ENGG*6600 Advanced Machine Learning
Winter 2023

UNIVERSITY of GUELPH

School of Engineering

(Revision 3: September, 04, 2019)

INSTRUCTIONAL SUPPORT

Instructor

Instructor:	Shawki Areibi, Ph.D., P.Eng.
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Teaching Assistant

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Information Technology Specialist

Technician:	Matt Kurylo
Office:	THORN 2363, ext. 52685
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Webpage and Courselink

SOE Web Page:	https://www.uoguelph.ca/engineering/
Courses Web Page:	https://sareibi.uoguelph.ca/undergraduate-courses/
ML Course Web Page:	http://islab.soe.uoguelph.ca/sareibi/TEACHING_dr/ENG6500_ML_html_dr/eng6500-ml.html
ML Courselink:	https://courselink.uoguelph.ca/shared/login/login.html

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LEARNING RESOURCES

Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*6600 Course Webpage site. You are responsible for checking the site regularly.

Required Resources

1. "Lecture Notes Prepared by Instructor", by Shawki Areibi. **Notes to accompany lectures will be posted on the Course Website and/or Courselink throughout the semester. Students will be granted access to the website when they register for the course.**

Recommended Resources

1. "Introduction to Machine Learning", by Etherm Alpaydin. **Publisher**: MIT Press, 2020, 4th Edition, ISBN 0262043793.
2. "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow", by Aurelien Geron O'Reilly Media Inc, 2019, ISBN 978-1-4020-6088-5.
3. "A Course in Machine Learning", by Hal Daume III, 2017.
   http://ciml.info/
4. "Deep Learning", by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016, freely available online.
5. "Machine Learning: A Probabilistic Perspective", by Kevin P. Murphy, MIT Press, 2012.

Additional Resources

1. **Lecture Information**: All the lecture notes are posted on the web page (week #1-#12).
2. **Project Information**: The handouts for the projects are within the project section. All types of resources regarding tutorials, links to web pages can be found in this section.
3. **Assignments**: Download the assignments according to the schedule given in this handout.
4. **Miscellaneous Information**: Other information related to Machine Learning are also posted on the web page.

Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements and/or changes will be posted to the course website/courselink. **It is your responsibility to check the course website regularly.**

Personal and confidential topics (e.g. marks) should be emailed to the instructor: sareibi@uoguelph.ca As per university regulations, all students are required to check their "uoguelph.ca" e-mail account regularly: e-mail is the official route of communication between the University and its student.

ASSESSMENT

Dates and Distribution

1. Labs/Assignments: 25%, See Section 5 for due dates
2. Project: 30%, Report Due Date: Week # 13
3. Paper Review: 10%, Week # 11
4. Final Exam: 35%
   April, Week # 13

Details

Assignments: There will be 4 assignments in total for this course. Each assignment will tackle a specific area discussed in class such as classification, regression, feature selection, clustering e.t.c Detailed instructions on the content of each assignment will be distributed during the term.

Project: Projects will be completed in groups. Every group will have 2 students. Each group will select a topic related to Machine Learning. You should conduct an in-depth study covering the problem to be solved and its origins, developments, and current status. This will involve extensive research; your findings should be documented in a report with the basic references cited. Students will propose a data-analysis problem and dataset. The students will solve the problem using a Machine Learning approach of their choosing. Students will have to submit a 1 page proposal to the instructor for approval. If the instructor does not approve the proposal, students will complete a project that will be assigned to them.

The deliverable will be a report in the format of the International Conference on Machine Learning – please use this LATEX style file. The report (pdf only) is due 2nd week of August and must be submitted via the CourseLink Dropbox tool.

Final Exam: The final exam will test students on material covered in lectures and assignments and will focus on concepts covered in class.

Course Grading Policies

Passing Grade: The passing grade is 65%.

Missed Assessments: When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration: https://calendar.uoguelph.ca/archived-calendars/2021-2022/graduate-calendar/

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Drop Date: The last date to drop one-semester courses, without academic penalty, is 40th day of classes. Two-semester courses must be dropped by the last day of the add period in the second semester. Refer to the Graduate Calendar for the schedule of dates:
http://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-w11.shtml

AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

Calendar Description

The aim of this course is to provide students with an introduction to algorithms and techniques of machine learning particularly in engineering applications. The emphasis will be on the fundamentals and not specific approach or software tool. Class discussions will cover and compare all current major approaches and their applicability to various engineering problems, while assignments and project will provide hands-on experience with some of the tools.

Course Aims

Companies face a profound shortage of talent with deep analytical skills. This course serves as a foundation for further academic or industry work in the age of big data. However, this course provides a broad overview of the field of machine learning. Students are encouraged to explore practical applications of these techniques across a wide variety of domains.

Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Understand the basic concepts of Machine Learning.
2. Identify and discuss general machine learning concepts such as generalization, overfitting, preprocessing, feature extraction, training/validation/test sets.
3. Recognize the most common Machine Learning paradigms: classification, regression, clustering, etc.
4. Implement debug, and evaluate basic Machine Learning algorithms.
5. When appropriate, choose among and apply off-the-shelf machine learning toolkits to problems in your field.

Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Course Web Page but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

Relationships with other Courses

ENGG*6600 will teach you plenty about Machine Learning Algorithms, its specification, design and implementation.

TEACHING AND LEARNING ACTIVITIES

Timetable

Lectures:

Lecture	Time	Location	Instructor
Wednesday	10:00 AM - 11:30 AM	RICH2531 or Online (Webex)	S. Areibi
Friday	10:00 AM - 11:30 AM	RICH2531 or Online (Webex)	S. Areibi

Lecture Schedule

Lectures	Lecture Topics	References	Learning Objectives
1-3	Overview of ML, Python, Frameworks	Chapter	1
4-5	Optimization Techniques for Machine Learning	Chapter	1
6-9	Data Preparation and Feature Extraction	Chapter	1,2,3
10	Evaluation of Regression/Classification	Chapter	5,6
11-14	Supervised Machine Learning Algorithms	Chapter	5,6
15-16	Unsupervised Machine Learning Algorithms	Chapter	2,3,5,6
17	Loss Functions and Parameter Tuning	Chapter	2,3,4,5
18-19	Ensemble Based Machine Learning Techniques	Chapter	3,4,5,6
20	Machine Learning Applications	Chapter	4,5
21	Meta Learning	Chapter	4,5
22-23	Deep Learning and Deep Networks	Chapter	2,3,4,5,6
24	Course Review	Chapter	4,5,6

Assignments

There will be between 4 assignments throughout the term. **Solve all problems** and hand it in during the lecture.

Assignment #	Handed In	Due Date	Topic
Assign #1	(Week #2)	(Week #4)	Data Exploration and Preprocessing
Assign #2	(Week #4)	(Week #6)	Regression
Assign #3	(Week #6)	(Week #8)	Classification
Assign #4	(Week #8)	(Week #9)	Clustering

Research Project

Projects will be conducted in groups of 2 students. **Sample projects could be found on the course web-page**.

Other Important Dates

1. **First Class**: January 11th 2023,
2. **Reading Week**: February 21st - February 25th,
3. **Drop Date:** Check Calendar
4. **Last Class**: Friday, April 7h, 2023.

5. **Exams Commence**: Week # 13, 2023.

ACADEMIC MISCONDUCT

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community - faculty, staff, and students - to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offence from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Resources

The Academic Misconduct Policy is detailed in the Graduate Calendar:
https://www.uoguelph.ca/registrar/calendars/graduate

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in the Program Guide:
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible

RECORDING OF MATERIALS

Presentations which are made in relation to course work-including lectures-cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

Resources

The Graduate Calendar is the source of information about the University of Guelph's procedures, policies and regulations which apply to graduate programs: http://www.uoguelph.ca/registrar/calendars/graduate/current