Algebra

Bioinformatics Bachelor's Degree

Departament de Matemàtiques

Learning plan

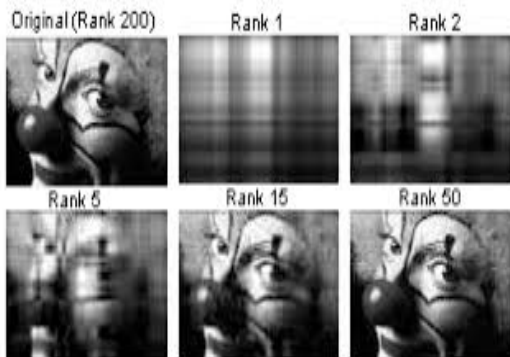Atenea: link to official syllabus and learning plan
Contents:

1. Matrices and linear systems
2. Vectors and coordinates
3. Linear maps
4. Eigenvalues and eigenvetors
5. Discrete linear dynamical systems applied to biology
6. Orthogonality

Assessment

- ▶ Maximum among:
  - ▶ Final Exam;
  - ▶ 60% Final Examen + 30% Mid Term Examen + 10%Python;
  - ▶ 90% Final Exam+ 10%Python where Python is the average grade of:
    - ▶ Python exam (December, week 9-13)
    - ▶ Python Delivery (December 20th)
- ▶ If fail, extraordinary grade will be: 90% Extra Exam+ 10%Python
- ▶ Exam dates and classrooms at: webpage
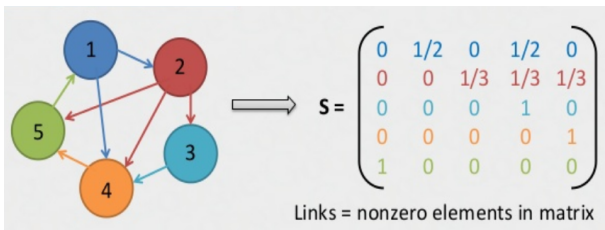 Mid term: Nov 7; Final Exam: January 13

Applications

▶ Data in matrix form: image compression with SVD

Applications

- Google Ranking (pagerank)

$$S = \begin{pmatrix} 0 & 1/2 & 0 & 1/2 & 0 \\ 0 & 0 & 1/3 & 1/3 & 1/3 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Links = nonzero elements in matrix

Applications

▶ Epidemics propagation: COVID-19, march 2020

$$\begin{pmatrix} S_{n+1} \\ E_{n+1} \\ I_{n+1} \\ R_{n+1} \end{pmatrix} = \begin{pmatrix} 1 & 0 & -\beta & 0 \\ 0 & 0.5 & \beta & 0 \\ 0 & 0.5 & 0.8 & 0 \\ 0 & 0 & 0.2 & 1 \end{pmatrix} \begin{pmatrix} S_n \\ E_n \\ I_n \\ R_n \end{pmatrix}$$

on

  ▶ S_n: ♯ susceptible individuals at day n
  ▶ E_n: ♯ exposed individuals at day n (infected but not infectious)
  ▶ I_n: ♯ infected individuals at day n
  ▶ R_n: ♯ recovered (and removed) individuals at day n

▶ Questions: How many people will be infected after a week? How does the the transmission rate β affect? Will distance measures be useful?

▶ Simple model (lineal SEIR model) but works in short term.

"All models are wrong but some are useful", George Box, 1976.

References

▶ Poole, D. Algebra lineal, una introducción moderna (3a ed.), Brooks/Cole, 2013.

▶ Friedberg, S., Insel, A., Spence, L. Linear Algebra (2nd edition). Prentice Hall, 1989. Chapter 3.

▶ Sauro, H. M. Systems biology: Linear Algebra for Pathway modeling, Ambrosius Publishing and Future skill software, 2014.