MACHINE LEARNING AND DATA-DRIVEN METHOD FOR MATERIAL MODELING, DESIGN, AND MANUFACTURING

TSUNG-HUI ALEX HAUNG[†], CHUIN-SHAN DAVID CHEN[†]
CHI-HUA YU[#] AND SHU-WEI CHANG[†]

[*] National Taiwan University
No. 1, Sec. 4, Roosevelt Rd., Da-an Dist., Taipei 106319, Taiwan
tsunghuihuang@ntu.edu.tw

[†] National Cheng Kung University
o. 1, University Road, East District, Tainan City 701, Taiwan

[#]National Taiwan University
No. 1, Sec. 4, Roosevelt Rd., Da-an Dist., Taipei 106319, Taiwan

ABSTRACT

This minisymposium provides a platform to discuss recent advances in machine learning and data-driven methodologies for material modeling, design, and manufacturing. With the rapid growth of artificial intelligence and high-performance computing, these approaches are transforming traditional paradigms in computational mechanics, materials science, and manufacturing engineering. The minisymposium brings together researchers developing and applying data-driven techniques to address complex multiscale and multiphysics problems. Key directions include the integration of physics-informed machine learning with continuum and discrete models, the development of surrogate and reduced-order models for efficient simulation, and data-driven discovery of constitutive laws and governing equations. Contributions leveraging experimental and industrial data for predictive modeling, digital twins, and real-time decision-making are particularly encouraged. Topics include, but are not limited to:

- Machine learning-based surrogate models and foundation models for materials and manufacturing
- Physics-informed and physics-guided machine learning for solid and structural mechanics
- LLM and AI-agentic application for material modeling, design, and manufacturing
- Data-driven computational mechanics without explicit constitutive laws
- Discovery of constitutive relations and governing equations from data
- Data-driven modeling of heterogeneous, anisotropic, and multiscale materials
- Machine learning for inverse problems and parameter identification
- Classical numerical method hybrid with AI/ML
- Reduced-order modeling and real-time simulation
- Integration of experimental data and AI for material characterization
- Digital twins and smart manufacturing systems
- Additive manufacturing and process optimization using data-driven approaches
- Semiconductor manufacturing and micro/nano-scale material modeling
- Uncertainty quantification, probabilistic modeling, and robustness analysis

- Interpretable and explainable AI for engineering applications

Applications may span solid/fluid mechanics, additive manufacturing, semiconductor processes, biomechanics, and other advanced material systems. Overall, this minisymposium aims to foster interdisciplinary dialogue and collaboration, highlighting the potential of machine learning and data-driven approaches to complement