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RF-PINNs for field reconstruction of laminar and turbulent flames to accelerate high-fidelity numerical simulations

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We developed a framework called RF-PINNs (Reactive Flow Physics-Informed Neural Networks) that reconstructs all reactive flow fields based on sparse velocity data [1]. The goal is to perform flow field reconstruction of unknown fields (e.g. temperature, density, species etc) using a minimal amount of data. In particular, we constrain ourselves to velocity profiles obtained from e.g. PIV measurements as data input for RF-PINNs. In this talk, I will demonstrate the effectiveness of our method on multiple cases including laminar and turbulent flames, and discuss how the reconstructed fields obtained from RF-PINNs can accelerate high-fidelity numerical simulations (in particular Direct Numerical Simulations or Large Eddy Simulations).

[1] Yadav, Casel and Ghani. “RF-PINNs: Reactive flow physics-informed neural networks for field reconstruction of laminar and turbulent flames using sparse data” in Journal of Computational Physics 524 (2025).
[2] Frohberg, Kandel and Ghani. „Physics-informed neural networks for reacting flows: Species recon- struction with finite rate chemistry from sparse velocity measurements“, under review at 13th Mediterranean Combustion Symposium (2024).