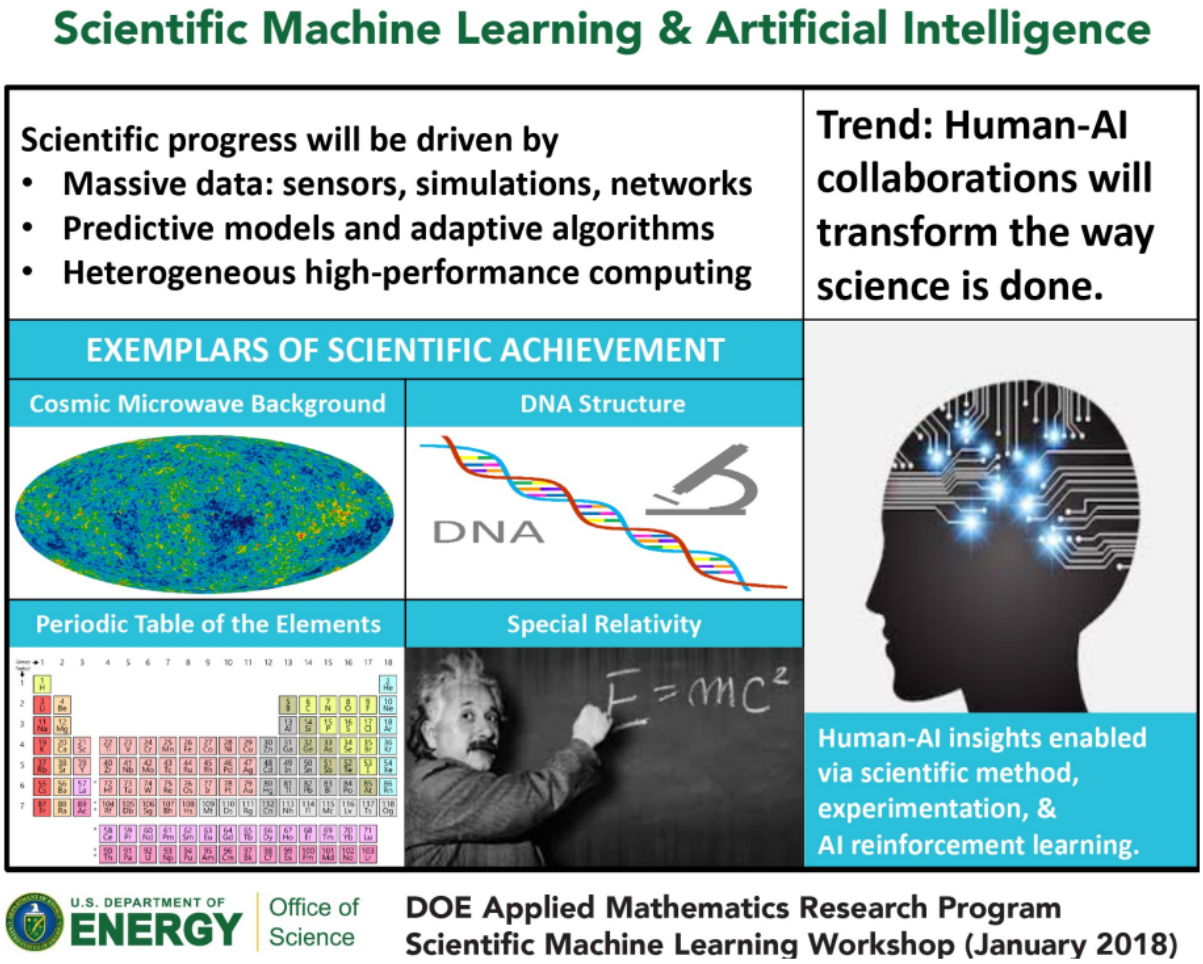
MANE 6961 Scientific Machine Learning
3 Credits, Spring 2024, Classroom: Sage 2707, M/Th 2-3:20 PM



Instructor: Prof. Shaowu Pan.

Contact Information: JEC 2032. `pans2@rpi.edu`. Office hour: M/Th 3:30 - 4:00 PM.

Course Description: Scientific machine learning (SciML) is a core component of artificial intelligence (AI) and a computational technology that can be trained, with scientific data, to augment or automate human skills. This course will introduce students to the theory and tools in SciML that are being used to interpret, analyze and modeling complex systems in science and engineering from the most general viewpoint of dynamical systems, i.e., nonlinear ordinary differential equations (ODE)/ partial differential equations (PDE) systems. Topics include review of linear algebra, singular value decomposition, SINDy, Koopman operator, physics-informed neural network, etc. Students will be expected to work on projects that requires coding experiences in Python and write documents in LaTeX.

Course Goals: You will learn the state-of-the-art tools in scientific machine learning with hands-on practice on solving related problems.

Disclaimer: Proof of the theorems will only be lightly covered. But as an engineer, you should remember the conclusions.

Textbook (optional): Brunton SL, Kutz JN. Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press; 2022 May 5. (**$50.99** on Amazon.)

Format: Lectures are all given in person unless otherwise notified. Homework is submitted via LMS.

Grading: HW: 40%, Project: 60%.

Pre-requisites: MANE 4962 Machine Learning for Engineering. Besides, students should be familiar with calculus, linear algebra, vector calculus, numerical methods, ordinary differential equations and partial differential equations. Most importantly, students should be familiar with programming in Python.

Policy:

- Allowable collaboration for homework is restricted to discussion of relevant concepts.
- An assignment or project will receive a 10% penalty if handed in within 24 hours of the deadline; a 25% penalty if handed in within a week of the deadline, and; a 100% penalty otherwise. In other words, assignments and projects handed in a week past the deadline will receive a grade of 0, notwithstanding excused absences.
- All homework is due on a specific day in class, unless an exception is discussed earlier.

Schedule:

Date	Lecture	Content	HW Due
M 01/08	1	Introduction & Review	
Th 01/11	2	Review	
M 01/15		[No Class - Martin Luther King Jr. Day]	
Th 01/18	3	Dimensionality reduction	
M 01/22	4	Dimensionality reduction	
Th 01/25	5	Dimensionality reduction	
M 01/29	6	Regression	
Th 02/01	7	Regression	
M 02/05	8	Regression	
Th 02/08	9	Regression	
M 02/12	10	Regression	
Th 02/15	11	Regression	
M 02/19		[No Class - President's Day]	
T 02/20	12	[Special Monday Schedule]	
Th 02/22	13	Learning for ODEs	
M 02/26	14	Learning for ODEs	
Th 02/29	15	Learning for ODEs	
M 03/04		[No Class - Spring Break]	
Th 03/07		[No Class - Spring Break]	
M 03/11	16	Learning for ODEs	
Th 03/14	17	Learning for ODEs	
M 03/18	18	Learning for ODEs	
Th 03/21	19	Learning for ODEs	
M 03/25	20	Learning for PDEs	
Th 03/28	21	Learning for PDEs	
M 04/01	22	Learning for PDEs	
Th 04/04	23	Learning for PDEs	
M 04/08		Project discussion	
Th 04/11		Project discussion	
M 04/15		Project presentations	
Th 04/18		Project presentations	
M 04/22		Project presentations	