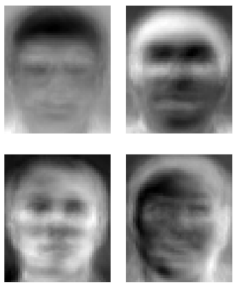
Department MATHEMATIK

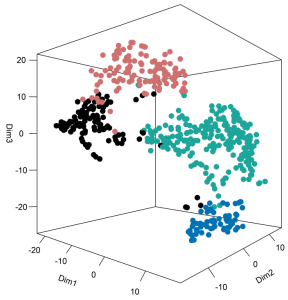
Friedrich-Alexander-Universität
Naturwissenschaftliche Fakultät

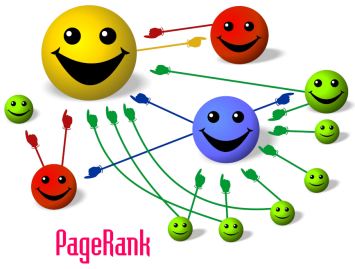
Numerical Solutions to Eigenvalue Problems: Theory and Applications

Bachelor/Master seminar in winter semester 2023/24

by Prof. Dr. Manuel Friedrich & Prof. Dr. Daniel Tenbrinck







Study courses: B.Sc./M.Sc. Data Science, B.Sc./M.Sc. Mathematik, B.Sc./M.Sc. Wirtschaftsmathematik, B.Sc. Technomathematik, M.Sc. Computational and Applied Mathematics

Requirements: English language skills, *Lineare algebra* is necessary, *Numerical analysis* is recommended.

StudOn: Bachelor seminar - `https://www.studon.fau.de/campo/course/376065`
Master seminar - `https://www.studon.fau.de/campo/course/376771`

Summary

Eigenvalue problems play an important role in many interesting applications. Some examples include:

- Segmentation of imaging data via **spectral clustering**
- Recommendation in search engines via **ranking algorithms**
- Data reduction via **principal component analysis**
- Face decompositions into features in **pattern recognition**

Due to the size of the matrices, in almost all cases it does not make sense to calculate the eigenvalues and associated eigenvectors exactly, but it is preferable to approximate them numerically. Often the matrices in the various applications also have a special shape, e.g. block diagonal shape or sparse form. Therefore, it makes sense to take these properties into account in the numerical solution and thus obtain efficient algorithms, such as:

- **(Inverse) Power methods**
- **Jacobi iterations, QR iterations**
- **Krylow subspace methods**

In this seminar we deal with the theory and application of different numerical methods for the solution of eigenvalue problems. We want to understand and discuss the existing algorithms and work out their advantages and disadvantages for certain applications.