Engineering Mechanics Institute Conference Minisymposium
Baltimore, Maryland; May 31 – June 3, 2022

MS 404 - Probabilistic Learning, Stochastic Optimization, and Digital Twins

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ABSTRACT

Many real-world engineering design problems can be formulated as optimization. Yet the curse of dimensionality with a large number of design variables, both discrete and continuous, makes the solution searching process difficult. Furthermore, interpretation of a large amount of simulation and experimental data needs advanced computation, data mining, big data analytics, and deep learning methodologies. The stochastic nature of real-world engineering systems makes these analyses even more challenging. Due to their complexity, real-world problems are difficult to solve using derivative-based local optimization algorithms. Probabilistic learning and stochastic optimization consider uncertainties in variables, data, models, and algorithms to solve real-world problems. During the last three decades, they have been a highly-researched topic and widely used for solving complex engineering problems. Another recent progress in modelling, simulation, and optimization of real-world engineering systems is digital twins. On this basis, the main theme of this Mini-Symposia is dedicated to developments of probabilistic learning, stochastic optimization, and digital twins methods which give a new light for solving problems deemed difficult in engineering sciences under uncertainties.
This Mini-Symposia strives to gather the latest development of probabilistic learning, stochastic optimization, and digital twins applications in real-world civil and mechanical engineering systems, particularly the ones under uncertainty. On this basis, this Mini-Symposia includes key applications of these tools on different engineering disciplines such as engineering design, monitoring and maintenance, structural systems, applied mechanics, etc. Theories, methodologies, tools, computational aspects for topics include (but not limited to):

- Machine learning and deep learning
- Neural networks with probabilistic reasoning
- Data-driven statistical inverse problems
- Probabilistic methods and statistical tools for scientific machine learning
- Stochastic and robust optimization using intelligent search methods
- Evolved systems with uncertainties
- Evolutionary and Swarm Intelligence with uncertainties
- Randomized algorithms (stochastic gradient, compressed sensing, etc.)
- Stochastic surrogate/metamodels with model-form and parameter uncertainties
- Data mining, pattern recognition, and data clustering
- Fuzzy control, optimization, and decision making under uncertainties
- Digital twins in product engineering such as engineering mechanics, system dynamics, reliability
- Digital twins in process engineering such as scheduling, system monitoring, maintenance, optimal control