COMP 3360 – Machine Learning Concepts and Usage

Course Description

Calendar entry

An introduction to machine learning and data modelling through applications across a variety of Computer and Data Science domains. May not be held with DATA 3010. Prerequisites: COMP 2080 and [COMP 2452 or (COMP 2150 and COMP 3190)] and [one of STAT 1150, STAT 2000 (B), STAT 2001 (B), STAT 2220, or PHYS 2496] and [one of MATH 1220, MATH 1300, or MATH 1301] and [one of MATH 1230, MATH 1500, MATH 1501, or MATH 1510].

General Course Description

This course introduces many of the current libraries, frameworks, and APIs for creating machine learning applications, covers well-known machine learning algorithms that can be used out-of-the-box, and explores machine learning concepts by way of code development.

Students will explore the use of convolution neural networks that exploit advanced computer hardware (i.e. general-purpose computing using GPUs) as applied to a variety of problems. While doing so they will encounter and learn to work with large datasets involving from a variety application domains, including images.

Detailed Prerequisites

Before entering this course, a student should:

- Have a solid foundation of object-oriented programming.
- Understand linear algebra concepts, such as vectors, matrices, eigenvalues, eigenvectors, and matrix operations.
- Have knowledge of probability distributions, statistical measures, hypothesis testing, and Bayesian reasoning.
- Be familiar with differentiation and partial derivatives.
- Have a basic understanding of how GPUs differ from CPUs in the context of accelerating and scientific computing.

Course Goals

By the end of this course students will:

- Have a comprehensive understanding of the core concepts in machine learning, including key algorithms, methodologies, and applications.
- Have the ability to approach real-world problems using data science and machine learning tools, from data preprocessing to model implementation.
- Be aware of the latest machine learning libraries, frameworks, and platforms that enhance the development and deployment of machine learning applications.
- Be able to leverage high-performance computing hardware, such as GPUs, to accelerate machine learning workflows (e.g. training models).
- Have knowledge of the application of advanced deep learning architectures and their use in solving complex tasks.
- Be aware of current advancements and emerging technologies in machine learning, preparing them for advanced study or practical application in the industry.

Learning Outcomes

Define and Differentiate Machine Learning Concepts

Students should be able to:

- Accurately explain the key principles of supervised and unsupervised learning, and identify the appropriate machine learning algorithms for different tasks.

Prepare and Process Datasets

Students should be able to:

- Conduct data preprocessing, including cleaning, normalization, and feature extraction, ensuring that data is well-suited for training machine learning models.

Visualize Data and Model Outputs

Students should be able to:

- Use visualization tools and libraries to interpret datasets, track model performance, and gain insights from machine learning results.

Apply GPU-Accelerated Algorithms

Students should be able to:

- Implement GPU-accelerated machine learning algorithms (e.g., clustering, regression, and dimensionality reduction) using APIs and frameworks.

Build and Utilize Deep Learning Models

Students should be able to:

- Use deep learning frameworks such as Keras to implement, fine-tune, and run inference on pre-trained models like CNNs, RNNs, GANs, and other advanced architectures.

Develop Machine Learning Solutions

Students should be able to:

- Leverage pre-existing machine learning templates to develop and customize models for various tasks by building on established frameworks.

Compare and Choose Deep Learning Frameworks

Students should be able to:

- Analyze and select between different deep learning frameworks (e.g., PyTorch, TensorFlow) based on their applicability to specific problems and project requirements.