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ConFlux: An Ecosystem for Data-enabled Computational Physics

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The pursuit of accurate predictive models is a central issue and pacing item in many scientific and engineering disciplines. With the recent growth in computational power and measurement resolution, there is an unprecedented opportunity to use data from fine-scale simulations, as well as critical experiments, to inform, and in some cases even define predictive models. While the general idea of data-driven modeling appears intuitive, the process of obtaining useful predictive models from data is less straightforward.
This talk will discuss a coordinated approach of experimental design, statistical inference and machine learning with the goal of improving the predictive capabilities.

Field inversion is used to obtain spatio-temporally distributed functional terms that directly address discrepancies in the structural form of the model. Once the inference has been performed over a number of problems that are representative
of the underlying physics, machine learning techniques are used to reconstruct the functional corrections in terms of variables that appear in the closure model. When the machine learning-generated model forms are embedded within a standard solver setting, we show that much improved predictions can be achieved, even in geometries and flow conditions that were not used in model training. The usage of
very limited data as an input to construct comprehensive model corrections provides a renewed perspective towards the use of vast, but sparse, amounts of available experimental datasets towards the end of developing predictive models.

The final part of the talk will provide a brief overview of a hardware/software ecosystem that is being developed at the University of Michigan to enable large-scale data-driven model development for computational physics applications.

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Session Classification: Related Projects

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