

Western University
Faculty of Engineering
Department of Electrical and Computer Engineering

ECE 9603 – Data Analytics Foundations
COURSE OUTLINE 2025-2026

DESCRIPTION

In recent years, developments in the Web, social media, IoT, sensors, and mobile devices have resulted in the ability to collect more data than ever. This course focuses on approaches and techniques for extracting value from such massive data through data analytics. Various forecasting approaches (such as moving averages, support vector regression, neural networks) and recommender systems will be covered. The emphasis will be on solving real world problems using those techniques. Deep learning will be explored because it can learn complex non-linear relationships commonly present in Big Data, capture various levels of abstraction, and learn good features from data. Challenges of data analytics with large data sets will be explored and emerging techniques for addressing those challenges will be discussed. Students are required to develop a project which provides an opportunity to explore in more details an area of data analytics and experience some of the challenges that they may face in their future work/research activities.

PREREQUISITES: At least one course in machine learning such as ECE9611 (DS3000) and at least one statistics course

ENROLLMENT RESTRICTIONS

Enrollment in this course is restricted to graduate students in Software Engineering 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.

INSTRUCTOR CONTACT INFORMATION

Course instructor: Dr. Alexandra L’Heureux
Email address: alheure2@uwo.ca
Office hours: TEB 357, hours TBD

COURSE FORMAT

This course is delivered in-person, video lectures may be provided as needed to accommodate student’s needs.

TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	<ul style="list-style-type: none">• Introduction• Describe the course objectives and expectations	<ul style="list-style-type: none">• Lecture slides	Week 1

	<ul style="list-style-type: none"> • Use the main terminology • Recognize different analytics types • Explain Big Data characteristics (Volume, Velocity, Variety, Veracity). • Identify common data challenges: imbalance, missing values, noise, bias. 		
2	<p>Forecasting Foundations</p> <ul style="list-style-type: none"> • Describe basic ARIMA concepts • Explain ARIM modeling • Use ARIMA for forecasting • Identify differences between time series and machine learning-based forecasting • Identify application scenarios for time series and machine learning-based forecasting 	<ul style="list-style-type: none"> • Lecture slides 	Week 1-2
3	<p>Data preparation and model evaluation</p> <ul style="list-style-type: none"> • Describe techniques for preparation of columnar, image, and text data • Use normalization techniques and feature scaling • Explain error metrics • Apply hold-out and cross-validation evaluation techniques • Identify core data challenges (missing data, noisy and mislabeled data, leakage) 	<ul style="list-style-type: none"> • Lecture slides • Code examples 	Week 2-3
4	<p>Support Vector Machine</p> <ul style="list-style-type: none"> • Use support vector machine (SVM) • Identify differences between hard and soft margin SVM • Understand non-linear SVM • Describe Support Vector Regression (SVR) • Understand the kernel trick 	<ul style="list-style-type: none"> • Lecture slides • Code examples 	Week 3
5	<p>Neural Networks</p> <ul style="list-style-type: none"> • Describe perceptron and multi-layer neural network • Describe gradient descent and 	<ul style="list-style-type: none"> • Lecture slides • 	Week 4

	<p>backpropagation</p> <ul style="list-style-type: none"> • Discuss activation and loss functions • Apply feedforward neural network • Implications of loss functions for optimization 		
6	<p>Deep Learning Architectures</p> <ul style="list-style-type: none"> • Identify the main factors that led to deep learning • Describe various architectures including autoencoders, GANs, RNNs, and CNN • Describe at a high level attention and transformers . • Identify use cases for various architectures 	<ul style="list-style-type: none"> • Lecture slides • Practice problems and questions 	Week 4-5
7	<p>Deep Learning – tuning and generalization</p> <ul style="list-style-type: none"> • Identify basic hyperparameter tuning for NN • Discuss the impact of learning rate on NN training • Describe strategies for dealing with overfitting • Connect tuning practices to Big Data challenges 	<ul style="list-style-type: none"> • Lecture slides • Practice problems and questions 	Week 6
8	<p>Recommender Systems</p> <ul style="list-style-type: none"> • Identify and explain different types of recommender systems • Identify ways to evaluate recommender systems • Recognize cold-start, sparsity, scalability, and drift challenges. • Discuss fairness and bias in recommender systems. 	<ul style="list-style-type: none"> • Lecture slides • Practice problems and questions 	Week 7
9	<p>Big Data Analysis and various paradigms</p> <ul style="list-style-type: none"> • Identify challenges of machine learning with Big Data • Discuss ways of dealing with challenges of ML with Big Data 	<ul style="list-style-type: none"> • Lecture slides • Practice questions • Research Paper 	Week 8

	<ul style="list-style-type: none"> Describe learning paradigms such as online, local, transfer, lifelong, and ensemble learning 	<ul style="list-style-type: none"> Lecture slides 	
10	Federated Learning <ul style="list-style-type: none"> Describe Federated Learning architectures and algorithms Identify privacy, security and communication challenges Discuss how federated learning relates to Big Data challenges. 	<ul style="list-style-type: none"> Lecture slides Research Paper 	Week 9
11	Reinforcement Learning <ul style="list-style-type: none"> Define Reinforcement learning Explain exploration vs exploitation Describe Q-learning and value/policy functions. 	<ul style="list-style-type: none"> Lecture slides Research Paper 	Week 10
12	Final project presentations		Week 11

SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Assessment Tools	Outcomes
Depth and breadth of knowledge	<ul style="list-style-type: none"> Assignments Project Paper Presentation Paper Connection 	<ul style="list-style-type: none"> Understanding of concepts, theories, and applications. Ability to apply studied approaches on practical problems. Analyze and explain a research paper in context of course topics. Extend understanding of weekly topics through targeted readings.
Research & scholarship	<ul style="list-style-type: none"> Project Paper Presentation Paper Connection 	<ul style="list-style-type: none"> Ability to devise novel solutions for data analytics problems. Conduct coherent and thorough analysis of different ways to solve data analytics problems. Engage critically with scholarly literature, synthesizing insights. Demonstrate the ability to identify, summarize, and connect research papers to course themes.
Application of knowledge	<ul style="list-style-type: none"> Assignments Project Peer Evaluation 	<ul style="list-style-type: none"> Ability to apply knowledge in a rational way to analyze a particular problem. Solve data analytics problems using existing approaches or a combination of existing approaches and tools. Evaluate peers by applying concepts learn from the course

Communication skills	<ul style="list-style-type: none"> • Project • Paper Presentation • Peer Review 	<ul style="list-style-type: none"> • Ability to communicate oral and written ideas, issues, results and conclusions clearly and effectively. • Communicate complex technical ideas clearly and engage in scholarly discussions. • Provide constructive, evidence-based feedback on peer presentations.
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ASSESSMENTS

Assessment Type	Material Covered	Tentative Due Date	Weight
Assignments (two)	Topic 1 to 7	Week 7 and 10	25%
Project report (one)		Week 11	40%
Project presentation (one)		Week 11	10%
Paper Connection	Chosen from Topics 8-11	By Week 11	5%
Pair Paper Presentation	Assigned one Topics from 6-11	Depends on Topic	15%
Peer Review	All topics	Week 11	5%

In order to pass the course, a student must obtain a mark of 50% or more in each component. A mark less than 50% in any component will result in a final course grade of 48% or less.

Missed Work: University policy on academic considerations requires that all requests for academic considerations must be accompanied by a self-attestation. Further information about academic considerations, and information about submitting this self-attestation with your academic consideration request may be found here.

Please note that any academic considerations granted in this course will be determined by the instructor, in consultation with the academic advisors in your Faculty of Registration, in accordance with information presented in this course outline.

Late Submission Policy: This course employs flexible deadlines for assignments and project report. The tentative assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed on the course website. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 48 hours past the deadline without academic penalty. Should students submit their assessment beyond 48 hours past the deadline, a late penalty of 10% of the available mark per day, to a maximum of 2 days late.

Project: The project provides the students with an opportunity to experience some of the challenges that they may face in their future work/research activities. The project topic and scope will be selected in consultation with the instructor. The deliverables will consist of a project proposal, a written report, and an oral presentation.

Pair paper Presentation: This presentation is considered to be a foundational objective of the course and is directly tied to the weekly topics. Students who are granted academic consideration for this assessment will be provided with a make-up to take place 1 week after the original date.

Activities in which collaboration is permitted:

- Project: Students collaborate with others in their own group where pairs have been approved
- Pair Paper Presentation:

Activities in which students must work alone (collaboration is not permitted):

- The paper connection
- Peer review
- The project (unless permission to work in pairs is granted)
- Assignments

RECOMMENDED READINGS AND REFERENCES

[1] Course notes

[2] Papers and supplementary reading list of recent research publications

[3] Rob J Hyndman and George Athanasopoulos, Forecasting: principles and practice, Otexts, <https://www.otexts.org/fpp>, 2018.

[4] Josh Patterson and Adam Gibson, Deep learning: A practitioner's approach, O'Reilly Media, 2017.

[5] Charu C. Aggarwa, Recommender systems: The textbook, Springer, 2016

[6] Jerome Friedman, Trevor Hastie, and Robert Tibshirani. The elements of statistical learning: The elements of statistical learning data mining, inference, and prediction. Second Edition. New York: Springer, 2009.

[7] Francesco Ricci, Lior Rokach, and Bracha Shapira (eds.). Recommender Systems Handbook. Third Edition. New York: Springer, 2022.

[8] Richard S. Sutton and Andrew G. Barto. Reinforcement Learning: An Introduction. Second Edition. Cambridge, MA: MIT Press, 2018.

[9] Qiang Yang, Yang Liu, Tianjian Chen, and Yongxin Tong. Federated Learning: From Fundamentals to Applications. San Diego, CA: Morgan Kaufmann/Elsevier, 2021.

CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an

academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: https://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>).

CONDUCT

Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

HEALTH/WELLNESS SERVICES

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. 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. Faculty of Engineering has a Student Wellness Counsellor. To schedule an appointment with the counsellor, contact Kristen Edwards (khunt29@uwo.ca) via confidential email and you will be contacted by our intake office within 48 hours to schedule an appointment.

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.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western is committed to working to end gender-based and sexual violence on campus and in our community 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.

SICKNESS

Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at:

<https://www.eng.uwo.ca/graduate/current-students/academic-support-and-accommodations/index.html>

ACCESSIBLE EDUCATION WESTERN (AEW)

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 strongly encouraged to register with Accessible Education Western (AEW): http://academicsupport.uwo.ca/accessible_education/index.html

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW 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.