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 (same groups as for the homeworks). 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 a 15-minute presentation. During the presentation, it will be important to first introduce the subject and explain why it is of interest (e.g., applications, related works, etc.). Also explain how the subject is related to linear algebra, matrix theory, and/or matrix computations. 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 presentation and 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.

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/1mdPO9ZYU7rohkatOT8RRhHWGXGadYO5ZHrmRSjuMAGc/edit?usp=sharing`.

You have to select your topic by Wednesday November 11, 2020, at the latest. The schedule for the presentations will be communicated after November 11.

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 or suggestion of the slides) during a 30-minute meeting at least one week before the presentation. To schedule the meeting, please send an email to zheming.wang@uclouvain.be, julien.calbert@uclouvain.be and guillaume.berger@uclouvain.be at least two weeks before the presentation. 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.

Machine learning and artificial intelligence:

5. Nonnegative factorization: Nonnegative matrix factorization.pdf, except Sections 3.1–3.2.

6. Spectral clustering: Spectral clustering.pdf.

7. Principal component analysis (PCA): Principal component analysis 1.pdf. You may also find Principal component analysis 2.pdf useful.

8. Matrix completion: Matrix completion.pdf, only Sections 1, 7.

9. Total least squares: Total least squares.pdf.

10. Regularized and constrained least squares: Regularized least squares.pdf.

11. Complexity and stability of the QR decomposition and least square problems: Section 5.2 of QR decomposition.pdf and Section 3.4 of the lecture notes of the course.

Other applications:

12. JSR for consensus: JSR for consensus.pdf.

13. Fast fourier transform: Fast Fourier transform.pdf and Section 7.2 of the lecture notes (in French).

14. Leontief input-output model: Leontief input-output model.pdf.

15. Trackable graphs: Trackable graphs.pdf.

16. Capacity of codes: Capacity of codes.pdf.

17. Perfect matching in graphs: Perfect matching in graphs.pdf, skip Section 4.

18. Polynomial matrices in control: Polynomial matrices in control.pdf.