

TIMG 5301

APPLIED ANALYTICS FOR TECHNOLOGY INNOVATION MANAGEMENT

Fall 2023

**Institute of Technology Entrepreneurship and
Commercialization, Carleton University**

Professor Weiss
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Tue, 6-9pm

Updates to this outline will be made as necessary.

Version 2.2

Instructor availability

The instructor is available via e-mail and Slack (preferred) any time. Office hours before class or by appointment.

Time and location

Tue, 6-9pm, hybrid (Nicol Building 4030 and online via BigBlueButton in Brightspace)

You can attend the class both in-person and online. Presentations of assignments will take place online. If you are attending in-person, be considerate of others: wear a mask, and ensure physical distancing.

Calendar description

TIMG 5301 [0.5 credit] Applied Analytics for Technology Innovation Management

Application of advanced business analytics in the domain of technology innovation management and technology entrepreneurship. Topics include supervised and unsupervised machine learning, anticipatory thinking, and anomaly detection, to inform managerial judgement and support strategic and operating decisions faced by managers and entrepreneurs.

Includes: Experiential learning activity

Prerequisites: TIMG 5001

Course objectives

The focus of this course is on the application of business analytics to managerial judgment and supporting strategic and operating decisions faced by managers and entrepreneurs. It is composed of three parts. In the first part, we examine the uses of AI in innovation and how entrepreneurs can develop business opportunities that build on recent advances in prediction technology. In the second part, we introduce a process for conducting analytics projects and discuss techniques related to data understanding, data preparation, modeling, and evaluation. These techniques include exploratory data analysis, classification, clustering, text mining, large language models, deep learning, reinforcement learning, and novelty detection. In the third part, we discuss the future and risks of analytics. In the experiential component of the course, you will identify an AI opportunity, and create machine learning models related to classification, large language models, and idea discovery. Instead of using existing analytics tools with predesigned features, students will become familiar with the versatility of the analytics capabilities of Python ML libraries and learn how to build their own AI apps.

Class sessions

Students can participate online by logging into the BigBlueButton on Brightspace. For the audio portion of the conference, you can also call into the conference server using the phone numbers provided on login, or using the built-in VOIP feature (click on the headset icon). A recording of the sessions will be available after class.

For the weekly sessions there will be assigned readings and tasks.

The course material and recordings of the class sessions will be made available on Brightspace.

Student evaluation

Course participants are required to complete group assignments, individual assignments, and a take home exam. To determine the course grade, the following weights apply:

- Assignment 1: Canvas of an AI opportunity (group) 15%
- Assignment 2: Classification for predicting startup success (group) 15%
- Assignment 3: Large language models for examining startup failure (group) 15%
- Assignment 4: Discovering novel ideas (group) 15%
- Lessons (individual, one for each group assignment) 20%
- Take home exam (individual) 20%

Assignments submitted late and presentations not made will receive a grade of zero. All students in a group receive the same grade. Final grade reports will follow Carleton University guidelines.

Assignments (group)

There are four group assignments. Groups should can have 3-4 members.

Assignment 1	Analyze a decision task and identify an opportunity for using AI to solve it. Document the AI opportunity with the AI canvas described in the readings.
Assignment 2	Apply classification to an entrepreneurial problem. Here you will create a classification model that predicts startup success from data on early-stage investments in Crunchbase.
Assignment 3	Large language models offer new opportunities for processing and generating text. Use text embeddings, clustering, and the ChatGPT API to examine the reasons for startup failure.
Assignment 4	Discovering what is new is a critical skill for entrepreneurs. Use an information-theoretic approach to evaluate the novelty of ideas.

Detailed instructions for each assignment will be posted at the beginning of each quarter of the course.

Assignments are due at the end of day noted in the schedule (see below).

Lessons (individual)

These are individual assignments about the group assignments, and take the form of a quiz.

There will be a variety of questions, including multiple-choice questions and questions that expect free-form answers. Questions will be about decisions you made when designing a model (eg, explain how you selected the features for a model) and coding the model (eg, describe how the code in a given section works).

Specification grading will be applied to free-form questions. This means that you either meet the minimum requirements and get the mark for this question or you don't. No partial marks will be awarded.

Lessons are due at the same time as the respective assignments.

Take-home exam (individual)

The exam will be a take-home exam.

The exam questions will both cover concepts from the readings and modeling concepts.

Exams are due on **Dec 22**.

Group work and free loaders

Group work is an important component of this course. You may elect to work in the same group to prepare both assignments or work in two different groups. Group conflicts are to be dealt with by the group in a way that is fair, fast and without personal attacks. The instructor does not settle group disputes.

The instructor will dissolve a group that is late submitting an assignment.

Free loaders are not welcome anywhere. This course is no exception. The best way to deal with free loaders is to not include their names in the first page of the group assignments. If a student's name does not appear in an assignment submitted by his or her group, the student must submit his or her own assignment. Failure to do so, the student will receive zero for the assignment. There is zero tolerance for free loaders.

Use of AI tools

AI tools like ChatGPT can be useful in many ways in your day-to-day work as an analytics professional. However, because they can also be abused, you must acknowledge the use of AI tools in any course work you submit.

Here are some guidelines for what not to do when using AI tools in your assignments:

- You should not rely solely on AI tools. It is important that you understand the material and complete assignments on your own. Use AI tools as a supplement, rather than a replacement for your work
- Do not use AI tools to plagiarize (also see the section on plagiarism below). Using AI to generate or modify content to evade plagiarism detection is unethical and violates academic integrity
- You cannot assume that AI responses are correct. AI can generate convincing but incorrect results

Note: These guidelines were adapted from <https://www.cs171.org/2023/syllabus>.

Special information for pandemic measures

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's symptom reporting protocols.

Masks: Carleton has paused the COVID-19 Mask Policy, but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Students with disabilities

Students with disabilities who require academic accommodations in this course are encouraged to contact the Paul Menton Centre (PMC) for Students with Disabilities to complete the necessary forms. After registering with the PMC, make an appointment with me in order to discuss your needs at least two weeks before the first assignment is due. This will allow for sufficient time to process your request

Plagiarism

Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offence that will not be tolerated. Please refer to the section on instructional offences in the Graduate Calendar for additional information. Plagiarism is against the TIM culture. A case of plagiarism will be referred to the Director of the TIM program and the Carleton University Ethics Committee. The instructor will not deal with the matter directly. The university has clear processes to deal with students who are suspected of plagiarism.

Administrative details

These are the rules of conduct for this course:

- Please notify the instructor via e-mail, if you will not attend a class.
- **You must be prepared for each class.** You do so by reading the material assigned and being prepared to discuss in class how what was read can be applied in product development organizations.
- We will use Brightspace to share files and upload assignments unless noted otherwise.
- **You need to sign up for Slack.** Course announcements will made on Slack. Course discussions will take place on Slack. Don't send me an email if you have a question, but use Slack.
- Each presenter must make his/her slides available to all other students by **3pm** on the day of the class.

Better journals

arXiv preprint (new research is often published here first)

Business Horizons

California Management Review

Harvard Business Review

Decision Support Systems

INFORMS Journal on Applied Analytics

Information Systems Research

Journal of Big Data

Journal of Business Analytics

Contribution to program learning goals

Learning goals	Not Covered	Introduced	Taught but Not Assessed	Taught <u>and</u> Assessed
TM1 Critical Thinking and Application of Knowledge Graduates will demonstrate a systematic understanding of knowledge, and a critical awareness of current problems and/or new insights.				✓
TM2 Research and Scholarship Graduates will demonstrate a conceptual understanding and methodological competence.				✓
TM3 Communication Capabilities Graduates will communicate ideas, issues, and conclusions clearly.				✓
TM4 Professional Capacity and Autonomy Graduates will demonstrate initiative and personal integrity when they interact with the TIM business ecosystem.		✓		

Applied Analytics for Technology Innovation Management: Schedule

Date	Topic	Readings	Due Dates
Sep 12	Session 1: Introduction	Kakatkar et al. (2020) Verganti et al. (2020) Bilgram & Laarmann (2023)	
Sep 19	Session 2: Prediction and judgment	Agrawal et al. (2020) Wilson et al. (2018) Agrawal et al. (2018) Wang et al. (2022)	
Sep 26	Session 3: Phases of an AI project	Overgoor et al. (2019) Wolf (2020)	
Oct 3	Session 4: Exploratory data analysis	Ferras-Hernandez et al. (2017) Rogel-Salazar (2018, ch. 2)	Assignment 1: Canvas of an AI opportunity
Oct 10	Session 5: Classification I	Miao et al. (2023) Moro et al. (2014) Varoquaux et al. (2015)	
Oct 17	Session 6: Classification II	Arroyo et al. (2019) Rudin & Carlson (2019)	
Oct 24	Break		
Oct 31	Session 7: Clustering and semi-supervised learning	Marra et al. (2015) Ozcan et al. (2021)	Assignment 2: Classification
Nov 7	Session 8: Large Language Models	Ozdemir (2023, ch. 1-3)	
Nov 14	Session 9: Topic modeling	Weiss (2021) Greene et al. (2014) Cantamessa et al. (2018)	
Nov 21	Session 10: Chance discovery and novelty	Jeong et al. (2019) Pournemat & Weiss (2021) Nielbo et al. (2021)	Assignment 3: Large language models
Nov 28	Session 11: Deep learning and reinforcement learning	Dong et al. (2021) Singh et al. (2022)	
Dec 5	Session 12: Future and risks	Gregory et al. (2021) Hao (2020) Bender et al. (2021)	
Dec 12			Assignment 4: Novelty

Readings

Readings for Session 1: Introduction

Kakatkar, C., Bilgram, V., & Füller, J. (2020). Innovation analytics: Leveraging artificial intelligence in the innovation process. *Business Horizons*, 63(2), 171-181.

Verganti, R., Vendraminelli, L., & Iansiti, M. (2020). Innovation and design in the age of artificial intelligence. *Journal of Product Innovation Management*, 37(3), 212-227.

Bilgram, V., & Laarmann, F. (2023). Accelerating innovation with generative AI: AI-augmented digital prototyping and innovation methods. *IEEE Engineering Management Review*, 51(2), 18-25.

Readings for Session 2: Prediction and judgment

- Agrawal, A., Gans, J., & Goldfarb, A. (2020). How to win with machine learning. *Harvard Business Review*, 5, 126-133.
- Wilson, H. J., & Daugherty, P. R. (2018). Collaborative intelligence: Humans and AI are joining forces. *Harvard Business Review*, 96(4), 114-123.
- Agrawal, A., Gans, J., & Goldfarb, A. (2018, April 17). A simple tool to start making decisions with the help of AI. *Harvard Business Review Digital Articles*.
- Wang, X., Yang, H., Han, H., Huang, Y., & Wu, X. (2022). Explore the entrepreneurial process of AI start-ups from the perspective of opportunity. *Systems Research and Behavioral Science*, 39(3), 569-580.

Readings for Session 3: Phases of an AI project

- Overgoor, G., Chica, M., Rand, W., & Weishampel, A. (2019). Letting the computers take over: Using AI to solve marketing problems. *California Management Review*, 61(4), 156-185.
- Wolf, C. T. (2020). AI Models and their worlds: Investigating data-driven, AI/ML ecosystems through a work practices lens. *International Conference on Information*, 651-664. Springer.

Readings for Session 4: Exploratory data analysis

- Ferràs-Hernández, X., Tarrats-Pons, E., & Arimany-Serrat, N. (2017). Disruption in the automotive industry: A Cambrian moment. *Business Horizons*, 60(6), 855-863.
- Rogel-Salazar, J. (2018). Chapter 2. *Data Science and Analytics with Python*. CRC Press.

Readings for Session 5: Classification I

- Miao, Q., Zheng, W., Lv, Y., Huang, M., Ding, W., & Wang, F. Y. (2023). DAO to HANOI via DeSci: AI paradigm shifts from AlphaGo to ChatGPT. *IEEE/CAA Journal of Automatica Sinica*, 10(4), 877-897.
- Moro, S., Cortez, P., & Rita, P. (2014). A data-driven approach to predict the success of bank telemarketing. *Decision Support Systems*, 62, 22-31.
- Varoquaux, G., Buitinck, L., Louppe, G., Grisel, O., Pedregosa, F., & Mueller, A. (2015). Scikit-learn: Machine learning without learning the machinery. *GetMobile: Mobile Computing and Communications*, 19(1), 29-33.

Readings for Session 6: Classification II

- Arroyo, J., Corea, F., Jimenez-Diaz, G., & Recio-Garcia, J. A. (2019). Assessment of machine learning performance for decision support in venture capital investments. *IEEE Access*, 7, 124233-124243.
- Rudin, C., & Carlson, D. (2019). The secrets of machine learning: Ten things you wish you had known earlier to be more effective at data analysis. *Operations Research & Management Science in the Age of Analytics*, 44-72. INFORMS.

Readings for Session 7: Clustering and semi-supervised learning

- Marra, A., Antonelli, P., Dell'Anna, L., & Pozzi, C. (2015). A network analysis using metadata to investigate innovation in clean-tech—Implications for energy policy. *Energy Policy*, 86, 17-26.
- Ozcan, S., Suloglu, M., Sakar, C. O., & Chatufale, S. (2021). Social media mining for ideation: Identification of sustainable solutions and opinions. *Technovation*, 107, 102322.

Readings for Session 8: Large language models

- Ozdemir, S. (2023). Chapters 1-3. *Quick Start Guide to Large Language Models*. Addison-Wesley.

Readings for Session 9: Topic modeling

- Weiss, M. (2021). Patterns for topic modeling. *Conference on Pattern Languages of Programs (PLOP)*, 1-13.
- Greene, D., O’Callaghan, D., & Cunningham, P. (2014). How many topics? Stability analysis for topic models. *European Conference on Machine Learning and Knowledge Discovery in Databases*, 498-513, Springer.
- Cantamessa, M., Gatteschi, V., Perboli, G., & Rosano, M. (2018). Startups’ roads to failure. *Sustainability*, 10(7), 2346.

Readings for Session 10: Chance discovery and novelty

- Jeong, B., Yoon, J., & Lee, J. M. (2019). Social media mining for product planning: A product opportunity mining approach based on topic modeling and sentiment analysis. *International Journal of Information Management*, 48, 280-290.
- Pournemat, M., & Weiss, M. (2021). Identifying business opportunities using topic modeling and chance discovery, *ISPIM*, 1-11.
- Nielbo, K. L., Baglini, R. B., Vahlstrup, P. B., Enevoldsen, K. C., Bechmann, A., & Roepstorff, A. (2021). News information decoupling: An information signature of catastrophes in legacy news media. *arXiv preprint arXiv:2101.02956*.

Readings for Session 11: Deep learning and reinforcement learning

- Dong, S., Wang, P., & Abbas, K. (2021). A survey on deep learning and its applications. *Computer Science Review*, 40, 100379.
- Singh, V., Nanavati, B., Kar, A. K., & Gupta, A. (2022). How to maximize clicks for display advertisement in digital marketing? A reinforcement learning approach. *Information Systems Frontiers*, 1-18.

Readings for Session 12: Future and risks

- Gregory, R. W., Henfridsson, O., Kaganer, E., & Kyriakou, S. H. (2021). The role of artificial intelligence and data network effects for creating user value. *Academy of Management Review*, 46(3), 534-551.
- Hao, K. (2020). We read the paper that forced Timnit Gebru out of Google. Here’s what it says. *MIT Technology Review*. <https://www.technologyreview.com/2020/12/04/1013294/google-ai-ethics-research-paper-forced-out-timnit-gebru/>
- Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the dangers of stochastic parrots: Can language models be too big? . *ACM Conference on Fairness, Accountability, and Transparency*, 610-623.

Suggested books

Many of these are available online (on O’Reilly via the Carleton library, or on the web).

- Albrecht, J., Ramachandran, S., & Winkler, C. (2021). *Blueprints for Text Analytics Using Python*. O’Reilly.
- Burkov, A. (2020). *Machine Learning Engineering*. True Positive. <http://www.mlebook.com>
- Deisenroth, M., Faisal, A., & Ong, C. (2020). *Mathematics for Machine Learning*. Cambridge.
- Dignum, V. (2020). *Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way*. Springer.
- Kelleher, J. D., Mac Namee, B., & D’Arcy, A. (2015). *Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies*. MIT Press.
- Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). *Mining of Massive Data Sets*. Cambridge. <http://mmds.org>
- Molnar, C. (2020). *Interpretable Machine Learning*. Leanpub. <https://leanpub.com/interpretable-machine-learning>
- Richards, T. (2021). *Getting Started with Streamlit for Data Science*. Packt Publishing.

- Rogel-Salazar, J. (2018). *Data Science and Analytics with Python*. CRC Press.
- Skansi, S. (2018). *Introduction to Deep Learning*. Springer.
- Taddy, M. (2019). *Business Data Science*. McGraw Hill.
- Vaughan, D. (2020). *Analytical Skills for AI and Data Science*. O'Reilly.