Machine Learning Technology and Techniques for Numerical Simulations with PDEs

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The aim of this talk is on the one hand to present numerical techniques based on Scientific Machine Learning to improve smoothing operators for geometric multigrid schemes as solvers of Partial Differential Equations (PDEs). Here, we concentrate on so-called SPAI schemes which have been designed to handle anisotropies due to the differential operators and/or the underlying computational meshes. On the other hand, we discuss how modern, resp., future High Performance Computing (HPC) facilities regarding massively parallel hardware together with very fast, but low precision accelerator hardware, particularly the Tensorcore units in NVIDIA VOLTA boards, can be exploited in numerical simulations. Our approach is based on the concept of "prehandling" (as "direct/explicit preconditioning") of the corresponding ill-conditioned systems of equations, for instance arising from Poisson-like problems, together with special matrix-vector, resp., matrix-matrix multiplications. In our talk, we provide preliminary numerical results as "proof-of-concept" and discuss the open problems and challenges.