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Domain-Aware Active Learning for Multifidelity Optimization

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Bayesian optimization is a popular strategy for the optimization of black-box objective functions [1]. In many engineering applications, the objective can be evaluated with multiple representations at different levels of fidelity, to enhance a trade-off between cost and accuracy. Accordingly, multifidelity methods have been proposed in a Bayesian framework to efficiently combine information sources, using low-fidelity models to enable the exploration of design alternatives, and improve the accuracy of the solution through limited high-fidelity evaluations [2]. Most multifidelity methods based on active learning search the optimal design considering only the information extracted from the surrogate model. This can preclude the evaluation of promising design configurations that can be captured only including the knowledge of the particular physical phenomena involved [3]. To address this issue, this presentation discusses original domain-aware multifidelity Bayesian frameworks to accelerate design analysis and optimization performances. In particular, our strategy comes with an active learning scheme to adaptively sample the design space, combining statistical data from the surrogate model with physical information from the specific domain. Our formulation introduces physics-informed utility functions as additional contributions to the acquisition functions. This permits to enhance the active learning with a physics-based insight and to realize a form of domain awareness which is beneficial to the efficiency and accuracy of the optimization task. The presentation will discuss several applications and implementations of the proposed approach for single discipline and multidisciplinary aerospace design optimization problems.

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