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Guest editorial: Modelling, data analytics and artificial intelligence in engineering – Part 1

This Special Issue of "Modelling, Data Analytics and Artificial Intelligence in Engineering" emerged from the momentum of MadeAI 2024, held in Porto, Portugal. As the inaugural gathering of its kind, the conference brought together researchers and industry experts from computer science, engineering and mathematics to explore how modelling, data analytics and artificial intelligence (AI) can jointly reshape engineering practice. The enthusiasm and intellectual energy of that meeting directly inspired this collection.

Across today's rapidly evolving technological landscape, modelling, data analytics and AI have become indispensable engines of innovation. They are transforming sectors as diverse as aerospace, automotive, construction, energy, healthcare, materials and transportation. Yet despite their shared mathematical and computational foundations, these fields are too often pursued in disciplinary isolation. Unlocking their full potential requires integration – conceptual, methodological and practical – through a systems-level perspective. This Special Issue aims to advance precisely that convergence.

The response from the global research community has been remarkable. More than thirty high-quality papers were accepted, spanning several major thematic areas. These include:

(1) AI-enhanced modelling and simulation, covering applications from aerodynamics and energy systems to healthcare operations and human behaviour.

(2) Data-driven engineering analytics, featuring advances in surrogate modelling, dimensionality reduction, uncertainty quantification and predictive maintenance.

(3) Machine learning for industrial processes, with contributions addressing manufacturing quality, materials characterisation, powertrain optimisation and structural monitoring.

(4) Deep learning and computer vision, applied to domains such as defect detection, biometric profiling, sports analytics and smart aquaculture.

(5) Intelligent infrastructure and urban systems, including traffic modelling, construction planning and climate-informed decision support.

(6) Foundational methods, such as physics-informed neural networks, optimal transport and novel approaches to representation learning.

Together, these contributions illustrate the breadth and depth of innovation emerging at the intersection of modelling, data analytics and AI. They also reaffirm the central message of MadeAI 2024: that the future of engineering lies not in isolated disciplines, but in their intelligent integration.

We hope this Special Issue serves as both a snapshot of current progress and a catalyst for future breakthroughs across academia and industry.

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