Reducing complexity of neural network models

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Reduced Order Modelling has become a mature field of research, with researchers focusing on nonlinear problems, coupled problems, differential-algebraic systems and more, as well as on a multitude of applications. Recently, 3 volumes in a handbook of MOR have been published as a result of the COST Action network EU-MORNET [1–3]. New challenges are appearing at the horizon, as researchers within the area of Computational Science and Engineering (CSE) have realized the potential of methods in the area of Artificial Intelligence (AI), most prominently Machine Learning (ML) and Artificial Neural Networks (ANN). Hybrid methods, combining CSE and AI, may be very useful for digital twinning, seen as one of the grand challenges in industry. However, there is growing criticism about AI: we do not know why methods work of do not work, methods know nothing about time, space and causality, the topology of networks is often guesswork, and more issues. For the MOR community, there are also important questions related to ML and ANN. Often the ANN are very large in size, with a dense set of connections (often a full graph). Can we use ROM methods to reduce the size of neural networks? Can we apply methods from our community to aid in the reduction and sparsification of neural networks? In this keynote lecture, we will discuss these challenges, indicate potential research directions and present some first results.

References

[1] P. Benner, S. Grivet-Talocia, A. Quarteroni, G. Rozza, W. Schilders, L.M. Silveira (Eds.): *Model Order Reduction. Volume 1: System- and Data-Driven Methods and Algorithms*. De Gruyter, 2021. (available Open Access: https://www.degruyter.com/serial/MOR-B/html)

[2] P. Benner, S. Grivet-Talocia, A. Quarteroni, G. Rozza, W. Schilders, L.M. Silveira (Eds.): *Model Order Reduction: Volume 2: Snapshot-Based Methods and Algorithms*, De Gruyter, 2021. (available Open Access: https://www.degruyter.com/serial/MOR-B/html)

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