Artificial Intelligence for Digital Additive Manufacturing (Code: g21rp)

Goal:

Additive manufacturing (AM) is a bottom-up manufacturing technology that creates complex three-dimensional (3D) parts through a layer-wise addition of material. Due to its outstanding ability to create parts with complex designs, multi-materials, and integrated functions, AM has been gradually adopted for high-performance applications, e.g., automotive, aerospace, and biomedical applications. With fewer manufacturing constraints, AM realizes advanced structures with a multiscale organic shape that otherwise would be unattainable. Examples of these structures include topological, cellular, and chain-mail structures, which are lightweight, strong, and designable. Structural optimization based on computational methods is significantly advanced for leveraging design freedom brought by AM to improve the performance of these structures. Meanwhile, the advent of multi-material AM makes it possible to develop structures with tailored properties, e.g., functionally graded and heterogeneous materials. Additionally, AM also paves the road for developing all-in-one smart devices with embedded intelligence, e.g., sensing, control, and actuating, and with integrated functionalities e.g., mechanical, electrical, and thermal functions. More importantly, AM also serves as the basis for developing other disruptive technologies, such as structural colours and metamaterials.

However, decision-making for AM is nontrivial due to limited information, large uncertainties, and high-dimensional decision spaces. These challenges are inherent to AM and limit the broader adoption of AM for industrial applications. Firstly, due to the layer-wise nature of AM, the underpinning mechanism behind various phenomena in AM, crossing multi-scale and involving multi-physics, are still not well-understood and characterized. These highly coupled and nonlinear relationships make it extremely difficult for engineers to make optimal decisions resulting in printed builds with precise geometry and properties. Moreover, the current AM process is still challenged by various uncertainties e.g., the fluctuation of thermal boundary conditions during print. These high uncertainties greatly hinder the use of AM in high-performance applications. Meanwhile, exploring and exploiting such a high-dimensional design space with AM is highly challenging, even for experienced designers. The lagging of design methods and tools behind the advent of manufacturing technology has jeopardized the full utilization of AM's unique capabilities for product innovation and production.

To deal with the challenges summarized above, it is highly desired to introduce machine intelligence to complement human intelligence for facilitating the economy, efficiency, and effectiveness of decisions. This paradigm shift aims to automate and integrate design and manufacturing activities, supporting the concurrent design of materials, structures, and processes, ultimately boosting the capabilities of AM processes and facilitating related product innovation and production.

This session provides an excellent forum for scientists, researchers, engineers, and industrial practitioners to meet and share experiences, theoretical knowledge, or case studies on the application of artificial intelligence in AM. Authors are invited to submit full papers describing original research work associated with various aspects of machine learning application in AM, such as data processing, machine-learning model development, and application examples in design, material development, process monitoring and control, and part evaluation.

Topics:

- AI-aided design for AM
- AI in AM process monitoring, modeling, and control
- Data-driven uncertainty qualification in AM process
- AM data fusion, integration, and registration for machine learning
- AI in material development for AM
- AI-aided human-machine collaboration in AM
- AI-driven digital twins of AM
- Physics-informed/constrained/guided machine learning in AM
- AI in quality control of AM process
- AI in adaptive process planning for AM process

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