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When Machine Learning meets Partial Differential Equations

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Résumé — Artificial Intelligence, and more particularly Machine Learning, is becoming ubiquitous in most, if not all, scientific fields. Available masses of data, be they experimental or simulated, allow the practitioner to unleash the power of Deep Learning and Differentiable Programming to better (faster and/or more accurately) simulate natural or artificial systems, complementing the good old mecanistic models based on PDEs. Different levels of interactions between data-based and principle-based modelling have been proposed, from accurate surrogate models to learning the residual of reduced models to complete resolution of the system of PDEs. We will illustrate such different situations with some case studies, including the use of more recent techniques like Graph Neural Networks, Transfer and Meta Learning.