AE4803 AIM Syllabus

Foundations of Scientific Machine Learning, 3-0-0-3 Credits

General Information

Description

This course introduces foundational methods, theory, and implementation for scientific machine learning, with a primary focus on regression models. Students will learn how to formulate scientific machine learning problems by (a) selecting a parametrized model class, and (b) defining an optimization problem to select the model parameters. Several formulations for both linear and nonlinear regression will be introduced, with emphasis on understanding both the mathematical concepts underlying the methods as well as hands-on implementation and assessment of the learned models. Programming assignments will use python. The course will introduce/review basic python programming as well as the use of the numpy, scipy, pandas, pytorch, and matplotlib modules.

Pre-Requisites

(1) Introductory programming: CS 1371 or CS 1301 or equivalent programming proficiency,
(2) Multivariable calculus (MATH 2552 or equivalent),
(3) Linear Algebra (MATH 1553/1554 or equivalent), and
(4) Probability and statistics (BMED 2400, ISYE 3770, ECE 3077, or MATH 3670).

Course Goals and Learning Outcomes

Upon successful completion of this course, you will be able to:

1. Understand the fundamental paradigm of machine learning (ML) methods as a combination of prescribing a parametrized model class and formulating an optimization problem to select parameters.
    a. Define the regression problem and be able to recognize whether a task can be naturally formulated as a regression problem.
    b. Explain how the supervised learning methods covered in class can be interpreted/explained in terms of this paradigm.
2. Implement, validate, and test basic versions of the supervised learning methods covered in class by
    a. Writing organized and correct Python code that implements the methods discussed,
    b. Assessing the performance and accuracy of the learned models using appropriate metrics,
    c. Applying appropriate model validation strategies and reporting their results,
    d. Describing potential limitations of the learned models.
3. Read, write, and orally communicate clear and precise technical descriptions of machine learning algorithms, experiments, and results, including correct use of standard mathematical notation and terminology.