

Doctoral Thesis

MÜLLER Michael

michaelm@fel.zcu.cz

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Errors and omissions excepted

Suggestions and discussions welcome, just leave a message

References

- [Ben+21] Peter Benner et al. *Model Order Reduction: Basic Concepts and Notation*. De Gruyter, 2021.
- [Che99] Yong Chen. “Model order reduction for nonlinear systems”. PhD thesis. Massachusetts Institute of Technology, 1999.
- [Sch08] Wil Schilders. “Introduction to model order reduction”. In: *Model order reduction: theory, research aspects and applications* (2008), pp. 3–32.

⚠ alert

This indicates an alert, passage is either wrong, confusing, misleading, or any other kind of high attention.

↻ revise

This indicates a revision, in general it's not wrong but explanation is poor, wording is improper, or not satisfying in general.

★ info

This is an information, it contains some side information that can be useful.

⊕ construction

This box contains information/ideas that are not yet formed into sentences, in other words this will be implemented next

1 random


- main topic: temperature models of electric machines
- goal: how to evaluate/estimate material properties/state of information if machine is running in the long run (> 20 years)
 - \Rightarrow one approach is MOR
 - especially state of duration: (non)-linear model
- idea: co-operate with Honza because matrix already given

26 2 State of the art

27 3 Why Model Order Reduction?

28 [[[Sch08, p. 8]; [Che99, p. 11]; [Ben+21, p. 2]]]

29 Real world problems are too complex to be solved analytically. In classes one deals
30 with simplifications like the projectile motions neglecting air resistance or

31  alert

!! second example needed

32 and representing electrons as point charges with no volume in space. However, if
33 one applies the underlying equations to reality things are not so easy anymore. Partial
34 differential equations (PDE) are usually the way to describe the laws of Physics. It
35 turns out that by trying to solve these equations there is only in the rarest cases an
36 algebraic expression as a solution. In all other cases equations must be solved numerically
37 and are therefore only approximations to the problem. One approach to compute
38 such approximations is using the finite element method (FEM). This computational
39 technique discretizes the domain of interest into finite cells (mesh) and with given
40 boundary conditions (BC) the field variable of the governing PDE is determined. The
41 more accurate the solution should be the more cells and more grid points that define
42 a cell are needed. Even for simple geometries the degrees of freedom (DOFs), i.e. the
43 numbers of unknown can be in orders of millions and billions. Using brute force (simply
44 adding abundant computational power with RAM and fastest processors) is not advisable
45 in terms of time and energy. Instead of dealing with the original large scale system
46 model simplifications reduces complexity. The trick here is to get rid of all superfluous
47 and unnecessary details that provide little to no contribution to the solution. This is
48 where model order reduction (MOR) got its name. The following picture gives a rough
49 explanation of this.

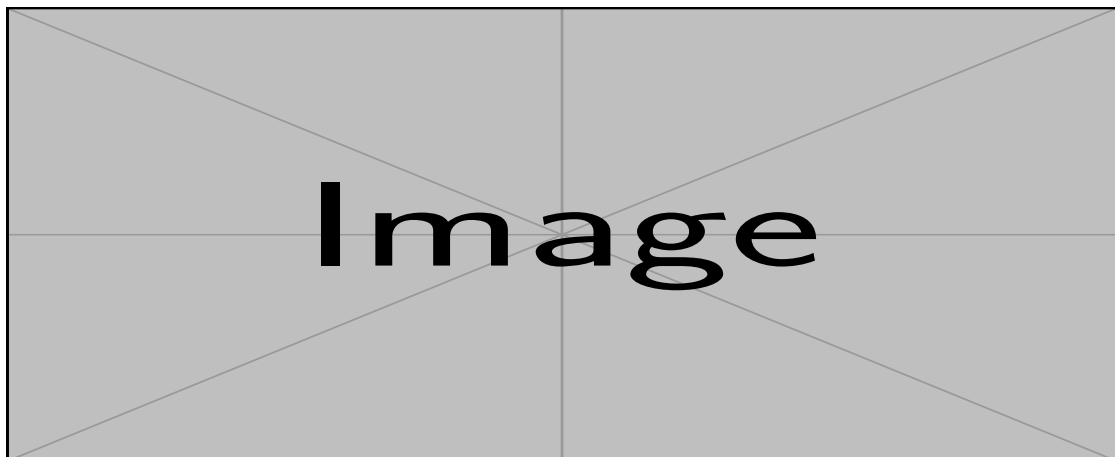



Fig. 3.1: [Ben+21, p. 2]. It seems that MOR is all about reducing the number of cells and grid points but that is not the essence. The picture is given to demonstrate what reducing complexity but still holding the basic structure looks like.

 revise

++ add more background from schilders

?? more background on FEM (examples where it is used today)

?? basic explaining equations for MWE

50

⊕ construction

++ further explanation what MOR stands for