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LEVERAGING MACHINE LEARNING ALGORITHMS FOR EFFICIENT OPTIMIZATION

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ABSTRACT

Inverse problems and structural optimization are cornerstones in the application of computational mechanics and physics to discover solutions to challenging problems in various engineering disciplines. The growing complexity of real-world applications needs innovative computational methodologies for efficient and effective optimization. This mini-symposium aims to explore the potential of machine learning (ML) in the realm of inverse problems, optimization, and optimal design. The symposium endeavors to bring together researchers and practitioners to discuss the interplay between traditional optimization techniques and innovative ML approaches. Specific sub-topics include, but are not limited to:

1. Surrogate-based Optimization: Highlighting the role of surrogate models, such as Gaussian Processes and Neural Networks, in reducing the computational overhead in iterative optimization tasks [1].

2. Topology Optimization: An in-depth exploration into the application of ML in optimizing material distribution within a predefined design space, contributing to lightweight and robust designs [2]. Specific emphasis on the usage of gradient based techniques including adjoint methods is encouraged.

3. Constraint Handling in ML approaches: A discourse on methodologies for efficiently managing constraints in optimization problems solved by ML techniques [3,4].

4. Real-world Applications: Case studies from illustrating the efficacy of ML in complex design optimization and inverse problems [5].

The goal of this mini-symposium is to discuss ML advancements in inverse problems and optimization applications. Submissions including dynamic behavior of materials, shock

physics, or multi-physics are strongly encouraged. We will encourage discussion highlighting the advantages and disadvantages of these methods.

REFERENCES

[1] Forrester, A., Sobester, A., & Keane, A. (2008). *Engineering design via surrogate modelling: a practical guide*. John Wiley & Sons.
[2] Bendsoe, M. P., & Sigmund, O. (2003). *Topology optimization: theory, methods, and applications*. Springer Science & Business Media.
[3] Coello, C. A. C. (2007). *Evolutionary algorithms for solving multi-objective problems*. springer. com.
[4] Ji, W., Chang, J., Xu, H. X., Gao, J. R., Gröblacher, S., Urbach, H. P., & Adam, A. J. (2023). Recent advances in metasurface design and quantum optics applications with machine learning, physics-informed neural networks, and topology optimization methods. *Light: Science & Applications*, *12*(1), 169.
[5] Sarker, I. H. (2021). Machine learning: Algorithms, real-world applications and research directions. *SN computer science*, *2*(3), 160.

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