Summary

Low-rank approximation techniques have become a key tool in scientific computing to deal with large-scale problems and high-dimensional data. This course covers state-of-the-art algorithms and current research in this area.

Content

- Theoretical background of low-rank matrix approximation
- Classical algorithms for low-rank approximation
- Randomized low-rank approximation
- Low-rank approximation by deterministic column/row selection
- Low-rank approximation by randomized sampling
- Basic introduction to tensors
- Tensor rank, CP, Tucker, and TT decompositions of tensors
- Alternating least-squares algorithms
- Optional: Riemannian optimization on low-rank matrix and tensor manifolds
- Optional: Dynamical low-rank approximation
- Applications of low-rank approximation in data analysis, model and dimensionality reduction

Keywords

numerical algorithms, linear algebra, matrix, tensor, random vectors, high dimensions, low rank

Learning Prerequisites

Required courses
Linear Algebra, Numerical Analysis

Recommended courses
Probability theory

Important concepts to start the course
Programming in Matlab, Python, Julia, or a similar language.

Learning Outcomes
By the end of the course, the student must be able to:
• Choose a suitable low-rank approximation techniques for treating a large-scale problem or high-dimensional data
• Analyze algorithms for low-rank approximation
• Prove fundamental results in low-rank approximation
• Implement low-rank approximation algorithms

Transversal skills
• Plan and carry out activities in a way which makes optimal use of available time and other resources.
• Use a work methodology appropriate to the task.
• Assess one's own level of skill acquisition, and plan their on-going learning goals.
• Demonstrate a capacity for creativity.
• Write a scientific or technical report.

Teaching methods
Lectures and exercises.

Expected student activities
Attending lectures, exercises, and doing a mini-project.

Assessment methods
Oral exam covering key concepts of the course. During the oral exam, the mini-project, which accounts for 20% of the grade, will be evaluated.

Supervision
Office hours No
Assistants Yes
Forum No

Resources
Bibliography
References to the current literature will be provided in the slides and lecture notes. Many of the linear algebra foundations of this course are contained in Horn/Johnson: Matrix Analysis, 2nd edition, CUP, 2012.

Références suggérées par la bibliothèque
• Matrix Analysis / Horn & Johnson

Notes/Handbook
Detailed slides and lecture notes will be provided as the course progresses.

Websites
• http://anchp.epfl.ch

Moodle Link
• https://go.epfl.ch/MATH-403