

Western University

Faculty of Engineering

Artificial Intelligence Systems Engineering Program

DATASCI 3000A – INTRODUCTION TO MACHINE LEARNING

Course Outline Fall 2026

COURSE DESCRIPTION:

This course introduces students to the fields of Machine Learning and Data Science. Through this course, students will learn various algorithms and how to implement them to solve real-world problems. Students will get hands-on experience in implementing these algorithms using various programming languages and platforms.

ACADEMIC CALENDAR: Data Science 3000A

https://www.westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_029875_1&SelectedCalendar=Live&ArchiveID=

Basic principles of machine learning (estimation, optimization, prediction, generalization, bias-variance trade-off, regularization) in the context of supervised (linear models, decision trees, deep neural networks) and unsupervised (clustering and dimensionality reduction) statistical learning techniques. The course emphasizes the ability to apply techniques to real data sets and critically evaluate their performance.

PRE OR COREQUISITES:

(Data Science 1200A/B or Computer Science 1026A/B or Computer Science 1027A/B or Computer Science 2120A/B or Digital Humanities 2220A/B or Engineering Science 1036A/B or Data Science 2000A/B or Integrated Science 2002B or Statistical Sciences 2864A/B); (Data Science 2000A/B or Integrated Science 2002B or Statistical Sciences 2857A/B or 0.5 course from the Introductory Statistics Course List); (Mathematics 1600A/B or Numerical and Mathematical Methods 1411A/B or the former Applied Mathematics 1411A/B or Data Science 2100A); (Calculus 1000A/B or Calculus 1500A/B or Numerical and Mathematical Methods 1412A/B or the former Applied Mathematics 1412A/B or Data Science 2100A). Note that Data Science 2000A/B, Integrated Science 2002B and Data Science 2100A can be used to fulfill multiple prerequisites.

ANTIREQUISITES:

the former Computer Science 4414A/B, the former Statistical Sciences 3850F/G, the former Software Engineering 4460A/B.

CEAB ACADEMIC UNITS:

Engineering Science 65%, Engineering Design 35%.

INSTRUCTOR INFORMATION:

Name:

Office:

Office Hours:

CONTACT HOURS:

Timetable information is available at <https://draftmyschedule.uwo.ca/>.

LECTURE:	
LAB:	

RECOMMENDED/ REQUIRED SOFTWARE:

- Python
- Jupyter Notebook
- VS Code
- Google Colab

RECOMMENDED RESOURCES/REFERENCES:

- Hastie, Tibshirani, Friedman. The Elements of Statistical Learning. Springer. [Available at: <https://link.springer.com/content/pdf/10.1007/978-0-387-84858-7.pdf>]
- Bishop, C. M., (2016), Pattern Recognition and Machine Learning, Springer. [Available at: <https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf>]
- Murphy, K. P., (2012), Machine Learning: a Probabilistic Perspective, MIT press. [Available at: <https://www.cs.ubc.ca/~murphyk/MLbook/>]
- Raschka, S., Mirjalili, V., (2017), Python Machine Learning, Packt Publishing. [Available at: <http://radio.eng.niigata-u.ac.jp/wp/wp-content/uploads/2020/06/python-machine-learning-2nd.pdf>]
- Müller, A., Guido, S., (2017), Introduction to Machine Learning with Python - A Guide for Data Scientists, O'Reilly. [Available at: [https://www.nrigroupindia.com/e-book/Introduction%20to%20Machine%20Learning%20with%20Python%20\(%20PDFDrive.com%20\)-min.pdf](https://www.nrigroupindia.com/e-book/Introduction%20to%20Machine%20Learning%20with%20Python%20(%20PDFDrive.com%20)-min.pdf)]
- Barber, D., (2012), Bayesian Reasoning and Machine Learning, Cambridge University press. [Available at: <http://web4.cs.ucl.ac.uk/staff/D.Barber/textbook/090310.pdf>]

- Zhang, A., et al., Dive into Deep Learning, Cambridge University press. [Available at: <https://d2l.ai/d2l-en.pdf>]

GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)

Knowledge Base	A	Engineering Tools	A	Impact on Society	
Problem Analysis	D	Individual & Team Work		Ethics and Equity	D
Investigation		Communication		Economics and Project Management	
Design	A	Professionalism		Life-Long Learning	

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES:

On successful completion of this course, students shall be able to

- Identify which problems can be tackled by DS methods, including which specific DS methods are applicable to a specific problem of interest.
- Wrangle data from a variety of sources into a dataset amenable to a DS solution.
- Conduct an in-depth DS-based analysis of a specific problem that is substantive in nature using packaged software as well as advanced statistical modeling and machine learning with the help of additional packages and/or programming techniques.
- Communicate the results of a data science solution to their peers and to a more general audience.
- Quantify uncertainty in a prediction and evaluate a trained model for bias and fairness before relying on it.

The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES	(CAEB) Graduate Attribute
1. Supervised Learning and Model Fitting (Chapters 1, 2 and 4) At the end of this section, students will be able to: - Define in words terminology related to supervised machine learning and data analytics - Define gradient descent mathematically	KB3, KB4, PA1, PA2, ET1, ET2

c. Define the various metrics used to evaluate machine learning models both in words and mathematically d. Define in words and mathematically the Regression and Classification algorithm (Linear Regression, Logistic Regression, Support Vector Machine (SVM), K-Nearest Neighbour (KNN)) e. List various applications of these algorithms f. Implement these algorithms	
2. Statistics, Prediction, and Maximum Likelihood (Chapter 3) At the end of this section, students will be able to: a. Generate exploratory data analysis plots and summary statistics. b. Use residual diagnostics to examine ordinary least squares assumptions. c. Describe the concept of a likelihood, in words. d. Know and apply the Principle of Maximum Likelihood for a simple example. e. Construct a likelihood for a simple model	KB3, KB4, PA2
3. Estimating Performance and Quantifying Uncertainty (Chapters 5 and 12) At the end of this section, students will be able to: a. Understand and Define in words and mathematically the following concepts/methods: Bias, Variance, Central Limit Theorem, Confidence Intervals, bootstrap method, prediction uncertainty, test error, and Bias-variance decomposition b. Apply bootstrap method and confidence intervals in a simple context	KB3, KB4, PA3, ET2
4. Cross-validation, Model Selection and Regularization (Chapter 5) At the end of this section, students will be able to: a. Understand the basic concepts, issues, assumptions and limitations in machine learning (e.g. base accuracy, overfitting, bias/variance, curse of dimensionality...). b. Understand and apply various cross-validation, model selection and regularization techniques/algorithms	KB4, PA2, PA3, D2, D3, ET2, ET3

5. Decision Trees and Random Forest (Chapters 6 and 7) At the end of this section, students will be able to: - Describe the components and use of a decision tree. - Define in words and mathematically the Random Forest Algorithm - Implement Decision Trees and Random Forest algorithms/Models	KB4, PA2, D2, ET2
6. Neural Networks (Chapter 8) At the end of this section, students will be able to: - Define in words and mathematically the Artificial Neural Network architecture - Approximate functions using this architecture - Implement this architecture along with backpropagation - Define in words and mathematically dropout regularization - List various applications of Artificial Neural Networks - Implement Artificial Neural Networks	KB4, PA2, D2, ET1, ET2, ET3
7. Deep Learning and Generative AI (Chapter 9) At the end of this section, students will be able to: - Define in words and mathematically deep neural networks - Define in words and mathematically generative models - Implement these algorithms and list various applications of them	KB4, PA2, D2, ET1, ET2, ET3
8. Unsupervised Learning and Clustering (Chapters 10 and 11) At the end of this section, students will be able to: - Define in words and mathematically clustering and hierarchical clustering algorithms - Define in words and mathematically the dimensionality reduction algorithms - Implement these algorithms and list various applications of them	KB4, PA2, PA3, D2, ET2
9. Ethical Considerations, Model Limitations & Causality (Chapter 12) At the end of this section, students will be able to: - Measure biases in the model predictions using different fairness metrics - Determining cause-and-effect relationships between variables	KB3, KB4, PA3, D3, EE2, EE4

EVALUATION:

Assessment Type	% Worth	Tentative Due Dates	CEAB GAs ASSESSED
Laboratory Deliverables	10%	Posted on OWL	KB4, PA2, PA3, ET1, ET2, ET3

Group Project	30%	Posted on OWL	D1, D2, D3, D4, PA1, PA2, PA3, ET1, ET2, ET3, EE2, EE4
Midterm Examination	20%	Posted on OWL	KB3, KB4, PA1, PA2, PA3
Final Examination	40%	Scheduled by the Office of the Registrar	KB3, KB4, PA2, PA3, EE2, EE4
Attendance (iClicker)	+2%	Recorded at every lecture	-

The four graded components sum to 100%. The lecture attendance bonus is applied after each graded component is calculated and cannot result in a final course mark above 100%. Marks will be assigned based on the method of analysis and presentation, correctness of solution, clarity, and neatness.

To obtain a passing grade in the course, a mark of 60% or more must be achieved on the final examination. A final examination mark < 60% will result in a final course grade of 48% or less. In addition, a cumulative lecture attendance rate of at least 70% is required across the semester; below that threshold, a student is reported to the Dean's Office and may, on the recommendation of the department and with the permission of the Dean, be denied permission to write the final examination. There is no separate minimum mark on the laboratory deliverables: they are weighted like every other component.

For this course, the following assessments have been designated as requiring supporting documentation:

- Midterm Exam
- Final Exam

COURSE POLICIES:

Laboratory Deliverables:

There are eight laboratory sessions with a deliverable. Lab 0, in Week 1, is a setup and practice submission and carries no marks. The seven marked laboratories are equally weighted and together are worth 10% of the course. Each laboratory is an individual, in-person deliverable: a single self-contained Jupyter notebook, worked on and submitted to Gradescope during your own two-hour laboratory session. Each notebook carries ten questions worth one point each, half for the numerical answer and half for the code that produced it. The last four digits of your student number set the random seed, so between seven and nine of the ten questions have answers that are yours alone. You may submit three times, and only the most recent submission will be marked. Python and the standard Python machine learning packages are used throughout. No laboratory mark is dropped. Laboratory attendance is mandatory, and the submission window is open only during your own session, so a missed laboratory is a missed deliverable and is graded 0 unless academic consideration is granted through the Student Absence Portal. There is no separate pass mark on the laboratory work: it is weighted like every other component.

Self-Reported Absence:

No weight-shifting is allowed for self-reported absence; missed work will be due after a covered period.

Midterm Test:

There will be one midterm test, a closed-book exam (no reference materials allowed), lasting two hours. Simple Calculators are permitted. If a student misses the midterm, the exam will not be rescheduled. Instead, the midterm weight will be added to the final exam, making the final exam worth 70% of the overall grade. If the student provides no valid justification for missing the midterm, they will receive a mark of zero for the test.

Final Examination:

Please note that the final exam is central to the learning objectives for this course. Accordingly, students seeking academic consideration for this assessment must provide formal supporting documentation. Students who are granted academic consideration for this assessment will have the following opportunity to make up this work: the final examination will take place during the regular examination period. It will be three hours long, closed-book, and no calculators are allowed.

A mark of 60% or more must be achieved on the final examination to obtain a passing grade in the course.

A final examination mark < 60% will result in a final course grade of 48% or less.

If you do not meet the above conditions, your final grade cannot exceed 48%. Students who have failed this course (i.e., final average < 50%) must repeat all course components.

Group Project:

Groups must consist of exactly 4 students in the same laboratory section of the course. Groups of three or five are not permitted. Individual marks can differ within a group: members are questioned individually during the laboratory demonstrations, and a member who cannot explain the group's code and choices does not receive the group's mark.

Project Presentation:

All project group members must present the project's slides in the lab and will be graded by the TA/Instructor during lab hours. Students who miss the lab for the presentation will be graded 0 for the Project Presentation.

Project Code:

The project code must be written in Python. Submit and share the project's GitHub repository with the course Instructor and TAs and have all project group members demonstrate the code in lab; the TA/Instructor will grade it during lab hours. Students who miss the lab demo will receive a 0 for the Code Demo.

Late Submission Policy:

No late submissions will be accepted; late submissions will be graded with 0%.

Use of English:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work (except examinations) may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance:

Attendance will be recorded during every lecture using iClicker. Students are expected to maintain a cumulative attendance rate of at least 70% throughout the semester. Students who fall below this threshold will be reported to the Dean's Office. Consistent with university regulations, any student who fails to meet this attendance requirement may, upon the recommendation of the department and with the permission of the Dean, be disqualified from writing the final examination.

ABSENCE FROM MANDATORY COURSE COMMITMENTS: Students must familiarize themselves with the Policy on **Academic Consideration for Absences:** <https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html>

I. Missed/Late Accommodation Policy

1. Students missing a test/ examination will report the absence by submitting Academic Consideration Request form through [STUDENT ABSENCE PORTAL](#).
2. Documentation must be provided as soon as possible.
3. Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence.

II. Exam Accommodation

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). **The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.**
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#). **PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.**

III. Medical Accommodation

1. Requests for Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
2. Requests for academic consideration must include the following components:
 - a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
 - b. Medical note. Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence.
 - c. Indication of the course(s) and assessment(s) affected by the request
 - d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline.

Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Registration.

IV. Religious Accommodation

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

V. Academic Integrity

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit [Academic Integrity Western Engineering for more information](#)

VI. Academic Offences

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.

[Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know](#)

Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on 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>). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VII. Faculty of Engineering AI Policy

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

VIII. Use of English Policy

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

IX. Accessibility

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the [Accessibility Western University](#) for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit [Academic Support & Engagement -Academic Accommodation](#).

X. Inclusivity, Diversity, and Respect

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the [Office of Equity, Diversity and Inclusion](#).

XI. Health and Well-Being

- [Health & Wellness Services – Students](#) - Offers appointment-based medical clinic for all registered part-time and full-time students.
- [Mental Health Support](#) - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.

- [Crisis Support](#) - For immediate assistance, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click [here](#).
- [Gender-Based Violence and Survivor Support](#) - Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts

[Engineering Undergraduate Services](#)
[Electrical and Computer Engineering](#)

[Office of the Registrar/Student Central](#)

Important Links

- [WESTERN ACADEMIC CALENDAR](#)
- [ACADEMIC RIGHTS AND RESPONSIBILITIES](#)
- [ENGINEERING PROGRESSION REQUIREMENTS AND ACADEMIC REGULATIONS](#)
- [UNIVERSITY STUDENTS' COUNCIL \(USC\) - SERVICES](#)
- [IMPORTANT DATES AND DEADLINES](#)
- [ACADEMIC CONSIDERATION FOR MEDICAL ILLNESS - UNDERGRADUATE STUDENTS](#)
- [ACCOMMODATIONS FOR RELIGIOUS HOLIDAYS](#)
- [SCHEDULING OF ASSIGNMENTS, TESTS, AND EXAMINATIONS](#)
- [STUDENT FORMS](#)
- [OFFICE OF THE REGISTRAR](#)
- [RETENTION OF ELECTRONIC VERSION OF COURSE OUTLINES \(SYLLABI\)](#)
- [ACADEMIC APPEALS](#)
- [STUDENT ABSENCE PORTAL](#)