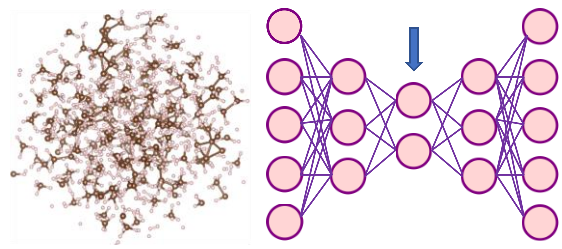
UCONN
SCHOOL OF ENGINEERING

United Technologies Corporation
Institute for Advanced Systems Engineering
UNIVERSITY OF CONNECTICUT

Graduate Courses in Systems Engineering

CSE/SE 5095 Machine Learning for Physical Sciences & Systems

What's Exciting About this Course? Scientific machine learning is a rapidly growing area of research and development, with machine learning starting to play a role in everything from aerospace to battery design. With this exciting interdisciplinary field as context, this course will address key concepts in applied machine learning and discuss challenges and opportunities for future innovation.



Course Description. This course is designed to provide students with foundational knowledge of applied aspects of machine learning, including methods for handling uncertain, small, and imbalanced data; feature selection and representation learning; and model selection and assessment. Students will also gain exposure to state-of-the-art research on interpretability of machine learning models, stability of machine learning algorithms, and meta-learning. Topics will be discussed in the context of recent advances in machine learning for materials, chemistry, and physics applications, with an emphasis on the unique opportunities and challenges at the intersection of machine learning and these fields. Some basic familiarity with machine learning is assumed as a prerequisite.

Course Outcomes

- Evaluate the efficacy of using machine learning to solve a particular problem in the physical science domain.
- Implement strategies for dealing with small, noisy, and/or imbalanced data.
- Use good design principles for feature engineering to construct features.
- Describe different deep learning strategies for representation learning.
- Choose appropriate methods for model selection and model assessment.
- Evaluate the results of machine-learned models reported in the literature.

Topics: Sample complexity, active learning, transfer learning, noisy data, imbalanced data, feature engineering, feature selection, dimensionality reduction, representation learning, generative adversarial networks, time series, model selection, model assessment, stability, interpretability, meta-learning. Applications include structure-property relationships for molecules and materials; computer vision and scientific imaging; molecular dynamics and turbulence modeling.

Course Objectives and Links to Overall Program Goals

Engineers obtain a strong foundational knowledge of machine learning principles and practices, which can be leveraged and applied in the design of machine learning models for physical science applications.