Towards a Benchmark Framework for Model Order Reduction in the Mathematical Research Data Initiative (MaRDI)

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The race for the most efficient, accurate, and universal algorithm in scientific computing drives innovation. Yet, this healthy competition is only beneficial if the research output is actually comparable to prior results. Fairly comparing algorithms can be a complex endeavor, as the implementation, configuration, compute environment, and test problems need to be well defined. Due to the increase in computer-based experiments, new infrastructure for facilitating the exchange and comparison of new algorithms is also needed. To this end, we propose a benchmark framework, which is a generic toolkit for comparing implementations of algorithms using test problems native to a community. Its value lies in its ability to fairly compare and validate existing methods for new applications, as well as compare newly developed methods with existing ones.

As a prototype for a more general framework, we have begun building a benchmark tool for the Model Order Reduction Wiki (MORWiki) [4]. The wiki features three main categories: benchmarks [2, 3], methods, and software. An editorial board curates submissions and edits entries. Data sets for linear and parametric-linear models are already well represented in the existing collection. Data sets for non-linear or procedural models, for which only evaluation data, rather than equations, are available, are being added and extended. Properties and interesting characteristics used for benchmark selection and later assessments are recorded in the model metadata.

The MORWiki collection will be the data basis for our model reduction benchmark tool. To this end, experiences from [1] serve as a prototype and will be extended to the remaining model classes and methods. The MORWiki will serve as a proof-of-concept for a living-document progress-tracker of a field, while also facilitating fair comparisons of new findings and methods. Its core information will be mirrored in the MaRDI-Portal, which is concurrently under development.

References

[1] U. Baur, P. Benner, B. Haasdonk, C. Himpe, I. Martini, and M. Ohlberger. Comparison of methods for parametric model order reduction of time-dependent problems. In P. Benner, A. Cohen, M. Ohlberger, and K. Willcox, editors, *Model Reduction and Approximation: Theory and Algorithms*, pages 377–407. SIAM, 2017.

[2] Y. Chahlaoui and P. Van Dooren. A collection of benchmark examples for model reduction of linear time invariant dynamical systems. Technical Report 2002–2, SLICOT Working Note, 2002. Available from `http://www.slicot.org`.

[3] J. G. Korvink and E. B. Rudnyi. Oberwolfach benchmark collection. In P. Benner, D. C. Sorensen, and V. Mehrmann, editors, *Dimension Reduction of Large-Scale Systems*, volume 45 of *Lect. Notes Comput. Sci. Eng.*, pages 311–315. Springer Berlin Heidelberg, 2005.

[4] The MORwiki Community. MORwiki - Model Order Reduction Wiki. `http://modelreduction.org`.