



EXERCISE SHEET 1

Exercise 1: Singular Value Decomposition of a Picture

Background information: Data reduction is another area where model reduction is used. The most prominent example would be the MP3 format, but also .zip archives or .jpg pictures. One very important topic in model reduction of mechanical systems is the *Singular Value Decomposition* (SVD) of a matrix. Additional information regarding the properties of SVD will follow in the lecture.

In this exercise, we will use the built-in SVD of the numeric program **MATLAB** to compress a digital picture.

- (a) Install Matlab¹ and revise its usage, e.g. with a tutorial².
- (b) Use the Matlab function `imread` to load a colored image as a matrix, convert it to gray scale with `rgb2gray` and display the colorless image with `imshow`. A gray scale picture is simply a matrix with each entry representing a pixel of value 0 (black) to 255 (white).
- (c) Search for additional information regarding the SVD of a picture.
- (d) Use the Matlab function `svd` in order to make low rank approximations of the matrix representing the picture. Use the ranks 1, 10, 20, 50 and 100.
- (e) Visualize the data reduction, i.e. show all 6 pictures in one figure, and compute the compression rate $c = \frac{\text{memory consumption of compressed image}}{\text{memory consumption of original image}}$.

Exercise 2: Bring your own example!

Prepare a short presentation (max. 5 minutes) about an area where you know or think that model reduction is used or can be applied.

Notes

- The homework is due on Sunday night October 30st, 2022 at 11:59 p.m.
- You can work in groups of up to 3 students. Hand in only one solution per group via ILIAS. Please test whether your code works without errors or additional files.
- Two groups will receive an e-mail on Monday to present their solutions next Tuesday in the middle of the lecture.

¹As a student, you can obtain Matlab from TIK without cost: <http://www.stud.uni-stuttgart.de/dienste/software/matlab.html>

²<https://www.groups.ma.tum.de/fileadmin/w00ccg/algebra/people/karpfinger/MATLAB-Tutorial.pdf>