CPSC 554X 2020W1
Machine Learning and Signal Processing

Logistics

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