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Western University
Faculty of Engineering
Department of Electrical and Computer Engineering

ECE 9603/9063 – Data Analytics Foundations
COURSE OUTLINE 2023-2024

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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 undergraduate programming course 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.

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	Introduction • Describe the course objectives and expectations • Use the main terminology • Recognize different analytics types	• Lecture slides	Week 1

2	Time series forecasting • Describe basic ARIMA concepts • Explain ARIM modeling • Use ARIMA for forecasting	• Lecture slides	Week 2
3	Data preparation and model evaluation • Describe techniques for preparation of columnar, image, and text data • Use normalization techniques • Explain error metrics • Apply hold-out and cross-validation evaluation techniques	• Lecture slides • Code examples	Week 3
4	Forecasting – Machine learning techniques • Identify differences between time series and machine learning-based forecasting • Identify application scenarios for time series and machine learning-based forecasting	• Lecture slides • Code examples	Week 4
5	Support Vector Machine • Use support vector machine (SVM) • Identify differences between hard and soft margin SVM • Understand non-linear SVM • Describe Support Vector Regression (SVR)	• Lecture slides • Code examples	Week 4-5
6	Neural Networks • Describe perceptron and multi-layer neural network • Describe gradient descent and backpropagation • Discuss activation and loss functions • Apply feedforward neural network	• Lecture slides • Practice problems and questions	Week 5-6
7	Deep Learning • Identify the main factors that led to deep learning • Describe various architectures including autoencoders, GANs, RNNs, and CNN • Identify use cases for various architectures	• Lecture slides • Practice problems and questions	Week 6-7

8	Deep Learning – tuning • Identify basic hyperparameter tuning for NN • Discuss the impact of learning rate on NN training • Describe ways of dealing with overfitting	• Lecture slides • Practice problems and questions	Week 8-9
9	Recommender Systems • Identify and explain different types of recommender systems • Identify ways to evaluate recommender systems	• Lecture slides • Practice problems and questions	Week 9-10
10	Big Data Analysis • Identify challenges of machine learning with Big Data • Discuss ways of dealing with challenges of ML with Big Data • Describe learning paradigms such as online, local, transfer, lifelong, and ensemble learning	• Lecture slides • Practice questions • Research Paper	Week 10-11
11	Final project presentations		Week 12

SPECIFC LEARNING OUTCOMES

Degree Level Expectation	Assessment Tools	Outcomes
Depth and breadth of knowledge	• Assignments • Project • Examinations	• Understanding of concepts, theories, and applications. • Ability to apply studied approaches on practical problems.
Research & scholarship	• Project	• Ability to devise novel solutions for data analytics problems. • Conduct coherent and thorough analysis of different ways to solve data analytics problems.
Application of knowledge	• Assignments • Project • Examinations	• 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.
Communication skills	• Project	• Ability to communicate oral and written ideas, issues, results and conclusions clearly and effectively.

ASSESSMENTS

Assessment Type	Material Covered	Tentative Due Date	Weight
Assignments (two)	Topic 1 to 8		20%
Project report (one)			40%
Project presentation (one)			10%
Final Exam	All topics		30%

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.

Late Submission Policy: There will be strict deadlines for the project and assignments. Late submissions will be penalized by 10% of the available mark per day, to a maximum of 3 days late

Project: The group 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.

Final Exam: The final examination will cover all course content.

<u>Activities in which collaboration is permitted:</u>
- Project: Students collaborate with others in their own group.

<u>Activities in which students must work alone (collaboration is not permitted):</u>
- The final exam and 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.

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.

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.