BUS Q775
Optimization and Machine Learning with Big Data
Winter 2021 Course Outline

Operations Management
DeGroote School of Business
McMaster University

COURSE OBJECTIVE

The objective of this course is to develop an understanding of the role of optimization in machine learning and how optimization can benefit from machine learning, in particular, when the optimization is carried in the presence of big data and/or complex problems. The ultimate goal is to help students develop expertise in the area of prescriptive big data analytics at the intersection of optimization and artificial intelligence. During this course, students are expected to gain hands-on experience with relevant optimization and machine learning computing platforms.

INSTRUCTOR AND CONTACT INFORMATION

Dr. Elkafi Hassini

hassini@mcmaster.ca

Day and Time: T 6:30-9:30 pm

COURSE DESCRIPTION

Since its early inception, machine learning has made use of optimization algorithms and modelling. Likewise, machine learning has benefited the field of optimization by providing opportunities for developing new solution approaches. With the wide availability of big data, current machine learning optimization algorithms have reached their performance limits, a serious handicap for real-time and streaming applications. On the other hand, big data has also offered challenges to existing optimization solvers such as Cplex. The course will cover foundational material on mathematical optimization and machine learning as well as hand on applications with big data using state of the art computing platforms.

LEARNING OUTCOMES

Upon completion of this course, students will be able to complete the following key tasks:

- Understand basics of large-scale optimization methods.
- Understand basics of machine learning algorithms.
- Understand how optimization is applied in machine learning.
- Understand how machine learning can be applied in optimization.
- Develop algorithms and programs for solving optimisation with big data.

REFERENCE MATERIALS

Bell, J. (2020). *Machine learning: hands-on for developers and technical professionals*. John Wiley & Sons.
Dean, J. (2014). *Big data, data mining, and machine learning: value creation for business leaders and practitioners*. John Wiley & Sons.
Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The elements of statistical learning: data mining, inference, and prediction*. Springer Science & Business Media.
Ignizio, J. P., & Cavalier, T. M. (1994). *Linear programming*. Prentice-Hall, Inc.
Manoochehri, M. (2013). *Data just right: introduction to large-scale data & analytics*. Addison-Wesley.
Martin, R. K. (2012). *Large scale linear and integer optimization: a unified approach*. Springer Science & Business Media.
Mohammed, M., Khan, M. B., & Bashier, E. B. M. (2016). *Machine learning: algorithms and applications*. CRC Press.
Rogers, S., & Girolami, M. (2016). *A first course in machine learning*. CRC Press.
Sra, S., Nowozin, S., & Wright, S. J. (Eds.). (2012). *Optimization for machine learning*. MIT Press.

EVALUATION

Components and Weights

Assignments	40%
Term Paper	
Outline	5%
Presentation	15%
Report	40%
Total	100%

Conversion

At the end of the course your overall percentage grade will be converted to your letter grade in accordance with the following conversion scheme.

Grade	Points	Equivalent Percentages
A+	12	90 – 100
A	11	85 – 89
A-	10	80 – 84
B+	9	77 – 79
B	8	73 – 76
B-	7	70 – 72
F	0	69 and under

Assignments (40%, individual work)

There will be two assignments one on optimization methods and the other on machine learning algorithms.

Term Paper (60%, individual work)

You will work on a term paper and you are required to: (1) Implement an algorithm on a big data set (2) present your work and (3) submit a report. You are encouraged to work on a problem related to your thesis research, if already known.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at:

www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations

MISSED ACADEMIC WORK

Late assignments will not be accepted. No extensions are available except under extraordinary circumstances. Please discuss any extenuating situation with your instructor at the earliest possible opportunity.

STUDENT ACCESSIBILITY SERVICES

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca.

For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities:

http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request, including the dates/times needing to be accommodated and the courses which will be impacted, to their Program Office normally within 10 days of the beginning of term. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

POTENTIAL MODIFICATION TO THE COURSE

The instructor reserves the right to modify elements of the course during the term. There may be changes to the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

COURSE SCHEDULE

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WEEK	TOPIC	ASSIGNMENTS
1	Introduction Big Data Optimization Machine Learning	
2-4	Predictive modelling with linear and integer programming	Term paper outline
5	Convex Programming Quadratic Programming Cone Programming Semidefinite Programming Robust Optimization	
6	Script Programming	Assignment 1
6-7	Supervised Learning Algorithms	
8-9	Unsupervised Learning Algorithms	
10-11	Probabilistic Inference Models	
12-13	Solution Methods	Assignment 2 Project Presentation and Report