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MACHINE LEARNING METHODS FOR THE NUMERICAL SIMULATION AND THE OPTIMIZATION DESIGN OF COMPLEX ENGINEERING SYSTEMS

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ABSTRACT

Machine learning and Artificial Intelligence techniques are a useful tool to achieve enhanced computational power, when employed to assist classical numerical methods, and more flexibility when used to directly approximate the solution of Partial Differential Equations. Both features are especially beneficial when high dimensional problems are considered.

Deep learning methodologies [1], together with unsupervised [2] and hybrid approaches can easily be exploited whenever the differential problem at hand can be formulated in terms of a loss function and hence a minimization problem should be tackled.

Moreover, multilayered artificial neural networks can be used to learn digitally from large datasets, enabling the digital representation to be more reliable and truthful to the real-world objectives. Therefore, the analysis and the design of complex engineering systems under topological and structural point of view become less dependent on idealized assumptions and more physically meaningful.

The focus of this session will be on learning methodologies that can be employed in the standard numerical simulation and in the optimization design of complex engineering systems. Some possible applications are: reduced order and surrogate plasticity models, coupled electro-mechanical problems, development of novel materials, optimized structural designs, topology optimization, fracture mechanics, molecular dynamics simulations, to name a few.

REFERENCES

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