Otto von Guericke University Magdeburg
Institute for Analysis and Numerics
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Computational Methods in Systems and Control Theory

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Model Reduction of Dynamical Systems
Exercise 1

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Problem 1. *Image compression using SVD*

This is a programming exercise to understand the concept of singular value decomposition and how it can be used to compress an image. Download and save the script `computesvd.m` and the testimage `test.tif` from the course webpage https://www.mpi-magdeburg.mpg.de/3668354/mor_ss19.

(a) Try different ranks for the low-rank representation and empirically determine the rank for which the compressed image resembles the original image. Obviously, there's no unique answer to this.

(b) Check the compression in terms of memory, achieved by the SVD representation.

Problem 2. *Laplace transform*

(a) Find Laplace transform of the following functions:

(i) $f(t) = 2t^2 - 3t + 5$,
(ii) $f(t) = t^2 e^{-2t}$,
(iii) $f(t) = \sin(2t)\cos(2t)$,
(iv) $f(t) = \sin(2t) + e^{-3t}\cos(2t)$.

(b) Invert each of the following Laplace transforms:

(i) $F(s) = \frac{4}{s^5}$,
(ii) $F(s) = \frac{32}{s(s^2+16)}$.

(c) Using Laplace transform, solve the following ordinary differential equations:

(i) $\ddot{x}(t) + x(t) = t$, $x(0) = 0$, $\dot{x}(0) = 2$,
(ii) $\ddot{x}(t) + 2\dot{x}(t) + 5x(t) = 8e^{-3t}$, $x(0) = \dot{x}(0) = 0$.

Extra: Use the symbolic toolbox of MATLAB to determine Laplace transforms.