

# Breaking the Mesh: Solving PDEs with Deep Learning

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Partial differential equations (PDEs) are ubiquitous in nearly all fields of applied physics and engineering, encompassing a wide range of physical and phenomenological models and conservation laws. In particular, many physical phenomena of interest can be described as a system of parameterized, time-dependent, non-linear PDEs. With the advent of spatial discretization schemes such as finite-difference, finite-volume, or spectral methods, many such problems can now be solved routinely, utilizing the high-performance computing (HPC) paradigm of distributed parallelism on large clusters of networked CPUs or GPUs. However, important challenges still remain regarding solution accuracy, convergence, and computational cost associated with these methods for problems with significant model complexity.

In recent years, machine learning techniques have been proposed as a promising alternative to conventional numerical methods. These techniques have been shown to have several advantages over conventional numerical methods, including:

- The resulting solution is meshless, analytical, and continuously differentiable.
- Using neural networks provides a solution with very good generalization properties.
- The computational cost of training is only weakly dependent on the problem dimension.
- Relatively few parameters may be required to model complex solutions.
- Temporal and spatial derivatives can be treated in the same way.
- Training is highly parallelizable on GPUs using open-source deep learning libraries.

During this symposium, we will provide an overview of the state-of-the-art techniques being used today to solve PDEs with deep learning and try to provide a sense of what will be possible in the future.

## Liste des orateurs

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