DEEP LEARNING AND MODEL REDUCTION - IS ACCURACY CONTROL FEASIBLE?

WOLFGANG DAHMEN

Abstract. According to a general perception, modern machine learning methodologies, in particular, deep learning (DL) are exerting a transformative impact on societal interactions, especially in "Big Data" scenarios. This nourishes the dream of "black box solutions" even in science and technology. A closer look reveals though that the most stunning success of (DL) has so far been in error-tolerant applications where the ground truth is foggy or where a concise error metric is missing.

Applications in science or technology are, however, often error-averse, in particular, when striving for prediction capability, which after all is a central objective in simulation sciences. This talk discusses inherent obstructions but also great opportunities for a general ubiquitous application scenario: recover "physical states of interest" by best fusing information provided by observational data and by (possibly "incomplete") governing physical laws, usually represented by parameter dependent families of partial differential equations (PDEs). In particular, we highlight the role of *variationally correct residual regression* and its main conceptual constituents, including stable variational formulations of PDEs, certifiable nonlinear model reduction, statistical estimation, or natural gradient flows in ensuing optimization tasks.

Mathematics Department, University of South Carolina, 1523 Greene Street, Columbia SC 29208, USA

Email address: wolfgang.anton.dahmen@math.sc.edu