MATH-403

Low-rank approximation techniques

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Cursus	Sem.	Type
Computational science and Engineering	MA1, MA3	Opt.
Ing.-math	MA1, MA3	Opt.
Mathématicien	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Oral
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

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
- Subspace iteration
- 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
- Riemannian optimization on low-rank matrix and tensor manifolds

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