Machine Learning, Modeling, and Simulation Principles

WEEK ONE: Welcome to the Course

- Course Overview and What You'll Learn
- The New Computational Paradigm
- Review of Linear Algebra and Matrix Operations

WEEK TWO: Modeling and Simulation

- Ordinary Differential Equations (ODEs)
- The Forward Euler Method
- Higher-Order Methods
- Implicit Methods
- Partial Differential Equations (PDEs)
- Spatial Discretization and Design Considerations
- Explicit and Implicit PDEs
- Boundary Conditions
- Linear Systems: Direct and Indirect Methods
- Nonlinear Systems and Root Finding

WEEK THREE: Optimization and Data-Driven Modeling

- Introduction to Optimization
- Anatomy of an Optimization Problem
- Least Squares Problems
- Gradient Descent
- Newton's Method
- Parameter Estimation and Nonlinear Least Squares

Course schedule is subject to change.

WEEK FOUR: From Optimization to Machine Learning

- Regression Problems
- Regression Methods and Least Squares
- Regularization
- Classification Problems
- Logistic Regression
- Stochastic Gradient Descent
- Assessing Model Fit: Holdout and Cross-validation

WEEK FIVE: Probabilistic Methods & Case Studies from Industry

- Introduction to Probabilistic Methods
- Monte Carlo Methods
- Probabilistic Forecasting
- Sensitivity Analysis
- Simulating Rare Events
- Case Studies in Machine Learning from Industry

CONCLUSION: Where to go next

Course schedule is subject to change.