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Wake Redirection Control for Optimization of Wind Farm Power Production

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Understanding and controlling power loss production of downstream wind turbines due to the impinging wake promoted by upstream turbines and orographic effects is of major importance for maximizing the potential energy generation. Not only that, but the increase in the turbulence level inside the wake might be responsible for the risk of mechanical damage to the turbine's devices (particularly important in blade fatigue). Wake redirection maneuvers have proved with significant potential, but so far, only open-loop control based on engineering steady-state models have been employed, presenting, as important limitations, the inability of including the variability on inflow conditions and uncertainties in pre-calculated parameters [1]. On the other hand, high-fidelity computer models are not suitable for online operation, which gives rise to the need for accurate and efficient reduced-order models. Here, within a broader effort, we focus on model discrepancy involving the use of analytical models for the wake [1] and CFD simulations through a multi-fidelity formulation employing Gaussian Processes. We also explore alternatives based on generative probabilistic models.

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