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Machine Learning vs. Constitutive Models: Can Data Replace Equations in Finite Element Analysis?

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Recent advances in machine learning (ML) have created new opportunities for modeling the mechanical behavior of polymers and composites. Conventional constitutive models require assumptions, parameter calibration, and often struggle with nonlinear, rate-dependent, and temperature-sensitive responses. ML approaches, trained directly on experimental data, offer an alternative, but important questions remain:
Can ML reliably replace constitutive equations, and how can these models be integrated into finite element analysis?
What level of physical constraints, data quality, and multi-axial representation is necessary to ensure accurate and stable predictions?
In this round-table discussion, I will outline current practices in ML-based material modeling, highlight potential advantages and limitations, and invite debate on whether data-driven constitutive laws can evolve into robust, physics-guided tools for FEM in real engineering applications.

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