# Business 9844 – Machine Learning for Management

# Winter 2025

Professor Prashant Rajaram
Office No. 2348
prajaram@ivey.ca

Faculty Assistant: Diala Assaad
Office No. 2350
dassaad@ivey.ca

**Date and Time: Mondays, 1:30 pm – 4:30 pm**
**Location: 2102 (12 Sessions)**      *Syllabus version: Jan 6, 2025*

## COURSE DESCRIPTION

The objective of this course is to introduce doctoral students in business to cutting-edge research on machine learning methods using structured and unstructured data. While machine learning methods have traditionally been used for prediction tasks, they are also increasingly being used for causal inference. The course will equip students with an improved understanding of the various applications of machine learning methods for academic research in business management. This includes prediction, causal inference, text/image/audio analysis and video analysis. In addition, the course also examines research on generative AI and the implications of AI in business management. While the majority of the course will be taught by discussing literature in the marketing field, the course will also be relevant for doctoral students in other areas of business management looking to improve their understanding of machine learning applications in business.

For a hands-on experience with machine learning methods, you are encouraged to take complementary courses in Data Science and Computer Science.

## COURSE OBJECTIVES

1. Introduce commonly used methods, tools and current perspectives in ML

2. Strengthen comprehension of key issues and frameworks in ML

3. Provide a foundation for critical thinking in ML applications

4. Spark interest in ML applications for solving business problems

5. Enhance understanding of the structure and writing style of business papers that use ML

6. Foster the development of original ideas based on your reading of the literature

## METHODS OF EVALUATION

| Component | Weight | Timeline |
|---|---|---|
| Class Contribution | 40% | Sessions 1 to 6 (20%), 6 to 12 (20%) |
| Mid Term Assignment | 20% | Assigned after Session 5 |
| Final Assignment | 20% | Assigned after Session 10 |
| Working Paper Presentations | 20% | Sessions 11 and 12 |
| Total | 100% | |

## CLASS CONTRIBUTION (40%)

Sessions 1 to 6 (20%) and Sessions 6 to 12 (20%)

This course is a seminar, which means active participation is essential. Engaging in discussions is vital for learning and maintaining an interactive class atmosphere. In each session, we will analyze, critique, and integrate ideas from the assigned readings. Your preparation and participation significantly contribute to everyone's learning experience.

Your participation will be graded on both the quality and quantity of your contributions. Complete the readings attentively and think critically about them. High-quality contributions are characterized by well-supported arguments, unique insights, and a deep comprehension of the assigned materials, including how they interrelate across sessions. Be prepared to think critically, take intellectual risks, and listen carefully to others. Your engagement will be evaluated based on your ability to stimulate thoughtful and meaningful discussions.

You should arrive at each seminar ready to discuss the main concepts, strengths, and weaknesses of each assigned reading. You should also be prepared to explain how the articles relate to one another. The learning outcomes of this course are tied to the effort you and your classmates invest. Passive attendance and note-taking are not sufficient for developing research skills. You should actively engage, think critically, and be prepared to articulate your viewpoints in class. Additionally, bringing in examples that help illustrate key findings from the readings will enhance your understanding.

"Expert" Role

Each required reading will have a designated "expert," a student who will develop a thorough understanding of the material and identify key aspects of the paper. The expert's role is to clarify any confusion and help drive the discussion forward. Hence, it is recommended that the expert

prepares discussion questions in advance of class, as they might be called upon to drive the discussion forward.

The number of times you'll serve as an expert will be determined by the following equation:
*Expected number of expert roles = Total number of required readings in the syllabus / Number of enrolled students*

It is crucial to prepare thoroughly for your expert assignments. If you are unable to fulfill your expert role for any reason, you can arrange to swap assignments with another student.

Our goal is to ensure that each required reading is well-covered. We will aim to match papers to students' interests, backgrounds, and strengths as much as possible. I will assign the experts for the first class (in advance) and going forward we will decide on the expert roles for the subsequent two classes at the beginning of each class.

The supplemental readings in the syllabus are for you to gain a deeper understanding of the material, but these will not be discussed in class.

**ASSIGNMENTS** (40%)

Mid-Term Assignment (20%) and Final Assignment (20%)

You will complete two assignments, one after Session 5 and another after Session 10, which will test you on the concepts discussed in the preceding five sessions. You will be asked to respond in a Word document to the questions posed. You can only use the class readings as a source to develop your response. Use of AI tools (including ChatGPT) are not permitted for this assignment.

Please use APA style citations in your response with a list of references at the end. Responses that show a clear understanding of the concepts and frameworks "discussed in class" will receive higher grades.

Assignments will be graded on a scale of Excellent, Good, Satisfactory, Fair, or Poor. Don't be discouraged if your grades aren't extremely high right away; it takes time to develop the skills needed to read and understand these types of papers thoroughly.

Be sure to title your assignments as follows and submit on Learn:

**Mid-Term Assignment_Lastname_Firstname.docx**

**Final Assignment_Lastname_Firstname.docx**

Mid Term Assignment is due by: Feb 23, 2025

Final Assignment is due by: April 7, 2025

**WORKING PAPER PRESENTATIONS (20%)**

In Sessions 11 and 12, you will present a working paper (of another author who is not part of this seminar) that uses machine learning methods and is, ideally, not yet accepted at a journal. It would be best if the paper is a current job market paper of a business school PhD student. You can search for relevant papers on SSRN or arXiv, or reach out to job market students in your network.

The presentation should be structured as follows: (a) identification of the research problem, (b) explaining why the problem may/may not be interesting, (c) overview of the modeling approach (with details if applicable), (d) data, (e) results and (f) commentary on the paper highlighting both positive and negative aspects and (g) opportunities for improvements in the paper and (h) future ideas based on the research done. There will be Q and A during the presentation. The last slide(s) should summarize the key highlights of the paper (including a summary of the critiques). The presentation maybe followed by further discussion among the group based on time available.

You will be graded on how well you have understood the paper and critiqued it (*scaled by (a) level of difficulty of the paper and (b) your background prior to enrolling in the course*). In other words, a student with a psychology background doing a fine job on an easier paper will receive the same grade as a student with a quantitative background doing a fine job on a tougher paper.

The selected paper should be different from any working papers listed in the syllabus, and you need to get your selection approved by me in advance of your talk. Deadline to send me an email to get your selection approved: Feb 16, 2025

**MATERIALS / REQUIRED READING / COURSE SCHEDULE**

See the Detailed Session Schedule Section below for a list of the required readings.

**COURSE RULES**

Penalties for Late Assignments: This course will apply the standard 10% penalty if 0-24 hours late, 20% penalty if 24-48 hours late, 50% if 48-72 hours late, 100% if more than 72 hours late

I will quit reading and grading an assignment that exceeds the page limit specified by the assignment instructions.

I expect you to attend all classes and I expect you to be on time and prepared. If you plan to be absent or late, email me ahead of time. You are responsible for consulting your classmates to determine what you missed. I will not meet to provide an overview of the missing session.

**ENROLLMENT RESTRICTIONS**

Enrollment in this course is restricted to graduate students in the Ivey PhD Program, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

## ACADEMIC OFFENCES: PLAGIARISM AND ACADEMIC INTEGRITY

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

## SUPPORT SERVICES: HEALTH AND WELLNESS

Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page http://www.music.uwo.ca, and our own McIntosh Gallery http://www.mcintoshgallery.ca. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html.

## STUDENT ACCESSIBILITY SERVICES

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program.

Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are encouraged to register with Student Accessibility Services, a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both SAS and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include

individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction. For more information, see http://www.sdc.uwo.ca/ssd

## DETAILED SESSION SCHEDULE

LIST OF PAPERS [subject to minor changes]

1.  Introduction

Required Readings:

- Athey, S., & Imbens, G. W. (2019). Machine learning methods that economists should know about. *Annual Review of Economics*, *11*(1), 685-725.
- Liu, X. (2023). Deep learning in marketing: a review and research agenda. *Artificial Intelligence in Marketing*, 239-271.
- Berger, J., Humphreys, A., Ludwig, S., Moe, W. W., Netzer, O., & Schweidel, D. A. (2020). Uniting the tribes: Using text for marketing insight. *Journal of marketing*, *84*(1), 1-25.
- Grewal, R., Gupta, S., & Hamilton, R. (2021). Marketing insights from multimedia data: text, image, audio, and video. *Journal of Marketing Research*, *58*(6), 1025-1033.

Supplemental Reading:

- LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *nature*, *521*(7553), 436-444.

2.  Prediction

Required Readings:

- Liu, Xiao, Param Vir Singh, and Kannan Srinivasan. "A structured analysis of unstructured big data by leveraging cloud computing." *Marketing science* 35, no. 3 (2016): 363-388.
- Netzer, O., Lemaire, A., & Herzenstein, M. (2019). When words sweat: Identifying signals for loan default in the text of loan applications. *Journal of Marketing Research*, *56*(6), 960-980.
- Zhang, M., & Luo, L. (2023). Can consumer-posted photos serve as a leading indicator of restaurant survival? Evidence from Yelp. *Management Science*, *69*(1), 25-50.

Supplemental Reading:

- Lemmens, A., & Croux, C. (2006). Bagging and boosting classification trees to predict churn. *Journal of Marketing Research*, *43*(2), 276-286.

3. Causal Inference

Background Reading:

- Athey, S., & Imbens, G. W. (2017). The state of applied econometrics: Causality and policy evaluation. *Journal of Economic perspectives*, *31*(2), 3-32.

Required Readings:

- Guo, T., Sriram, S., & Manchanda, P. (2021). The effect of information disclosure on industry payments to physicians. *Journal of Marketing Research*, *58*(1), 115-140.
- Gordon, B. R., Moakler, R., & Zettelmeyer, F. (2023). Close enough? a large-scale exploration of non-experimental approaches to advertising measurement. *Marketing Science*, *42*(4), 768-793.
- Tian, Z., Dew, R., & Iyengar, R. (2024). Mega or micro? Influencer selection using follower elasticity. *Journal of Marketing Research*, *61*(3), 472-495.

Supplemental Readings:

- Ellickson, P. B., Kar, W., & Reeder III, J. C. (2023). Estimating marketing component effects: Double machine learning from targeted digital promotions. *Marketing Science*, *42*(4), 704-728.
- Turjeman, D., & Feinberg, F. M. (2024). When the data are out: Measuring behavioral changes following a data breach. *Marketing Science*, *43*(2), 440-461.

4. Text Analysis

Required Readings:

- Timoshenko, A., & Hauser, J. R. (2019). Identifying customer needs from user-generated content. *Marketing Science*, *38*(1), 1-20.
- Liu, X., Lee, D., & Srinivasan, K. (2019). Large-scale cross-category analysis of consumer review content on sales conversion leveraging deep learning. *Journal of Marketing Research*, *56*(6), 918-943.
- Puranam, D., Kadiyali, V., & Narayan, V. (2021). The impact of increase in minimum wages on consumer perceptions of service: A transformer model of online restaurant reviews. *Marketing Science*, *40*(5), 985-1004.

Supplemental Readings:

- Chakraborty, I., Kim, M., & Sudhir, K. (2022). Attribute sentiment scoring with online text reviews: Accounting for language structure and missing attributes. *Journal of Marketing Research*, *59*(3), 600-622.
- Hong, J., & Hoban, P. R. (2022). Writing more compelling creative appeals: A deep learning-based approach. *Marketing Science*, *41*(5), 941-965.

5. Image Analysis – 1

Required Readings:

- Liu, L., Dzyabura, D., & Mizik, N. (2020). Visual listening in: Extracting brand image portrayed on social media. *Marketing Science*, *39*(4), 669-686.
- Li, Y., & Xie, Y. (2020). Is a picture worth a thousand words? An empirical study of image content and social media engagement. *Journal of Marketing Research*, *57*(1), 1-19.
- Hartmann, J., Heitmann, M., Schamp, C., & Netzer, O. (2021). The power of brand selfies. *Journal of Marketing Research*, *58*(6), 1159-1177.

6. Image Analysis – 2

Required Readings:

- Zhang, S., Lee, D., Singh, P. V., & Srinivasan, K. (2022). What makes a good image? Airbnb demand analytics leveraging interpretable image features. *Management Science*, *68*(8), 5644-5666.
- Dzyabura, D., El Kihal, S., Hauser, J. R., & Ibragimov, M. (2023). Leveraging the power of images in managing product return rates. *Marketing Science*, 42(6), 1125-1142.
- Sisodia, A., Burnap, A., & Kumar, V. (2024). EXPRESS: Generative Interpretable Visual Design: Using Disentanglement for Visual Conjoint Analysis. *Journal of Marketing Research*, 00222437241276736.

Supplemental Reading:

- Feng, X. F., Zhang, S., Liu, X., Srinivasan, K., & Lamberton, C. P. (2024). An AI method to score celebrity visual potential from human face. Conditionally Accepted at *Journal of Marketing Research*

7. Audio Analysis

Required Readings:

- Wang, X., Lu, S., Li, X. I., Khamitov, M., & Bendle, N. (2021). Audio mining: The role of vocal tone in persuasion. *Journal of Consumer Research*, *48*(2), 189-211.
- Chang, H. H., Mukherjee, A., & Chattopadhyay, A. (2023). More voices persuade: The attentional benefits of voice numerosity. *Journal of Marketing Research*, *60*(4), 687-706.
- Fong, H., Kumar, V., & Sudhir, K. (2024). A theory-based explainable deep learning architecture for music emotion. *Marketing Science*.

Supplemental Reading:

- Boughanmi, K., & Ansari, A. (2021). Dynamics of musical success: a machine learning approach for multimedia data Fusion. *Journal of Marketing Research*, *58*(6), 1034-1057.

8. Video Analysis

Required Readings:

- Zhou, Mi, George H. Chen, Pedro Ferreira, and Michael D. Smith. "Consumer behavior in the online classroom: Using video analytics and machine learning to understand the consumption of video courseware." *Journal of Marketing Research* 58, no. 6 (2021): 1079-1100.
- Yang, J., Zhang, J., & Zhang, Y. (2024). Engagement that sells: Influencer video advertising on tiktok. *Marketing Science*
- Chakraborty, I., Chiong, K., Dover, H., & Sudhir, K. (2024). Can AI and AI-Hybrids detect persuasion skills? Salesforce hiring with conversational video interviews. *Marketing Science*.

Supplemental Reading:

- Cheng, M., & Zhang, S. (2024). Reputation burning: Analyzing the impact of brand sponsorship on social influencers. *Management Science*.

9. Multi-view Representation

Required Readings:

- Dew, R., Ansari, A., & Toubia, O. (2022). Letting logos speak: Leveraging multiview representation learning for data-driven branding and logo design. *Marketing Science*, *41*(2), 401-425.
- Burnap, A., Hauser, J. R., & Timoshenko, A. (2023). Product aesthetic design: A machine learning augmentation. *Marketing Science*, *42*(6), 1029-1056.
- Luo, X., Jia, N., Ouyang, E., & Fang, Z. (2024). Introducing machine-learning-based data fusion methods for analyzing multimodal data: An application of measuring trustworthiness of microenterprises. *Strategic Management Journal*.

10. Frontiers in AI

Required Readings [Also see next page]:

- Luo, X, Tong S, Fang Z, Qu Z. (2019), "Frontiers: Machines versus Humans: The Impact of Artificial Intelligence Chatbot Disclosure on Customer Purchases," *Marketing Science*, 38 (November), 937–947.
- Zhang, S., Mehta, N., Singh, P. V., & Srinivasan, K. (2021). Frontiers: Can an artificial intelligence algorithm mitigate racial economic inequality? an analysis in the context of airbnb. *Marketing Science*, *40*(5), 813-820.
- Reisenbichler, M., Reutterer, T., Schweidel, D. A., & Dan, D. (2022). Frontiers: Supporting content marketing with natural language generation. *Marketing Science*, *41*(3), 441-452.

- Ali Goli, Amandeep Singh (2024) Frontiers: Can Large Language Models Capture Human Preferences?. *Marketing Science* 43(4):709-722.

Supplemental Readings:

- Li, P., Castelo, N., Katona, Z., & Sarvary, M. (2024). Frontiers: Determining the validity of large language models for automated perceptual analysis. *Marketing Science*, *43*(2), 254-266.

11. Working Paper Presentations

12. Working Paper Presentations