Course Outline

Instructor

- Prof. Ahmed Ashraf
  E3–504B EITC
  (204) 474–8179
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Office Hours
- By appointment.

Teaching Assistant
- Mahboobeh Norouzi
  norouzim@myumanitoba.camfo

Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  3 hours x 5 weeks = 15 hours

Prerequisites:
- MATH 3132 Engineering Mathematical Analysis 3

Course Website:
https://umanitoba.ca/umlearn

Important Dates

- **Term Test**
  October 27th, 2020
  6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
  November 23rd, 2020
- **Thanksgiving Day**
  October 12th, 2020
  No classes or examinations
- **Remembrance Day**
  November 11th, 2020
  No classes or examinations
- **Fall Term Break**
  November 9th –13th, 2020
  No classes or examinations

ECE 4450 – Applied Computational Intelligence

Fall 2020

IMPORTANT NOTICE – Mandatory Requirement to Report

This course will be conducted using remote instruction. Students who are accessing the course from outside of Canada or the USA ***must notify the instructor*** and indicate in which country they are located. Access to software may be restricted from some countries and failure to comply with these restrictions may result in criminal prosecution.

Course Objectives

This course applies computationally intelligent algorithms to solve difficult computer engineering and computer science problems. This course consists of the following components: standard lecture delivery, hands-on, and project based. The theory of several computationally intelligent algorithms will be presented in class. Along with receiving the theory in class, students are required to demonstrate their understanding by implementing the algorithms in software to solve given difficult engineering problems, which have shown to be intractable with the application of conventional algorithms.

Course Content

The following topics will be covered:

- Introduction
- Nearest neighbour classification
- Decision Trees
- Ensemble Methods
- Linear regression
- Linear Classification
- Support Vector Machines
- Boosting
- Neural Networks
- Principal Component Analysis
- Probabilistic Models
- Clustering Methods
- Gaussian Mixture Models
- Expectation Maximization
- Matrix Factorization
- Reinforcement Learning

Laboratories

The following topics may be covered in the labs:
- Application of Linear Regression.
- Application of Logistic Regression.
- Analysis of the Backpropagation algorithm in ANNs.
- Investigation of the SVM algorithm in classification problems.
- Investigation and novel addition to the simulate annealing and genetic algorithms for classification problems.

Textbooks

Elements of Statistical Learning, T. Haste, R. Tibshirani, and J. Friedman, Springer, 2008.
https://web.stanford.edu/~hastie/Papers/ESLII.pdf

Information Theory, Inference, and Learning Algorithms, D. Mackay, Cambridge University Press, 2003.
http://www.inference.org.uk/itprnn/book.pdf

Reference

Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2006.
https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 70%
- Engineering Design: 30%

Graduate Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/ environment
EE: Ethics and equity
EP: Economics and project management
LL: Life-long learning

Competency Levels

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability to rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

Learning Outcomes

1. Ability to choose the appropriate machine learning algorithm to solve a computational intelligent demanding problem.
2. Develop Matlab programs to implement computationally intelligent algorithms.
3. Identify, define, and describe the components of the computationally intelligent algorithms studied in this course.
4. Create and design novel methods to implement parts of given algorithms.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	2		3	3								
2	4	4	4	4	5	2						
3	4	2	3	5								
4	4	4	3	4	3	3						

Evaluation

The final course grade is determined by the student's performance on assignments, in laboratories, and on examinations. Students must complete a subset of the laboratories in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Assignments	25	F, S	1, 2, 3, 4
Term Test	25	F, S	2, 3
Final Examination	50	S	1, 2, 3, 4

∗ Method of Feedback: **F** - Formative (written comments and/or oral discussion), **S** - summative (numerical grade)

CEAB Graduate Attributes Assessed

DE.3 – Uses tools to complete engineering activities.

ET.1 – Develops/implements possible solutions to an open-ended design problem, leading to an appropriate recommendation.

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Requirements and Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's *General Academic Regulations*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

Supplemental Information

Copyright Notice

Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.