Carleton UNIVERSITY | Department of Systems and Computer Engineering

SYSC 4906
Special Topics

Calendar description

At the discretion of the Department, a course dealing with selected advanced topics of interest to students in Biomedical and Electrical, Communications, Computer Systems, Electrical, Software Engineering, and Engineering Physics may be offered.

http://calendar.carleton.ca/undergrad/courses/SYSC/

Prerequisites

Permission of the Department.

Prior knowledge

Students should:

- Be proficient in software development in at least one language.
- Be able to program in Python or learn to do so on their own time within the first two weeks of class.
- Understand basic probability and statistics.
- Have strong math skills, including working with differential equations, matrix operations, and gradients.

Course objectives

This course will follow “The One Hundred Page Machine Learning Book” from cover-to-cover. Students will gain an introductory-level understanding of both supervised and unsupervised machine learning (ML), including deeper knowledge of a number of algorithms of each type. Students will learn how to evaluate and quantify predictive performance of ML systems. Students will also become familiar with one or more ML development environments with practical assignments and demonstrations.

List of topics

- Math/Notation/Definitions.
- ML algorithms 1 (linear and logistic regression).
- ML algorithms 2 (decision trees).
- ML algorithms 3 (support vector machines and K-Nearest neighbour).
- Anatomy of a learning algorithm (e.g. gradient descent, building blocks of a learning algorithm).

- Feature engineering, learning algorithm selection, Train/Test/Validation sets, under-fitting, over-fitting, regularization.
- Model performance assessment, hyperparameter tuning/cross-validation.
- Neural networks (multi-layer feed-forward networks, backpropagation).
- Deep learning (convolutional neural networks, recurrent neural networks).
- Problems & solutions (e.g. Kernel regression, multiclass classification, one-class classification, multi-label classification, ensemble learning, label sequences, sequence-to-sequence learning, active learning, semi-supervised learning, one-shot learning, zero-shot learning).
- Advanced practice (class imbalance, combining classifiers, algorithm efficiency, training neural networks, encoding input data, regularization, multiple inputs & outputs, transfer learning).
- Density estimation, clustering.
- Dimensionality reduction, outlier detection.
- Metric learning, learning to rank, learning to recommend, denoising auto-encoders.
- Natural Language Processing (NLP) 1, NLP 2.
- Topic modeling, gaussian processes, generalized linear models, probabilistic graphic models.
- Markov Chain Monte Carlo, genetic algorithms, reinforcement learning.
- Ethical development and deployment of ML.

Learning outcomes

By the end of this course, students should be able to:

- Demonstrate understanding of basic supervised and unsupervised machine learning models.
- Develop models to solve various types of machine learning problems, including regression.
- Classification, natural language processing, and clustering.
- Demonstrate a theoretical and practical understanding of a number of machine learning approaches including decision trees, logistic and linear regression, support vector machines, neural, networks, convolutional networks, and recurrent neural networks.
- Apply existing machine learning platforms to develop classification and regression models.
- Understand how to quantify predictive performance of machine learning models (i.e. metrics and basic experiment design).

Graduate Attributes (GAs)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes at the time of graduation. There are no GA's related to this course. For more information, please visit: https://engineerscanada.ca/.

Instructor and TA contact

Specific to course offering (tbd)

Textbook (or other resources)

Specific to course offering (tbd)

Evaluation and grading scheme

Specific to course offering (tbd)

Breakdown of course requirements

Specific to course offering (tbd)

Tentative week-by-week breakdown

Specific to course offering (tbd)

General regulations

Specific to course offering (tbd)