or prior work experience is recommended.

Appendix B

Master of Management in Artificial Intelligence (MMAI) Course Summaries

Courses are arranged into three groups. See Figure 1. This is the sequence in which full-time and part-time students are expected to take these courses. For a full-time student, each group corresponds to a full term of study. A part-time student may take two of the courses per term from each group depending on personal schedules and course availability.

1. Required Courses (45 credits)

ADVANCE PREPARATION (required by all confirmed entrants)

Satisfactory completion of the **Udemy.com**[®] online video courses prior to commencement of studies:

Required:

- Calculus
- Statistics
- Computer Science

Term 1 Courses

SB/MMAI 5000 3.00 Artificial Intelligence Fundamentals

This course will introduce students to the field of artificial intelligence, with a focus on AI-driven business applications. The course also provides a historical perspective tracing the emergence of basic terminologies and concepts of contemporary AI. In addition, students will be introduced to key artificial intelligence techniques including knowledge representation and symbolic reasoning, biologically inspired approaches to artificial intelligence, supervised, unsupervised and reinforcement learning, multi-agent systems, planning and natural language processing. This course is a pre-requisite for MMAI 5040.

SB/MGMT 6300 3.00 Case Analysis and Presentation Skills

This course is designed to give students the opportunity to practice and develop their analytical thinking and presentation skills. The key objective of the course is to train students to participate successfully in national and international case competitions. A secondary objective is to prepare students to interview successfully for management consulting positions. MMAI students will analyze cases and deliver presentations.

SB/MMAI 5100 3.00 Database Fundamentals

Database Management Systems are computer-based systems used by organizations to manage the vast amount of data that accompany daily operations, support data analysis, and enable intelligent decision making. This course provides an applied introduction to database management systems and their use in the business environment. The course covers the fundamentals of database analysis and design. It also provides a hands-on experience in designing and building databases using Oracle or MySQL Database. Specific topics covered include the role of database systems, the relational database model, and entity-relationship diagrams, as well as applied skills such as formulating queries, designing forms, and creating reports in SQL (Structured Query Language). At the end of the course students will be able to design and build a fully operational database to support business decision making and operations.

SB/MMAI 5200 3.00 Algorithms for Business Analysis

The course covers main approaches to design and analysis of algorithms used in business contexts, including important algorithms and data structures, and results in complexity and computability. The main contents are: review of algorithm analysis such as search in ordered array, binary insertion sort; an introduction to divide and conquer algorithms; graphs; and applications of greedy algorithms. These applications will be covered in business context and will be linked to specific business applications. This course is a pre-requisite for MMAI 5300.

GS/PHIL 5340 3.00 Ethics of AI

This course provides an overview of social and ethical issues arising from emerging Artificial Intelligence technology. The course will explore both existing and future technology applications, with a focus on learning to recognize and anticipate novel ethical challenges. By practicing ethical analysis in written and oral presentation, students will develop future-oriented skills applicable to technologies not yet invented. Topics, that are currently relevant or in the near future, will include algorithmic transparency and bias, big data surveillance and privacy, autonomous robotics in transport and warfare, economic and legal consequences of labour automation, use of robots as caregivers, and the effects of AI-human interaction on human ethical behavior. Topics, that are relevant in the long term, will include theoretical issues such as whether AI can or should ever make independent ethical decisions, whether AI might ever be entitled to moral rights of its own, and how humanity can contain the risks of 'superintelligent' future AI. The course will also consider whether the tech industry needs its own set of AI-related professional ethics (modeled on medical, business, and engineering ethics). What are the distinctive social responsibilities of AI companies and research institutions? What are the obligations of individual AI professionals?

Term 2 Courses

SB/MMAI 5040 3.00 Business Applications of Artificial Intelligence I

This course builds on the introductory perspective provided by MMAI 5000, which emphasizes practical business applications of artificial intelligence rather than the conventional focus on the derivation of methods from first principles. The emphasis in this course will be on automation and autonomous cyber-physical system applications of artificial intelligence in business contexts. Students gain a holistic view of artificial intelligence as applied to practical business

contexts through a combination of case studies (in and out of class) as well as in-class lab-style technical explorations. These are complimented by assignments and two projects throughout the course. Furthermore, students gain practical knowledge of the managerial applications of AI across several business contexts from guest speakers and detailed business case studies. This course is a pre-requisite for xxxx and MMAI 5400.

SB/MBAN 5140 3.00 Visual Analytics and Modelling

This course is an introduction to the theories of visual communication design applied in data visualization and visual analytics. Students become familiar with data-driven decision-making workflows and theories and practices of storytelling. The course focuses on visual design principles, data structures, taxonomy of data visualization models and weekly tutorials using the Tableau software.

SB/MMAI 5300 3.00 Numerical Analysis

Numerical analysis is concerned with finding numerical solutions to problems for which analytical solutions either do not exist or are not readily or cheaply obtainable. This course provides an introduction to the subject, focusing on the three core topics of iteration, interpolation and quadrature. The module starts with “interpolation schemes,” methods for approximating functions by polynomials, and “quadrature schemes,” numerical methods for approximating integrals, will then be explored in turn. The second half of the module looks at solving systems of linear and nonlinear equations via iterative techniques. In the case of linear systems, examples will be drawn from the numerical solution of differential equations. Students will learn about practical and theoretical aspects of all the algorithms. Insight into the algorithms will be given through illustrations, but the course does not require any programming.

SB/ORGS 6350 3.00 Managing Change

As the environment of many business and nonprofit organizations becomes increasingly complex and unstable, it is imperative that managers be able to create a climate of flexibility and adaptability in their operations. Organizations must be able to undertake major change without destructive side effects to be truly successful. This course surveys the major methods available to the modern manager for effectively managing the process of change and creating a general climate in which needed changes are sought and welcomed throughout the organization. The course emphasizes case studies and the discussion of alternative change management models.

SB/MMAI 6050 6.00 AI Consulting Project I

The AI Consulting Project is the capstone integrative course of the MMAI program. It will allow students to deepen their understanding of the subject matter and methodologies, as well as provide an opportunity for hands-on, problem-driven research and application. It is an intensive, 2-term course where groups of 4 MMAI students undertake a comprehensive artificial intelligence (AI) project of an organization (“client site”) and provide business insights to enhance the site’s future success. At the conclusion of the AI consulting project students submit and present their final work to a panel of at least two experts, including the course director, and also to the client site.

Term 3 Courses

SB/MMAI 5090 3.00 Business Applications of Artificial Intelligence II

This course bridges the theoretical foundation and the business applications of artificial intelligence technology. Through in-class lecturing and hands-on activities, students learn fundamentals of AI technology, formulate business problems in AI paradigm and Applications of AI in addressing business problems. AI applications are embedded in the infrastructure of many products and services, including search engines, medical diagnoses, speech recognition, robot control, web search, advertising and so on so forth. This course provides a broad overview of applying modern artificial intelligence in business. Students learn how machines can engage in problem solving, reasoning, learning, and interaction. Students gain an appreciation and case-based experience of this dynamic field in the context of business problems. The class covers up-to-date AI applications in various domains such as Recommendation Systems, FinTech, Social Network Analytics, Sentiment Analysis etc.

SB/MMAI 5500 3.00 Applications of Neural Networks and Deep Learning in Business

This course covers the theory and practice of deep learning. Topics covered include training methods and loss functions, automatic differentiation and backpropagation, network architectures for different learning problems, validation, model selection and software tools.

SB/MMAI 5400 3.00 Natural Language Processing

There has been an increasing demand for better retrieval, processing, and analysis of textual information in modern society in recent years due to the availability of a huge and ever-growing amount of textual data from both inside organizations and the Internet. Well known examples include web search engines (e.g., Google), document and content management systems, email filtering, social media sentiment analysis, automated question answering (e.g., IBM's Watson on Jeopardy!), natural language interfaces in games and mobile devices, and big data text analytics for business/competitive intelligence. Natural language processing (NLP), also known as computational linguistics, which aims to process and understand natural languages and text, is the driving force that makes these tasks and systems possible. This course focuses on the principles and technologies of statistical machine-learning-based NLP and their application in text analytics, including retrieval, extraction, recognition, and analysis of information from large textual collections. Prerequisite: MMAI 5040 3.00 Business Applications of Artificial Intelligence 1 and MMAI 5300 3.00 Numerical Analysis.

SB/ORGS 6500 3.00 Interpersonal Managerial Skills

Research demonstrates that people and their ability to work effectively together are critical success factors for organizations. This course focuses on specific personal and interpersonal skills for organizational (and professional) effectiveness. With an emphasis on experiential exercises, the course helps students develop skills such as communication; time, conflict and stress management; performance management; gaining influence; and self-awareness (including emotional intelligence).

SB/MMAI 6050 6.00 AI Consulting Project II

The AI Consulting Project is the capstone integrative course of the MMAI program. It will allow students to deepen their understanding of the subject matter and methodologies, as well as provide an opportunity for hands-on, problem-driven research and application. It is an intensive, 2-term course where groups of 4 MMAI students undertake a comprehensive artificial intelligence (AI) project of an organization (“client site”) and provide business insights to enhance the site’s future success. At the conclusion of the AI consulting project students submit and present their final work to a panel of at least two experts, including the course director, and also to the client site.

Appendix C

Master of Management in Artificial Intelligence (MMAI) Curriculum Map

Legend: I = Introduced, D = Developed, R = Reinforced, A = Assessed Individually for Achievement

	TERM 1					TERM 2					TERM 3				
Program Level Goals & Learning Objectives: Graduates of the Master of Management in Artificial Intelligence program are able to ...	SB/MMAI 5000 Artificial Intelligence Fundamentals	SB/MGMT 6300 Case Analysis and Presentation Skills	SB/MMAI 5100 Database Fundamentals	SB/MMAI 5200 Algorithms for Business Analysis	GS/PHIL 5340 Ethics of AI	SB/MMAI 5040 Business Applications of Artificial Intelligence I	SB/MMAI 5140 Visual Analytics and Modeling	SB/MMAI 5300 Numerical Analysis	SB/ORGS 6350 Managing Change	SB/MMAI 6050 Consulting Project 1	SB/MMAI 5090 Business Applications of Artificial Intelligence II	SB/MMAI 5500 Appl. of N. Networks & Deep Learning in Business	SB/MMAI 5400 Natural Language Processing	SB/ORGS 6500 Interpersonal Managerial Skills	MMAI 6050 Consulting Project 2
Goal 1: Core Business AI Understanding															
1.1 Describe the key components of the artificial intelligence (AI) field.	I		I	I		D	R	D			A	D	R		R
1.2 Connect key AI components to the cornerstones of modern business management	I			D		I	I				A	R			

	TERM 1					TERM 2					TERM 3				
Program Level Goals & Learning Objectives: Graduates of the Master of Management in Artificial Intelligence program are able to ...	SB/MMAI 5000 Artificial Intelligence Fundamentals	SB/MGMT 6300 Case Analysis and Presentation Skills	SB/MMAI 5100 Database Fundamentals	SB/MMAI 5200 Algorithms for Business Analysis	GS/PHIL 5340 Ethics of AI	SB/MMAI 5040 Business Applications of Artificial Intelligence I	SB/MMAI 5140 Visual Analytics and Modeling	SB/MMAI 5300 Numerical Analysis	SB/ORGS 6350 Managing Change	SB/MMAI 6050 Consulting Project 1	SB/MMAI 5090 Business Applications of Artificial Intelligence II	SB/MMAI 5500 Appl. of N. Networks & Deep Learning in Business	SB/MMAI 5400 Natural Language Processing	SB/ORGS 6500 Interpersonal Managerial Skills	MMAI 6050 Consulting Project 2
Goal 2: Critical Thinking and AI Applications															
2.1 Analyze the application of AI technologies for business problems, including knowledge management, information retrieval, decision support systems, natural language processing, process automation, personalization & visualizations	I		I	I		D					A				R
2.2 Design, implement, evaluate, and refine AI technologies for solving business problems	I					D						A	R		R

	TERM 1					TERM 2					TERM 3				
Program Level Goals & Learning Objectives: Graduates of the Master of Management in Artificial Intelligence program are able to ...	SB/MMAI 5000 Artificial Intelligence Fundamentals	SB/MGMT 6300 Case Analysis and Presentation Skills	SB/MMAI 5100 Database Fundamentals	SB/MMAI 5200 Algorithms for Business Analysis	GS/PHIL 5340 Ethics of AI	SB/MMAI 5040 Business Applications of Artificial Intelligence I	SB/MMAI 5140 Visual Analytics and Modeling	SB/MMAI 5300 Numerical Analysis	SB/ORGS 6350 Managing Change	SB/MMAI 6050 Consulting Project 1	SB/MMAI 5090 Business Applications of Artificial Intelligence II	SB/MMAI 5500 Appl. of N. Networks & Deep Learning in Business	SB/MMAI 5400 Natural Language Processing	SB/ORGS 6500 Interpersonal Managerial Skills	MMAI 6050 Consulting Project 2
2.3 Understand and analyze the trade-offs between computational complexities and business benefits in applying different AI techniques and models	I				D	D					R	R	A		
2.4 Apply strategic thinking skills for managerial decision making		I			I			R			R			R	A
Goal 3: Professional Communication															
3.1 Deliver a clear, effective and engaging oral presentation on applied AI technologies appropriate for both technical		I			D		D	R	R						A

	TERM 1					TERM 2					TERM 3				
Program Level Goals & Learning Objectives: Graduates of the Master of Management in Artificial Intelligence program are able to ...	SB/MMAI 5000 Artificial Intelligence Fundamentals	SB/MGMT 6300 Case Analysis and Presentation Skills	SB/MMAI 5100 Database Fundamentals	SB/MMAI 5200 Algorithms for Business Analysis	GS/PHIL 5340 Ethics of AI	SB/MMAI 5040 Business Applications of Artificial Intelligence I	SB/MMAI 5140 Visual Analytics and Modeling	SB/MMAI 5300 Numerical Analysis	SB/ORGS 6350 Managing Change	SB/MMAI 6050 Consulting Project 1	SB/MMAI 5090 Business Applications of Artificial Intelligence II	SB/MMAI 5500 Appl. of N. Networks & Deep Learning in Business	SB/MMAI 5400 Natural Language Processing	SB/ORGS 6500 Interpersonal Managerial Skills	MMAI 6050 Consulting Project 2
and non-technical audiences.															
3.2 Prepare a clear, effective and engaging written report on applied AI technologies appropriate for both technical and non-technical audiences.		I			D		D			R					A
3.3 Apply appropriate strategies to work effectively in interdisciplinary teams.		I			I	D		D	R	R	R	R	D	A	
Goal 4: Ethical Behaviour & Social Responsibility															
4.1 identify the ethical and societal implications of AI and its applications in business	I	D			A					R			R		R

Schulich School of Business
Master of Management in Artificial Intelligence (MMAI)
Program-Level Learning Outcomes & Assessments

Learning Outcome	Course Assessed in	Assessment (Individually Completed)
Core Business AI Understanding		
1.1 Describe the key components of the artificial intelligence (AI) field, including search heuristics, knowledge representation, automated planning, agent-based systems, machine and deep learning, and probabilistic reasoning	SB/MMAI 5000 3.00 Artificial Intelligence Fundamentals	Final Exam
1.2 Connect key AI components to the cornerstones of modern business management	SB/MMAI 5090 3.00 Business Applications of Artificial Intelligence II	Final Exam
Critical Thinking and AI Applications		
2.1 Analyze the application of AI technologies for business problems, including knowledge management, information retrieval, decision support systems, natural language processing, process automation, personalization and visualizations	SB/MMAI 5090 3.00 Business Applications of Artificial Intelligence II	Final Exam
2.2 Design, implement, evaluate, and refine AI technologies for solving business problems	SB/MMAI 5040 3.00 Business Applications of Artificial Intelligence I	Final Exam
2.3 Understand and analyze the trade-offs between computational complexities and business benefits in applying different AI techniques and models	SB/MMAI 5200 3.00 Algorithms for Business Analysis	Final Exam
2.4 Apply strategic thinking skills for managerial decision making	SB/MMAI 5090 3.00 Business Applications of Artificial Intelligence II	Final Exam
Professional Communication		
3.1 Deliver a clear, effective and engaging oral presentation appropriate for both technical and non-technical audiences	SB/MGMT 6300 3.00 Case Analysis & Presentation Skills	Case Presentation
3.2 Prepare a clear, effective and engaging written report appropriate for both technical and non-technical audiences	SB/MBAN 5040 3.00 Visual Analytics & Modelling	Project # 2

3.3 Apply appropriate strategies to work effectively in interdisciplinary teams	SB/MMAI 6050 6.00 AI Consulting Project	Peer & Instructor Evaluation
Ethical Behaviour & Social Responsibility		
4.1 Identify the ethical and societal implications of AI and its applications in business	GS/PHIL 5340 3.00 Ethics of AI	Written Assignment
4.2 Describe, analyze, and devise solutions for ethical and social issues that arise in the application of AI in business	GS/PHIL 5340 3.00 Ethics of AI	Written Assignment

The program has established a detailed assurance of learning (AoL) plan for the purposes of demonstrating and documenting students' performance levels with respect to the program's expected learning outcomes and DLEs. Each program-level learning outcome will be measured by an individually completed final assessment embedded in particular courses throughout the curriculum (see curriculum map above). Student performance on these final assessments will be assessed against pre-established performance benchmarks, conveyed through the use of rubrics where appropriate. Certain rubrics, such as those designed to measure 'soft-skills'-related outcomes (e.g., presentation, reflection and teamwork skills) will be implemented program-wide to provide a consistent definition of program-level expectations as well as a well-scaffolded, formative approach to the development and measurement of core skills throughout the curriculum. A sample program-wide rubric for the assessment of presentation and teamwork skills (Outcome 3.3) is included below.

Documentation of students' performance levels with regard to learning outcomes will be performed through Schulich's new learning management system, Canvas. This system offers robust learning outcome functionality in which outcomes can be set and aligned at both the course and program levels, and assessments can be aligned to outcomes through the use of course-specific or program-wide grading rubrics. The grading of student work in Canvas results in the automatic collection and compilation of data on student progress and allows for the tracking and reporting of performance levels to support the enhancement of curriculum and teaching, the identification of at-risk students, and reporting requirements for accreditation processes. The performance data will serve as the basis of the program's assurance of learning plan, enable evidence-based decision-making with regards to the identification of gaps in student performance in relation to the expected learning outcomes and enable the 'closing of the loop' on its curricular improvement initiatives undertaken to address these gaps.

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Assessment Rubric for Presentation Skills Learning Outcomes

	Core Competencies & Indicators	Unsatisfactory (D)	Below Expectations (C)	Meets Expectations (B)	Exceeds Expectations (A)
1.	Organization of Ideas				
	Introduction	Presentation lacks a clear or compelling introduction that orients the audience to the topic. Audience interest in the topic is not generated at the outset.	Introduction is at times unclear or unconvincing or does not orient the audience to the topic. Minimal audience interest in the topic is generated at the outset.	Presentation opens with a clear introduction that orients the audience to the topic and generates some interest from the outset.	Presentation opens with a clear, compelling, and engaging introduction that orients the audience and captures interest from the outset.
	Body	Does not structure arguments in a logical manner. Organization of ideas does not support understanding of the main argument. No connection between body, introduction or conclusion.	Structure of arguments often does not appear logical or well-reasoned. Organization of ideas contributes little to understanding of the main argument. Vague connection between body, introduction and conclusion.	Logical reasoning pattern is evident, resulting in an effective argument structure. Organization of ideas supports understanding of the main argument. Clear relationship between body, introduction and conclusion.	Logical reasoning pattern is both evident and compelling, enabling a highly effective argument structure. Organization of ideas strongly supports understanding of the main argument. Clear relationship between body, introduction and conclusion making it easy for the audience to follow.
	Conclusion	Presentation lacks a conclusion, or conclusion is vague, unclear or disconnected from key claims or evidence.	Conclusion is weak, poorly formulated, or poorly linked to the evidence or key claims.	Conclusion is clear and concise and is clearly linked to the evidence and key claims made throughout the presentation.	Meets expectations, plus conclusion is engaging and thoroughly explores the implications and significance of the topic.
2.	Content & Quality of Ideas				
	Main Argument	Presentation lacks a clear central message, or multiple inconsistent messages are conveyed throughout.	Central argument can be deduced but is not explicitly stated or reinforced.	Conveys a clear and consistent central message throughout the presentation.	Central message is compelling, precisely stated and appropriately repeated.
	Use of Supporting Evidence & Sources	Claims are supported by irrelevant or inappropriate evidence. Presentation lacks sources or sources used lack the appropriate range or quality.	Uses a few inappropriate facts or irrelevant, inaccurate, or unpersuasive ideas to support the main argument. Evidence provided is from a minimal range of sources or some sources are inappropriate or of poor quality.	Appropriate facts and relevant, accurate and persuasive ideas are used to support the main argument. Credible evidence provided from an appropriate range of quality sources.	Appropriate and highly relevant, accurate, and persuasive ideas are used to support the main argument. Credible evidence from a wide range of quality sources is provided; extensive research beyond standard or typical sources is demonstrated.
	Audience & Purpose	Content and components are inconsistent with audience and purpose.	Content and components at times lack relevance to audience and purpose.	Content and components are appropriate for audience and purpose.	Content and components are nuanced and expertly selected for audience and purpose.
	Originality & Creativity	Presentation is neither original nor creative.	Presentation is only minimally original or creative.	Presentation is generally original and/or creative.	Presentation is highly original and creative.
3.	Body Language & Auditory Mechanics				
	Eye- Contact, Volume, Articulation, Pace & Tone	Does not look at audience; reads notes and/or only looks at the instructor. Delivery is unnatural and/or unprepared. Volume is too soft to hear or distractingly loud. Articulation is poorly executed/unclear. Mumbles or runs words together. Pace is too fast or too slow. Tone is unprofessional and/or inappropriate for the audience and purpose.	Delivery is mechanical with occasional instances of natural delivery. Occasional eye contact with the audience. Some preparation evident but frequently reads from notes or slides. Volume is sometimes inaudible or inappropriately loud. Articulation is occasionally clear. Pace is inconsistent (at times too fast or too slow). Tone is sometimes unprofessional and/or inappropriate for the audience and purpose.	Delivery is natural and helps build rapport with the audience. Strong eye contact with the audience is maintained most of the time. Delivery is prepared (occasionally reads from notes or slides). Volume is consistently audible by the entire audience. Articulation is consistently clear. Pace is appropriate to facilitate audience understanding. Tone is generally professional and appropriate for the audience and purpose.	Delivery is natural and helps build engagement with the audience. Strong eye contact with the audience is maintained throughout the presentation. Delivery is thoroughly prepared (rarely reads from notes or slides). Volume is audible and varied to emphasize key points and enhance audience interest. Articulation is clear precise and engaging. Pace is natural and varied to emphasize key points and enhance audience interest. Tone is consistently engaging, professional and appropriate for the audience and purpose.
4.	Use of Visuals Aids				
		Does not use visual aids, or uses inappropriate or distracting visual aids.	Uses visual aids that are sometimes distracting or undermine understanding of the presentation.	Uses visual aids that have a clear purpose and guide the audience throughout the presentation.	Uses visual aids that have a clear purpose, are thoughtful and enrich the presentation.
5.	Time Management				
		Goes significantly over or under allotted time. Misses important points completely.	Struggles to deliver presentation in the allotted time (may rush at the end of the presentation). Spent too little or too much time on important points.	Delivers presentation in the allotted time. Sufficiently covers important points.	Meets expectations, plus devotes more or less time to components based on their relative importance. Demonstrates an understanding of how to modify timing based on unanticipated constraints.
6.	Response to Audience Questions				
		Cannot answer audience questions	Answers some audience questions but not clearly or completely.	Encourages audience questions and answers most clearly and completely.	Encourages audience questions and answers all clearly and completely.
7.	Coordination in Team Presentations				
		Not all members participate; team members do not have clearly defined roles and the team appears uncoordinated.	All team members participate, but not equally. Team members do not have clearly defined roles and/or the team often appears uncoordinated.	All team members participate for about the same length of time and are able to answer questions. The team is most coordinated but there are a few moments of doubt and/or imbalance.	All team members participate, answer questions, and contribute equally to the success of the presentation. The team appears highly coordinated with clearly defined roles.

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Assessment Rubric for Teamwork Learning Outcomes

	Core Competencies & Indicators	Unsatisfactory (D)	Below Expectations (C)	Meets Expectations (B)	Exceeds Expectations (A)
1.	Interpersonal Communication				
	Communicates respectfully with team members using effective tone and body language	Does not communicate with team members or does so disrespectfully	Communicates respectfully but does so inconsistently or to select members only	Communicates respectfully with all team members using effective tone & body language	Meets expectations plus encourages other team members to communicate respectfully
	Uses effective strategies to communicate with speakers of differing cultures, skills and preferences	Does not use strategies or uses ineffective strategies to communicate with speakers of differing cultures, skills and preferences	Attempts to use strategies but does so inconsistently or has to be supported by other team members	Consistently uses effective strategies to communicate with speakers of differing cultures, skills and preferences	Meets expectations plus supports team members in communicating with speakers of differing backgrounds, skills and preferences
	Contributes to establishing standards of performance and norms of practice, and adheres to them throughout the project, refining as needed	Does not contribute to standards or norms or establishes destructive standards and norms	Begins to informally identify standards and norms but they do not make advances in guiding the team	Contributes to standards and norms that guide the team and adheres to them throughout the project	Meets expectations plus respectfully holds team members accountable to standards and norms
	Conveys a constructive, inclusive, and motivating attitude about the team and its work	Conveys a negative attitude in a way that hinders the team	Attempts to convey a constructive, inclusive or motivating attitude but is inconsistent	Consistently conveys a constructive, inclusive and motivating attitude about the team and its work	Meets expectations plus encourages other team members to adopt a constructive, inclusive or motivating attitude
	Articulates the merits of alternative ideas from others and offers new and helpful suggestions that build on those ideas	Does not articulate the merits of alternative ideas, diminishes the ideas of others, offers no suggestions, or doesn't build on the ideas of others	Repeats suggestions made by others without incorporating any novel or useful ideas or rarely builds on the ideas of others	Recognizes and articulates the merits of alternative ideas and offers new suggestions that build on the ideas of others	Meets expectations plus synthesizes and refines the suggestions of others to offer helpful ideas that advance the work of the team
	Provides assistance to team members as needed or required	Does not assist team members or intervenes and disrupts the work of others	Assists some team members but ignores others or provides limited assistance	Consistently provides assistance to all team members as needed or required	Meets expectations plus provides support to team in finding ways to meet their individual obligations
2.	Quality of Work				
	Produces quality individual contributions that advance the work of the team	Does not produce work or work is not usable and must be redone by others	Quality of work is inconsistent; occasionally needs to be checked or redone by others to be acceptable	Quality of work is satisfactory; only minor improvements required	Meets expectations plus proactively helps team members who produce work that requires improvements
3.	Conflict Resolution				
	Identifies and effectively addresses conflict	Does not identify or address conflict or contributes to the escalation of conflict	Identifies conflict but makes little effort to address it or effort is ineffective	Identifies and effectively addresses conflict in the team until resolution is reached	Meets expectations plus consistently encourages an atmosphere of open dialogue and constructive argument
4.	Organization				
	Completes all assigned tasks by the established deadlines	Assigned tasks are not completed by the deadline or at all	Completes some tasks by the deadline; may sometimes require reminding or support from team	Completes all assigned tasks by the deadline	Completes all work in advance with enough time to improve quality before the deadline
	Attends team meetings regularly and on time	Does not attend team meetings or is often late or absent without notifying the team	Is sometimes late and/or absent; may notify team	Attends team meetings regularly and on time; consistently notifies team if late or absent	Meets expectations plus follows up with team to catch up on what was missed if absent
	Initiates and responds to team communication in a timely manner	Does not initiate or respond to team communication	Sometimes initiates and responds to team communication but communication may be delayed or unhelpful	Regularly initiates and responds to team communication in a timely manner	Meets expectations plus initiates for or follows up with other team members when necessary
5.	Reflection & Self-Awareness				
	Assesses how one's actions impact the team and adapts actions or outlook based on feedback or the needs of the team	Does not adapt actions or outlook based on the needs of the team or adapts detrimentally	Does not readily adapt actions or outlook; has to be prompted by others	Adapts actions and/or outlook based on the needs of the team	Meets expectations plus constructively helps others adapt

**Mapping of Master Degree Level Expectations against
Master of Management in Artificial Intelligence (MMAI) Program Learning Outcomes**

Master Degree Level Expectations		MMAI Outcomes	
1. Depth and breadth of knowledge	A systematic understanding of knowledge, including, where appropriate, relevant knowledge outside the field and/or discipline, and a critical awareness of current problems and/or new insights, much of which are at, or informed by, the forefront of their academic discipline, field of study, or area of professional practice.	1. Core Business AI Understanding	<p>1.1 Describe the key components of the artificial intelligence (AI) field, including search heuristics, knowledge representation, automated planning, agent-based systems, machine and deep learning, and probabilistic reasoning</p> <p>1.2 Connect key AI components to the cornerstones of modern business management</p>
2. Research and scholarship	<p>A conceptual understanding and methodological competence that:</p> <p>a) enables a working comprehension of how established techniques of research and inquiry are used to create and interpret knowledge in the discipline;</p> <p>b) enables a critical evaluation of current research and advanced research and scholarship in the discipline or area of professional competence; and</p> <p>c) enables a treatment of complex issues and judgments based on established principles and techniques; and,</p> <p>On the basis of that competence, has shown at least one of the following:</p> <p>a) development and support of a sustained argument in written form; or</p> <p>b) originality in the application of knowledge.</p>	2. Critical Thinking and AI Applications	<p>2.1 Analyze the application of AI technologies for business problems, including knowledge management, information retrieval, decision support systems, natural language processing, process automation, personalization and visualizations</p> <p>2.2 Design, implement, evaluate, and refine AI technologies for solving business problems</p> <p>2.3 Understand and analyze the trade-offs between computational complexities and business benefits in applying different AI techniques and models</p> <p>2.4 Apply strategic thinking skills for managerial decision making</p>
3. Level of application of knowledge	Competence in the research process by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting.		
6. Awareness of limits of knowledge	Cognizance of the complexity of knowledge and of the potential contributions of other interpretations, methods, and disciplines.		
4. Professional capacity / autonomy	<p>a) The qualities and transferable skills necessary for employment requiring:</p> <p>i) exercise of initiative and of personal responsibility and accountability; and</p> <p>ii) decision-making in complex situations;</p> <p>b) The intellectual independence required for continuing professional development;</p>	4. Ethical Behaviour & Social Responsibility	<p>4.1 Identify the ethical and societal implications of AI and its applications in business</p> <p>4.2 Describe, analyze, and devise solutions for ethical and social issues that arise in the application of AI in business</p>

	<p>c) The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and</p> <p>d) The ability to appreciate the broader implications of applying knowledge to particular contexts.</p>		
5. Level of communications skills	The ability to communicate ideas, issues and conclusions clearly.	3. Professional Communication	<p>3.1 Deliver a clear, effective and engaging oral presentation appropriate for both technical and non-technical audiences</p> <p>3.2 Prepare a clear, effective and engaging written report appropriate for both technical and non-technical audiences</p> <p>3.3 Apply appropriate strategies to work effectively in interdisciplinary teams</p>

Mapping of Master of Management in Artificial Intelligence (MMAI) Program Learning Outcomes against Master Degree Level Expectations

MMAI Outcomes		Master Degree Level Expectations
<p>1. Core Business AI Understanding</p>	<p>1.1 Describe the key components of the artificial intelligence (AI) field, including search heuristics, knowledge representation, automated planning, agent-based systems, machine and deep learning, and probabilistic reasoning</p> <p>1.2 Connect key AI components to the cornerstones of modern business management</p>	<p><u>Depth and Breadth of Knowledge</u></p> <p>A systematic understanding of knowledge, including, where appropriate, relevant knowledge outside the field and/or discipline, and a critical awareness of current problems and/or new insights, much of which are at, or informed by, the forefront of their academic discipline, field of study, or area of professional practice.</p> <p><u>Research & Scholarship:</u></p> <p>A conceptual understanding and methodological competence that:</p> <p>a) enables a working comprehension of how established techniques of research and inquiry are used to create and interpret knowledge in the discipline;</p> <p>b) enables a critical evaluation of current research and advanced research and scholarship in the discipline or area of professional competence; and</p> <p>c) enables a treatment of complex issues and judgments based on established principles and techniques;</p>
<p>2. Critical Thinking and AI Applications</p>	<p>2.1 Analyze the application of AI technologies for business problems, including knowledge management, information retrieval, decision support systems, natural language processing, process automation, personalization and visualizations</p> <p>2.2 Design, implement, evaluate, and refine AI technologies for solving business problems</p> <p>2.3 Understand and analyze the trade-offs between computational complexities and business benefits in applying different AI techniques and models</p> <p>2.4 Apply strategic thinking skills for managerial decision making</p>	<p><u>Level of application of knowledge:</u></p> <p>Competence in the research process by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting.</p> <p><u>Research & Scholarship:</u></p> <p>On the basis of that competence, has shown at least one of the following:</p> <p>b) Originality in the application of knowledge.</p> <p><u>Professional capacity / autonomy:</u></p> <p>a.ii) decision-making in complex situations</p> <p>b) The intellectual independence required for continuing professional</p>

		<p>development</p> <p>d) The ability to appreciate the broader implications of applying knowledge to particular contexts</p> <p><u>Awareness of Limits of Knowledge:</u></p> <p>Cognizance of the complexity of knowledge and of the potential contributions of other interpretations, methods, and disciplines</p>
3. Professional Communication	<p>3.1 Deliver a clear, effective and engaging oral presentation appropriate for both technical and non-technical audiences</p> <p>3.2 Prepare a clear, effective and engaging written report appropriate for both technical and non-technical audiences</p> <p>3.3 Apply appropriate strategies to work effectively in interdisciplinary teams</p>	<p><u>Research & Scholarship:</u></p> <p>On the basis of that competence, has shown at least one of the following:</p> <p>a) development and support of a sustained argument in written form</p> <p><u>Level of Communications Skills:</u></p> <p>The ability to communicate ideas, issues and conclusions clearly.</p> <p><u>Professional Capacity / Autonomy:</u></p> <p>a) The qualities and transferable skills necessary for employment requiring:</p> <p>i) exercise of initiative and of personal responsibility and accountability</p>
4. Ethical Behaviour & Social Responsibility	<p>4.1 Identify the ethical and societal implications of AI and its applications in business</p> <p>4.2 Describe, analyze, and devise solutions for ethical and social issues that arise in the application of AI in business</p>	<p><u>Professional capacity / autonomy:</u></p> <p>a) The qualities and transferable skills necessary for employment requiring:</p> <p>i) exercise of initiative and of personal responsibility and accountability; and</p> <p>ii) decision-making in complex situations;</p> <p>c) The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research</p>

Appendix D

Competitive Landscape

University	Degree Granted	Duration	General Approach	Specializations
Canada				
Queen's University Smith School of Business	Master of Management in Artificial Intelligence	A 12-month program starting in September. Classes on Tuesday evenings and alternate Saturdays at Smith Toronto in downtown Toronto. Plus, two one-week residential sessions at Goodes Hall in Kingston.	A balance between technical, management, and problem-solving content. A capstone project in the final module allows individual students to apply AI solutions to real business cases provided by program partners. This is structurally a similar program to the proposed MMAI at Schulich. However, Schulich has a set of relationships to the local AI Business Community and on-site facilities (notably the Deloitte Lab) that make us the more competitive offering.	N/A
United States of America				
New York University Stern School of Business	MS in Data Analytics & Business Computing	a 12-month full-time course of study, the three-semester curriculum is 36 credits, including a capstone project that culminates the program and connects students with real-world practice.	A data-driven approach to solve business challenges in the era of big data with the interdisciplinary nature of business analytics offering a broad yet rigorous curriculum in business (finance, marketing, revenue management, operations), data science (statistics,	N/A

			<p>econometrics, data mining, data visualization), and management science (optimization, stochastic modeling, simulation) emphasizing both quantitative and technical methods and their applications in different functional areas in business. This program shares many similarities with the proposed MMAI at Schulich. Overall, it is somewhat more science driven while the Schulich approach will be more managerial in its outlook.</p>	
<p>The University of Arizona Eller College of Management</p>	<p>Master of Science in Business Analytics</p>	<p>Students have the option of completing the 33-unit program in two or three semesters (10 or 16 months). A summer internship is possible in the three-semester program.</p>	<p>This program provides essential knowledge and skills in three critical areas: Data management, Statistics, and Analytic method. While the 16-months option is comparable to the Schulich MMAI, the 10-month program is certainly not. Also, the location of the program at the University of Arizona limits the ability to create close relationships with world class companies nearby.</p>	<p>electives in accounting, economics, finance, management information systems and marketing. The program also includes professional development.</p>
<p>Rutgers University Rutgers Business School</p>	<p>Master of Information Technology and Analytics</p>	<p>30 credits Full-time or part-time study Finish in as little as one year (full-time). STEM qualified</p>	<p>The program intends to bridge the gap between IT and business, teaching both the domain and technical knowledge</p>	<p>Accounting Information Systems</p>

		<p>program for international students considering Optional Practical Training (OPT). Based out of Newark campus</p>	<p>necessary to face tough challenges in the industry. Similar approach to the Schulich MMAI. The school's location allows for excellent relations to world-class companies. The main difference is Schulich's facilities and the more managerially oriented curriculum.</p>	
<p>University of Maryland Robert H. Smith School of Business</p>	<p>Master of Science in Information Systems</p>	<p>30 credits can be completed in as little as 9 months, though most students complete the program in 16 months.</p>	<p>The curriculum delivers real-world learning supported by theory and practice. Smith School's partnerships with companies like Ernst & Young, Deloitte, PricewaterhouseCoopers, and KPMG make it a very competitive program. It's positioning is similar to that of Schulich's MMAI.</p>	<p>N/A</p>
<p>University of Utah David Eccles School of Business</p>	<p>Master of Science in Business Analytics</p>	<p>33 Credit hours Core: 30 Electives: 3 For the full-time program. Full-Time students complete the program in 3 semesters. Part-Time students complete the program in 4-6 semesters. Students complete a hands-on capstone project as the culmination of their degree. The capstone is an in-depth, consulting-based project where students complete data analysis for industry partners.</p>	<p>The business analytics curriculum is designed to help students increase their skills in each of these areas, and students exit the program ready to successfully compete in the world of big data. The coursework is designed to prepare students to complete the Associate Certified Analytics Professional (aCAP) certification through INFORMS. Subjects, including data storage and management, data</p>	<p>N/A</p>

		The capstone project is three credit hours completed over three semesters.	analysis, data visualization and the application of analytics to business, prepare students for this highly recognized certification. This is a very competitive program. It's positioning is similar to that of Schulich's MMAI.	
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Appendix E

Master of Management in Artificial Intelligence Program Core Course and Potential Instructor List

	Course	Title	Instructor	Full /Part Time (FT/PT)	Rank	Area
1.	SB/MMAI 5000 3.00	Artificial Intelligence Fundamentals	Zhepeng Li	FT	Assistant	OMIS
			Hjalmar Turesson	PT	N/A	
2.	SB/MGMT 6300 3.00	Case Analysis & Presentation Skills	Ashwin Joshi	FT	Associate	MKTG
			Brent Lyons	FT	Assistant	ORGS
3.	SB/MMAI 5100 3.00	Database Fundamentals	Henry Kim	FT	Associate	OMIS
			Zhepeng Li	FT	Assistant	
			Stephen Keelan	PT	N/A	
4.	SB/MMAI 5200 3.00	Algorithms for Business Analysis	Markus Biehl	FT	Associate	OMIS
			Scott Yeomans	FT	Full	
			Ikjyot Singh Kohli	PT	N/A	
5.	GS/PHIL 5340 3.00	Ethics of AI	Regina Rini	FT	Assistant	PHIL
6.	SB/MMAI 5040 3.00	Business Applications of Artificial Intelligence I	Hjalmar Turesson	PT	N/A	OMIS
			Mel Gabriel			
7.	SB/MBAN 5140 3.00	Visual Analytics and Modelling	Stefan Popowycz	PT	N/A	OMIS
8.	SB/MMAI 5300 3.00*	Numerical Analysis	Markus Biehl	FT	Associate	OMIS
			Scott Yeomans	FT	Full	
			Hjalmar Turesson	PT	N/A	
9.	SB/MMAI 6050 6.00	AI Consulting Project	Murat Kristal	FT	Associate	OMIS
10.	SB/MMAI 5090 3.00*	Business Applications of Artificial Intelligence II	Zhepeng Li	FT	Assistant	OMIS
11.	SB/MMAI 5500 3.00	Applications of Neural Networks and Deep Learning in Business	Zhepeng Li	FT	Assistant	OMIS
12.	SB/MMAI 5400 3.00	Natural Language Processing	Henry Kim	FT	Associate	OMIS
			Hjalmar Turesson	PT	N/A	
13.	SB/ORGS 6350 3.00	Managing Change	Kevin Tasa	FT	Associate	ORGS
14.	SB/ORGS 6500 3.00	Interpersonal Managerial Skills	Stephen Friedman	PT	N/A	ORGS

Appendix F

Statement of Support from Anchor Dean

Memorandum

To: To Whom It May Concern
CC: Professor Murat Kristal, Chair, MMAI Task Force
From: Detlev Zwick, Acting Dean
Date: October 18, 2018
Subject: Master of Management in Artificial Intelligence Proposal

I would like to enthusiastically express my full support for the proposed Master of Management in Artificial Intelligence (MMAI) program. This program will enable students who have graduated from business or non-business programs to obtain the critical functional and cross-functional skills needed for a successful career in the fast expanding, demanding and heterogeneous field of management of AI.

The need for graduates with the skill set of a manager of AI is high and growing rapidly. Currently, only one specialized program exists in Ontario (Queen's University) and very few others in North America. Therefore, there is a significant need for programs that can deliver excellent training in management skills, AI technologies and ethics. The proposed MMAI represents such a program and we are confident that our graduates will succeed in a job market that is high paying, fast-moving and full of gratifying career opportunities.

Just as with all our programs, Schulich will staff this program with high quality full-time and part-time faculty. Because of its extensive partnership network with leading companies in Toronto, Schulich is fully capable of delivering high quality experiential projects to the students. Already, many companies have signed on to the AI Consulting project, paying \$25,000 to do so, even though the program has not yet launched. Therefore, no additional resources will be required to source and support the AICPs.

The Schulich School has the facilities in place to offer this program. Through the partnership with Deloitte the program offers a world-class environment, such as the Schulich Deloitte Cognitive Analytics and Visualization Lab located in the school's brand-new Graduate Study & Research Building. This new addition to the school is a \$60 million state of the art building, which is home to 3 large classrooms, several seminar rooms, a media production facility and offices for Schulich's Centers of Excellence.

Even though teaching staff is in place to deliver the program, the Operations Management and Information Systems (OMIS) area, which will deliver the program (with support from other areas), is authorized to hire two additional tenure-stream faculty members over the next three years. These two hires were submitted to the President as part of Schulich's 3-year hiring plan, which was approved by the president. A world class data scientist has already been hired in partnership with Deloitte. This person will support lab work, research and AICP projects.

At this time, we do not foresee the need to add any additional non-academic resources, such as additional recruiting, student or career support personnel. As the program grows, non-academic support, especially in career advisor and recruiting will be added via the usual mechanisms. Some of these resources may be shared with the Master of Business Analytics and other programs.

In conclusion, I wish to express my full support for this program and thank the task force for a well- conceptualized proposal.

November 12, 2018

RE: BBA/IBBA Program, Schulich School of Business

Dear Associate Dean Zwick

I'm writing this letter on behalf of Lassonde School of Engineering, in consultation with Prof. Simone Pisana, Graduate Program Director at the department of Electrical Engineering and Computer Science (EECS). We have reviewed and carefully considered the proposal for the creation of the new Master of Management in Artificial Intelligence (MMAI) in the Schulich School of Business at York University.

We understand that this new professional degree program, offered by the Schulich School of Business, and will address a need for Management expertise in the rapidly expanding field of Artificial Intelligence. We note that at Lassonde, also have recently introduced the AI specialization in our Master of Science in Computer Science program and are in the process of proposing a professional Master's program in Data Science with an AI focus. Comparing the proposed MMAI program with our AI specialization and Data Science programs, we are confident that our programs will not be competing with MMAI for students, considering that we will have significantly different learning outcomes. Furthermore, we anticipate that students in our programs may find interest in a few of the MMAI courses such as the Business Applications of AI, case management and presentation skills.

Together, the Faculty of Science, Schulich, and Lassonde will be well positioned to lead AI training for the growing demand that is emerging in Canada.

Regards

A handwritten signature in black ink, appearing to read "Regina Lee".

Regina Lee, PhD, PEng

Cc: Dean Jane Goodyer, Vide Dean Uyen T Nguyen, Prof. Simone Pisana

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Memorandum

To: Detlev Zwick, BBA / iBBA Program, Schulich School of Business

From: Jennifer Steeves, Associate Dean – Research & Graduate Education &
Alex Mills, Associate Dean - Students

Date: November 6, 2018

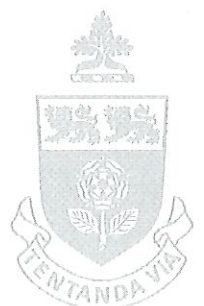
Subject: Program Proposal for a Master of Management in Artificial Intelligence
(MMAI).

J.S. 

The Faculty of Science supports the proposal for the creation of the new Master of Management in Artificial Intelligence (MMAI) in the Schulich School of Business at York University.

This new professional degree program will address a need for Management expertise in the rapidly expanding field of Artificial Intelligence. It will be unique in that students will be trained in both managerial and technical skills producing graduates who can support management of wide range of rapidly emerging high level AI technologies. There is no overlap between this program and courses offered in the Faculty of Science. Both the Faculty of Science and the Lassonde School of Engineering at York University are presently training graduates who will be poised to work in the field of AI and in turn the Schulich MMAI will yield leaders in AI-management.

JS/js



External Appraisal Report

Dr. Alice Pitt, Vice Provost Academic
931 Kaneff Tower
4700 Keele Street
Toronto, ON
Canada, M3J 1P3

January 22, 2019.

Dear Dr. Pitt,

It was a pleasure to serve on the external reviewing team for the proposed Master of Management in Artificial Intelligence (MMAI) program at the Schulich School of Business, York University. The review involved studying the program in detail, evaluating the credentials of the faculty supporting the program and on-site discussions with key stakeholders.

Overall, we are enthusiastic in supporting this program and believe it is very timely, designed well and supported well by a talented and energetic team of faculty and university administrators. There are not many programs that are similar to this – a strength of the program – hence, direct comparisons are difficult. However, the program appears to deliver on its learning outcomes and goals. In this letter, we offer comments and feedback based on the external appraisal report criteria outlined in the York University Quality Assurance Procedures. Details are as follows.

Outline of the Visit

During our visit to the Schulich School of Business on Monday, January 7th, we were fortunate to engage in lively discussions with the following:

- Academic Vice Provost and Dean of Graduate Studies at York University
- The Dean and Associate Dean of the Schulich School of Business
- Faculty members of the MMAI task force and other full-time faculty and part-time instructors that will be involved with the program
- Current students enrolled in various undergraduate and graduate degree programs at Schulich
- Staff members that support the admissions, student services, career development, and library functions

As part of the visit, we also toured facilities at the Schulich School of Business, including classrooms, computer labs, meeting rooms, and the new Schulich Deloitte Visual Cognitive Analytics Lab.

General Objectives of the Program, Need, and Demand

The primary objective of the program is to place students in AI-related managerial positions in the private, public, and non-profit sectors. This objective is well-aligned with the Schulich

School and York University's broader mission. We believe the program name and degree designation are appropriate and consistent with the curriculum, student learning objectives, and program-level goals.

With respect to need and demand, the program is closely aligned with the Vector Institute's 1000AIMS initiative, which supports Ontario's goal of producing 1000 graduates annually in the field of AI within the next five years. In addition to serving demand in the local Ontario region, based on our discussions with faculty and staff at Schulich, there is a sense that the prospective student pool and employers pertaining to the MMAI program are both geographically much broader, encompassing high AI-growth markets such as North America, Asia and Europe. Given Schulich's strong global footprint, MMAI seems well-positioned to cater to the supply and demand needs of such a wider geographic market.

Program Content, Curriculum, Structure, Learning Outcomes

On the curricular side, the design of the program has been thought through quite systematically. The coursework includes a combination of technical and managerial content. Unlike programs that separate out technical and managerial content into separate courses, it was refreshing to see that many of the proposed courses actually had these two components integrated within the course itself. The two-semester project course will also allow the students to apply the knowledge from the courses into real-world applications. It was particularly refreshing to see companies that have already signed-on to participate in these projects with commitments of approximately \$25K toward supporting the projects. Great execution of these project courses will require close involvement with industry partners and it appears that the program has been designed with such close interaction in mind. Further, Schulich's close connections with leading firms and executives is a major plus for this program.

Also on the curricular side, it was encouraging to see that the content provided by the program can position students for a broad range of opportunities in the field. Courses in AI, algorithms, data science, databases, numerical analysis, visualization, NLP coupled with case analyses and business foundations (through additional electives) will provide Schulich students with a broad background in the field to pursue opportunities in many different areas. The ethics of AI course is in particular an important component and appears to be positioned well (early) in the program to help students understand the societal and people impact of AI.

We do have a few suggestions on the curriculum that we discuss in our recommendations.

Resources

We were equally impressed by the quality of the faculty supporting this program. Many of the courses, while new, appear to have existing faculty who can cover them. Based on our discussions and examination of bios/CVs, these faculty clearly have a wealth of expertise on relevant topics such as the foundations and theory of AI and machine learning, as well as the state-of-the-art tools, techniques, and practices. Overall, the program appears to have a good

mix of full-time tenure stream research faculty and part-time faculty with active involvement in industry. MMAI's faculty composition seems consistent with what is found at other top business school degree programs, with over 50% of the content delivered by full-time faculty, while actively leveraging knowledgeable practitioners with strong academic credentials and teaching experience. This mix will be essential to ensure that the program offers insightful perspectives from both the research as well as the applied angles – academic rigor coupled with industry relevance. The plan to hire two additional faculty members (approved by the President as part of the college's three year plan) will also be a significant plus in terms of offering additional faculty resource support for this program.

The program also appears to leverage existing staff expertise and resources needed to fuel a successful launch. Further, the incorporation of one or two new staff members for this program (as noted in the proposal) will help from a student success perspective.

We do have a few suggestions on the need for greater staff-side resources (see recommendations for details).

Quality of Student Experience

By incorporating a nice mixture of full-time and part-time faculty, the two consulting courses, and several options for the two elective courses, the MMAI program is well-positioned to ensure the intellectual quality of the student experience. Based on our discussions with the students we do have some recommendations, noted below, to further enhance this.

Recommendations

As part of our review we have some specific recommendations for the leadership to consider. While the program as proposed is ready for launch and none of these are required changes, we believe that they can further strengthen what appears to be a very well thought-through program. These recommendations are:

Curriculum-related:

1. *Explore a business foundations "boot camp."* One of the limitations of any specialized Master's program is not being able to offer a breadth of courses in all the functional disciplines. This is quite common among most of the specialized Master's programs we have seen across the world. However, the MMAI graduates will still need a broad grasp of important business concepts in finance, accounting, strategy & management, marketing, operations and information systems. Currently, the coursework does integrate many of the business skills into specific courses; hence students do get some exposure. However, augmenting this with directly delivered content in these areas in the form of a one-week long intense boot camp at the start of the program may better align curriculum with the managerial learning objectives and positioning of the program. The faculty will need to decide which topics across the functional areas are important to cover in the boot camp since an exhaustive overview is infeasible. The

boot camp itself can then be designed as a “30-40 hour mini-MBA” prior to the start of the specialized Master’s program. It is important to note that the boot camp idea is by no means the only way to incorporate the necessary business foundations content into the curriculum. We simply suggested it as one relatively easier approach for onboarding diverse student populations to create an appropriate baseline of business knowledge without significantly disrupting the rest of the program design.

2. *Consider injecting content related to Enterprise AI.* One of the missing pieces in the content was an overview of enterprise AI architectures. Today AI systems combine software, hardware, the cloud and people & processes to deliver real-time solutions. AI is an important consideration in enterprise-level digital transformation at the intersection of datafication, platformization, consumerization, and democratization. As one example, much of the revolution in self-driving cars has been supported by novel internet of things (IoT) hardware and architecture frameworks, in addition to data-driven algorithms. This broader discussion of current “architectures” in AI, and how AI relates to enterprise digital strategy, will provide students with the necessary perspective pertaining to real-world enterprise AI solutions. We don’t see the need for a new course on this topic, but recommend the addition of a module in one of the existing courses that addresses this gap.

3. *Add a full-time faculty member to the AI fundamentals course.* Presently, this course is being taught entirely by part-time faculty with impressive industry experience. We’re all products of our experiences – practitioners are often biased towards more recent trends and phenomenon. Full-time faculty involvement in this course can help ensure that students have a more balanced perspective on the fundamental theories and practices of AI.

Resource-related:

4. *Add a staff person to identify capstone projects and manage corporate relations.* We recommend hiring a new staff member for program support. The staff member can help identify capstone projects and manage corporate relationships. This is a common staff position/role in most specialty master’s programs involving multi-semester corporate sponsored capstone projects. The corporate partner acquisition funnel, coupled with the immense communication and coordination costs needed to manage the relationship, necessitate staff support. In the absence of adequate staff support, these tasks can take up valuable faculty/program director time that would be better utilized supporting student efforts toward the successful execution of these projects.

5. *Consider providing the student body a modest budget to plan events.* We recommend the student body (see below) be provided a small budget of their own to plan events, speaker series or workshops to enhance the quality of the student experience. While we explain the rationale for this further below, the budget for these activities itself can be relatively modest to start with and can grow based on how the program chooses to manage these activities.

6. *Closely monitor the Ethics in AI course for continuity, quality, and consistency.* The Ethics in AI course is a particularly important course in the program and is the only one taught from outside the college of business. This course is currently slated to be taught by a post-doctoral scholar, funded in part by the college of business. We recommend having a clear long-term plan for how this course will be funded and supported, as well as how quality and consistency will be maintained. This non-business post-doctoral scholar may enrich student learning outcomes, but better explicating the plan will help ensure the long-term viability and quality of the course.

Quality of Student Experience-related:

7. *Consider forming a program-level student body.* We recommend forming a program-level student body that can serve as liaisons to the faculty with the broader goal of enhancing student experience. We envision this body taking the lead in organizing speaker series, or workshops, related to AI that can provide a constant stream of cutting-edge content from AI industry practitioners. Some of the speakers solicited may even “skype in” or provide short talks to the students through teleconference facilities, thereby opening up a vast range of global expert resources that can be tapped into. While such experiences can enhance the quality of student experience in any program, they are likely even more important in an area like AI where rapid advancements are being made constantly in industry as well. The idea of having a student body lead these efforts was motivated by three factors. First, external speakers sometimes respond more favorably when contacted directly by students rather than staff. Second, these “self-arranged” events will likely have better attendance among students. Third, it will place less stress on limited faculty and staff resources.

Thank you for the opportunity to serve as part of the external review team and best wishes for a successful launch.

Sincerely,



Ahmed Abbasi
Associate Dean and Murray Research Professor
Director, Center for Business Analytics
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Memorandum

To: Alice Pitt, Vice Provost Academic
CC: Julie Parna, Thomas Loebel, YUQAP
From: Detlev Zwick, Acting Dean
Date: January 30, 2019
Subject: Response to the External Review of Master of Management in Artificial Intelligence Proposal

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I'm writing this memo in response to the external reviewers' report on their inspection of the proposed Master of Management in Artificial Intelligence to be offered by the Schulich School of Business. The review included an in-depth examination of the program's proposed curriculum, learning outcomes, extracurricular activities, existing and planned resource allocation as well as expected market demand for the program. During their visit of the school, the reviewers had a chance to meet with the Academic Vice Provost and Dean of Graduate Studies at York University, the Dean and Associate Dean of the Schulich School of Business, Faculty members of the MMAI task force and other full-time faculty and part-time instructors that will be involved with the program. In addition, the reviewers met with students currently enrolled in various undergraduate and graduate degree programs at Schulich as well as staff members that support the admissions, student services, career development, and library functions. Finally, the reviewers had a chance to explore the school's facilities including the new Schulich Deloitte Visual Cognitive Analytics Lab, which represents an important element in the delivery of a world-class program. I am therefore confident that **the reviewers gained a comprehensive and detailed understanding of the proposed program, the school's ability to deliver it and the expected demand for this offering.**

I was therefore delighted to learn that **the reviewers' assessment of the program was very positive.** The report commends the high quality of the curriculum and expresses confidence in Schulich's ability to attract, train and place high-caliber students. Indeed, while the reviewers offer several very insightful recommendations for improving the curriculum and the academic and administrative execution of the program, **they state that "the program as proposed is ready for launch and none of these [recommendations] are required changes."** While this overall assessment of the program and the school is very encouraging, **we agree with the reviewers that the recommendations offered in the report will help us to further improve the quality of the curriculum and the resource base supporting it.** The reviewers offer recommendations in three areas: curriculum, support structures and student governance and experience. We address each recommendation below:

1) Curriculum-related recommendations

The reviewers make **three specific recommendations** to improve the curriculum.

a. *The Business Foundation "Boot Camp"*

The point of this recommendation is to strengthen the managerial content of the curriculum. The reviewers find the curriculum very strong on the technical side of AI but 'light' on the managerial skills required of our graduates. On reflection

of this observation, we fully agree with the reviewers and decided to strengthen the curriculum's content of managerial skills significantly. Specifically, we will implement **two changes** that we believe will improve the managerial training in the MMAI.

1. We will implement a 3-day **business foundation boot camp** (see Appendix for a likely structure of this 3-day boot camp) that focuses on three functional areas of Business (rather than all areas): Marketing, Accounting and Finance. One teaching day (6 hours of instruction) will be dedicated to each subject. There are three reasons for such a focused approach. First, knowledge from other functional business areas such as Operation Management and Information Systems and Strategy is covered well in the existing curriculum. Second, skills in the remaining functional area of business, organizational behavior, will be addressed with two new core courses (see next point). Finally, incoming students must complete a set of mandatory online modules in calculus, statistics and computer science before the start of the program (see Program proposal, section 4 for details). We therefore need to be mindful of the amount of course work students must complete before starting the actual program. A focused approach for the Business Fundamentals boot camp will keep the preparation course work at a more reasonable load.
2. We are **adding two mandatory courses** to the curriculum that we believe will make a significant difference to the students' managerial skill set. These two courses are: *Managing Change* and *Interpersonal Managerial Skills*. This change does not add to the students' course load because we eliminated two elective courses in exchange. While this means that MMAI students no longer have any electives, we believe with the reviewers that it is critical for our students' success as managers of AI to have as strong a foundation in managerial skills and concepts as is possible to convey in a one-year program. As one reviewer pointed out in conversation, many one-year programs make do without electives to ensure consistency in skills and achieved learning outcomes across the student bod.

We believe that in combination, these two changes address the reviewers' recommendations comprehensively and make the program well balanced along the managerial and the technical dimensions.

b. Ensure sufficient content related to Enterprise AI

The reviewers agreed that one of the missing pieces in the content of the curriculum was an **overview of enterprise AI architectures**. The curriculum focuses on data-driven algorithms and software, yet, enterprise-level digital transformation requires AI systems that combine software, hardware, the cloud and people & processes to deliver real-time solutions. The reviewers recommend classes where AI is discussed at the level of enterprise architecture, so students understand how AI solutions are part of a system.

We concur with the reviewers' view that managing AI requires a systems approach that includes data-related software, hardware, the cloud and people & processes. The reviewers noted that the curriculum covers very well software and processes of AI. Our changes to the curriculum described above

under 1a. address the role of people as well as processes. Therefore, we agree with the reviewers that **the area that needs strengthening is hardware and AI Enterprise architecture. Therefore, we now include specific classes dedicated to studying AI Enterprise Architecture in three different courses:**

1. The week 12 class of *MMAI 5000 Artificial Intelligence Fundamentals* now introduces the topic of AI hardware architecture via a discussion of specific subtopics:
 - a. Information Architecture plays a key role in establishing order in the continuous evolution of emerging data technologies.
 - b. Introduction of specific measures that organizations should take to embrace AI and streaming data technologies,
 - c. Introduction of AI Enterprise Architecture and IoT and how they relate to business.
2. In week 1 of the course *MMAI 5040 Advanced Artificial Intelligence* students now delve deeper into the AI Enterprise Architecture tackling technologies such as:
 - a. Embodied Artificially Intelligent Agents in Conjunction with AI Enterprise Architecture
 - b. Sensor hardware and business implications around the deployment of autonomous systems in conjunction with AI Enterprise Architecture.
3. The course *MMAI 5090 Business Applications of Artificial Intelligence* now includes a specific business case on the development and integration of AI Enterprise Architecture. Through the case the students learn about challenges and opportunities of using AI Enterprise Architecture in organizations to create competitive advantage.

c. *The Fundamentals Course should be taught by an FT faculty member.*

Given the central role of this course in the program, the reviewers felt that this course should be taught by a full-time faculty member. We fully agree with this recommendation and **we now have assigned this course to Assistant Professor of Operations Management Zhepeng Li** for teaching (please see his CV in the proposal). In addition, the home of the proposed program is Schulich Operations Management and Information Systems (OMIS) area. This area has **approval to hire three additional tenure stream faculty** and searches are currently underway. These new hires will support the new program. We should also point out that the part time faculty member listed as **additional instructor for this course, Hjalmar Turesson, holds a PhD from Princeton University in Neuroscience and maintains an active research program in AI-related areas.** Hjalmar is on an extended contract with Schulich. Therefore, we believe that the fundamentals course is in excellent hands.

2) Resource-related Recommendations

In their report, the reviewers make **three insightful recommendations regarding the resource base** supporting the program. We will address them below:

a) *Add administrative staff person*

To make this program a success, much hinges on the quality and availability of capstone projects required for the two-term AI consulting project course. Obtaining a strong supply of high quality projects requires building, growing and managing corporate relations. While the designated program director for the proposed program, Dr. Murat Kristal, has built such a strong network and can point to a large pool of projects his corporate partners have already commissioned and committed to financially (which is especially impressive given that the program is not yet approved!), going forward the work of acquiring new partners, identifying and coordinating projects and fostering corporate relationships must be supported by a designated staff member. Such a person would enable the program director and other faculty members to focus on the important work of supporting student learning during, and the successful execution of, the consulting projects.

Fully recognizing the need for additional administrative support, the dean has approved the hiring of a full-time staff person dedicated entirely to the new Master program.

b) *Provide a budget for students to plan their own extracurricular events*

Extracurricular activities play an important part in all Schulich Master programs. **In the appendix**, please find a list of **workshops and other events that are already planned** for the new MMAI program. In addition, the student body (through an executive to be elected by the students, see final recommendation below), will have **access to up to \$10,000 per year** to plan additional extracurricular activities.

c) *Closely monitor the Ethics in AI course for continuity, quality, and consistency.*

The reviewers recognized that the *Ethics in AI* course is a particularly important course in the program and is the only one taught from outside the college of business. This fact seems to be cause for concern regarding long-term commitment to the course and ensuring quality of teaching. While we fully share the reviewers' concern, we are confident that our current arrangement with the Department of Philosophy at York University as well as the Lassonde School of Engineering will ensure both excellent teaching and continuity. **The course was developed by CRC Prof. Regina Rini**, who will also be teaching the course in its first year. In subsequent years, the plan is to have the course taught by a **post-doctoral fellow with expertise in the required subject area** and under the guidance of Dr. Rini. We are therefore confident that this course will be of the highest quality. **In addition, this course is supported financially by funding commitments from three different sources: The Vector Institute, Schulich and Lassonde.** Funding for the first two years is secured with additional years contingent on the

dean's approval. We are therefore confident that we have secured a model for the continuous funding of this course.

3) Quality of Student Experience-related Recommendation

The reviewers recommend allowing students to form a program-level student body that can serve as liaisons to the faculty with the broader goal of enhancing student experience. We are in full support of this recommendation. Currently, **specialized master programs such as the MMAI are represented by the Graduate Business Council (GBC)**. The GBC is an executive committee made up of elected representatives from Schulich Master programs, including the MBA, IMBA and in the future the MMAI. Each specialized program elects a representative to the GBC. However, **in addition to this, we support the idea of the MMAI having its own elected committee** to deal with specific program-related issues such as organizing speaker series, workshops and other extracurricular events including social gatherings and industry-related networking and mentoring events. **Such program-specific committees already exist for our other specialized master programs.**

In conclusion, we would like to thank the external reviewers for their willingness to visit Schulich and assess our proposed program very thoroughly and competently. The feedback we received from the reviewers was very insightful. The Program Task Force was delighted take on the recommendations from the reviewers and implement several changes in the curriculum and its support structure that undoubtedly will make the program better.

Appendix

Business Fundamentals Boot Camp: Suggested Format

MMAI Bootcamp: Fall 2019

DAY 1		
10:00 am	Registration	SSB N201
10:30 am	Welcome: Maximizing Your MMAI Experience <i>Murat Kristal, Program Director, MMAI</i>	SSB N201
11:00 am	Grad School 101	SSB N201
11:30 am	LUNCH & Q&A	SSB N201
1:00 pm	Building Tour & Orientation	Schulich Building
2:00 pm	Library Resources Orientation <i>Bronfman Business Library</i>	SSB S236
3:30 pm	Academic Orientation <i>Murat Kristal, Program Director, MMAI</i>	SSB N201
4:30 pm	Break	
5:00 pm - 9:00 pm	Launch Week Social Events (optional) <i>Club Fair, Dean's Welcome & Leaders Panel, Dean's Reception</i>	View schedule here
DAY 2		
9:00 am	Welcome/Arrival	SSB N201
9:30 am	Module 1 : Fundamentals of Accounting	SSBW256
12:00 pm	LUNCH & Q&A	SSB N201
1:00 pm - 4:00 pm	Module 1 cont'd : Fundamentals of Accounting	SSBW256
DAY 3		
9:00 am	Welcome/Arrival	SSB N201
9:30 am	Module 2 : Fundamentals of Finance	SSBW255
12:00 pm	LUNCH & Q&A	N201
1:00 pm - 4:00 pm	Module 2 cont'd : Fundamentals of Finance	SSBW255
5:30 pm	MMAI Meet & Greet <i>Cocktail reception with faculty, current students, industry guests and student clubs. (Dress code: business casual)</i>	ELC Dining Room
DAY 4		
9:00 am	Welcome/Arrival	SSB N201
9:30 am	Module 3 : Fundamentals of Marketing	SSBW255
12:00 pm	LUNCH & Q&A	SSB N201
1:00 pm - 4:00 pm	Module 3 cont'd : Fundamentals of Marketing	SSBW255
5:00 pm	Wrap-Up	SSB N201

Extracurricular Activities

Outside the curricular activities students have the option to engage in regular extracurricular learning opportunities. Below is a list of workshops, speaker series and other types of extracurricular activities that will be offered to students of the MMAI program.

A. Leadership Speaking Series – 5 sessions

Main learning objective is to perfect and polish professional speaking. This program is based on the science of Speech Pathology (i.e. How the brain makes new speech changes, whether these changes apply to accent, the voice, pacing and eliminating negative speech habits.)

Learning Outcomes:

- Pronounce English clearly and confidently
- Use individual tone and pacing to deliver a strong message
- Use voice projection, voice pitch and resonance
- Eliminate negative speech habits (“um”, “up” tone, etc.)
- Use body language and facial expression
- Deliver dynamic presentations
- Build confidence and success in job interviews
- Present ideas more persuasively - so that people appreciate the full value of insights

B. Business Analytics Case Preparation – 3 sessions

This series intends to develop analytical thinking in solving business problems--simple and complex. The focus is on defining analytical thinking, its importance, and differences from synthetic and other forms of logical approaches to solve problems and make conclusions and recommendations for Business Analytics cases. The workshop series will instill necessary skills needed to understand key success factors for technical case interviews leading to a successful interviews and careers in business analytics. The course is delivered via the following modules which have rigour of both analytical methods and tools and real world examples and case studies to explain concepts to arrive at logical conclusions. One of the key objectives of the course is to also develop skills to work with partial data and facts to make best possible analytical judgements and recommendations necessary for successful case analysis that has become a standardized practice across industries.

The workshops include a curriculum guide that contains a description of each topic discussed and in-class activities to highlight the skills and knowledge discussed. It also includes a folder with data sources and case studies that are used for the in-class activities and case practice.

Learning Outcomes:

- Analytic vs Synthetic Thinking - Case study
- Pattern recognition, outliers, co-movement of variables - Examples and case study
- Causation vs Correlation - Examples and case study
- Predictive vs Prescriptive Analysis - Examples and case studies
- Survey Analytics - Examples and case studies
- Big Data vs Non-Big Data - Examples and case studies
- Analytics in Business - Theory vs Practice
- Machine Learning, Artificial Intelligence
- Conclusion

C. Hadoop Workshop

Hadoop is an open-source software framework for storing data and running applications on clusters of commodity hardware. It provides massive storage for any kind of data, enormous processing power and the ability to handle virtually limitless concurrent tasks or jobs. The workshop will include a curriculum guide that contains a description of each topic discussed and in-class activities to highlight the skills and knowledge discussed.

Learning Outcomes:

- Introduction Advanced analytics at a particle accelerator
- Review Big data, databases and map-reduce
- Interactive Exercise – Map-Reduce
- Hive – Exemplary Hadoop “Database”
- How to Deliver Hadoop to Clients with a Relational Database
- Spark – The Data Scientist’s Go-To Toolbox
- Interactive Exercise – Using Spark for Analytics
- Further learning resources

D. SQL Workshop

Structured Query Language (SQL) is a standard computer language for relational database management and data manipulation. SQL is used to query, insert, update and modify data. The workshop will include a curriculum guide that contains a description of each topic discussed and in-class activities to highlight the skills and knowledge discussed.

Learning Outcomes:

- Introducing SQL Server: Schemas, Constructing tables, Data Types
- SQL Overview: Basic elements of query, Clauses, Operators, Handling NULL
- Querying multiple Tables: Different kinds of Joins, Set Operators
- Scalar Functions: Arithmetic, String, Data Type Conversions, CASE
- Aggregate Functions: Grouping and Aggregates
- Subqueries, CTE, Views
- Introduction to Stored Procedures

E. Tableau Data Visualization Workshop

Students learn the key skills needed to excel in a data-driven environment and learn techniques to

solve data-driven business problems in any industry through effective data visualization. The workshop includes a description of each topic discussed and in-class activities to highlight the skills and knowledge discussed. It also includes a digital folder with Tableau workbooks and data sources that are used for the in-class activities.

Learning Outcomes:

- Build advanced charts and visualizations
- Learn statistical techniques to analyze data
- Understand how to combine data from multiple data sources and tables
- Create better dashboards by leveraging visual communication design best practices
- Learn how to connect with data sources.
- Discover how to use Tableau to create powerful interactive visualizations.
- Generate complex calculations to improve data discovery.
- Create basic calculations including arithmetic, custom aggregations and ratios, date math, and quick table calculations.
- Transform data with a number of visualization types, including cross tabs, bar charts, geographic maps, scatterplots and others.
- Build dashboards to share visualizations across the organization.
- Understand Tableau terminology.
- Learn Tableau tips and tricks.

F. **Azure Overview of Platform and Technology**

Technical Learning Outcomes:

- Adding Users and General Admin
- Data Loading
- Loading Data into HDFS
- Example of exposing data and processing
- DevTest Labs
- PowerBI Demonstration

G. **Data Governance Lecture Series - 3 sessions**

This workshop series provides examples of data governance practices and implementation techniques, cybersecurity concerns and strategies, Canadian and international privacy regulations, artificial intelligence/machine learning and evolutionary computing implications, and compliance requirements.

Emphasis is placed on the practical application of big data supported by presentations and discussions by industry leaders with modern examples of data sciences utilization in modern organizations,

The objective of this workshop series is to impart fundamental and practical knowledge regarding:

- modern business applications of data sciences
- principles, guidelines and applicable regulations related to data governance, digital ethics, and data privacy,
- ethical management and regulatory responsibilities associated with the use of big data, analytics, machine learning and artificial intelligence.

H. **Career Marketing: Resume and Cover Letter - 3 part series**

This workshop explains the different types of resumes with a focus on how to research, identify and explore career paths, define critical elements, and highlight qualifications and accomplishments in a compelling and relevant format. There are “take-home” resume assignments which are to be completed and submitted at the completion of the workshop series. Final Resumes are approved and uploaded into the MBAN Resume Book which is distributed to MBAN employers.

Learning Outcomes:

- Industry Overview (transitioning from classroom to corporate)
- Exploring Career Paths for MBANs
- Purpose of a Resume
- Various Formats (Chronological, Functional, Hybrid, C.V)
- Anatomy of a Resume (Categories and Sections)
- Guidelines and Integrity
- Developing Accomplishment Statements (S.T.A.R) – assignment
- Resume Checklist and Samples
- Supplementary documentation (Transcripts etc.)
- Cover Letters Techniques
- Thank You Letters and Follow-up

I. Personal Branding and Personal Statement Workshops (networking and on-line presence)

The objective of this workshop focuses on Personal Branding through the application of tactical and improvisational techniques to develop professional poise and credibility.

Learning Outcomes:

- The Value of Professional Presence and First Impressions
- What is Networking? Building your circle of influence – Examples and assignment
- Professional Grooming and Etiquette
- Personal S.W.O.T (distinguish yourself, recognize your unique skills, manage weaknesses and threats, take advantage of the opportunities) – Examples and assignment
- Personal Branding and On-line presence (leveraging blogs, Social Media – Facebook, LinkedIn, Twitter) – Examples and assignment of Personal Statement
- Techno-etiquette and Business Communication (professional emails, voice mail and texting, video/tele-conference calls)



Appendix G

Statement from the University Library



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LIBRARIES

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Memorandum

To: Murat Kristal, Program Director, Master of Business Analytics,
Schulich School of Business

From: Joy Kirchner, Dean of Libraries

Date: October 26, 2018

Subject: Library Support for Master of Management in Artificial Intelligence

As the attached memo attests, York University Libraries are well-situated to support the proposed new graduate program in the management of artificial intelligence. The Libraries have extensive collections to support teaching, learning, and research in this area due to existing curricular and research strengths in artificial intelligence and related business areas at York University. The Libraries have a long-established relationship with the Schulich School of Business that helps ensure support for acquiring needed and specialized resources in business programs is facilitated. Further, there is librarian expertise at York to support faculty and students within this program.

The Libraries are engaged in extensive restructuring at the moment, with the aim of continuing to provide the excellent collections and instructional and consultation expertise it has provided in the past, but to also better leverage library expertise and infrastructure to better support emerging needs around resource accessibility, open educational resources, and data management, to name a few. You will be hearing more about these developments over the coming months.

We look forward to our continued work with the Schulich School of Business over the coming years and are excited to fully support this new program.





Statement of Library Support for a Master of Management in Artificial Intelligence (MMAI) Program

Schulich School of Business

York University Libraries

Oct 25, 2018

Submitted by Xuemei Li, Business Librarian, Open Scholarship Department, York University Libraries

INTRODUCTION

This library statement is written in support of the proposed new *Master of Management in Artificial Intelligence (MMAI)* program, which requires students to complete 45 credits through either full-time (one year) or part-time (two years) study preceded by a mandatory pre-start program. A limited amount of advanced standing may be granted to students who possess appropriate prior qualifications. The degree focuses on strategic thinking, managerial decision making, AI technologies, design techniques, and ethics in AI. The objective is to produce well-rounded managers who have the potential to become leaders in AI management. A key component of the program is the integration of acquired knowledge through a capstone community-involved experiential learning project (the so-called AI Consulting Project, or AICP). This project will take place during the 2nd and 3rd terms. During the AICP students will make extensive use of the newly developed Schulich Deloitte Visual Cognitive Analytics Lab. The program is designed primarily for students who have recently graduated from a non-business degree program such as science, engineering, liberal arts, and applied arts. In addition, the program may attract some individuals who have worked in other fields of business and wish to add management of AI to their skill set.

This library support statement has been prepared in accordance with the guidelines outlined in the Quality Assurance Framework as set out by the Ontario Universities Council on Quality Assurance.

The program proposal and the associated course outlines for constituent courses have been closely reviewed. The library can support this program through a variety of relevant online and print resources of relevance to the academic field of management in artificial intelligence and related subject-areas, taught in this program. The library's instructional services (in-person and online), research assistance, library facilities, inter-library loan services, and other resources will also support this program. In addition, a designated librarian is assigned as the liaison to all programs in Operations Management and Information Systems (OMIS) and is available as a resource to both faculty and students in OMIS programs at Schulich. At the current time this role is filled by Xuemei Li.

It should be noted that library support for this new program is well established as the Schulich School of Business already has a well-established stream in both management and OMIS as part of its existing programs. Moreover, of the 13 required courses, which comprise this program, 3 are existing masters-level courses. As a result, library resources to support them are already in place.

A review of the reading materials for the 10 new courses unique to this proposed program generally indicates an intent to post required readings such as case studies or articles to associated Schulich Learning Management System Canvas course sites. In a few cases, textbooks are listed or other recommended books. In cases where books are not already owned by the Bronfman Business Library, they will be ordered for addition to the collection. Where readings listed are required, and instructors want a copy to be on hand in the Business Library, course instructors are advised that they can be placed on reserve or short-term loan in order to ensure equitable access to high demand materials among students. Article readings prescribed as part of these new courses from journals or magazines such as the *Harvard Business Review* are available through the Business Library's extensive e-journal collection.

COLLECTIONS SUPPORT

A wide range of resources are available to support this proposed MMAI program. The Libraries' collection includes items in a range of different formats including print, electronic, audio-visual and microform resources. Different information resources held at YUL and relevant to this program include but are not limited to monographs, journals, reference materials, videos, DVDs, and statistics. E-resources can be accessed from all libraries and campus locations and from off-campus through the Libraries' web site.

Materials for addition to the Bronfman Business Library's collection, including the management in artificial intelligence resources, are selected from various publishers and more information is provided below where individual types of collections materials are discussed. The business librarians have established approval plans with various vendors to ensure the timely acquisition of new publications in the subject areas. Approval plans are supplemented by individual orders resulting from faculty or graduate student requests. Most materials in the collection are English language, sourced primarily from publishers in Canada, the United States and Great Britain and major European countries. Consortial purchases of digital resources are also significant in collection building, especially in the area of e-journals and business databases including periodical indexes. Every year trials of databases are organized by the Bronfman Business Library to ensure that e-resources coming to the management in artificial intelligence are reviewed, and where budget permits, acquired.

Location of Resources

A huge component of the relevant collection to support this new program in the management in artificial intelligence is available online in the form of e-books, e-journals, article databases, specialist databases, streaming videos, etc.

It is anticipated that registrants in this program will sometimes wish to draw on materials in related subject areas, e.g. data science, marketing, computer science, and ethical and social responsibilities and the Libraries are very well poised to support this program. For example, Steacie Library is the primary library on campus with technological collections, with some materials relating to artificial intelligence, computer science and data analytics. In addition, materials pertaining to quantitative research methods are found primarily at the Scott Library and Steacie Library. Related audio-visual materials are located in the Sound and Moving Image Library (SMIL) at the Scott Library. Currently Bronfman Business Library holds almost 25,000 monographs which include books in the management in artificial intelligence. Much of this material is held in the HD, HF and HG call number ranges.

Books and E-Books

At the Steacie Library where most artificial intelligence books at YUL are housed, there is strong emphasis on the acquisition of current imprints and on the maintenance of a current collection. Multiple copies of heavily used items are placed on course reserve.

The print book collection is supplemented through a range of e-book packages from different publishers. These can be accessed by the York academic community via the Libraries' catalogue or by browsing the e-book platforms individually. One primary e-book package of relevance to the area of the management in artificial intelligence is *Skillsoft Books*. This collection provides access to current practitioner and trade press e-books, and therefore supplements the print monograph collection where the emphasis is on acquisition of scholarly or academic publications. Other e-book packages of relevance include *Proquest Ebook Central*, *SpringerLink*, *E-books at Scholars Portal* and *Oxford Scholarship Online*.

Reference Materials

Print and digital specialized encyclopedias, dictionaries, glossaries, handbooks, directories and biographical sources are available in the Libraries' collection in support of research. This includes materials located in the Reference Room of the Bronfman Business Library of relevance to the management in artificial intelligence.

Periodicals

The journal collection supporting the management in artificial intelligence is excellent. York University Libraries subscribe to all the core journals in the management of artificial intelligence and related fields.

Examples of some key journals, magazines and proceedings available in print or online include but are not limited to *Computational Linguistics*, *Natural Language Engineering*, *Machine Learning*, *Journal of Machine Learning Research*, *Robotics and Machine Learning*, *International Journal of Machine Learning and Applications*, *Artificial Intelligence*, *Journal of Artificial Intelligence*, *Applications of Artificial Intelligence*, *Cybernetics and Systems*, *IEEE Intelligent Systems*, *AI & Society*, *Minds and Machines*, *International Journal of Pattern Recognition and Artificial Intelligence*, *AI Magazine*, *Pattern Recognition Letters*, *International Journal of Pattern Recognition and Artificial Intelligence* and *Journal of Experimental, Theoretical Artificial Intelligence*, *ACL: Annual Meeting of the ACL and NAACL*, etc.

Generally, access is now provided to the electronic versions of current and back issues of periodicals. Such extensive and intensive coverage is made possible in part by the consortial agreements York has with other universities in Ontario and Canada. Two of the largest consortiums are the Canadian Knowledge Research Network (CRKN) and Scholars Portal (via the Ontario Council of University Libraries), which provide access to e-journals from publishers such as Oxford University Press, Emerald, Elsevier and Cambridge University Press.

Many journals are also made available directly from publishers' web sites. In addition, the aggregator databases, including *Business Source Complete* (Ebsco) and *Proquest Business*, provide access to thousands of full-text management in artificial intelligence journals, magazines and trade publications, as well as newspaper articles. In addition, *Factiva* and *Lexis Nexis Academic* provide access to the full-text of thousands of newspapers, including back files. For a detailed guide to newspaper sources available at the Libraries this guide can be consulted:

<http://researchguides.library.yorku.ca/news>

Periodical Databases & Indexes

The Libraries subscribe to a very large number of subject-specific and inter-disciplinary periodical indexes/databases. *Proquest Business* and *Business Source Complete* are the primary databases of relevance to support the new MMAI and offer sophisticated search capabilities for identifying

a large number of scholarly, academic and trade articles on myriad management in artificial intelligence themes. In addition *Scholars Portal* offers full-text of many leading business titles from prominent publishers such as Wiley, Emerald, Elsevier etc. A number of other databases are also relevant to themes studied in courses offered as part of this program. In addition, for coverage of management in artificial intelligence issues in a Canadian context, the database *CBCA Complete* is especially relevant. As mentioned above, the library also offers full-text of many newspapers, and where students in this program wish to search for topics of relevance to management in artificial intelligence themes in Canadian or international newspapers, databases such as *Canadian Newsstand*, *Factiva* and *Lexis Nexis Academic* serve as powerful search engines.

The business library offers an online guide to finding business articles including links to key articles databases and tips on how to search and navigate them:

<http://www.library.yorku.ca/cms/bbl/guides/articles/>

Most databases possess the capability of linking to full-text journal articles, should the library subscribe to the parent journal. This is supported by link resolver technology/SFX so that users can go from a database citation to one of a number of destinations, including the full-text of the article (where available), the catalogue record for the journal (if owned by the library), or an online request form to order the article via interlibrary-loan.

Videos/DVDS

Videos on themes of relevance to management in artificial intelligence are available in VHS or DVD format at the Sound and Moving Image Library (SMIL) which is located on the main level of the Scott Library. These may be borrowed by students or faculty and arrangements for showing videos in classes can be made. There is also a substantial and growing collection of business videos available in streaming format. Most titles can be found through keyword searching of the library's catalogue and by applying the streaming video filter. This includes over 2,000 business and economics videos available via *Films on Demand*. In addition, the videos contained in the e-collection *Skillsoft Books*, offer both e-books and videos related to management in artificial intelligence.

Management in Artificial Intelligence Research

The library also offers a number of databases that provide specialized management in artificial intelligence research reports and data. Gartner Intraweb, a specialized e-resource for IT industry research, covers topic areas relevant to management in artificial intelligence. Statista offers a wide range of consumer and market data, including consumer market forecasts and digital market outlooks. It also covers reports and statistics in artificial intelligence. For technical perspectives, ACM Digital Library covers topics on human-computer interaction, artificial intelligence and information systems. For more technical articles research in artificial intelligence, please consult the Computer Science research guide for more relevant databases:

<http://researchguides.library.yorku.ca/cse>

Company and Industry Research

Company and Industry research are important for students of the new MMAI program. Especially for the 2nd and 3rd term integrative consulting project, students will engage in experiential education opportunities that include working with organizations to address real-world AI management related problems. Company and industry databases will be of relevance to these students when they evaluate the organization's current AI strategy to identify specific projects to work on to develop actionable recommendations for the client organization. The Bronfman Business Library offers company and industry research guides with research tips and descriptions and links to all key resources:

<http://www.library.yorku.ca/cms/bbl/guides/companyresearch/>

<http://www.library.yorku.ca/cms/bbl/guides/industryresearch/>

Country and International Business Research

Management in artificial intelligence is no longer solely a national issue. Country and international business research are important for students in the new MMAI program. *BMI Research*, *Marketline* and *Passport* include country reports with forecast information. *Marketline Advantage* provides in-depth country PESTLE reports. The Bronfman Business Library has a Country and International Business Information research guide with research tips and descriptions and links to all key resources:

<http://researchguides.library.yorku.ca/countryinternationalbusiness>

LIBRARY SERVICES AND SPACES

Library Instruction and Information Literacy Instruction

Information literacy is an essential component of a student's education and includes the skills to define an information need and to find, retrieve, evaluate, use and cite information. The Bronfman Business Library has an active information literacy program supporting both Schulich's undergraduate and graduate programs, helping equip students with skills needed to complete assignment tasks. At the graduate level, information literacy is particularly important for graduating future AI managers who will be involved in research such as gathering comprehensive company, industry, marketing, economics and AI technologies information to inform their managerial decisions on the design and implementation of practical AI-related solutions and technologies.

Many students who return to study at a graduate level have likely been in practice for many years and may not have had the opportunity to conduct research in an ongoing and systematic way. Therefore, integrating IL into coursework at the beginning stages of the program will allow them to use the skills and integrate them into their professional lives.

To implement IL in a directed and systematic way, the assigned librarian is available to work with faculty members and curriculum committees to:

- articulate learning objectives related to information literacy;
- decipher how they might be mapped strategically into courses; and
- co-design and implement assignments that hone and assess both the disciplinary content and the research process.

For several years, Bronfman Business Library has successfully supported a capstone course of the Schulich MBA program – MGMT 6100: Strategy Field Study. Business librarians have delivered workshops and provided online resources especially at its Phase one stage on finding a site and locating secondary research on relevant company, industry, market, finance, economics, country and citation management topics etc.

https://www.library.yorku.ca/web/bbl/guides/601_support/

As an example, the core course that might be considered for IL integration is related to a capstone community-involved experiential learning project that involves hands-on, problem-driven research and application in business is **MMAI 6050** Consulting Project

In addition to in-person instruction opportunities, the library is also developing a suite of online learning resources for business students called BRYT (Business Research at York Toolkit): <http://bryt.library.yorku.ca/>. This toolkit includes short videos and step-by-step PDF guides that show students how to use specialized business research databases to conduct business research.

Liaison and Research Assistance

Individual research assistance is available at all major York libraries through in-person reference as well as through chat, e-mail and telephone service. The primary library with professionals trained in business research tools is the Bronfman Business Library and students of this proposed

new program are encouraged to seek out assistance at this library especially. This assistance is offered seven days a week except during the month of August when the library is closed on weekends. Xuemei Li is the subject specialist librarian assigned to management in artificial intelligence and appointments with her are available on request. More information about research help options at the Bronfman Business Library is available here: <http://www.library.yorku.ca/web/bbl/ask-a-question/>

In addition, students can consult subject guides for research assistance. Please see the Bronfman Business Library web site for links to these guides:
<http://www.library.yorku.ca/web/bbl/guides/>

Managing Research Results & Generating Bibliographies

It is noted that many of the course outlines associated with this new program, make reference to the importance of well-formatted bibliographies. The Bronfman Business Library offers a comprehensive Business Citation Guide which includes examples of how to cite a wide range of different types of business information:

<http://researchguides.library.yorku.ca/bizcitations>

Technical support for the use of citation management software, including *Zotero* and *Mendeley*, is available within the Libraries. Guides created by York librarians are available for both citation management tools:

researchguides.library.yorku.ca/zotero

researchguides.library.yorku.ca/mendeley

Resource Sharing

Graduate students in the MMAI program have access to the collections of other university libraries through the interlibrary loan system called *RACER* (Rapid Access to Collections by Electronic Requesting), an initiative of Scholars Portal. The Resource Sharing Department can obtain materials from libraries around the world. Books are borrowed free of charge and students can obtain copies of journal articles for free. Interlibrary loan requests can be made online.

Adaptive Services

A variety of services for differently abled students is available by arrangement with Library Accessibility Services (LAS) located at Scott Library. LAS staff provide transcription services for required readings in alternate formats and retrieving items from the library stacks. The Libraries also provide assistance with using adaptive technology located at the Scott Library.

Library Facilities

There are a variety of types of study environments in the Bronfman Business Library, which accommodate students with different needs. This includes computer workstations, open tables, individual study carrels, comfortable lounge seating, and monitored silent study space. Six group study rooms are available for students to book online. All graduate students also have access to the Graduate Student Reading Room at the Scott Library. There is wireless connectivity throughout the libraries and network

drops are also available. Students may borrow laptops or projectors from the library. In addition, both black and white and colour wired and wireless printing is available to students, in addition to photocopying and scanning services.

Appendix 1: York University Libraries Annual Statistics 2016-17

CIRCULATION	2014/2015	2015/2016	2016/2017
Scott			
Circulation Services	60, 572	65,512	60,000
Reserves	29,823	27,532	16,931
Self Check	109,078	89,268	74,178
Total	138,901	182,312	151,109
Sound and Moving Image Library			
Circulation	22,468	17,523	14,691
Reserves	217	250	132
Total	22,685	17,773	14,823
Archives & Special Collections	3,337	2,828	2,815
Map Library			
Circulation	227	326	351
Reserves	223	116	147
GIS	325	1,451	591
Total	775	1,893	1,089
Bronfman			
Circulation	4,130	4,573	4,762
Reserves	5,681	5,128	4,067
Total	9,811	9,701	8,829
Frost			
Circulation	17,622	17,534	17,630
Reserves	1,990	1,906	1,709
Total	19,448	19,440	19,339
Steacie			
Circulation	9,662	6,991	7,335
Reserves	20,169	17,719	11,816
Self check	8,031	6,268	5,074
Total	34,565	30,978	24,225
Total Circulation	268,029	212,274	187,427
Total Reserves	58,103	52,651	34,802
Total Item Circulation	326,132	264,925	222,229
Renewals	299,835	236,535	206,389
Total Transactions	625,967	501,460	428,618
Nellie Rowell Langford Library	988	1058	919
Education Resource Centre	11,656	704	1013

USE OF ERESOURCES	2013/2014	2015/2016	2016/2017
Number of successful fulltext article re	3,469,115	3,258,533	3,658,345
Number of database searches	21,373,886	27,317,313	20,697,352

LAPTOP LENDING	2014/2015	2015/2016	2016/2017
Scott	1,251	3,866	4,971
Bronfman	182	286	676
Frost	478	494	895
Steacie	148	893	1,372
Total	2,059	5,539	7,914

ITEMS SHELVED	2014/2015	2015/2016	2016/2017
Scott			
Circulation	365,085	361,225	312,315
Government Documents	4,131	2,225	1,430
Microtext	13,839	11,669	12,610
Reference	530	595	150
Reserves	1,511	2,705	680
Map Library	2,320	2,354	2,354
Archives & Special Collections	6,026	2,828	2,815
Bronfman	14,441	13,974	14,480
Frost	32,337	28,285	24,709
Steacie	23,188	22,166	19,748
Total	463,408	448,026	391,291

COLLECTION GROWTH	As of 30-Apr-15	As of 30-Apr-16	As of 30-Apr-17
Print Volumes	2,714,182	2,398,271	2,417,989
Microform Units	4,271,143	4,359,357	4,232,805
Journal Titles/Other Subscriptions	3,765	3,860	3,579
Digital Journal Titles	43,514	43,514	44,830
Digital Monograph Titles	774,904	802,311	1,289,510
Media			
Maps	139,779	139,849	140,044
Aerial Photographs	5,051	5,051	5,051
GIS Data titles	701	703	707
Sound Recordings	50,130	51,768	52,287
Videocassettes	8,688	8057	8069
Films	2679	2,679	2,679
DVDs	24,524	25,328	23,374
Manuscripts and Archives			
Manuscripts (Linear metres)	4,683	4,795	4,858
University Records (Linear metres)	965	1,016	1,143
Photographs (Linear metres)	399	401	401
Moving Image Archives (Linear metres)	89,087	89,102	89,138
Born Digital Archives	214.6	4,386	4,578
Titles Catalogued	84,577	114,869	53,405

DIGITAL COLLECTIONS @ York	2014/2015	2015/2016	2016/2017
Digital Items Created	13,897	18,647	8,316*
Total Digital Items	105,591	124,238	132,554

*changes in metadata required before uploading of scanned items. Large upload expected in 2017-18.

RESOURCE		2014/2015	2015/2016	2016/2017
Interfilm	Total	8,156	8,016	7,764
Interfilm	Total	4,504	4,077	3,613

REFERENCE SERVICES		2014/2015	2015/2016	2016/2017
Scott				
Information				
Desk		8,422	11,603	12,089
Reference		10,240	3,877	9,792
Other		18,662	15,480	21,881
Total Transactions				
Scott		6,634	6,783	6,225
Reference		1,526	946	2,774
Reference		8,160	7,729	8,999
Other				
Total Transactions				
		83	N/A N/A	555
Sound and Moving		719	N/A	633
Image Reference		802		1,188
Other				
Total Transactions			553	
		379	686	587
Map		1,008	1,239	784
Library		1,387		1,371
Refere				
nce			35	
Other		67	127	49
Total Transactions		253	162	213
		320		262
Archives & Special				
Collections New Users			7,316	
Returning		4,855	4,301	5,894
users Total		10,975	11,617	3,270
Users		15,830		9,164
Bronfma				
n		2,947	5,083	
Reference		7,928	6,710	4,161
nce		10,875	11,793	6,568
Other				10,729
Total Transactions			3,145	
		1,509	1,110	3,925
Stacie				
Refere		2,485	4,255	3,314
nce		3,994		7,239
			34,645	
Other		25,149	52,275	33,698
Total Transactions		60,030	52,275	60,833
			2,602	
Frost				
		2,742		1,950

LIBRARY INSTRUCTION	2013/2014		2015/2016		2016/2017	
	Classes	Participants	Classes	Participants	Classes	Participants
Archives	28	590	19	125	33	547
Bronfman	101	4,287	92	4,512	116	5,594
Frost	79	1,699	77	1,848	50	1,113
Maps	22	1,108	22	624	18	469
Scott	310	11,306	290	10,872	251	10,699
Steacie	104	4,145	128	3,423	99	4,266
Total	644	23,135	628	21,404	567	22,688

LIBRARY ACCESSIBILITY SERVICES	2014/2015	2015/2016	2016/2017
Total Texts Provided	1,730	2571	2887

STUDY SEATS	2014/2015	2015/2016	2016/2017
Scott	2,108	2,108	2,108
Bronfman	321	321	321
Frost	247	247	247
Steacie	337	337	337
Total	3,013	3,013	3,013

Turnstile Count	2014/2015	2015/2016	2016/2017
Scott	2,262,666	2,209,087	2,136,478
Bronfman	292,726	275,211	287,526
Frost	83,737	89,261	82,821
Steacie	128,472	289,398	276,109
Total	2,767,601	2,862,957	2,782,934

OPERATING BUDGET	2014/2015	2015/2016	2016/2017
Salaries	\$ 11,426,013	\$ 11,564,144	\$ 11,711,207
Part Time Assistance	\$ 875,189	\$ 715,435	\$ 734,578
Benefits	\$ 2,684,614	\$ 2,747,151	\$ 3,115,743
Subtotal	\$ 14,985,816	\$ 15,026,730	\$ 15,561,528
Collections	\$ 9,989,296	\$ 11,684,041	\$ 11,746,068
Binding	\$ 46,527	\$ 56,107	\$ 46,650
Subtotal	\$ 10,035,823	\$ 11,740,148	\$ 11,792,718
General operating	\$ 1,869,197	\$ 1,850,577	\$ 1,772,805
Total Expenses	\$ 26,854,658	\$ 28,617,454	\$ 29,127,051
Recovery	-\$ 790,731	-\$ 806,852	-\$ 644,437
Total Expenses less recovery	\$ 26,063,928	\$ 27,810,602	\$ 28,482,614
Gifts in Kind	\$ 704,842	\$ 358,900	\$ 1,825,253

Appendix H

New Course Proposal Template

The following information is required for all new course proposals. To facilitate the review/approval process, please use the headings below (and omit the italicized explanations below each heading).

1. Program: Schulich MMAI Program

2. Course Number: SB/MMAI 5000

3. Credit Value: 3.00

4. Long Course Title:
Artificial Intelligence Fundamentals

5. Short Course Title:
Artificial Intelligence Fundamentals

6. Effective Session:
Fall 2019

7. Calendar (Short) Course Description:

This course introduces students to the field of artificial intelligence, with a focus on AI-driven business applications. It provides a historical perspective tracing the emergence of basic concepts of contemporary AI. Students learn key artificial intelligence techniques including knowledge representation and symbolic reasoning, biologically inspired approaches to AI, supervised, unsupervised and reinforcement learning, multi-agent systems and natural language processing.

8. Expanded Course Description:

This course will introduce students to the field of artificial intelligence, with a focus on AI- driven business applications. The course also provides a historical perspective tracing the emergence of basic terminologies and concepts of contemporary AI. In addition, students will be introduced to key artificial intelligence techniques including knowledge representation and symbolic reasoning, biologically inspired approaches to artificial intelligence, supervised, unsupervised and reinforcement learning, multi-agent systems, planning and natural language processing. This course is a prerequisite for MMAI 5040 3.00.

9. Evaluation:

Course work includes three (3) assignments, one (1) midterm exam, a final exam, and in-class participation.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	3	10%	30%	Individual
Class Participation	1	10%	10%	Individual
Midterm Exam	1	30%	30%	Individual
Final Exam	1	30%	30%	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions” (p. 5).

10. Integrated Courses:

N/A

11. Rationale:

This course will lay the foundations for an understanding of advanced artificial intelligence business applications. It will also provide detailed knowledge of AI applications used in the analytics industry.

12. Faculty Resources:

This course will be taught by instructors who are currently teaching in the MBAN Program. No additional faculty resources will be needed.

13. Crosslisted Courses:

N/A

14. Bibliography and Library Statement:

See attached.

15. Physical Resources:

No additional physical resources needed.



New Course Proposal Template (Part B - Schulich Use Only)

16. Instructors and Faculty Coordinator

Initial instructor

N/A

Alternative instructors

Hjalmar Turesson, Ph.D.

Course coordinator

Murat Kristal, Director, MMAI Program

17. Specializations

Primary area or specialization

MMAI Program

Secondary areas or specializations

N/A

18. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55

Expected enrolment

55

Evidence for enrolment expectations

Numbers are based on similar demand for the MBAN program.

19. Human Participants Research

N/A

20. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the following conditions required by Faculty Council applies:

- a) **The Area is deleting courses with at least the same total number of credits.**

N/A

b) Provide a convincing case for the proposed course.
Fundamental to MMAI program

Course Originator

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name

Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below (minimum 6) confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Ashwin Joshi

David A. Johnston

M. David Rice

Henry M. Kim

Richard Irving

Theodoros Peridis

<Name of faculty member>

<Name of faculty member>

<Name of faculty member>

Approvals:

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving
Signature

October 19, 2018
Date

Richard Irving
Name of Coordinator or Director

OMIS
Area or Specialization

Degree Program

I support the addition of the course to the SSB curriculum.

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name of Task Force Chair

MMAI
Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick
Signature

October 22nd 2018
Date

Detlev Zwick
Name of Committee Chair

Master Programs Committee
Committee

Course Outline

Fall 2018

Mondays, 2:30-5:30pm, beginning on September 10, 2018
S128 SSB

Instructor

TBA
S337 Seymour Schulich Building
TBA
Office hours: TBA

Assistant

Paula Gowdie Rose
S337 Seymour Schulich Building
416-736-5074
pgowdierose@schulich.yorku.ca

Brief Description

This course emphasizes practical business applications of artificial intelligence rather than the conventional focus on the derivation of methods from first principles. Students are introduced to the field of artificial intelligence, through a historical perspective that covers the basic terminology and concepts. The course covers multiple facets of artificial intelligence including knowledge representation and symbolic reasoning; biologically inspired approaches to artificial intelligence; supervised, unsupervised, and reinforcement Learning; multi-agent systems; planning; and natural language processing. Students gain a holistic view of Artificial Intelligence as applied to practical business contexts through a combination of case studies (in and out of class) as well as in-class lab-style technical explorations, which are complimented by assignments throughout the course.

Prerequisite(s): NONE

Contents

Course Learning Outcomes.....	1
Deliverables at a Glance	2
Course Material	2
Student Preparation for Class and Class Participation: Expectations	2
Class-by-Class Syllabus.....	3
Written Assignments/Projects and Exam[s]: Descriptions	6
Evaluation of Written Assignments/Projects and Exams.....	6
Calculation of Course Grade	7
General Academic Policies: Grading, Academic Honesty, Accommodations and Exams	8
Quick Reference: Summary of Classes, Activities and Deliverables	8

Course Learning Outcomes

- Discuss the history of Artificial Intelligence
- Describe Artificial Intelligence terminology and concepts.

- Represent Knowledge in a convenient form in order to solve a business problem.
- Formulate an Artificial Intelligence strategy in order to deliver value for organizational stakeholders.
- Classify a Machine Learning scenario as Supervised, Unsupervised, or Reinforcement Learning.
- Apply symbolic reasoning, biologically-inspired methods, multi-agent systems, planning, and Natural Language Processing as appropriate to achieve a business goal.
- Students gain a holistic view of Artificial Intelligence as applied to practical business contexts.

Deliverables at a Glance

Course work includes three (3) assignments, a midterm exam and a final exam as well as marks earned for in class participation:

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	3	10%	30%	Individual
Midterm Exam	1	30%	30%	Individual
Final Exam	1	30%	30%	Individual
Class Participation	1	10%	10%	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions” (p. 5).

Course Material

The course uses a set of handouts, and two textbooks used as a reference for technical background and business perspectives, respectively. The textbooks can be purchased at the York University Bookstore (<http://bookstore.blog.yorku.ca>):

Artificial Intelligence: A Modern Approach, 3rd Edition, Stuart Russell and Peter Norvig, Pearson,(2010).

Artificial Intelligence and Machine Learning for Business: A No-Nonsense Guide to Data Driven Technologies, Steven Finlay, Relativistic, (2017).

The Course Materials Database (CMD) has been created within Schulich’s Lotus Notes. It contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook as indicated in the Course Materials Database (CMD).

Class Participation (contribution). Students earn participation marks evenly throughout the term, through participating in in-class discussions, presentations, and reflection surveys following guest speaker visits.

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on the course CMD, and when changes need to be announced between classes, an email will be sent to students' Lotus Notes email accounts, notifying them of the change.

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
-----------	--

September 10 (1)	<u>Introduction to AI – a historical perspective</u>
---------------------	--

- What is Artificial Intelligence?
- Origins of AI
- Turing Completeness
- Turing Test
- Approaches to realizing AI
- Business Applications of AI

Read:

- Instructor Handout(s)

September 17 (2)	<u>Knowledge-based systems</u>
---------------------	--------------------------------

- First-order logic
- Expert systems
- Knowledge Acquisition
- Applications of Knowledge-based systems to business

Read:

- Instructor Handout(s)

Assignment #1 is handed out

September 24 (3)	<u>Biologically Inspired & Ensemble Methods I</u>
---------------------	---

- Biological inspiration for Neural Computing
- Perceptrons
- Activation Functions
- Neural Networks
- Deep Learning
- Application of Neural Networks to business domains

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
	Read: <ul style="list-style-type: none"> • Instructor Handout(s)
October 1 (4)	<u>Biologically Inspired & Ensemble Methods II</u> <ul style="list-style-type: none"> • Biological Inspiration for Evolutionary Computing • Fitness • Crossover • Genetic Algorithms • Genetic Programming • Business applications of evolutionary computing. Read: <ul style="list-style-type: none"> • Instructor Handout(s) Assignment #2 is handed out Assignment Due: <ul style="list-style-type: none"> ▪ Assignment #1
October 8 (5)	<u>Supervised Learning</u> <ul style="list-style-type: none"> • Introduction to Supervised Learning. • Requirements for Supervised Learning. • Approaches and techniques for Supervised Learning. • Applications of Supervised Learning in business. Read: <ul style="list-style-type: none"> • Instructor Handout(s)
October 15 (6)	<u>Unsupervised Learning</u> <ul style="list-style-type: none"> • Introduction to Unsupervised Learning. • Requirements for Unsupervised Learning. • Approaches and techniques for Unsupervised Learning. • Unsupervised Learning applications to business domains. Read: <ol style="list-style-type: none"> 1. Instructor Handout(s)
October 22	<i>Reading Week – No Class</i>
October 29 (7)	<u>Midterm Exam</u>
November 5	<u>Reinforcement Learning</u>

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
(8)	<ul style="list-style-type: none"> • Introduction to Reinforcement Learning. • Requirements for Reinforcement Learning. • Approaches and techniques for Reinforcement Learning • Application of Reinforcement Learning within business contexts. <p>Read:</p> <ol style="list-style-type: none"> 1. Instructor Handout(s)
November 12 (9)	<p><u>Representations of Knowledge</u></p> <ul style="list-style-type: none"> • Fuzzy Sets • Ontologies <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) <p>Assignment #3 is handed out Assignment Due: <i>Assignment #2</i></p>
November 19 (10)	<p><u>Natural Language Processing</u></p> <ul style="list-style-type: none"> • Approaches and techniques for Natural Language Processing • Information Retrieval • Text Mining • Machine Translation • Conversational Systems <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s)
November 26 (11)	<p><u>Multi-Agent Systems</u></p> <ul style="list-style-type: none"> • Multi-Agent Systems for implementing Business Solutions • Multi-Agent Systems for Modelling Business Processes <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s)
December 3 (12)	<p><u>Introduction to Enterprise Level AI Architecture</u></p> <ul style="list-style-type: none"> • Information Architecture plays a key role in establishing order in the continuous evolution of emerging data technologies. • Introduction of specific measures that organizations should take to embrace AI and streaming data technologies,

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
-----------	--

- Introduction of AI Enterprise Architecture and IoT and how they relate to business.

Read:

- Instructor Handout(s)

Assignment Due:

- **Assignment #3**

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

October 1	<u>Assignments</u>
November 12	Students complete three assignments over the duration of the course. The assignments generally require students to implement an Artificial Intelligence business solution, using the toolkit learned in the course. Students must submit assignments at the beginning of class, in the form of computer printouts. Each assignment is worth 10%. <i>Value: 3 x 10% = 30%</i>
December 3	
October 29	<u>Midterm Exam</u> The midterm test will cover material from the first half of the course. It will take place in lab and will consist of a series of assignments to be completed in the three-hour period. <i>Value: 30%</i>
Please refer to the Exam Schedule	<u>Final Exam</u> The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions and short-answer questions. The three-hour exam will take place at a time and place to be announced. <i>Value: 30%</i>

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: The students will lose 5% of their assignment grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical mark to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

A+	[100% - 90%]
A	[89% - 80%]
A-	[79% - 70%]
B+	[69% - 60%]
B	[59% - 50%]
B-	[49% - 40%]
C+	[39% - 30%]
C	[29% - 20%]
C-	[19% - 10%]
F	[9% - 0%]

Note that letter grade "A" corresponds to the interval from 89% to 80%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

The Schulich School does not use a percentage scale or prescribe a standard conversion formula from percentages to letter grades. Conversions within a course are at the discretion of the instructor.

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Student Handbook or the Student Services & International Relations website:

http://www.schulich.yorku.ca/client/schulich/schulich_lp4w_lnd_webstation.nsf/page/Enrolment+Grades+and+Convocation!OpenDocument#tabs-2

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University's policy on academic honesty, which may be found in the Student Handbook and on the Student Services & International Relations website:

http://www.schulich.yorku.ca/client/schulich/schulich_lp4w_lnd_webstation.nsf/page/Academic+Honesty!OpenDocument

Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Student Handbook or contact Student Services.

For counseling & disability services, contact Student Services or see <http://www.yorku.ca/cds/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Director of Student Services (SSB Room W262) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For more details, see:

http://schulich.yorku.ca/client/schulich/schulich_lp4w_lnd_webstation.nsf/page/Enrolment+-+MBA+Exam+Schedule?OpenDocument

Quick Reference: Summary of Classes, Activities and Deliverables

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)	Written Preparation
1. September 10 Introduction to AI – a historical perspective	<ul style="list-style-type: none"> • What is Artificial Intelligence? • Origins of AI • Turing Completeness • Turing Test • Approaches to realizing AI • Business Applications of AI 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
2. September 17 Knowledge-based systems	<ul style="list-style-type: none"> • First-order logic • Expert systems • Knowledge Acquisition • Applications of Knowledge-based systems to business 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
3. September 24 Biologically Inspired & Ensemble Methods I	<ul style="list-style-type: none"> • Biological inspiration for Neural Computing • Perceptrons • Activation Functions • Neural Networks • Deep Learning • Application of Neural Networks to business domains 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
4. October 1 Biologically Inspired & Ensemble Methods II	<ul style="list-style-type: none"> • Biological Inspiration for Evolutionary Computing • Fitness • Crossover • Genetic Algorithms • Genetic Programming • Business applications of evolutionary computing. 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
5. October 8 Supervised Learning	<ul style="list-style-type: none"> • Introduction to Supervised Learning. • Requirements for Supervised Learning. • Approaches and techniques for Supervised Learning. • Applications of Supervised Learning in business. 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
6. October 15 Unsupervised Learning		<ul style="list-style-type: none"> • Instructor Handout(s) 	
	<i>NO CLASS (Reading Week)</i>		
7. October 29	Midterm Exam		

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)	Written Preparation
Midterm Exam			
8. November 5 Reinforcement Learning	<ul style="list-style-type: none"> • Introduction to Reinforcement Learning. • Requirements for Reinforcement Learning. • Approaches and techniques for Reinforcement Learning • Application of Reinforcement Learning within business contexts. 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
9. November 12 Representations of Knowledge	<ul style="list-style-type: none"> • Fuzzy Sets • Ontologies 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
10. November 19 Natural Language Processing	<ul style="list-style-type: none"> • Approaches and techniques for Natural Language Processing • Information Retrieval • Text Mining • Machine Translation • Conversational Systems 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
11. November 26 Multi-Agent Systems	<ul style="list-style-type: none"> • Multi-Agent Systems for implementing Business Solutions • Multi-Agent Systems for Modelling Business Processes 	<ul style="list-style-type: none"> • Instructor Handout(s) 	
12. December 3 Planning	<ul style="list-style-type: none"> • Autonomous Agents in the context of a Business Environment • Modelling an Environment • Approaches to planning within the environment 	<ul style="list-style-type: none"> • Instructor Handout(s) 	

Faculty of Graduate Studies New Course Proposal

1. **Program:** Schulich Master of Management in Artificial Intelligence
2. **Course Number:** MMAI 5200
3. **Credit Value:** 3.00
4. **Long Course Title:** Algorithms for Business Analysis
5. **Short Course Title:** Algorithms for Business Analysis
6. **Effective Session:** Fall 2019

7. **Calendar (Short) Course Description**

The course covers main approaches to design and analysis of algorithms used in business contexts, including important algorithms and data structures, and results in complexity and computability. This course is a pre-requisite for MMAI 5300.

8. **Expanded Course Description**

The course covers main approaches to design and analysis of algorithms used in business contexts, including important algorithms and data structures, and results in complexity and computability. The main contents are: review of algorithm analysis such as search in ordered array, binary insertion sort; an introduction to divide and conquer algorithms; graphs; and applications of greedy algorithms. These applications will be covered in business context and will be linked to specific business applications. This course is a pre-requisite for MMAI 5300.

9. Evaluation

The evaluation measures are comprised of individual assignments, group projects, written exam and class participation. Course deliverables are broken down as in the following table.

<i>Deliverable</i>	<i>Quantity</i>	<i>% Weight</i>	<i>Total %</i>	<i>Author</i>
<i>Assignments</i>	<i>3</i>	<i>10</i>	<i>30</i>	<i>Individual</i>
<i>Research Project</i>	<i>1</i>	<i>10</i>	<i>20</i>	<i>Group</i>
<i>Midterm Exam</i>	<i>1</i>	<i>20</i>	<i>20</i>	<i>Individual</i>
<i>Final Exam</i>	<i>1</i>	<i>30</i>	<i>30</i>	<i>Individual</i>
			100%	

10. Integrated Courses

N/A

11. Rationale

Please see Master of Management in Artificial Intelligence program proposal.

12. Faculty Resources

TBA

13. Cross-listed Courses

N/A

14. Bibliography and Library Statement

There are no pre-assigned required readings for this course. However, if handouts are distributed prior to or during the formal class meetings it is expected that they be read. If any handouts are copyrighted, the cost for these materials will be absorbed by the program. A Canvas site (LMS) has been created for this course. Every Canvas site includes some important general information for Schulich students. The instructor posts rubrics, resources and special instructions on assignments on Canvas. Please get into the habit of checking Canvas on a regular basis. Feel free to e-mail the instructor with questions or concerns throughout the term.

15. Physical Resources

No additional physical resources are needed to run this course.



Faculty of Graduate Studies

New Course Proposal

Part B (Schulich Use Only)

16. Instructors and Faculty Coordinator

Initial instructor

Mel Gabriel, Ph.D.

Alternative instructors

Murat Kristal, Ph.D.

Course coordinator

Murat Kristal, Director, MMAI Program

17. Specializations

Primary area or specialization

Business Intelligence

Secondary areas or specializations

N/A

18. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55 students

Expected enrolment

50 students

Evidence for enrolment expectations

Enrolment based on demand for MBAN program.

19. Human Participants Research

No

20. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the three following conditions required by Faculty Council applies:

a) The Area is deleting courses with at least the same total number of credits.

Does not apply. This is not an elective class.

b) Provide a convincing case for the proposed course.

N/A

11. Course Originator

Murat Kristal
Signature

Sept 5, 2018

Murat Kristal
Name

12. Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Ashwin Joshi

David A. Johnston

M. David Rice

Henry M. Kim

Richard Irving

Theodoros Peridis

<Name of faculty member>

<Name of faculty member>

<Name of faculty member>

13. Approvals

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving
Signature

Oct 19, 2018
Date

Richard Irving
Area Coordinator or Specialization Director

OMIS
Area or Specialization

Degree Program

This course has received the approval of the Program Committee, and I support the addition of the course to the SSB curriculum.

Murat Kristal

Signature

Sept. 5, 2018

Date

Murat Kristal

Name of Task Force Chair

MMAI

Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick

Signature

October 22nd 2018

Date

Detlev Zwick

Name of Committee Chair

Master Programs Committee

Committee

MMAI 5200 3.00: Algorithms for Business Analysis



Course Outline

Winter 2020

Time, Room: TBA

Instructor

Biography: TBA

Room: TBA

Office hours: TBA

Assistant

Paula Gowdie Rose

S337 Seymour Schulich Building

416-736-5074

pgowdierose@schulich.yorku.ca

Brief Description

The course covers main approaches to design and analysis of algorithms used in business contexts, including important algorithms and data structures, and results in complexity and computability. The main contents are: review of algorithm analysis (search in ordered array, binary insertion sort, merge sort, worst-case and average-case time complexity, minimum complexity of sorting n elements for small n , 2-3 trees, asymptotic notation); divide and conquer algorithms (master theorem, integer multiplication, matrix multiplication, fast Fourier transform); graphs (breadth-first search, connected components, topological ordering, depth-first search, way from planar graphs to Robertson-Seymour theorem); dynamic programming (chain matrix multiplication, shortest paths, edit distance, sequence alignment, extensions of dynamic programming); greedy algorithms (binary heaps, Dijkstras algorithm, minimum spanning tree, Huffman codes, matroids); randomized algorithms (selection, quick sort, global minimum cut, hushing); P and NP (Cooks theorem, examples of NP-complete problems); approximate algorithms for NP- hard problems or polynomial algorithms for subproblems of NP-hard problems (set cover, vertex cover, maximum independent set, 2-SAT); partial recursive functions (theorem of Post, Diophantine equations).

This course is a prerequisite for MMAI 5300 3.00

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Course Learning Outcomes

On completion of this unit successful students will have:

- Describe and use standard algorithms and techniques in business context
- Design algorithms to solve specific business problems
- Analyze algorithms’ running times and space complexity
- Clearly and articulately state the intuitions behind these algorithms
- Analyze existing data structures
- Choose an appropriate data structure for a business problem and give a pseudocode implementation
- Prove a problem is NP-complete using reduction and understand the managerial implications

Deliverables at a Glance

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	3	10	30	Individual
Research Project	1	20	20	Group
Midterm exam	1	20	20	Individual
Final exam	1	30	30	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions”, p. 6.

Course Material

Required Materials

- Introduction to Algorithms, 3rd Edition, Cormen, Leiserson, Rivest, Stein, MIT Press 2009, ISBN 9978-0-262-03384-8/978-0-262-53305-8

A Canvas site has been created for this course. It contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook as indicated on Canvas.

Class Participation (contribution). Students earn participation marks evenly throughout the term, through participating in in-class discussions, presentations, and reflection surveys following guest speaker visits.

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on Canvas, and when changes need to be announced between classes, an email will be sent to students' email accounts, notifying them of the change.

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

Algorithmic Analysis

- Week #1 Read:
- Course Outline

Data Structures I

- Week #2 Read:
- Instructor Handout(s)
- Prep:
- Preparatory materials posted online in Canvas System

Data Structures II

- Week #3 Read:
- Instructor Handout(s)
-

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
-----------	--

Prep:

- Preparatory materials posted online in Canvas System
-

Dynamic Programming I

Week #4 Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 1** due before class
-

Dynamic Programming II

Week #5 Read:

- Instructor Handout(s)
-

Week #6 **Midterm 1**

Greedy Algorithms

Week #7 Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 2** due before class
-

Randomized Algorithms

Week #8 Read:

- Instructor Handout(s)
-

Amortized Analysis

Week #9 Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 3** due before class
-

Week #10

Graph Algorithms I and II

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

Read:

- Instructor Handout(s)
-

NP-Completeness I and II

Week #11

Read:

- Instructor Handout(s)

Deliverable:

- **Group Project** due before class
-

Approximation Algorithms & Undecidability

Week #12

Read:

- Instructor Handout(s)
-

Final Exam

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

TBD

Assignments

The assignments require students to answer a set of questions closely related to the handouts or textbook contents or conduct numerical experiments. The textbook and prior lectures provide all the information students need to complete the assignments. Students must submit assignments at the beginning of the lecturing session on the due date.

Value: 3 x 10% = 30%

TBD

Research Project

Students need to form project teams of size 3– 4 and complete the projects within a specified time period by submitting a project report and the computer code. The project requires a team to apply the learned techniques to implement a data-centered business problem.

Value: 1 x 20% = 20%

TBD

Midterm Exam

The material for the midterm exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.

Value: 20%

Due Date

TBD

Final Exam

The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.

Value: 30%

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: The students will lose 5% of their assignment grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical mark to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

Letter Grade	Numerical Grade	Percentage Grade
A+	9	100% - 95%
A	8	94% - 90%
A-	7	89% - 85%
B+	6	84% - 80%
B	5	79% - 74%
B-	4	73% - 70%
C+	3	69% - 65%
C	2	64% - 60%
C-	1	59% - 50%
F	0	Below 50%

Note that letter grade "A" corresponds to the interval from 94% to 90%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Graduate Academic Policy Handbook or the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University's policy on academic honesty, which may be found in the Graduate Academic Policy Handbook and on the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Graduate Academic Policy Handbook or contact Student & Enrolment Services.

For Student Accessibility Services (SAS) , contact Student Services or see <https://accessibility.students.yorku.ca/> <https://accessibility.students.yorku.ca/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student & Enrolment Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student & Enrolment Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Director of Student & Enrolment Services (SSB Room W263W263) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For more details, see:

<http://schulich.yorku.ca/graduate-handbook>

Faculty of Graduate Studies New Course Proposal

1. **Program:** Schulich Master of Management in Artificial Intelligence
2. **Course Number:** MMAI 5300
3. **Credit Value:** 3.00
4. **Long Course Title:** Numerical Methods and Analysis
5. **Short Course Title:** Numerical Analysis
6. **Effective Session:** Winter 2020
7. **Calendar (Short) Course Description**

Numerical analysis is concerned with finding numerical solutions to problems for which analytical solutions either do not exist or are not readily or cheaply obtainable. This course provides an introduction to the subject, focusing on the three core topics of iteration, interpolation and quadrature. Students will learn about both practical and theoretical aspects of algorithms. Pre-requisite: MMAI 5200.

8. **Expanded Course Description**

The course explores complex systems requiring computational methods. Numerical methods, based upon sound computational mathematics, create the basic algorithms underpinning computer predictions in modern systems science. Such methods include techniques for simple optimisation, interpolation from the known to the unknown, linear algebra underlying systems of equations, ordinary differential equations to simulate systems, and stochastic simulation under random influences. Topics covered are: the mathematical and computational foundations of the numerical approximation and solution of scientific problems; simple optimisation; vectorisation; clustering; polynomial and spline interpolation; pattern recognition; integration and differentiation; solution of large-scale systems of linear and nonlinear equations; modelling and solution with sparse equations; explicit schemes to solve ordinary differential equations; random numbers; stochastic system simulation. Pre-requisite: MMAI 5200. This course is also a pre-requisite for MMAI 5500 and MMAI 5400.

After taking this course, students will be able to:

- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
- Apply numerical methods to obtain approximate solutions to business problems.

- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Analyze and evaluate the accuracy of common numerical methods.

9. Evaluation

The evaluation measures are comprised of individual assignments, group projects, written exam and class participation. Course deliverables are broken down as in the following table.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	2	10	20	Individual
Projects	1	20	20	Group
Midterm 1 exam	1	20	20	Individual
Midterm 2 exam	1	20	20	Individual
Final exam	1	20	20	Individual
			100%	

10. Integrated Courses

N/A

11. Rationale

Please see Master of Management in Artificial Intelligence program proposal.

12. Faculty Resources

TBA

13. Cross-listed Courses

N/A

14. Bibliography and Library Statement

There are no pre-assigned required readings for this course. However, if handouts are distributed prior to or during the formal class meetings it is expected that they be read. If any handouts are copyrighted, the cost for these materials will be absorbed by the program. A Canvas site (LMS) has been created for this course. Every Canvas site includes some important general information for Schulich students. The instructor posts rubrics, resources and special instructions on assignments on Canvas. Please get into the habit of checking Canvas on a regular basis. Feel free to e-mail the instructor with questions or concerns throughout the term.

15. Physical Resources

No additional physical resources are needed to run this course.



Faculty of Graduate Studies

New Course Proposal

Part B (Schulich Use Only)

16. Instructors and Faculty Coordinator

Initial instructor

Mel Gabriel, Ph.D.

Alternative instructors

Murat Kristal, Ph.D.

Course coordinator

Murat Kristal, Director, MMAI Program

17. Specializations

Primary area or specialization

Business Intelligence

Secondary areas or specializations

N/A

18. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55 students

Expected enrolment

50 students

Evidence for enrolment expectations

Enrolment based on demand for MBAN program.

19. Human Participants Research

No

20. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the three following conditions required by Faculty Council applies:

a) The Area is deleting courses with at least the same total number of credits.

Does not apply. This is not an elective class.

b) Provide a convincing case for the proposed course.

N/A

14. Course Originator

Murat Kristal

Signature

Sept 5, 2018

Date

Murat Kristal

Name

15. Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Ashwin Joshi

David A. Johnston

M. David Rice

Henry M. Kim

Richard Irving

Theodoros Peridis

<Name of faculty member>

<Name of faculty member>

<Name of faculty member>

16. Approvals

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving

Signature

Oct 19, 2018

Date

Richard Irving

Area Coordinator or Specialization Director

OMIS

Area or Specialization

Degree Program

This course has received the approval of the Program Committee, and I support the addition of the course to the SSB curriculum.

Murat Kristal

Signature

Sept. 5, 2018

Date

Murat Kristal

Name of Chair Task Force

MMAI

Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick

Signature

October 22nd 2018

Date

Detlev Zwick

Name of Committee Chair

Master Programs Committee

Committee

MMAI 5300 S 3.00: Numerical Analysis



Course Outline

Winter 2020

Time, Room: TBA

Instructor

Biography: TBA

Room: TBA

Office hours: TBA

Assistant

Paula Gowdie Rose

S337 Seymour Schulich Building

416-736-5074

pgowdierose@schulich.yorku.ca

Brief Description

Numerical analysis is concerned with finding numerical solutions to problems for which analytical solutions either do not exist or are not readily or cheaply obtainable. This course provides an introduction to the subject, focusing on the three core topics of iteration, interpolation and quadrature.

The module starts with 'interpolation schemes', methods for approximating functions by polynomials, and 'quadrature schemes', numerical methods for approximating integrals, will then be explored in turn.

The second half of the module looks at solving systems of linear and nonlinear equations via iterative techniques. In the case of linear systems, examples will be drawn from the numerical solution of differential equations.

Students will learn about practical and theoretical aspects of all the algorithms. Insight into the algorithms will be given through illustrations, but the course does not require any programming.

Prerequisite: MMAI 5200 3.00 Algorithms for Business Analysis

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Course Learning Outcomes

On completion of this unit successful students will have:

- demonstrate, and mitigate for the effect of, non-exact arithmetic on the approximation of simple mathematical calculations,
- construct, apply theorems regarding polynomials which pass through a given set of coordinates that can be used in business optimization models,
- construct, apply theorems regarding, quadrature schemes for the numerical approximation of integrals that can be used in business optimization models,
- implement iterative methods for the approximation of solutions to linear and non-linear equations,
- apply theorems regarding the convergence of such iterative schemes to given business problems.

Deliverables at a Glance

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	2	10	20	Individual
Projects	1	20	20	Group
Midterm 1 exam	1	20	20	Individual
Midterm 2 exam	1	20	20	Individual
Final exam	1	20	20	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions”, p. 6.

Course Material

Required Materials

- J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, Springer-Verlag, ISBN 0-387- 90420-4

- L.N. Trefethen and D. Bau, Numerical Linear Algebra, Society of Industrial and Applied Mathematics
- C.T. Kelley, Iterative methods for linear and nonlinear equations, Society of Industrial and Applied Mathematics

A Canvas site has been created for this course. It contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook as indicated on Canvas.

Class Participation (contribution). Students earn participation marks evenly throughout the term, through participating in in-class discussions, presentations, and reflection surveys following guest speaker visits.

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on Canvas, and when changes need to be announced between classes, an email will be sent to students' email accounts, notifying them of the change.

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
-----------	--

Preliminaries of Computing

Basic concepts: round-off errors, floating point arithmetic, Convergence

Week #1

Read:

- Course Outline

Numerical solution of Nonlinear Equations

- a) Bisection method, fixed-point iteration, Newton's method.
b) Error analysis for Iterative Methods.
c) Computing roots of polynomials

Week #2

Read:

- Instructor Handout(s)
-

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

Prep:

- Preparatory materials posted online in Canvas System

Deliverable:

- **Assignment 1** due before class
-

Interpolation and Polynomial Approximation

- a) Lagrange Polynomial
- b) Divided Differences
- c) Hermite Interpolation

Week #3

Read:

- Instructor Handout(s)

Prep:

- Preparatory materials posted online in Canvas System
-

Numerical integration and differentiation

- a) Trapezoidal rule, etc., Gaussian quadrature and Euler-Maclaurin formula

Week #4

Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 2** due before class
-

Week #5

Midterm 1

Applied Linear Algebra

- a) Direct methods for solving linear systems, numerical factorizations.
- b) Eigenvalue problems

Week #6

Read:

- Instructor Handout(s)
-

IVP problems for ODE

- a) Euler's, Taylor, Runge-Kutta, and multistep methods, Stability.

Week #7

Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 3** due before class
-

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

Week #8

Numerical linear algebra
a) Direct methods
b) Iterative methods

Read:
▪ Instructor Handout(s)

Week #9

Approximation theory
a) Least square approximation

Read:
• Instructor Handout(s)

Deliverable:
• **Assignment 4** due before class

Week #10

Midterm 2

Week #10

Approximating Eigenvalues
a) Power method, Householder's method

Read:
• Instructor Handout(s)

Week #11

Boundary-Value Problems for Ordinary Differential Equations BVP for ODE
a) Mathematical Theories
b) Finite Difference Method For Linear Problems

Read:
• Instructor Handout(s)

Deliverable:
□ **Group Project** due before class

Week #12

Boundary-Value Problems for Ordinary Differential Equations BVP for ODE
c) The Finite Difference Formulation
d) Convergence Analysis
e) Shooting methods

Read:
□ Instructor Handout(s)

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
-----------	--

Final Exam

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

TBD	<p><u>Assignments</u></p> <p>The assignments require students to answer a set of questions closely related to the handouts or textbook contents, or conduct numerical experiments. The textbook and prior lectures provide all the information students need to complete the assignments. Students must submit assignments at the beginning of the lecturing session on the due date.</p> <p>Value: 2 x 10% = 20%</p>
TBD	<p><u>Group Project</u></p> <p>Students need to form project teams of size 3– 4, and complete the projects within a specified time period by submitting a project report and the computer code. The project requires a team to apply the learned techniques to implement a data-centered business problem.</p> <p>Value: 1 x 20% = 20%</p>
TBD	<p><u>Midterm 1 Exam</u></p> <p>The material for the midterm exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.</p> <p>Value: 20%</p>
TBD	<p><u>Midterm 1 Exam</u></p> <p>The material for the midterm exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.</p> <p>Value: 20%</p>
TBD	<p><u>Final Exam</u></p> <p>The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.</p> <p>Value: 20%</p>

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: The students will lose 5% of their assignment grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical mark to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

Letter Grade	Numerical Grade	Percentage Grade
A+	9	100% - 95%
A	8	94% - 90%
A-	7	89% - 85%
B+	6	84% - 80%
B	5	79% - 74%
B-	4	73% - 70%
C+	3	69% - 65%
C	2	64% - 60%
C-	1	59% - 50%
F	0	Below 50%

Note that letter grade “A” corresponds to the interval from 94% to 90%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Graduate Academic Policy Handbook or the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University’s policy on academic honesty, which may be found in the Graduate Academic Policy Handbook and on the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Accommodations. For accommodations sought due to exam conflicts, religious reasons,

unavoidable absences or disabilities, please refer to the Graduate Academic Policy Handbook or contact Student & Enrolment Services.

For Student Accessibility Services (SAS) , contact Student & Enrolment Services or see <https://accessibility.students.yorku.ca/> <https://accessibility.students.yorku.ca/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student & Enrolment Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student & Enrolment Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Director of Student & Enrolment Services (SSB Room W263W263) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For more details, see:

<http://schulich.yorku.ca/graduate-handbook>

Faculty of Graduate Studies

New Course Proposal

- 1. Program:** Schulich Master of Management in Artificial Intelligence
- 2. Course Number:** MMAI 5500
- 3. Credit Value:** 3.00
- 4. Long Course Title:** Applications of Neural Networks and Deep Learning in Business
- 5. Short Course Title:** Application of Deep Learning in Business
- 6. Effective Session:** Summer 2020
- 7. Calendar (Short) Course Description**

Deep learning systems, embodied by a variety of neural network models, are used increasingly in modern business applications. Students will learn about the basics of neural network and deep learning, and their applications to a range of business issues. By the end of the course, students will have sufficient domain knowledge to address practical business problems.

8. Expanded Course Description

Deep learning systems, embodied by a variety of neural network models, are increasingly used in modern business applications, in areas such as social media, FinTech, personalization, HR management and healthcare management etc. Through lecturing and experiential learning components, students taking this course will learn about the basics of neural network and deep learning, and their applications to a range of business issues. By the end of the course, students will have sufficient domain knowledge to be able to apply it to address practical business problems.

Throughout this course, students should be able to:

- Understand the fundamental of deep learning and its value in business contexts.
- Apply appropriate deep learning methods & systems to formulate and address various business problems.
- Determine business strategies for deep learning systems development based on business features and data characteristics.
- Discuss the frontier use of deep learning in early adoption for industrial applications.

9. Evaluation

The evaluation measures are comprised of individual assignments, group projects, written exam and class participation. Course deliverables are broken down as in the following table.

<i>Deliverable</i>	<i>Quantity</i>	<i>% Weight</i>	<i>Total %</i>	<i>Author</i>
<i>Assignments</i>	<i>4</i>	<i>10</i>	<i>40</i>	<i>Individual</i>
<i>Midterm Exam</i>	<i>1</i>	<i>25</i>	<i>65</i>	<i>Individual</i>
<i>Final Project</i>	<i>1</i>	<i>35</i>	<i>100</i>	<i>Group</i>
			100%	

10. Integrated Courses

N/A

11. Rationale

Fundamental to the MMAI program, this course will lay the foundations of the understanding of neural network and deep learning in business applications for our MMAI students. It will provide them details that are used in AI-related industry.

12. Faculty Resources

This course will be taught by Instructors who are currently teaching in the MMAI Program. No additional faculty resources will be needed.

13. Cross-listed Courses

N/A

14. Bibliography and Library Statement

The course outline says this: The course uses a set of handouts, and two textbooks used as a reference for technical background and business perspectives, respectively. The textbooks can be accessed free online:

Text 1 - Deep Learning, by Ian Goodfellow, Yoshua Bengio, Aaron Courville, Online book (2017).

Text 2 - Neural Networks and Deep Learning, by Michael Nielsen, Online book (2016).

The Course Materials Database (CMD) has been created within Schulich's Lotus Notes. It contains general information for Schulich students and information and materials specific to this course.

15. Physical Resources

No additional physical resources needed.

Faculty of Graduate Studies
New Course Proposal
Part B (Schulich Use Only)

16. Instructors and Faculty Coordinator

Initial instructor

Zhepeng (Lionel) L, Ph.D

Alternative instructors

Hjalmar Turesson, Ph.D

Course coordinator

Murat Kristal, Director, MMAI Program

17. Specializations

Primary area or specialization

MMAI Program

Secondary areas or specializations

N/A

18. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55

Expected enrolment

Around 40-50

Evidence for enrolment expectations

The enrolment number is estimated based on similar demand for the MBAN program.

19. Human Participants Research

N/A

20. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the three following conditions required by Faculty Council applies:

a) The Area is deleting courses with at least the same total number of credits.

N/A

b) Provide a convincing case for the proposed course.

Fundamental to MMAI program

Course OriginatorZhepeng (Lionel) Li
SignatureNov. 7, 2018
DateZhepeng (Lionel) Li
Name**Supporting Faculty Members**

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course. The faculty members whose names appear below confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Marcia Annisette
NameDavid Rice
NameAshwin Joshi
NameTheodore Peridis
NameDavid Johnston
Name_____
Name**Approvals****Area or Specialization**

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Murat Kristal
SignatureNovember 8, 2018
DateMurat Kristal
Area Coordinator or Specialization DirectorMaster of Management in AI
Task Force Chair**Degree Program**

I support the addition of the course to the SSB curriculum.

Murat Kristal
Signature

Date

Murat Kristal
Name of Task Force Chair

MMAI
Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick
Signature

Jan 10, 2019
Date

Detlev Zwick
Name of Committee Chair

MPC-PCC
Committee

MMAI 5500 3.00: Applications of Neural Networks and Deep Learning in Business



Course Outline

Summer 2020

Meeting time TBA, beginning on TBA

Venue TBA

Instructor

TBA

Office hours: TBA

Assistant

Paula Gowdie Rose

S337 Seymour Schulich Building

416-736-5074

pgowdierose@schulich.yorku.ca

Brief Description

Deep learning systems, embodied by a variety of neural network models, are increasingly used in modern business applications, in areas such as social media, FinTech, personalization, HR management and healthcare management etc. Through lecturing and experiential learning components, students taking this course will learn about the basics of neural networks and deep learning, and their applications to a range of business issues. By the end of the course, students will have sufficient domain knowledge to be able to apply it to address practical business problems.

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Course Learning Outcomes

- Understand the fundamental of deep learning and neural network models and their value in business contexts.
- Apply appropriate deep learning methods & systems to formulate and address various business problems.

- Determine business strategies for deep learning systems development based on business features and data characteristics.
- Discuss the frontier use of neural network-based deep learning in early adoption for industrial applications.

Deliverables at a Glance

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	4	10	40	Individual
Midterm Exam	1	25	25	Individual
Final Project	1	35	35	Group
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions”, p. 6.

Course Material

The course uses a set of handouts, and two textbooks used as a reference for technical background and business perspectives, respectively. The textbooks can be accessed free online:

[Text 1] Deep Learning, by Ian Goodfellow, Yoshua Bengio, Aaron Courville, Online book (2017).

[Text 2] Neural Networks and Deep Learning, by Michael Nielsen, Online book (2016).

In Canvas system, it contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook or hand-outs as indicated in the Course Materials Database (Canvas).

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on the course Canvas page, and when changes need to be announced between classes, an email will be sent to students’ email accounts, notifying them of the change.

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
Week #1	<u>Course Overview & Introduction to Deep Learning in Business</u> Students will gain an overview of the course goal, structure and deliverables. The instructor will explain the history and upcoming trends of deep learning related techniques such as deep and recurrent neural networks and convolutional neural

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
	<p>networks and how deep learning is applied to business contexts. Deep learning products and services in practice will also be introduced.</p> <p>Read:</p> <ul style="list-style-type: none"> • Course Outline • [Text 1] Chapter 1
Week #2	<p><u>Business Strategies for Deep Learning</u></p> <p>We will go over the business considerations and strategies for machine learning. We explore examples for viable strategic models in organizations. Given the heterogenous characteristics and needs of businesses, such strategies should fit to different data structures, deployment options, and competitive environments.</p> <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) <p>Prep:</p> <ul style="list-style-type: none"> • Preparatory materials posted online in Canvas System_ <p>Deliverable:</p> <ul style="list-style-type: none"> • Assignment 1 due before class
Week #3	<p><u>Neural Network and Cognitive Basis</u></p> <p>This lecture builds the background and cognitive basis for biology-inspired computing, specifically neural computations. Students are then introduced to neural networks. The class introduces models of neurons and simple learning approaches based on these models.</p> <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) <p>Prep:</p> <ul style="list-style-type: none"> • Preparatory materials posted online in Canvas System_
Week #4	<p><u>Feed-forward & Backpropagation Mechanisms</u></p> <p>Students will be introduced to the universality of computing with neural networks. It elaborates on the information flow in neural networks. Typical mechanisms that enable learning in deep neural networks are covered.</p> <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) • [Text 1] Chapter 6, [Text 2] Chapter 2 <p>Deliverable:</p> <ul style="list-style-type: none"> • Assignment 2 due before class
Week #5	<p><u>Training for Neural Networks</u></p> <p>Critical components for any machine learning approach concentrates on the learning step. Students will learn function optimization and gradient descent. Training a neural network depends on determining parameters of the network. Rather than treating deep learning as a black box, you will understand what drives the performance and</p>

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
	<p>learn how to get deep learning to work well. Business best-practices for building deep learning applications will be introduced as well, such as TensorFlow by Google.</p> <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) • [Text 1] Chapter 8, [Text 2] Chapter 5
Week #6	<p>Midterm Exam</p>
Week #7	<p><u>Convolutional Neural Networks (CNN) Fundamentals</u></p> <p>Convolutional neural networks have achieved tremendous success in business applications. This lecture will introduce the theoretical foundation of convolutional neural network models. It explains the motivation for using convolution in neural networks. Then we describe the convolution function and pooling operation. Student will learn the working mechanism of multilayer perceptrons.</p> <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) • [Text 1] Chapter 9, [Text 2] Chapter 6 <p><u>Deliverable:</u></p> <ul style="list-style-type: none"> • Assignment 3 due before class
Week #8	<p><u>Business Applications of CNN</u></p> <p>Thanks to CNN, computer vision has much more powerful. This session will teach students how to build convolutional neural networks in addressing a number of business applications ranging from fashion product recognition to reading of radiology images. Students have the opportunity to learn about the transformative strength of deep learning via hands-on experience.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
Week #9	<p><u>Recurrent Neural Networks (RNN) Fundamentals</u></p> <p>Recurrent neural networks have become very effective models for temporal/sequential data. This session will teach how to represent sequential/temporal data as well as parameter sharing. We will cover backpropagation through time, feedforward RNN and bidirectional RNN.</p> <p>Read:</p> <ul style="list-style-type: none"> • Instructor Handout(s) • [Text 1] Chapter 10, [Text 2] Chapter 6 <p><u>Deliverable:</u></p> <ul style="list-style-type: none"> • Assignment 4 due before class
Week #10	<p><u>Business Applications of RNN</u></p> <p>RNN has improved the performance of a range of machine learning tasks in applications, such as natural language understanding, speech recognition, real-time bidding, advertising campaigns, and future market price forecasting. In this session, student will</p>

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
	<p>understand how to build and train RNN in applications and well-known variants (e.g., LSTM) in usage. Hands-on examples are incorporated in this lesson.</p> <p>Read:</p> <ul style="list-style-type: none"> Instructor Handout(s)
Week #11	<p><u>Guest Speaker Lecture: Explore and Exploit on the Fronts of Deep Learning Applications</u></p> <p>Deep learning has become a cutting-edge feature of business practice. Managers are exploring adoption of deep learning in various industries. A guest speaker will provide examples of how deep learning supports new business practices as well as potential opportunities for future applications.</p> <p>Read:</p> <ul style="list-style-type: none"> Instructor Handout(s) <p>Deliverable:</p> <ul style="list-style-type: none"> Group Project due before class
Week #12	<p><u>Newer Deep Learning Approaches</u></p> <p>Deep learning methods are changing every day. Recent developments in deep learning and neural network models will be introduced in this session. It includes but are not limited to Sequential Models, Generative Adversarial Learning, and Reinforcement Learning. The focus will be on the application of such newer models.</p> <p>Read:</p> <ul style="list-style-type: none"> Instructor Handout(s)

The End of Course

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

TBD

Assignments

The assignments require students to answer a set of questions related to the handouts and textbook readings. Sometimes students will conduct numerical experiments. The textbook and prior lectures provide all the information students need to complete the assignments successfully. Students must submit assignments at the beginning of the class session on the due date.

Value: 4 x 10% = 40%

TBD

Midterm Exam

The material for the midterm exam incorporates all the techniques discussed in the course up to the point of the midterm exam. The exam includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.

Value: 25%

Due Date

TBD

Final Project

One of the primary goals of the course is to prepare students to manage deep learning methods in a real-world business context. For this project realistic management problems with background descriptions will be provided to student teams. Each project team will choose one problem from a range of business domains, including FinTech, Collaborative Filtering, Sentiment Analysis, Social Media Analytics, Telecom Customer Retention, etc. Students are expected to design, analyse, and evaluate deep learning algorithms and systems to address the selected management problem. Students will form project teams of (3– 4 students per team) and complete the projects by submitting a project report. The project requires a team to apply the learned techniques and implement a solution to a data-centred business problem.

Value: 1 x 35% = 35%

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: Students will lose one letter grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical marks to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

A+	9
A	8
A-	7
B+	6
B	5
B-	4
C+	3
C	2
C-	1
F	0

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

The Schulich School does not use a percentage scale or prescribe a standard conversion formula from percentages to letter grades.

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Graduate Academic Policy Handbook or the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

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Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Graduate Academic Policy Handbook or contact Student & Enrolment Services.

For Student Accessibility Services (SAS) , contact Student & Enrolment Services or see <https://accessibility.students.yorku.ca/> <https://accessibility.students.yorku.ca/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student & Enrolment Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student & Enrolment Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Director of Student & Enrolment Services (SSB Room W263W263) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For more details, see:

<http://schulich.yorku.ca/graduate-handbook>

Quick Reference: Summary of Classes, Activities and Deliverables

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)
Week 1 Course Overview	Students will gain an overview of the course goal, structure and deliverables. The instructor will explain the history and upcoming trends of deep learning related techniques such as deep and recurrent neural networks and convolutional neural networks and how deep learning is applied to business contexts. Deep learning products and services in practice will also be introduced.	<ul style="list-style-type: none">• Course outline• Text 1
Week 2 Business Strategies	We will go over the business considerations and strategies for machine learning. We explore examples for viable strategic models in organizations. Given the heterogenous characteristics and needs of businesses, such strategies should fit to different data structures, deployment options, and competitive environments.	<ul style="list-style-type: none">• Instructor Handout(s)
Week 3 Neural Networks	This lecture builds the background and cognitive basis for biology-inspired computing, specifically neural computations. Students are then introduced to neural networks. The class introduces models of neurons and simple learning approaches based on	<ul style="list-style-type: none">• Instructor Handout(s)

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)
	these models	
Week 4 Feed-forward & Backpropagation Mechanisms	Students will be introduced to the universality of computing with neural networks. It elaborates on the information flow in neural networks. Typical mechanisms that enable learning in deep neural networks are covered.	<ul style="list-style-type: none"> • Instructor Handout(s) • Text 1
Week 5 Training for Neural Networks	Critical components for any machine learning approach concentrates on the learning step. Students will learn function optimization and gradient descent. Training a neural network depends on determining parameters of the network. Rather than treating deep learning as a black box, you will understand what drives the performance and learn how to get deep learning to work well. Business best-practices for building deep learning applications will be introduced as well, such as TensorFlow by Google.	<ul style="list-style-type: none"> • Instructor Handout(s) • Text 1
Week 6	Midterm Exam	
Week 7 Convolutional Neural Networks (CNN) Fundamentals	Convolutional neural networks have achieved tremendous success in business applications. This lecture will introduce the theoretical foundation of convolutional neural network models. It explains the motivation for using convolution in neural networks. Then we describe the convolution function and pooling operation. Student will learn the working mechanism of multilayer perceptrons.	<ul style="list-style-type: none"> • Instructor Handout(s) • Text 1
Week 8 Business Applications of CNN	Thanks to CNN, computer vision has much more powerful. This session will teach students how to build convolutional neural networks in addressing a number of business applications ranging from fashion product recognition to reading of radiology images. Students have the opportunity to learn about the transformative strength of deep learning via hands-on experience.	<ul style="list-style-type: none"> • Instructor Handout(s)
Week 9 Recurrent Neural Networks (RNN) Fundamentals	Recurrent neural networks have become very effective models for temporal/sequential data. This session will teach how to represent sequential/temporal data as well as parameter sharing. We will cover backpropagation through time, feedforward RNN and bidirectional RNN.	<ul style="list-style-type: none"> • Instructor Handout(s) • Text 1
Week 10 Business Applications of RNN	RNN has improved the performance of a range of machine learning tasks in applications, such as natural language understanding, speech recognition, real-time bidding, advertising campaigns, and future market price forecasting. In this session, student will understand how to build and train RNN in applications and well-known variants (e.g., LSTM) in usage. Hands-on examples are incorporated in this lesson.	<ul style="list-style-type: none"> • Instructor Handout(s)
Week 11 Guest Speaker Lecture	Deep learning has become a cutting-edge feature of business practice. Managers are exploring adoption of deep learning in various industries. A guest speaker	

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)
	will provide examples of how deep learning supports new business practices as well as potential opportunities for future applications.	
Week 12 Newer Deep Learning Approaches	Deep learning methods are changing every day. Recent developments in deep learning and neural network models will be introduced in this session. It includes but are not limited to Sequential Models, Generative Adversarial Learning, and Reinforcement Learning. The focus will be on the application of such newer models.	<ul style="list-style-type: none"> • Instructor Handout(s)

New Course Proposal Template

The following information is required for all new course proposals. To facilitate the review/approval process, please use the headings below (and omit the italicized explanations below each heading).

1. Program:

Schulich MMAI Program

2. Course Number:

SB/MMAI 6050

3. Credit Value:

6.00

4. Long Course Title:

AI Consulting Project

5. Short Course Title:

AI Consulting Project

6. Effective Session:

Winter 2020

7. Calendar (Short) Course Description:

The AI Consulting Project is an intensive, 2-term course where groups of 4 students undertake a comprehensive artificial intelligence (AI) project of an organization and provide business insights to enhance the site's success. At the conclusion of the project students present their work to a panel of at least two experts, including the course director, and to the client site.

8. Expanded Course Description:

The AI Consulting Project is the capstone integrative course of the MMAI program. It will allow students to deepen their understanding of the subject matter and methodologies, as well as provide an opportunity for hands-on, problem-driven research and application. It is an intensive, 2-term course where groups of 4 MMAI students undertake a comprehensive artificial intelligence (AI) project of an organization ("client site") and provide business insights to enhance the site's future success. At the conclusion of the AI consulting project students submit and present their final work to a panel of at least two experts, including the course director, and also to the client site.

9. Evaluation:

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column. Details shown below.

Assignment/Task	Quantity	% Weight	Total %
Milestone 1 (Proposal)	1	10%	10%
Milestone 2 (ETL)	1	10%	20%
Milestone 3 (Methodology)	1	15%	35%
Milestone 4 (Initial Results)	1	15%	50%
Final Presentation	1	25%	75%
Final Report	1	25%	100%

10. Integrated Courses:

N/A

11. Rationale:

This experiential course is the capstone course of the MMAI Program. This course integrates the topics taught in the MMAI Program and allows students to apply their learnings from other MMAI courses in a real life situation.

12. Faculty Resources:

This course will be taught by instructors who are currently teaching in the MBAN Program. No additional faculty resources will be needed.

13. Crosslisted Courses:

N/A

14. Bibliography and Library Statement:

See attached.

15. Physical Resources:

This course will be taught in the new Deloitte Schulich Cognitive Visualization and Analytics Lab that is established in the Cheryle and Robert McEwen Schulich Graduate Building.

New Course Proposal Template (Part B - Schulich Use Only)



16. Instructors and Faculty Coordinator

Initial instructor

Murat Kristal, Ph.D

Alternative instructors

Zhepeng (Lionel) Li, Ph.D

Course coordinator

Murat Kristal, Director, MMAI Program

23. Specializations

Primary area or specialization

MMAI Program

Secondary areas or specializations

N/A

24. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55

Expected enrolment

50

Evidence for enrolment expectations

Based on the similar program MBAN.

17. Human Participants Research

N/A

23. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the following conditions required by Faculty Council applies:

- c) **The Area is deleting courses with at least the same total number of credits.**
N/A
- d) **Provide a convincing case for the proposed course.**
See MMAI Program Proposal.

Course Originator

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name

Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below (minimum 6) confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant Ashwin Joshi

David A. Johnston M. David Rice

Henry M. Kim Richard Irving

Theodoros Peridis <Name of faculty member>

<Name of faculty member> <Name of faculty member>

Approvals:

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving _____ Oct 19, 2018 _____
Signature Date

Richard Irving _____ OMIS _____
Area Coordinator or Specialization Director Area or Specialization

Degree Program

I support the addition of the course to the SSB curriculum.

Murat Kristal _____ October 19, 2018 _____
Signature Date

Murat Kristal _____ MMAI _____
Name of Task Force Chair Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick _____ October 22nd 2018 _____
Signature Date

Detlev Zwick _____ Master Programs Committee _____
Name of Committee Chair Committee

MMAI 6050 6.00: AI Consulting Project



Winter 2020 & Summer 2020

Instructor

Murat Kristal

S341 Seymour Schulich Building (SSB) Email: mkristal@schulich.yorku.ca Telephone: (416) 736-2100 x. 44593 Office hours: by appointment

Assistant

Paula Gowdie Rose 416-736-5074 S337 SSB
pgowdierose@schulich.yorku.ca

Professor Kristal, PhD (North Carolina), is the Program Director of the **Master of Management in Artificial Intelligence (MMAI)** program and an Associate Professor of Operations Management and Information Systems. His research focuses on the areas of supply chain and operations management. Recent research projects include resource allocation in manufacturing firms, sustainable manufacturing, how supply chains adapt to survive in competitive environments, and how mass customization capability can be developed through organizational learning and knowledge management.

Course Description

The AI Consulting Project is the capstone integrative course of the MMAI program. It will allow students to deepen their understanding of the subject matter and methodologies, as well as provide an opportunity for hands-on, problem-driven research and application. It is an intensive, 2-term course where groups of 4 MMAI students undertake a comprehensive artificial intelligence (AI) project of an organization (“client site”) and provide business insights to enhance the site’s future success. At the conclusion of the AI consulting project students submit and present their final work to a panel of at least two experts, including the course director, and also to the client site.

How the Course Works

Successful completion of this project requires several key steps, outlined below and detailed throughout the course outline.

Students must form into groups of 4 and have their groups confirmed by the end of the first term. Schulich will provide the company of study to the groups. If you have found a company that you would like to study, please submit the company’s name and a company contact person to me for approval by the end of the first term. The organization must be an on-going business, a non-profit, a start-up, or a community organization. From January through August, each group will engage in an AI project that will be negotiated between

the student group, the organization’s management, and me, and formalized in a document called the “Statement of Work”.

Student groups are expected to meet with the course instructor every other week. The objective of the status update meetings is to provide a comprehensive update on where you are at vis-a-vis completing the project on time at the end of the third term. To have a successful status update meeting, the group will need to do a review of what was started at the beginning of the project, describe what has changed since the beginning of the project, and update me on the status of the group's research.

The groups are expected to deliver the following milestones regarding the project:

Milestone 1: Understanding the business process and identification of the AI problem solved by the group.

Milestone 2: Identification of variables associated with the AI problem and outlining the details of the ETL (Extract Transform and Load) Process.

Milestone 3: A detailed overview of the methodologies that will be used in order to solve the business problem.

Milestone 4: Initial analysis results, and discussion on what needs to be done in order to finalize the project.

Milestone 5: Final delivery of the project.

At the end of the third term, each group will present their final report (20 minutes) and be prepared to answer questions (for up to another 40 minutes). Groups will also submit their final report, of no more than 40 pages, double-spaced, using 12 pt. type. The expectations for what is required in the final report are provided in a document that is attached. Importantly, there is no marking grid per se, as each organization will demand a different approach and therefore a different grading scheme.

Prerequisites/Corequisites/Course Exclusions: This is the capstone course that spans the last two terms of the MMAI program. Students are expected to successfully complete all course work in order to be eligible for graduation.

Course Learning Outcomes

Upon completion of the AICP, students will be able to distil large quantities of data in a clear and concise manner to solve real-life problems in computational intelligence, decision-making enabled by machine learning, and traditional symbolic AI initiatives. They will gain a keen understanding of the constraints and opportunities for leveraging artificial intelligence within the context of a real organization or situation.

Furthermore, students will gain a conceptual understanding and methodological competence of:

- established techniques of artificial intelligence which are used to create and interpret knowledge in various business environments;
- the treatment of complex issues and judgments using quantitative methodologies;
- value creation for organizations using artificial intelligence as a key measurement of performance and organizational planning.

The AICP experience will also hone the qualities and transferable skills necessary for employment, including:

- the exercise of initiative and of personal responsibility and accountability;
- the intellectual independence required for continuing professional development;
- the ability to appreciate the broader implications of artificial intelligence to particular contexts; and
- the ability to communicate complex and/ or ambiguous ideas, issues and conclusions clearly.

Evaluation

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column. Details shown below.

Assignment/Task	Quantity	% Weight	Total %
Milestone 1 (Proposal)	1	10%	10%
Milestone 2 (ETL)	1	10%	20%
Milestone 3 (Methodology)	1	15%	35%
Milestone 4 (Initial Results)	1	15%	50%
Final Presentation	1	25%	75%
Final Report	1	25%	100%

Please note that the focus on group work is meant to reflect the nature of how work is done in many firms wherein people regularly form teams to work on key issues. The best time to deal with discord within a group is when it appears, rather than when the final project is due. If team members experience disagreement that they cannot resolve themselves, they should speak with me about it.

To ensure that the team members each deliver on their commitments to the project, a formal peer evaluation process will be used throughout the projects and discussed at each of the milestone meetings. A peer grade allocation process will be used to assess the contributions of individual members to the team. Criteria for the peer evaluation include attendance and participation at team meetings; preparation for meetings; cooperativeness in getting work done; time and effort put into the project; timeliness

and quality of the work; use of interpersonal and group dynamic skills, and any other elements of teamwork.

Please take this very seriously, because I do. I will consider this input in assigning the final grade. The grade allocation form is attached and must be submitted, signed by all team members before the final presentation begins. If the document cannot be agreed upon by all group members, the final meeting will be rescheduled at my convenience.

Course Material

Required Readings:

There are no required readings for this course, but there is a reading list that is highly recommended, especially in light of the fact that your group may not have much experience in the areas of consulting, or market research. Further there are some readings on making excellent presentations that should be thoroughly examined.

- HBR Case: When Consultants and Clients Clash. Harvard Business School Press Reprint 97605X
- Market Research: Listen & Learn. **Product #:** 2750BC-PDF-ENG, Harvard Business School Press
- Why the Lean Start Up Changes Everything. Reprint R1305C, Harvard Business School Press
- Market Research Toolbox Chapter 9 and 10 by Ed Mcquarrie
- "How to Pitch a Brilliant Idea" Elsbach, K. HBR September 2003
- "Presenting to Win "The Art of Telling Your Story"" Weissman, J. Pages XXIX-XLII, 3-25
- "Pitfalls in Meetings and How to Avoid Them" Edward Prewitt **Product #**U9806D-PDF-ENG HBS Press

Links to the readings will be posted on the York University Library web site. To access this site, go to www.library.yorku.ca and click on Course Reserve Material, then enter the course number.

Course Materials Database (Canvas):

A Canvas site has been created for this course. The Canvas site includes some important general information for Schulich students. I post rubrics, resources and special instructions on assignments on Canvas. Please get into the habit of checking Canvas on a regular basis. Feel free to e-mail me with questions or concerns throughout the term.

Expectations of Students in the Course

Classes: This course has 6 formal classroom sessions. First class will be held in the beginning of the Winter Term, where I will introduce you to the course and take you through the deliverables and timetable for completion. We will also discuss the scoping

process, the research process, and the importance of confidentiality. Course procedures and grading guidelines will also be discussed. You will also choose the specific dates and times for your milestone meetings with me. This class is mandatory for all students in the course.

The second formal session will occur during week 3 of the Winter Term, when we will meet as a full group. This session is also the first deliverable (Milestone 1) of the course, in which you will present a proposal outlining the scope of your project. You will be asked to make a presentation with no more than 10 slides that outlines the company, the business problem and the expected outcomes of the project. The presentation in this meeting is worth 12.5% of your total grade.

The third formal session will occur either the week before or after Winter Reading Week. In this meeting, the groups will present their data sources and how they will conduct the ETL process (Milestone 2) for the analytics project. The presentation in this meeting is worth 12.5% of your total grade.

The fourth formal session (Milestone 3) will occur in the last week of the Winter Term. In this session, you will present a detailed outline of the methodologies that you will follow to analyze your data. The presentation in this meeting is worth 12.5% of your total grade.

The fifth formal session (Milestone 4) will occur either the week before or after the Summer Reading Week. In this meeting, the groups will present the initial results of their analysis of the data. The presentation in this meeting is worth 12.5% of your total grade.

At the end of the Summer Term, at the sixth formal session, the groups will deliver their Final Presentation to me and to the representatives of the organizations that they are working for. The presentation in this meeting is worth 25% of your total grade.

Initiative and Communication: Because this course has few scheduled classes, it is critical that each team manages their workload and takes initiative to develop and complete the project plan. Providing a good solid project report to the client not only increases your learning and career prospects, but also increases Schulich's reputation among the employer community. While there are six formal assessment points for your progress, you are encouraged to make an appointment with me if you are facing any challenges with data collection, your client, your analysis or the working relationships within your group.

Presentations: All the team members are required to be present in all formal sessions. Failing to attend the formal presentations will lead to 10% reduction in your final grade.

Note: If any changes in this schedule become necessary, notifications will be posted on the course Canvas site, and when changes need to be announced

between classes, an email will be sent to students' email accounts, notifying them of the change.

Week to Week Course Schedule

Winter 2020

<u>Activity</u>	<u>Date</u>
Formal Class Room Session 1	Week 1
Groups Confirmed	Week 1
Milestone 1	Week 3
Milestone 2	Week 6 or 7
Milestone 3	Week 13

Summer 2020

Milestone 4	Week 6 or 7
Milestone 5	Week 13

Assignments

Performance in this course will be evaluated based on five assignments: The Project Plan or the Proposal, the Presentation on the ETL Process, the Methodology Paper and Presentation, Initial Analysis Report and Presentation, and Final Report and Presentation. A more detailed description of the assignments follows. Rubrics for the written assignments will be posted on the course website.

Submission Instructions: For the written assignments, please complete all written reports in no less than 12-point font. Please submit hard copies of your reports and final documents to me at the presentation meetings.

Please submit your documents in this format: [XYZ Inc.PP] for the project plan, and similarly for the Status report (XYZ Inc.SR) and Final report (XYZ Inc.FR). Please also make sure you include your names and student numbers on the front of the document itself. **All late submissions will lose 5% of the final grade per day. Assignments that are more than one week overdue will not be accepted, and will be assigned a grade of**

zero.

The Project Plan or Proposal will be a preliminary assessment of the company's competitive position in its industry, and a project plan for addressing the specific analytics problem the company faces, delivered to your academic project supervisor as a presentation with an accompanying report. This will be worth 12.5% of the course

grade, and it will be due on third week of the Winter Term. You will also have to show evidence that the company has signed off on your project plan.

The ETL Report (Milestone 2). Over the following 3 or 4 weeks, students will conduct primary research on the available data sets within the organization and how these data sets will be extracted from the organization. The students might have to help the organization with SQL coding or providing them with SFTP processes. This will be worth 10% of the course grade, and should be delivered as a presentation.

The Methodology Presentation and Report (Milestone 3). Based on the analysis of the analytics problem the team will present a detailed report on how to analyze the data, the assumptions of the analyses methodology and the appropriateness of the chosen methodology for the analytics problem. The presentation will be accompanied with a written report of no more than 15 double-spaced pages plus appendices. Importantly, teams must present this report to me in a 20-minute presentation. This will be worth 15% of your grade.

The Initial Results Presentation and Report (Milestone 4). In this stage, you will share your initial results with me and the organization that you are working for. As a result, your presentation and the accompanying report must be succinct and written in a way that can be understood by the client site. The presentation will be accompanied with a written report of no more than 15 double-spaced pages plus appendices. This will be worth 15% of your grade.

The Final Presentation and Report. In the final month of the Winter Term, students will complete any remaining research and write up the results of their study, incorporating all feedback they have received. They will make recommendations to address the company's issue for this project, as well as for any ways of solving the company's analytics problem. The presentation and the report combined will be worth 50% of the course grade, and it will be due on the last week of the winter Term. The written report will be no more than 40 double-spaced pages, plus appendices. Importantly, teams must present this report to me in a 20-minute presentation and the client site.

23. Evaluation of Assignments

Rubrics for each assignment are attached and will be posted on Canvas by the beginning of the Winter Term.

24. Calculation of Course Grade

In this class, final course grades will be determined by the following process: Each assignment will receive a grade. These will be combined according to the weightings assigned to each assignment to give a final grade. Grades may be rounded up or down depending on the final class distribution.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1.

Letter Grade	Numerical Grade	Percentage Grade
A+	9	100% - 95%
A	8	94% - 90%
A-	7	89% - 85%
B+	6	84% - 80%
B	5	79% - 74%
B-	4	73% - 70%
C+	3	69% - 65%
C	2	64% - 60%
C-	1	59% - 50%
F	0	Below 50%

Note that letter grade “A” corresponds to the interval from 94% to 90%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Graduate Academic Policy Handbook or the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize

themselves with York University's policy on academic honesty, which may be found in the Graduate Academic Policy Handbook and on the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

New Course Proposal Template

The following information is required for all new course proposals. To facilitate the review/approval process, please use the headings below (and omit the italicized explanations below each heading).

1. Program:

Schulich MMAI Program

2. Course Number:

SB/MMAI 5040

3. Credit Value:

3.00

4. Long Course Title:

Business Applications of Artificial Intelligence I

5. Short Course Title:

Business Applications of AI I

6. Effective Session:

Winter 2020

7. Calendar (Short) Course Description:

The emphasis in this course will be on automation and autonomous cyber-physical system applications of artificial intelligence. Students will delve deeper into topics which include: probabilistic reasoning & handling uncertainty; search; perception & sensing; human- computer interfacing; conversational systems; and autonomous robotics, drones, and autonomous vehicles.

8. Expanded Course Description:

This course builds on the introductory perspective provided by MMAI 5000, which emphasizes practical business applications of artificial intelligence rather than the conventional focus on the derivation of methods from first principles. The emphasis in this course will be on automation and autonomous cyber-physical system applications of artificial intelligence in business contexts. Students gain a holistic view of artificial intelligence as applied to practical business contexts through a combination of case studies (in and out of class) as well as in-class lab-style technical explorations. These are complimented by assignments and two projects throughout the course. Furthermore, students gain practical knowledge of the managerial applications of AI across several business contexts from guest speakers and detailed business case studies.

9. Evaluation:

Course work includes three (3) assignments, one (1) midterm exam, a final exam, and in-class participation.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	3	5%	15%	Individual
Project	2	20%	40%	Group
Class Participation	1	10%	10%	Individual
Final Exam	1	35%	35%	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions” (p. 5).

10. Integrated Courses:

N/A

11. Rationale:

Managers of AI have to possess an advanced understanding of artificial intelligence applications to devise effective AI solutions to business problems.. This course will also provides details about AI use in the analytics industry.

12. Faculty Resources:

This course will be taught by Instructors who are currently teaching in the MMAI Program. No additional faculty resources will be needed.

13. Crosslisted Courses:

N/A

14. Bibliography and Library Statement:

See attached.

15. Physical Resources:

Ideally this course would be taught with the help of a robotics kit, estimated cost \$500 per student. Existing graduate lab facilities can be used.



New Course Proposal Template (Part B - Schulich Use Only)

28. Instructors and Faculty Coordinator

Initial instructor

N/A

Alternative instructors

Hjalmar Turesson, Ph.D

Course coordinator

Murat Kristal, Director, MMAI Program

29. Specializations

Primary area or specialization

MMAI Program

Secondary areas or specializations

N/A

30. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55

Expected enrolment

55

Evidence for enrolment expectations

Enrolment based on demand for MBAN program

31. Human Participants Research

N/A

32. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the following conditions required by Faculty Council applies:

- e) The Area is deleting courses with at least the same total number of credits.**
N/A
- f) Provide a convincing case for the proposed course.**
See MMAI Program Proposal Program Document.

Course Originator

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name

Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below (minimum 6) confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Ashwin Joshi

David A. Johnston

M. David Rice

Henry M. Kim

Richard Irving

Theodoros Peridis

<Name of faculty member>

<Name of faculty member>

<Name of faculty member>

Approvals:

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and

I support the addition of the course to the SSB curriculum.

Richard Irving

Signature

Oct 19, 2018

Date

Richard Irving

Area Coordinator or Specialization Director

OMIS

Area or Specialization

Degree Program

I support the addition of the course to the SSB curriculum.

Murat Kristal

Signature

October 19, 2018

Date

Murat Kristal

Name of Task Force Chair

MMAI

Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick

Signature

October 22nd 2018

Date

Detlev Zwick

Name of Committee Chair

Master Programs Committee

Committee

Course Outline

Winter 2019

Mondays, 2:30-5:30pm, beginning on January 11, 2018
S128 SSB

Instructor

TBA

Office hours: TBA

Assistant

Paula Gowdie Rose

S337 Seymour Schulich Building

416-736-5074

pgowdierose@schulich.yorku.ca

Brief Description

This course builds on the introductory perspective provided in Artificial Intelligence in Business I which emphasizes practical business applications of artificial intelligence rather than the conventional focus on the derivation of methods from first principles. The emphasis in this course will be on automation and autonomous cyber-physical system applications of artificial intelligence. As with the introductory Artificial Intelligence in Business I course, students gain a holistic view of artificial intelligence as applied to practical business contexts through a combination of case studies (in and out of class) as well as in-class lab-style technical explorations. These are complimented by assignments and two projects throughout the course. Furthermore, students gain practical knowledge of the industrial application of the field through guest speakers and detailed business case studies, which explore the application of artificial intelligence to several business contexts.

Prerequisite(s): NONE

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Course Learning Outcomes

- Deploy Artificial Intelligence solutions in an automation and autonomous cyber-physical business context.

- Apply probabilistic reasoning & handling of uncertainty within a business domain.
- Consider design factors of human-computer interfacing when implementing business solutions.
- In the context of autonomous robotics, drones, and vehicles; perform search tasks using perception, sensing, and planning.
- Discuss the use of conversational AI systems in multiple market verticals.

Deliverables at a Glance

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	3	5	15	Individual
Projects	2	20	40	Group
Final exam	1	35	35	Individual
Class participation		10	10	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions”, p. 6.

Course Material

The course uses a set of handouts, and two textbooks used as a reference for technical background and business perspectives, respectively. The textbooks can be purchased at the York University Bookstore (<http://bookstore.blog.yorku.ca>):

Artificial Intelligence: A Modern Approach, 3rd Edition, Stuart Russell and Peter Norvig, Pearson (2010).

Artificial Intelligence and Machine Learning for Business: A No-Nonsense Guide to Data Driven Technologies, Steven Finlay, Relativistic, (2017).

The Course Materials Database (CMD) has been created within Schulich’s Lotus Notes. It contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook as indicated in the Course Materials Database (CMD).

Class Participation (contribution). Students earn participation marks evenly throughout the term, through participating in in-class discussions, presentations, and reflection surveys following guest speaker visits.

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on the course CMD, and when changes need to be announced between classes, an email will be sent to students' Lotus Notes email accounts, notifying them of the change.

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
January 11 (1)	<p><u>Embodied Artificially Intelligent Agents in Conjunction with AI Enterprise Architecture</u></p> <p>Students will be review key concepts specific to embodied artificial agents, as well as the business implications around the deployment of autonomous systems in conjunction with AI Enterprise Architecture.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Course Outline
January 18 (2)	<p><u>Search</u></p> <p>Methods are presented to perform computational search, incorporating mathematical optimization approaches. Applications are discussed in the context of knowledge and also arbitrary graphs in a business context.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
January 25 (3)	<p><u>Probabilistic Reasoning</u></p> <p>Probabilistic methods are presented for performing inference including the Naïve Bayes Classifier and Bayesian Networks. Consequences of statistical properties for the application of Artificial Intelligence to a business context are discussed.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
February 1	<p><u>Handling Uncertainty</u></p>

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
(4)	<p>Methods are presented for quantifying uncertainty, as well as formalisms and approaches for reasoning under uncertain conditions or assumptions. Criteria for making simple and complex business decisions are presented.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s) <p><u>Assignment Due:</u></p> <ul style="list-style-type: none"> ▪ Assignment 1
February 8 (5)	<p><u>Perception & Sensing I</u></p> <p>For embodied agents within an environment interaction with sensors bridges the gap between the cyber and physical worlds. Students learn how to interface autonomous agents within a business environment with data coming from a variety of sensor types.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
February 15 (6)	<p><u>Perception & Sensing II</u></p> <p>Advanced topics in perception, sensing, and actuation are covered including Computer Vision and the use of motors.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
February 22	<i>Reading Week – No Class</i>
March 1 (7)	<p><u>Interactions within the Organization: Human-Computer Interfacing</u></p> <p>The integration of autonomous agents within human organizations is considered in detail. Approaches for increasing productivity and efficiency within contemporary business environments are discussed.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s) <p><u>Project Due:</u></p> <ul style="list-style-type: none"> ▪ Project A
March 8 (8)	<p><u>Case study: Conversational Systems</u></p> <p>Increasingly, conversational Artificial Intelligence systems are interacting with customers and also within the organization. The architecture of these systems is discussed, as well as studying their adoption in the marketplace.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
	<p><u>Assignment Due:</u></p> <ul style="list-style-type: none"> ▪ Assignment 2
<p>March 15 (9)</p>	<p><u>Case Study: Advanced Robotics, Drones, and Autonomous Vehicles</u> The deployment of advanced mobile robots, drones, and autonomous vehicles is occurring in the marketplace. The implication of this for organizations is discussed, as are new business models in the context of the regulatory atmosphere.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
<p>March 22 (10)</p>	<p><u>Case Study: Healthcare Applications</u> Healthcare is an increasing area of interest for deployments in the healthcare industry. We study the business issues around use cases in healthcare and investigate some methodologies and frameworks for implementing these use cases.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s)
<p>March 29 (11)</p>	<p><u>Case Study: Entertainment and Gamification</u> Often, cutting edge features and technologies are spearheaded and find early adoption in the entertainment industry. We study new Artificial Intelligence related technologies introduced into the marketplace and how these may find their place in other industry verticals in the near future.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s) <p><u>Project Due:</u></p> <ul style="list-style-type: none"> ▪ Project B
<p>April 5 (12)</p>	<p><u>Case Study: Contemporary Topics in Artificial Intelligence</u> We will “invert the classroom” and students will be given the chance to present a case based on contemporary topics in the business applications of artificial intelligence.</p> <p>Read:</p> <ul style="list-style-type: none"> ▪ Instructor Handout(s) <p><u>Assignment Due:</u></p> <ul style="list-style-type: none"> ▪ Assignment 3
<p>April 12</p>	<p>Final Exam</p>

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

February 1	<u>Assignments</u>
March 8	The assignments require students to answer a set of questions closely related to the handouts or textbook contents, or conduct numerical experiments. The textbook and prior lectures provide all the information students need to complete the assignments. Students must submit assignments at the beginning of the lecturing session on the due date. Value: 3 x 5% = 15%
April 5	
March 1	<u>Projects A & B</u>
March 29	Students need to form project teams of size 3– 4, and complete the projects within a specified time period by submitting a project report and the computer code. The project requires a team to apply the learned techniques to implement a data-centred business problem. Value: 2 x 20% = 40%
April 12	<u>Final Exam</u> The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced. Value: 35%

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: The students will lose 5% of their assignment grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical mark to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

A+	[100% - 90%]
A	[89% - 80%]
A-	[79% - 70%]
B+	[69% - 60%]
B	[59% - 50%]
B-	[49% - 40%]
C+	[39% - 30%]
C	[29% - 20%]
C-	[19% - 10%]
F	[9% - 0%]

Note that letter grade "A" corresponds to the interval from 89% to 80%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

The Schulich School does not use a percentage scale or prescribe a standard conversion formula from percentages to letter grades. Conversions within a course are at the discretion of the instructor.

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Student Handbook or the Student Services & International Relations website:

http://www.schulich.yorku.ca/client/schulich/schulich_lp4w_ind_webstation.nsf/page/Enrolment+Grades+and+Convocation!OpenDocument#tabs-2

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University's policy on academic honesty, which may be found in the Student Handbook and on the Student Services & International Relations website:

http://www.schulich.yorku.ca/client/schulich/schulich_lp4w_ind_webstation.nsf/page/Academic+Honesty!OpenDocument

Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Student Handbook or contact Student Services. For counseling & disability services, contact Student Services or see <http://www.yorku.ca/cds/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Director of Student Services (SSB Room W262) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For more details, see:

http://schulich.yorku.ca/client/schulich/schulich_lp4w_ind_webstation.nsf/page/Enrolment+-+MBA+Exam+Schedule?OpenDocument

Quick Reference: Summary of Classes, Activities and Deliverables

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)	Written Preparation
1. January 11 Embodied Artificially Intelligent Agents	Students will be review key concepts specific to embodied artificial agents, as well as the business implications around the deployment of autonomous systems	<ul style="list-style-type: none"> Instructor Handout(s) 	
2. January 18 Search	Methods are presented to perform computational search, incorporating mathematical optimization approaches. Applications are discussed in the context of knowledge and also arbitrary graphs in a business context	<ul style="list-style-type: none"> Instructor Handout(s) 	
3. January 25 Probabilistic Reasoning	Methods are presented for quantifying uncertainty, as well as formalisms and approaches for reasoning under uncertain conditions or assumptions. Criteria for making simple and complex business decisions are presented	<ul style="list-style-type: none"> Instructor Handout(s) 	
4. February 1 Handling Uncertainty	<ul style="list-style-type: none"> Biological Inspiration for Evolutionary Computing Fitness Crossover Genetic Algorithms Genetic Programming Business applications of evolutionary computing. 	<ul style="list-style-type: none"> Instructor Handout(s) 	
5. February 8 Perception & Sensing I	For embodied agents within an environment interaction with sensors bridges the gap between the cyber and physical worlds. Students learn how to interface autonomous agents within a business environment with data coming from a variety of sensor types.	<ul style="list-style-type: none"> Instructor Handout(s) 	
6. February 15 Perception & Sensing II	Advanced topics in perception, sensing, and actuation are covered	<ul style="list-style-type: none"> Instructor Handout(s) 	

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)	Written Preparation
	including Computer Vision and the use of motors		
	<i>NO CLASS (Reading Week)</i>		
7. March 1 Interactions within the Organization: Human-Computer Interfacing	The integration of autonomous agents within human organizations is considered in detail. Approaches for increasing productivity and efficiency within contemporary business environments are discussed		
8. March 8 Case study: Conversational Systems	Increasingly, conversational Artificial Intelligence systems are interacting with customers and also within the organization. The architecture of these systems is discussed, as well as studying their adoption in the marketplace	<ul style="list-style-type: none"> • Instructor Handout(s) 	
9. March 15 Case Study: Advanced Robotics, Drones, and Autonomous Vehicles	The deployment of advanced mobile robots, drones, and autonomous vehicles is occurring in the marketplace. The implication of this for organizations is discussed, as are new business models in the context of the regulatory atmosphere	<ul style="list-style-type: none"> • Instructor Handout(s) 	
10. March 22 Case Study: Healthcare Applications	Healthcare is an increasing area of interest for deployments in the healthcare industry. We study the business issues around use cases in healthcare and investigate some methodologies and frameworks for implementing these use cases	<ul style="list-style-type: none"> • Instructor Handout(s) 	
11. March 29 Case Study: Entertainment and Gamification	Often, cutting edge features and technologies are spearheaded and find early adoption in the entertainment industry. We study new Artificial	<ul style="list-style-type: none"> • Instructor Handout(s) 	

Class No., Title and Date	In-Class Case/Exercise	Reading Preparation (excluding cases and optional readings)	Written Preparation
	Intelligence related technologies introduced into the marketplace and how these may find their place in other industry verticals in the near future		
12. April 5 Case Study: Contemporary Topics in Artificial Intelligence	We will “invert the classroom” and students will be given the chance to present a case based on contemporary topics in the business applications of artificial intelligence	<ul style="list-style-type: none"> • Instructor Handout(s) 	

Faculty of Graduate Studies New Course Proposal

- 1. Program:** Master of Management in Artificial Intelligence
- 2. Course Number:** SB/MMAI 5100
- 3. Credit Value:** 3.00
- 4. Long Course Title:** Database Fundamentals
- 5. Short Course Title:** Database Fundamentals
- 6. Effective Session:** Fall 2019
- 7. Calendar (Short) Course Description:**

Database Management Systems are computer-based systems used by organizations to manage the vast amount of data that accompany daily operations, support data analysis, and enable intelligent decision making. This course provides an applied introduction to database management systems and their use in the business environment. The course covers the fundamentals of database analysis and design.
- 8. Expanded Course Description:**

Database Management Systems are computer-based systems used by organizations to manage the vast amount of data that accompany daily operations, support data analysis, and enable intelligent decision making. This course provides an applied introduction to database management systems and their use in the business environment. The course covers the fundamentals of database analysis and design. It also provides a hands-on experience in designing and building databases using Oracle or MySQL Database. Specific topics covered include the role of database systems, the relational database model, and entity-relationship diagrams, as well as applied skills such as formulating queries, designing forms, and creating reports in SQL (Structured Query Language). At the end of the course students will be able to design and build a fully operational database to support business decision making and operations.
- 9. Evaluation:**

Course work includes three (4) assignments, one (1) group project, a final exam, and in-class participation.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	4	10%	40%	Individual
Class Participation	1	10%	10%	Individual
Group Project	1	20%	20%	Group
Final Exam	1	30%	30%	Individual

Assignment/Task	Quantity	% Weight	Total %	Author
			100%	

10. Integrated Courses:

N/A

11. Rationale:

Please see Master of Management in Artificial Intelligence program proposal

12. Faculty Resources:

This course will be taught by Instructors who are currently teaching in the MMAI Program. No additional faculty resources will be needed.

13. Crosslisted Courses:

Not crosslisted

14. Bibliography and Library Statement:

See attached.

15. Physical Resources:

No additional physical resources needed.



New Course Proposal Template (Part B - Schulich Use Only)

33. Instructors and Faculty Coordinator

Initial instructor

N/A

Alternative instructors

Hjalmar Turesson, Ph.D.

Course coordinator

Murat Kristal, Director, MMAI Program

34. Specializations

Primary area or specialization

MMAI Program

Secondary areas or specializations

N/A

35. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55

Expected enrolment

55

Evidence for enrolment expectations

Numbers are based on similar demand for the MBAN program.

36. Human Participants Research

N/A

37. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the following conditions

required by Faculty Council applies:

g) The Area is deleting courses with at least the same total number of credits.
Does not apply. This is not an elective.

h) Provide a convincing case for the proposed course.
N/A

Course Originator

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name

Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below (minimum 6) confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Ashwin Joshi

David A. Johnston

M. David Rice

Henry M. Kim

Richard Irving

Theodoros Peridis

<Name of faculty member>

<Name of faculty member>

<Name of faculty member>

Approvals:

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving
Signature

Oct 19, 2018
Date

Richard Irving
Area Coordinator or Specialization Director

OMIS
Area or Specialization

Degree Program

I support the addition of the course to the SSB curriculum.

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name of Task Force Chair

MMAI
Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick
Signature

October 22nd 2018
Date

Detlev Zwick
Name of Committee Chair

Master Programs Committee
Committee

MMAI 5100 3.00: Database Fundamentals



Course Outline

Semester Year: TBA

SECTION	DAY	TIME	ROOM (SSB)	BEGINNING	INSTRUCTOR
TBA					

Instructors
Name, Location, Tel, Email, Hours

Administrative Assistant: Paula Gowdie Rose, 416-736-5074, S337N SSB, pgowdierose@schulich.yorku.ca

Biography of Instructor: TBA

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Brief Description

Database Management Systems are computer-based systems used by organizations to manage the vast amount of data that accompany daily operations, support data analysis, and enable intelligent decision making. This course provides an applied introduction to database management systems and their use in the business environment. The course covers the fundamentals of database analysis and design. It also provides a hands-on experience in designing and building databases using Oracle or MySQL Database. Specific topics covered include the role of database systems, the relational database model, and entity-relationship diagrams, as well as applied skills such as formulating queries, designing forms, and creating reports in SQL (Structured Query Language). At the end of the course students will be able to design and build a fully operational database to support business decision making and operations.

1. Course Learning Outcomes

This course has six primary objectives, which will be introduced in class lectures and reinforced through labs, assignments and course textbook reading. Class learning objectives include the

ability to:

- Explain what is conceptual modeling and logical database design within business context.
- Create an entity relationship diagram given a business description.
- Explain how to convert a conceptual model (entity-relationship diagram) into a working relational model.
- Explain the difference between first, second, and third normal form and normalize a database.
- Write SQL statements to build and manage databases (Data Definition Language) as well as manipulate existing data (Data Manipulation Language) that will help businesses to run more efficiently.
- Explain and use inner queries in SQL statements that may arise within business context.

Getting Help

Email: E-mail the instructor with any queries about the course such as administrative issues, questions regarding the grading of the assignments, midterm or final exam, or if you have brief questions about the material. ***Please put MMAI 5100, the section #, your full name and brief heading (i.e., description of what the email is about) as the first part of the subject line in all e-mail correspondence.*** We will try to respond within two business days (48 hours) but if you do not get a response within this time frame, please send another email as we probably did not get the original email. For any other issues, please come speak with the instructor during office hours. Please be professional in all your email correspondence. For more information on how to write an effective and professional email, please see the following links: <http://writingcenter.unc.edu/handouts/effective-e-mail-communication/>
<http://researchguides.library.yorku.ca/content.php?pid=476543&sid=3902786>

Meetings and Office Hours: Students are invited to attend office hours on a drop-in basis. No prior appointments are required for scheduled office hours. Students can also meet with the instructor outside office hours by requesting an appointment (i.e., send an email to the instructor). If you cannot attend a scheduled appointment, notify the instructor as soon as possible. If you schedule an appointment and do not show up, this may affect your ability to schedule future appointments.

Course Announcements: All general course emails and announcements from your instructor will be posted and sent in [Canvas](#). This correspondence will be sent to the email account you have specified in your [Canvas](#) profile. Note that some section-specific messages may be sent to your email account within the Schulich mail system rather than through Canvas. ***It is your responsibility to ensure that you have access to both sources of information and check each regularly.***

35. Deliverables at a Glance

Course work includes participation activities and the following deliverables: five assignments, one group project and one final exam. **Marks will not be adjusted until all deliverables have been submitted and the final grade has been compiled.** For each deliverable, the grading will be performed by combining all sections into one and assessing students relative to the entire cohort.

Deliverable	Quantity	% Weight	Total %	Author
Homework Assignments	4	10	40	Individual
Group Project	1	20	20	Group of 2-3
Final Exam	1	40	30	Individual
Class Participation Activities	1	10	10	Individual
Total			100%	

36. Course Material

Text: Required reading for this course includes the following custom book, which is available for purchase from the York University bookstore (<http://bookstore.blog.yorku.ca>):

Modern Database Management, 12th Edition, Jeffery A. Hoffer, Ramesh Venkataraman, and Heikki Topi, Prentice Hall Press, 2015. ISBN-13: 978-0133544619.

Course website: An online learning platform ([Canvas](#)) has been created. - It contains information and materials specific to this course, including lecture slides, practice problems and information regarding additional readings. Check it frequently. You will also access and submit homework assignments on CanvasCanvas. Because of the large volume of information available on CanvasCanvas, information will be grouped by topic (lectures, general information, practice materials, homework, etc.).

Access to CanvasCanvas requires a Passport York login and password. If you do not have a Passport York account, you can find information on how to obtain one at <http://computing.yorku.ca/students/home/passwords-passport-york-access/>

37. CanvasCanvas Student Preparation for Class and Class Participation: Expectations

Participating honestly in this academic community ensures that the York University degree

that you earn will continue to be valued and respected as a true signifier of your individual work and academic achievement. All suspected cases of academic dishonesty will be investigated. If you have any questions as to what is and is not permitted, do not hesitate to contact the course instructor or your academic advisors. Potential offences include, but are not limited to:

In papers and assignments:

- Using someone else's ideas or words without appropriate acknowledgement (i.e., citations).
- Submitting your own work in more than one course without the permission of the instructor.
- Making up sources or facts that are false (i.e., the claim is completely unsubstantiated).
- Obtaining or providing unauthorized assistance on any assignment (this includes collaborating with others on assignments that are supposed to be completed individually).

On test and exams:

- Using or possessing any unauthorized aids (e.g., cell phone, graphing calculators).
- Looking at someone else's answers at any time during the exam.
- Misrepresenting your identity or having another individual write your exam.
- Submitting an altered exam or assignment for re-grading.

Misrepresentation:

- Falsifying institutional documents, grades or university documentation (e.g., medical notes).

Late Assignments: Please note that all assignments are due at the date and time specified. The exact date and time will be given in the assignment and on [Canvas](#). Late work will not be accepted. Exceptions will only be granted for medical and other serious emergencies. Please make every effort to let your instructor know in advance if your assignment is going to be late – use email. Supporting documentation will be required as per the [Schulich policy](#) on missed tests and assignments.

Group Work: Up to three students can work on an assignment. Although it is possible to complete the assignments by yourself, we recommend 2-3 students per group. Only one assignment per group should be submitted. Assignments will be submitted online via [Canvas](#). Groups can consist of students from other sections of the course. However, the assignment must be submitted at the earliest designated due date amongst all group members or else the submission will not be accepted. Learning to work together in teams is an important aspect of your education and preparation for your future careers. That said, project-based teamwork is often new to students and you are therefore reminded of the following expectations with respect to behavior and contributions to your team project.

When working in a team, Schulich students are expected to:

- Treat other members with courtesy and respect and honor the group ground rules.
- Contribute substantially and proportionally to each assignment.
- Ensure enough familiarity with the entire contents of the assignment so as to be able to sign off on it as original work and meet the assignment timeline as established by the team.

Resolving Group Conflicts: Conflicts are part of the team's process of learning how to work together effectively and when handled well, can generate creativity and bring multiple perspectives to the solution. Student teams are collectively expected to work through their misunderstandings as soon as they arise (and prior to submission of the final project). In cases where teams are unable to arrive at a solution that works for all members, the team must bring this to the attention of the instructor.

38. Class-by-Class Syllabus

Lectures will have a significant interactive component. Your attendance is expected. If you have a laptop, it is recommended that you bring it along to all lectures, particularly those where there will be a greater emphasis on computation. Students will earn credit for active participation in course activities.

Readings from the text or supplementary materials will be assigned for each of the topics in the course. These are useful for preparation prior to lecture as well as to reinforce class concepts after each session.

Practice problems are selected exercises for you to work on to gain experience in each of the problem solving areas. They will not be graded. Solutions may be posted on [Canvas](#). You may choose to do as many of these problems as you like, and may work on them individually or in groups. In order to maximize your learning, you should attempt the problem individually before working with others. While the suggested problems are a good reflection of the material covered in the course, they are not necessarily comprehensive, and students are encouraged to work on additional problems beyond those suggested.

Boot camp. At the end of each module (and in preparation for the test on that topic), students will have the opportunity to take a mock mini-test during the lecture period. The test will simulate real exam conditions (it will be a timed test) and results will be provided during the session. This is an opportunity to get immediate feedback on your mastery of the material and preparedness for the test. It also allows the instructor to identify and further reinforce any concepts students are struggling with.

Note: If any changes in this schedule become necessary, notifications will be posted on [Canvas](#). When changes need to be announced between classes, an email will be sent to students' email accounts, notifying them of the change. Check your email and the course website regularly. It is your responsibility to ensure that you are up-to-date.

DATE/WEEK	TOPICS/ASSIGNED READINGS/ASSIGNED WORK DUE
Week #1	<u>Intro to DBMS & Conceptual Design – ER Model I</u> <ul style="list-style-type: none"> • Reading: Chapter 1-3 □ Homework Assignment 1
Week #2	<u>Conceptual Design – ER Model II & Review and Exercises</u> <ul style="list-style-type: none"> • Reading: Chapter 3 <p>Deliverables:</p> <ul style="list-style-type: none"> • Homework Assignment 1 (due before class)
Week #3	<u>Lab I: Create and Populate Table</u> <p>Deliverables:</p> <ul style="list-style-type: none"> □ Questions due in class
Week #4	<u>Enhanced ER Model & Logical DB Design</u> <ul style="list-style-type: none"> • Reading: Chapter 4, 5 • Homework Assignment 2
Week #5	<u>Lab II: Define Key and Constraints</u> <p>Deliverables:</p> <ul style="list-style-type: none"> • Homework Assignment 2 (due before class)
Week #6	<u>Transforming Conceptual Design to Logical Design & Exercises</u> <ul style="list-style-type: none"> • Reading: Chapter 5 • Homework Assignment 3
Week #7	<u>Normalization & Exercises</u> <ul style="list-style-type: none"> • Reading: Chapter 5 • Group Project Assignment <p>Deliverables:</p> <ul style="list-style-type: none"> • Homework Assignment 3 (due before class)
Week #8	<u>SQL Language I & II</u> <ul style="list-style-type: none"> • Reading: Chapter 6, 7 • Homework 4

DATE/WEEK	TOPICS/ASSIGNED READINGS/ASSIGNED WORK DUE
<i>Week #9</i>	<u>Lab III: DML</u> Deliverables: <ul style="list-style-type: none"> • Homework Assignment 4 (due before class)
<i>Week #10</i>	<u>Advanced Databases - Data Warehousing</u> <ul style="list-style-type: none"> • Reading: Chapter 9
<i>Week #11</i>	<u>Advanced Databases - NoSQL</u> <ul style="list-style-type: none"> • Reading: Chapter 11
<i>Week #12</i>	<u>Lab IV: Datamart & Hadoop</u> Deliverables <ul style="list-style-type: none"> • Group Project (due before class)
<u>Final Exam</u>	

39. Written Assignments/Projects and Exam[s]: Descriptions

Due Date

As per schedule (in class)

Participation

During 10 regularly scheduled class sessions, you will have the opportunity to earn a cumulative total of 10% of your final course grade. How the credit is earned will vary from session to session – it could be granted for bringing to class some data or an example (as instructed in a previous session), for completing an in-class participatory exercise, or simply for attendance. Some activities will take place in groups, others may be individual. Unless special permission has been arranged with your instructor prior to class, you must attend your regularly scheduled section to earn credit.

Value: 10%

TBD

Assignments

You will prepare 4 assignments. There is basically one assignment for each topic area. Each assignment is worth 10%. You will complete and submit short exercises reinforcing concepts learned in class. Assignments themselves as well as detailed instructions regarding submission expectations will be posted on [Canvas](#). All instructions for assignments are expected to be followed. Assignments are to be submitted online using your [Canvas](#) account before the designated due date. **NO LATE ASSIGNMENTS WILL BE ACCEPTED.**

Value: 4 x 10% = 40%

TBD

Group Project

Students can form a team of 2-3. You will complete the project tasks, submit a project report in written, and conduct a presentation in class.

Value: 20%

Please refer to the exam schedule

Final Exam

Date, time and location of the final exam TBA. Please refer to the exam schedule. The University's Registrar's office sets specific examination dates after the term begins and enrolment patterns are identified. Students should not make plans to be away from Toronto during any portion of the announced examination period until the dates for their specific examinations have been announced.

Due Date

Max length: 3 hours in duration

Value: 40%

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Calculation of Course Grade

Letter Grade	Numerical Grade
A+	9
A	8
A-	7
B+	6
B	5
B-	4
C+	3
C	2
C-	1
F	0

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

The Schulich School does not use a percentage scale or prescribe a standard conversion formula from percentages to letter grades. Conversions within a course are at the discretion of the instructor.

For more details on the index, grading policy, and grade point average (GPA) requirements, consult your Graduate Academic Policy Handbook.

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University's policy on academic honesty, which may be found on the Graduate Academic Policy Handbook and on the Student Services & International Relations Schulich website:

<http://schulich.yorku.ca/current-students/academic-honesty/>

Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Graduate Academic Policy Handbook or contact Student & Enrolment Services.

For Student Accessibility Services (SAS) , contact Student & Enrolment Services or see <http://cds.info.yorku.ca/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student & Enrolment Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Associate Director, Undergraduate Programs Unit at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Associate Director, Undergraduate Programs Unit (SSB Room W263W263) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For a copy of this document, visit <http://www.registrar.yorku.ca/pdf/attending-physicians-statement.pdf>

Recording Lectures. Lectures and course materials prepared by the instructor are considered by the University to be an instructor's intellectual property covered by the Canadian Copyright Act. Students wishing to record a lecture or other course material in any way are required to ask the instructor's explicit permission, and may not do so unless it is granted (note: students who have been previously granted permission to record lectures as an accommodation for a disability are, of course, excepted). This includes tape recording, filming, photographing PowerPoint slides, [Canvas](#) materials, etc. If permission is granted, it is intended for the individual student's own study purposes and does not include permission to "publish" them in anyway. It is absolutely forbidden for a student to publish an instructor's notes to a website or sell them in any other form without formal permission.

Faculty of Graduate Studies

New Course Proposal

1. **Program:** Schulich Master of Management in Artificial Intelligence
2. **Course Number:** MMAI 5090
3. **Credit Value:** 3.00
4. **Long Course Title:** Business Applications of Artificial Intelligence II
5. **Short Course Title:** Business Apps of A II
6. **Effective Session:** Summer 2020
7. **Calendar (Short) Course Description**

This course bridges the theoretical foundation and the business applications of artificial intelligence technology. Through in-class lecturing and hands-on activities, students learn fundamentals of AI technology, formulate business problems in AI paradigm and Applications of AI in addressing business problems. The class covers up-to-date AI applications such as Recommendation Systems, FinTech, Social Network Analytics, Sentiment Analysis etc.

8. Expanded Course Description

Artificial Intelligence has emerged as an increasingly impactful discipline in science and technology. AI applications are embedded in the infrastructure of many products and industries search engines, medical diagnoses, speech recognition, robot control, web search, advertising and so on so forth. This course provides a broad overview of applying modern artificial intelligence. Learn how machines can engage in problem solving, reasoning, learning, and interaction. Gain an appreciation and case-based experience of this dynamic field. The class covers up-to-date AI applications in various domains such as Recommendation Systems, FinTech, Social Network Analytics, Sentiment Analysis etc.

Throughout this course, students should be able to:

- Understand critical methods of Artificial Intelligence solutions in autonomous business contexts.
- Apply appropriate AI paradigm and technology to formulate and address various business problems.
- Consider design factors of AI technology when implementing business solutions, via case studies.
- Discuss the frontier use of AI in multiple market verticals.

9. Evaluation

The evaluation measures are comprised of individual assignments, group projects, written exam and class participation. Course deliverables are broken down as in the following table.

<i>Deliverable</i>	<i>Quantity</i>	<i>% Weight</i>	<i>Total %</i>	<i>Author</i>
<i>Assignments</i>	<i>4</i>	<i>10</i>	<i>40</i>	<i>Individual</i>
<i>Projects</i>	<i>1</i>	<i>10</i>	<i>20</i>	<i>Group</i>
<i>Final Exam</i>	<i>1</i>	<i>30</i>	<i>30</i>	<i>Individual</i>

<i>Class Participation</i>	<i>1</i>	<i>10</i>	<i>10</i>	<i>Individual</i>
			100%	

10. Integrated Courses

N/A

11. Rationale

Please see Master of Management in Artificial Intelligence program proposal.

12. Faculty Resources

TBA

13. Cross-listed Courses

N/A

14. Bibliography and Library Statement

There are no pre-assigned required readings for this course. However, if handouts are distributed prior to or during the formal class meetings it is expected that they be read. If any handouts are copyrighted, the cost for these materials will be absorbed by the program. A Course Materials Database ('CMD') has been created for this course. Every CMD includes some important general information for Schulich students. The instructor posts rubrics, resources and special instructions on assignments on the CMD. Please get into the habit of checking the CMD on a regular basis. Feel free to e-mail the instructor with questions or concerns throughout the term.

15. Physical Resources

No additional physical resources are needed to run this course.

Faculty of Graduate Studies

New Course Proposal

Part B (Schulich Use Only)

16. Instructors and Faculty Coordinator

Initial instructor

Zhepeng (Lionel) Li, Ph.D.

Alternative instructors

Hjalmar Turesson, Ph.D.

Course coordinator

Murat Kristal, Director, MMAI Program

17. Specializations

Primary area or specialization

Master of Business Analytics

Secondary areas or specializations

N/A

18. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55 students

Expected enrolment

50 students

Evidence for enrolment expectations

Enrolment based on demand for MBAN program.

19. Human Participants Research

No

20. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the three following conditions required by Faculty Council applies:

a) The Area is deleting courses with at least the same total number of credits.

Does not apply. This is not an elective class.

b) Provide a convincing case for the proposed course.

N/A

1. Course Originator

Murat Kristal

Signature

October 19, 2018

Date

Name

2. Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course.

The faculty members whose names appear below confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Name

David Rice

Name

David A. Johnston

Name

Richard Irving

Name

Henry Kim

Name

<Name of faculty member>

Name

Theodore Peridis

Name

<Name of faculty member>

Name

Ashwin Joshi

Name

<Name of faculty member>

Name

3. Approvals

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving

Signature

October 19, 2018

Date

Area Coordinator or Specialization Director

OMIS

Area or
Specialization

Degree Program

This course has received the approval of the Program Committee, and I support the addition of the course to the SSB curriculum.

Murat Kristal

October 19, 2018

Signature

Date

MMAI

Program Director

Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick

October 22nd 2018

Signature

Date

Detlev Zwick

Master Programs Committee

Name of Committee Chair

Committee

Course Outline

Summer 2020

Time, Room: TBA

Instructor

Biography: TBA

Room: TBA

Office hours: TBA

Assistant

Paula Gowdie Rose

S337 Seymour Schulich Building

416-736-5074

pgowdierose@schulich.yorku.ca

Brief Description

Artificial Intelligence has emerged as an increasingly impactful discipline in science and technology. AI applications are embedded in the infrastructure of many products and industries search engines, medical diagnoses, speech recognition, robot control, web search, advertising and so on so forth. This course provides a broad overview of applying modern artificial intelligence. Learn how machines can engage in problem solving, reasoning, learning, and interaction. Gain an appreciation and case-based experience of this dynamic field. The class covers up-to-date AI applications in various domains such as Recommendation Systems, FinTech, Social Network Analytics, Sentiment Analysis etc.

Prerequisite(s): NONE

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Course Learning Outcomes

- Understand methods of Artificial Intelligence solutions in autonomous business contexts.
- Apply appropriate AI paradigm and technology to formulate and address various business problems.

- Consider design factors of AI technology when implementing business solutions, using cases.
- Discuss the frontier use of AI in multiple market verticals.

Deliverables at a Glance

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	2	10	20	Individual
Projects	1	20	20	Group
Midterm	1	30	30	Individual
Final exam	1	30	30	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions”, p. 6.

Course Material

The course uses a set of handouts, and two textbooks used as a reference for technical background and business perspectives, respectively. The textbooks can be purchased at the York University Bookstore (<http://bookstore.blog.yorku.ca>):

Artificial Intelligence: A Modern Approach, 3rd Edition, Stuart Russell and Peter Norvig, Pearson_(2010).

Data Science for Business, 1st Edition, Forster Provost and Tom Fawcett, O’ Reilly Media, Inc. (2013).

The Course Materials Database (CMD) has been created within Schulich’s Lotus Notes. It contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook as indicated in the Course Materials Database (CMD).

Class Participation (contribution). Students earn participation marks evenly throughout the

term, through participating in in-class discussions, presentations, and reflection surveys following guest speaker visits.

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on the course CMD, and when changes need to be announced between classes, an email will be sent to students' Lotus Notes email accounts, notifying them of the change.

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
Week #1	<p><u>Course Overview & Unsupervised Learning</u> Students will be review key concepts specific to embodied artificial intelligence technology. We begin with the unsupervised learning methods including clustering and association rules, as well as their business implications.</p> <p>Read:</p> <ul style="list-style-type: none">• Course Outline
Week #2	<p><u>Supervised Learning I: Tree-based Methods</u> We review correlation, classification, and prediction within data sets, and contextualize supervised learning within a business analytics environment</p> <p>Read:</p> <ul style="list-style-type: none">• Instructor Handout(s) <p>Prep:</p> <ul style="list-style-type: none">• Preparatory materials posted online in Moodle System
Week #3	<p><u>Supervised Learning II: Regression & SVM</u> Students are introduced to regression methods based on linear equations and matrix calculus. Optimization problems; what is an objective function, the constraints, the feasible set, and the optimal set. What are the considerations when building an optimization problem?</p> <p>Read:</p> <ul style="list-style-type: none">• Instructor Handout(s)• DS Ch. 4: Fitting a Model to Data <p>Prep:</p> <ul style="list-style-type: none">• Preparatory materials posted online in Moodle System
Week #4	<p><u>Supervised Learning III: Probabilistic Graphical Models</u> Learn important probabilistic modeling languages for representing complex domains and how the graphic models extend to decision making. Use ideas from discrete data structures to efficiently encode and manipulate probability distributions over high-</p>

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

dimensional spaces. Apply the basics of the Probabilistic Graphical Model representation and learn how to construct them, using both human knowledge and machine learning techniques to reach conclusions and make good decisions under uncertainty.

Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 1** due before class
-

Week #5

Reinforcement Learning

Reinforcement Learning (RL) provides a powerful paradigm for artificial intelligence and the enabling of autonomous systems to learn to make good decisions. RL is relevant to an enormous range of tasks, including robotics, game playing, consumer modeling and healthcare. This class will introduce the field of RL. Students will learn about the core challenges and approaches in the field, including generalization and exploration.

Read:

- Instructor Handout(s)
-

Week #6

Midterm

Week #7

Applications in Recommendation Systems

We have seen automated recommendations everywhere - on Netflix's home page, on YouTube, and on Amazon as these machine learning algorithms learn about your unique interests and show the best products or content for individual customers. We will cover the recommendation approaches based on collaborative filtering and work our way up to modern techniques such as matrix factorization methods.

Read:

- Instructor Handout(s)
-

Week #8

Applications in FinTech: Market Predictive

Increasingly, finance practitioners are interested in the Artificial Intelligence tools, which help with their predictive, personalization, and optimization tasks. Students will learn how to formulate market predictive problems and apply machine learning methods to address them, in the FinTech context.

Read:

- Instructor Handout(s)
-

Week #9

Applications in Social Network Analysis: LinkedIn Case

Network-based marketing, social platform and career service have proven to be successful. Social network analysis has played a critical role to enable such businesses. We are about to learn the measurement, propagation, and analysis of social networks.

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

It will also cover how to apply AI techniques to address social network analysis problems in business practice.

Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 2** due before class
-

Week #10 Applications in Text Mining & Sentiment Analysis

Unstructured text data account for a significant source in terms of business value as well as data volume. Student will learn how to extract value from Twitter for business purposes such as marketing and finance. With sentiment analysis we find out if the crowd has a positive or negative opinion towards a product, person, or company brand.

Read:

- Instructor Handout(s)
-

Week #11 Frontier of Artificial Intelligence and its application

Cutting edge features and technologies are spearheaded and find early adoption in various industries. We introduce new Artificial Intelligence related technologies in the marketplace and how these may find their place in other industry verticals in the near future.

Read:

- Instructor Handout(s)

Deliverable:

- **Group Project** due before class
-

Week #12 Case Study: AI Enterprise Architecture

We will “invert the classroom” and students will be given the chance to make a presentation that links the concepts learned in the classroom to an AI Enterprise Architecture. This will enable the students to see how AI can be applied as a business capability and provide organizations with competitive advantage..

Read:

- Instructor Handout(s)
-

Final Exam

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

TBD	<u>Assignments</u> The assignments require students to answer a set of questions closely related to the handouts or textbook contents, or conduct numerical experiments. The textbook and prior lectures provide all the information students need to complete the assignments. Students must submit assignments at the beginning of the lecturing session on the due date. Value: 2 x 10% = 20%
TBD	<u>Group Project</u> Students need to form project teams of size 3– 4, and complete the projects within a specified time period by submitting a project report and the computer code. The project requires a team to apply the learned techniques to implement a data-centred business problem. Value: 1 x 20% = 20%
TBD	<u>Midterm</u> Value 30%
TBD	<u>Final Exam</u> The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced. Value: 30%

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: The students will lose 5% of their assignment grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical mark to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

A+	[100% - 90%]
A	[89% - 80%]
A-	[79% - 70%]
B+	[69% - 60%]
B	[59% - 50%]
B-	[49% - 40%]
C+	[39% - 30%]

C	[29% - 20%]
C-	[19% - 10%]
F	[9% - 0%]

Note that letter grade “A” corresponds to the interval from 89% to 80%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

The Schulich School does not use a percentage scale or prescribe a standard conversion formula from percentages to letter grades. Conversions within a course are at the discretion of the instructor.

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Student Handbook or the Student Services & International Relations website:

http://www.schulich.yorku.ca/client/schulich/schulich_lp4w_ind_webstation.nsf/page/Enrolment+Grades+and+Convocation!OpenDocument#tabs-2

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University’s policy on academic honesty, which may be found in the Student Handbook and on the Student Services & International Relations website:

http://www.schulich.yorku.ca/client/schulich/schulich_lp4w_ind_webstation.nsf/page/Academic+Honesty!OpenDocument

Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Student Handbook or contact Student Services.

For counseling & disability services, contact Student Services or see <http://www.yorku.ca/cds/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student Services; it will be placed in the student’s file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the

Director of Student Services (SSB Room W262) within 48 hours of missing the final exam. Students who miss a final exam due to illness must have their doctor complete an “Attending Physician’s Statement.” For more details, see:

http://schulich.yorku.ca/client/schulich/schulich_lp4w_Ind_webstation.nsf/page/Enrolment+-MBA+Exam+Schedule?OpenDocument

Faculty of Graduate Studies

New Course Proposal

1. **Program:** Schulich Master of Management in Artificial Intelligence
2. **Course Number:** MMAI 5400
3. **Credit Value:** 3.00
4. **Long Course Title:** Natural Language Processing
5. **Short Course Title:** Natural Language Processing
6. **Effective Session:** Summer 2020
7. **Calendar (Short) Course Description**

This course focuses on the principles and technologies of statistical machine-learning-based natural language processing and their application in text analytics, including retrieval, extraction, recognition, and analysis of information from large textual collections. Prerequisite: MMAI 5040 3.00 Business Applications of Artificial Intelligence I and MMAI 5300 3.00 Numerical Analysis.

8. **Expanded Course Description**

There has been an increasing demand for better retrieval, processing, and analysis of textual information in modern society in recent years due to the availability of a huge and ever-growing amount of textual data from both inside organizations and the Internet. Well known examples include web search engines (e.g., Google), document and content management systems, email filtering, social media sentiment analysis, automated question answering (e.g., IBM's Watson on Jeopardy!), natural language interfaces in games and mobile devices, and big data text analytics for business/competitive intelligence. Natural language processing (NLP), also known as computational linguistics, which aims to process and understand natural languages and text, is the driving force that makes these tasks and systems possible. This course focuses on the principles and technologies of statistical machine-learning-based NLP and their application in text analytics, including retrieval, extraction, recognition, and analysis of information from large textual collections. Prerequisite: MMAI 5040 3.00 Business Applications of Artificial Intelligence 1 and MMAI 5300 3.00 Numerical Analysis.

After completing this course, students will be able to:

- Work with text data using the Natural Language Tool Kit.
- Load and manipulate custom text data.
- Analyze text to discover sentiment, important key words, and statistics.

9. **Evaluation**

The evaluation measures are comprised of individual assignments, group projects, written exam and class participation. Course deliverables are broken down as in the following table.

<i>Deliverable</i>	<i>Quantity</i>	<i>% Weight</i>	<i>Total %</i>	<i>Author</i>
<i>Assignments</i>	<i>4</i>	<i>10</i>	<i>40</i>	<i>Individual</i>
<i>Projects</i>	<i>1</i>	<i>10</i>	<i>20</i>	<i>Group</i>
<i>Midterm Exam</i>	<i>1</i>	<i>20</i>	<i>20</i>	<i>Individual</i>
<i>Final Exam</i>	<i>1</i>	<i>20</i>	<i>20</i>	<i>Individual</i>
			100%	

10. Integrated Courses

N/A

11. Rationale

Please see Master of Management in Artificial Intelligence program proposal.

12. Faculty Resources

TBA

13. Cross-listed Courses

N/A

14. Bibliography and Library Statement

There are no pre-assigned required readings for this course. However, if handouts are distributed prior to or during the formal class meetings it is expected that they be read. If any handouts are copyrighted, the cost for these materials will be absorbed by the program. A Canvas site (LMS) has been created for this course. Every Canvas site includes some important general information for Schulich students. The instructor posts rubrics, resources and special instructions on assignments on Canvas. Please get into the habit of checking Canvas on a regular basis. Feel free to e-mail the instructor with questions or concerns throughout the term.

15. Physical Resources

No additional physical resources are needed to run this course.



Faculty of Graduate Studies New Course Proposal Part B (Schulich Use Only)

16. Instructors and Faculty Coordinator

Initial instructor

Mel Gabriel, Ph.D.

Alternative instructors

Murat Kristal, Ph.D.

Course coordinator

Murat Kristal, Director, MMAI Program

17. Specializations

Primary area or specialization

Business Intelligence

Secondary areas or specializations

N/A

18. Student Contact and Enrolment

Contact hours

36 hours

Maximum enrolment

55 students

Expected enrolment

50 students

Evidence for enrolment expectations

Enrolment based on demand for MBAN program.

19. Human Participants Research

No

20. Conditions for Approval

If this proposal is for a new elective course, please indicate which one of the three following conditions required by Faculty Council applies:

a) The Area is deleting courses with at least the same total number of credits.

Does not apply. This is not an elective class.

b) Provide a convincing case for the proposed course.

N/A

53. Course Originator

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name

54. Supporting Faculty Members

The course originator should consult with other interested parties and obtain their support. Support should be obtained from other units of the university if their interests are related to this course. The faculty members whose names appear below confirm that they have examined this course proposal. They feel it is a worthwhile addition to the SSB curriculum and does not, to their knowledge, significantly duplicate the content of existing courses.

Adam Diamant

Ashwin Joshi

David A. Johnston

M. David Rice

Henry M. Kim

Richard Irving

Theodoros Peridis

<Name of faculty member>

<Name of faculty member>

<Name of faculty member>

55. Approvals

Area or Specialization

I have reviewed this course proposal with the faculty members of this Area or Specialization, and I support the addition of the course to the SSB curriculum.

Richard Irving
Signature

Oct 19, 2018
Date

Richard Irving
Area Coordinator or Specialization Director

OMIS
Area or Specialization

Degree Program

This course has received the approval of the Program Committee, and I support the addition of the course to the SSB curriculum.

Murat Kristal
Signature

October 19, 2018
Date

Murat Kristal
Name of Task Force Chair

MMAI
Program

Program Committee

This course proposal has received the approval of the relevant Program Committee and documentation attesting to the faculty member support for the course has been received and archived by the committee chair.

Detlev Zwick
Signature

October 22nd 2018
Date

Detlev Zwick
Name of Committee Chair

Master Programs Committee
Committee

MMAI 5400 3.00: Natural Language Processing



Course Outline

Summer 2020

Time, Room: TBA

Instructor

Biography: TBA

Room: TBA

Office hours: TBA

Assistant

Paula Gowdie Rose

S337 Seymour Schulich Building

416-736-5074

pgowdierose@schulich.yorku.ca

Brief Description

There has been an increasing demand for better retrieval, processing, and analysis of textual information in modern society in recent years due to the availability of a huge and ever-growing amount of textual data from both inside organizations and the Internet. Well known examples include web search engines (e.g., Google), document and content management systems, email filtering, social media sentiment analysis, automated question answering (e.g., IBM's Watson on Jeopardy!), natural language interfaces in games and mobile devices, and big data text analytics for business/competitive intelligence. Natural language processing (NLP), also known as computational linguistics, which aims to process and understand natural languages and text, is the driving force that makes these tasks and systems possible. This course focuses on the principles and technologies of statistical machine-learning-based NLP and their application in text analytics, including retrieval, extraction, recognition, and analysis of information from large textual collections. Prerequisite: MMAI 5040 3.00 Business Applications of Artificial Intelligence 1 and MMAI 5300 3.00 Numerical Analysis.

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Course Learning Outcomes

After completing this course, students should be able to:

- explain fundamental concepts, principles, and models of natural language processing within a business context.
- explain the use of state-of-the-art statistical learning machines and tools for NLP and text analytics.
- analyze large text collections by using suitable statistical NLP approaches.
- design system structures and integrate open source components for statistical NLP and text analytics applications that will help business with their digital transformation efforts.
- evaluate and improve the performance of a selected statistical learning machine for a specific NLP task that will reduce the computational time for business applications.

Deliverables at a Glance

In the table below, the impact of each task on your final grade for the course is indicated in the “% weight” column.

Assignment/Task	Quantity	% Weight	Total %	Author
Assignments	4	10	40	Individual
Projects	1	20	20	Group
Midterm exam	1	20	20	Individual
Final exam	1	20	20	Individual
			100%	

For details, see “Written Assignments/Projects and Exam[s]: Descriptions”, p. 6.

Course Material

Required Materials

- Articles from journals such as *Computational Linguistics*, *Natural Language Engineering*, and *Machine Learning Journal* and conference proceedings (e.g., ACL, ICML, NAACL, EMNLP, HLT, AAAI, IJCAI), all available through AU Library Services databases.
- Selected materials from online resources including *Wikipedia* and NLP Tutorials.
- Selected contents from a list of relevant books (all available online):

S. Bird, E. Klein, and E. Loper. 2009. *Natural Language Processing with Python—Analyzing Text with the Natural Language Toolkit*. O’Reilly Media. Available at <http://www.nltk.org/book/>

T., Hastie, R. Tibshirani, and J. Friedman. 2009. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2ed. Springer. Available at <https://web.stanford.edu/~hastie/ElemStatLearn/>

C.D. Manning, P. Raghavan, and H. Shutze. 2008. *Introduction to Information Retrieval*. Cambridge University Press. Available at <http://nlp.stanford.edu/IR-book/>

A course site has been created in Schulich's Learning Management System Canvas. It contains general information for Schulich students and information and materials specific to this course. Check it frequently.

Student Preparation for Class and Class Participation: Expectations

Preparation. Students should come prepared to class having read the sections of the textbook as indicated on the Canvas course site.

Class Participation (contribution). Students earn participation marks evenly throughout the term, through participating in in-class discussions, presentations, and reflection surveys following guest speaker visits.

Class-by-Class Syllabus

Topics, readings, and other preparations for every class are listed below

Note: If any changes in this schedule become necessary, notifications will be posted on Canvas, and when changes need to be announced between classes, an email will be sent to students' email accounts, notifying them of the change.

DATE/WEEK	TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE
	<u>Linguistics and Statistics Essentials</u>
Week #1	Read: <ul style="list-style-type: none">• Course Outline
	<u>SAS® Visual Text Analytics for unstructured data using the combined power of natural language processing, machine learning and linguistic rules.</u>
Week #2	Read: <ul style="list-style-type: none">• Instructor Handout(s) Prep:

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

- Preparatory materials posted online in Canvas System
- Deliverable:
- **Assignment 1** due before class
-

Language Models for Information Retrieval

- Week #3
- Read:
- Instructor Handout(s)
- Prep:
- Preparatory materials posted online in Canvas System
-

Markov Models for POS Tagging

- Week #4
- Read:
- Instructor Handout(s)
- Deliverable:
- **Assignment 2** due before class
-

Probabilistic Grammar and Parsing

- Week #5
- Read:
- Instructor Handout(s)
-

Week #6 **Midterm**

Statistical Machine Learning

- Week #7
- Read:
- Instructor Handout(s)
- Deliverable:
- **Assignment 3** due before class
-

Text Classification and Clustering

- Week #8
- Read:
- Instructor Handout(s)
-

Week #9 Semantic Structures and Parsing

DATE/WEEK TOPIC(S)/ASSIGNED READING(S)/ASSIGNED WORK DUE

Read:

- Instructor Handout(s)

Deliverable:

- **Assignment 4** due before class
-

Named Entity and Relation Extraction

Week #10

Read:

- Instructor Handout(s)
-

Web Search and Question Answering

Week #11

Read:

- Instructor Handout(s)

Deliverable:

- **Group Project** due before class
-

Topic Modeling, Opinion Mining, and Sentiment Analysis

Week #12

Read:

- Instructor Handout(s)
-

Final Exam

Written Assignments/Projects and Exam[s]: Descriptions

Due Date

TBD

Assignments

The assignments require students to answer a set of questions closely related to the handouts or textbook contents, or conduct numerical experiments. The textbook and prior lectures provide all the information students need to complete the assignments. Students must submit assignments at the beginning of the lecturing session on the due date.

Value: 4 x 10% = 40%

TBD

Group Project

Students need to form project teams of size 3–4, and complete the projects within a specified time period by submitting a project report and the computer code. The project requires a team to apply the learned techniques to implement a data-centred business problem.

Due Date

Value: 1 x 20% = 20%

TBD

Midterm Exam

The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.

Value: 20%

TBD

Final Exam

The material for the final exam incorporates all the techniques discussed in the course. It includes problem-solving questions, short-answer questions, and one case question. The three-hour exam will take place at a time and place to be announced.

Value: 20%

Evaluation of Written Assignments/Projects and Exams

Mark breakdowns for individual assignment are as indicated with the assignments themselves.

Late Delivery: The students will lose 5% of their assignment grade for every day an assignment is delayed.

Calculation of Course Grade

In this class, final course grades will be determined by the following process: The instructor will assign numerical mark to each assignment or test. Each component will be multiplied by its weight, and then a letter grade for the course is assigned according to the following table:

Letter Grade	Numerical Grade	Percentage Grade
A+	9	100% - 95%
A	8	94% - 90%
A-	7	89% - 85%
B+	6	84% - 80%
B	5	79% - 74%
B-	4	73% - 70%
C+	3	69% - 65%
C	2	64% - 60%
C-	1	59% - 50%
F	0	Below 50%

Note that letter grade "A" corresponds to the interval from 94% to 90%.

General Academic Policies: Grading, Academic Honesty, Accommodations and Exams

Grades at Schulich are based on a 9-value index system. The top grade is A+ (9) and the minimum passing grade is C- (1). To keep final grades comparable across courses, sections of required core courses are normally expected to have a mean grade between 4.7 and 6.1

For more details on the index, grading policy, and grade point average (GPA) requirements, see the Graduate Academic Policy Handbook or the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Academic honesty is fundamental to the integrity of university education and degree programs, and applies in every course offered at Schulich. Students should familiarize themselves with York University's policy on academic honesty, which may be found in the Graduate Academic Policy Handbook and on the Student Services & International Relations website:

<http://schulich.yorku.ca/graduate-handbook>

Accommodations. For accommodations sought due to exam conflicts, religious reasons, unavoidable absences or disabilities, please refer to the Graduate Academic Policy Handbook or contact Student Services.

For Student Accessibility Services (SAS) , contact Student & Enrolment Services or see <https://accessibility.students.yorku.ca/>.

Exams (Absence from)

Midterm. Students who miss a midterm examination must contact their course instructor within 24 hours and provide the course instructor with documentation substantiating the reason for the absence. A copy of the documentation must also be submitted to Student & Enrolment Services; it will be placed in the student's file.

Final. Within 24 hours of missing a final examination, students must contact the Director of Student & Enrolment Services at (416) 736-5060 and must also contact their course instructor. Formal, original documentation regarding the reason for missing the exam must be submitted to the Director of Student & Enrolment Services (SSB Room W263) within 48 hours of missing the final exam.

Students who miss a final exam due to illness must have their doctor complete an "Attending Physician's Statement." For more details, see:

<http://schulich.yorku.ca/graduate-handbook>