LINMA2380 Matrix Computations: Topic presentations

Task: The topic presentations will take place during the last three lectures of the semester. For this, you have to choose one topic per group. Below are a few propositions with a related material (to be found in "Material for topic presentations" on Moodle). Of course, you may also resort to any external resource on the subject.

You will be asked to present your topic in the form of a **15-to-20-minute mini-course** (plus 5 additional minutes for questions). Presentations shorter than **15 minutes** will be penalized. Note that each member of the group must take part in the presentation. During the presentation, it will be important to

- introduce the subject and explain why it is of interest (e.g., applications, related works, etc.);
- explain how the subject is related to linear algebra, matrix theory, and/or matrix computations;
- discuss an application;
- make a numerical example on the board.

By the day of the presentation, you are required to prepare a one-page summary of the topic, to distribute to your fellow students.

For the written summary, focus on how linear algebra and matrix theory plays a central role in the topics, and skip the technical details and involved proofs. Give a few definitions, a leading result, a nice picture showing the application in practice. It must not be exhaustive, but just help the students to remember the topic. Keep it simple, as you will be requested to re-explain one topic, sampled at random, during the exam. The summary must be sent in pdf format on the day of the presentation to Julien.

Organisation: You are required to choose a topic (different for each group) by completing the Google Sheet "Group choice for topic presentations" available at this address:
https://docs.google.com/spreadsheets/d/1aLEgO1V1QO4EJtTSW8RFyyzZQMJPWbhL7vkToD2T1PA/edit?usp=sharing.

You have to select your topic by **Friday November 10, 2023**, at the latest.

To ensure that the presentations will meet the requirements of the course, we will ask each group to present the outline of their presentation (with a draft of the slides) during a 30-minute meeting **at least two weeks** before the presentation. To schedule the meeting, please send an email to the assistant in charge of your topic: julien.calbert@uclouvain.be and guillaume.berger@uclouvain.be. Note that the quality of this predefense will be taken into account in the final grade. The meeting is also the opportunity to ask the questions you might have regarding the topic.

Good work ☺

Theory:

1. Membership problem in 2D: Membership problem in 2D.pdf.
2. Skolem's problem: webpage "Open question: effective Skolem-Mahler-Lech theorem" (available at this address: https://terrytao.wordpress.com/2007/05/25/open-question-effective-skolem-mahler-lech-theorem/).
3. Fast matrix multiplication: Fast matrix multiplication.pdf, Section 23.1.
4. The finiteness conjecture: The finiteness conjecture.pdf.
5. Max plus algebra: MaxPlusAlgebra.pdf.
6. Kruskal tensor decomposition theorem Tensor-Based Methods.pdf.

Machine learning and artificial intelligence:

1. Nonnegative factorization: Nonnegative matrix factorization.pdf, except Sections 3.1–3.2.
2. Principal component analysis (PCA): Principal component analysis.pdf.
3. Matrix completion: Matrix completion.pdf, only Sections 1, 7.
4. Total least squares: Total least squares.pdf.
5. Spectral clustering: Spectral clustering.pdf.
6. Gaussian Processes: Advanced Lectures on Machine Learning.pdf, only Chapter 4: "Gaussian Processes in Machine Learning".
7. Gaussian Mixtures: Understanding Machine Learning - From Theory to Algorithms.pdf, only Chapter 24.4.

Other applications:

1. JSR for consensus: JSR for consensus.pdf.
2. Leontief input-output model: Leontief input-output model.pdf.
3. Trackable graphs: Trackable graphs.pdf.
4. Capacity of codes: Capacity of codes.pdf.
5. Perfect matching in graphs: Perfect matching in graphs.pdf, skip Section 4.
6. Polynomial matrices in control: Polynomial matrices in control.pdf.