Applying Machine Learning to Engineering and Science Schedule

All Graded Assignments are due the last day of the course.
Items preceded by a star (★) are graded.

GET STARTED (15 min)

- Entrance Survey (2 min)
- Welcome (3 min)
- Schedule (1 min)
- Introduce Yourself (3 min)
- Teaching Team (3 min)

CASE 1: FEATURE ENGINEERING IN LI-ION BATTERY LIFE PREDICTION (1.5 hrs)

- About Prof. Richard Braatz (1 min)
- Introduction to Feature Engineering (1 min)
- Predicting Lithium Ion Battery Lifetime (4 min)
- Identifying Features (3 min)
- Three Types of Regularization (2 min)
- Applying Feature Engineering (2 min)
- Why Feature Engineering and Elastic Net Matters (1 min)
- ★ Graded Assignment (60 min)
- Case 1 Content Questions / Discussion Forum (10 min)

CASE 2: MACHINE LEARNING FOR COMPUTATIONAL IMAGING (2 hrs)

- About Prof. George Barbastathis (1 min)
- Machine Learning for Computational Imaging (5 min)
- Inverse Problems (4 min)
- Phase Retrieval (4 min)
- Phase Extracting Neural Network (5 min)
- Perceptual Loss (5 min)
- Learning to Synthesize (6 min)
- Tomography (6 min)
- Computational Imaging Conclusion (3 min)
- ★ Graded Assignment (75 min)
- Case 2 Content Questions / Discussion Forum (10 min)

CASE 3: SEISMIC DEEPFAKES: NEURAL NETS TO GENERATE MISSING DATA (1.5 hrs)

- About Prof. Laurent Demanet (1 min)
- Introduction to Seismic Waves (5 min)
- Wave Equations (5 min)
- Inversion (5 min)
- From High to Low Frequencies (2 min)
- Where Neural Networks Finally Come In (3 min)
- Training and Testing (5 min)
- Inversion Revisited (4 min)
- ★ Graded Assignment (60 min)
- Resources
- Case 3 Content Questions / Discussion Forum (10 min)

CASE 4: PREDICTION OF OIL AND GAS PRODUCTION (2 hrs)

- About Prof. John Williams (1 min)
- Minimizing Decision-Making Risk (2 min)
- Oil and Gas Leases: Predicting Future Production Rates (5 min)
- Linear Regression and Predicting with Data (14 min)
- Predicting Future Production Rates: Results (5 min)
- ★ Graded Assignment (60 min)
- Case 4 Content Questions / Discussion Forum (10 min)

CASE 5: MACHINE LEARNING IN GEOMETRIC REPRESENTATIONS (2 hrs)

- About Prof. Justin Solomon (1 min)
- Introduction to Machine Learning from Geometric Representations (7 min)
- Two Modalities of 3D Geometric Data (5 min)
- Deep Learning from Point Clouds (8 min)
- Applications of Point Cloud Learning (8 min)
- Deep Learning from Vector Data (8 min)
- Frontiers in 3D Learning (4 min)
- ★ Graded Assignment (60 min)
- Case 5 Content Questions / Discussion Forum (10 min)

CASE 6: QUANTIFYING RISK IN COMPLEX SYSTEMS USING MACHINE LEARNING (2 hrs)

- About Prof. Themistoklis Sapsis (1 min)
- Quantifying Risk of Extreme Events (2 min)
- Probabilistic Description of Extreme Events (2 min)
- Challenges Related to Extreme Events (5 min)
- A Better Approach to Calculating Probability (4 min)
- Active Learning and Optimal Experimental Design (7 min)
- Using a New Output-Weighted Criterion (5 min)
- Q Criterion Results (9 min)
- References
- ✭ Graded Assignment (60 min)
- Case 6 Content Questions / Discussion Forum (10 min)

CASE 7: MACHINE LEARNING FOR ACCELERATING COMPUTATIONAL MATERIALS DISCOVERY (2.5 hrs)

- About Prof. Heather Kulik (1 min)
- Introduction to Inorganic Chemistry (8 min)
- The Machine Learning Tradeoff (8 min)
- Representations of Transition Metals (6 min)
- Training Set Performance and Details (8 min)
- Feature Selection (9 min)
- Uncertainty Quantification (10 min)
- Accelerating Discovery (12 min)
- ✭ Graded Assignment (75 min)
- Case 7 Content Questions / Discussion Forum (10 min)

CASE 8: PRACTICAL MACHINE LEARNING IN COMPOSITE DESIGN (2 hrs)

- About Prof. Markus Buehler (1 min)
- What Is Materials Science and Engineering? (5 min)
- Introducing Machine Learning to Materials Design (4 min)
- Using Machine Learning for Image Classification (5 min)
- Complementing Conventional Methods with Machine Learning (4 min)
- Predicting Fracture Propagation (5 min)
- Hype vs. Reality: Challenges for the Future (6 min)
- ✭ Graded Assignment (60 min)
- Case 8 Content Questions / Discussion Forum (10 min)

CASE 9: MACHINE LEARNING IN AEROSPACE (2 hrs)

- About Prof. Youssef Marzouk (1 min)
- Inverse Problems from the Subsurface to the Atmosphere
- Uncertainty Quantification for Inverse Problems: the Bayesian Approach
- Dimensionality Reduction: What Do the Data Really Say?
- Surrogate Modeling: How to Speed Up Expensive Simulations?
- Data Assimilation: From Static to Sequential Data
- Ensemble Methods
- Supervised Learning and Approximate Bayesian Computation
- ★ Graded Assignment (60 min)
- Case 9 Content Questions / Discussion Forum (10 min)

CONCLUSION (2 min)

- Exit Survey (2 min)