CPSC 554X 2020W1

Machine Learning and Signal Processing

Logistics

Instructor	Robert Xiao
TA	Tim Straubinger
Office Hours	By appointment with the instructor
Contact	Email: brx@cs.ubc.ca Tim (TA): timstr@cs.ubc.ca
Communication	Piazza (piazza.com/ubc.ca/winterterm12020/cpsc554x/home) Used for assignments, lecture notes, discussions Canvas (https://canvas.ubc.ca/courses/63162) Used for assignment handin, grades, video lectures and recordings
Lectures	Tuesday and Thursday, 2:00-3:30pm Pacific Time Collaborate Ultra tab on Canvas; all lectures recorded

Course Description

This is a graduate-level introduction to the theory and practice of applying machine learning and signal processing techniques to real-world signals, especially 1-D signals (e.g. acoustic, electromagnetic) and 2-D signals (e.g. images).

Prior familiarity with machine learning techniques is required (*e.g.* an undergrad course in machine learning such as UBC's CPSC 340 Machine Learning and Data Mining). Familiarity with the Python programming language is recommended.

Course Outline and Schedule

Note: The course schedule is subject to change.

- Signals and Digital Signal Representation [5 lectures]
    - Types of Signals
    - Sampling Theory
    - Digital Representations
    - Aliasing Effects
- Signal Acquisition [3 lectures]
    - Physical Processes and Phenomena
    - Sensors and Data Sources
    - SNR
    - Filtering and Filter Techniques
- Frequency Analysis [8 lectures]
    - Fourier Transform
    - Spectrograms, Bands, Windowing

    - The FFT and Practical Considerations
    - 2D FFT, DCT
    - Frequency Component Analysis
    - Frequency-Based Features
- Review: Simple Machine Learning [6 lectures]
    - Decision Trees, Information Gain & Theory
    - k-Means Clustering
    - Support Vector Machines
- Training and Testing [3 lectures]
    - Overfitting
    - Train/Test Splits
    - Cross-fold Validation
- Advanced Topics [9 lectures]
    - Extended Featurization and Feature Selection
    - Regression
    - Deep Learning

Assessment

This course features a significant project component. Students will work in groups of 2 to 3 to complete an end-to-end system, comprising signal acquisition, signal processing, featurization, and machine learning, topped off with a demonstrative use-case for the machine learning output.

- **5% - Participation**
    - Attendance, participation in in-class discussion, etc.
- **25% - Homework**
    - There will be approximately four assignments throughout the term to test your understanding of the topics, to be completed individually.
- **70% - Group Project**
    - **10% - Project Proposal** - A written document summarizing your proposed project
    - **25% - Milestones** - The project is structured as a set of milestones. At each milestone, you will tag your code and write a summary of the work completed.
    - **15% - Project Demo** - Every team will present their project to the class in the form of a demonstration with explanation (at the end of term)
    - **20% - Final Project Report**