

MATH-403

**Low-rank approximation techniques**

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
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Remark**

pas donné en 2021-22

**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>