San José State University

Math 253: Mathematical Methods for Data Visualization

Lecture 2: Matrix Computing in MATLAB

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Outline

- **Focus of this lecture**: Vector and matrix operations in MATLAB

- **Learning resources**:

    - Language fundamentals[1]

    - Matrices and arrays[2]

    - Linear algebra[3]

- **HW2** (programming): due 2/11 in class

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[1]https://www.mathworks.com/help/matlab/language-fundamentals.html
[2]https://www.mathworks.com/help/matlab/matrices-and-arrays.html
[3]https://www.mathworks.com/help/matlab/linear-algebra.html

What is MATLAB?

MATLAB is an abbreviation for "matrix laboratory."

Linear algebra functions and matrix operations in MATLAB are built on LAPACK (Linear Algebra Package),[4] which is a large Fortran library of routines that provides fast, robust algorithms for numerical linear algebra and matrix computations.

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[4]`http://www.netlib.org/lapack/`
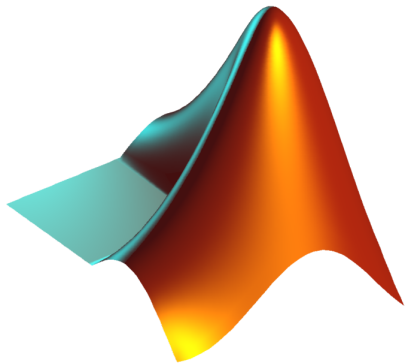
Why MATLAB?

- Efficient and specially designed for linear algebra operations

- High quality and powerful data plotting

- Simple, flexible, easy to use

- Very thorough documentation with examples

- The dimension reduction algorithms were all originally implemented in MATLAB

My strategies for teaching MATLAB as a tool of this course

- Focus on what is truly needed by this course (i.e., linear algebra operations, and later data plotting)

- Example-based

- Emphasize on good practices in MATLAB programming (through my experience)

    - simplicity

    - efficiency

    - clarity

In-class demonstrations

See sample scripts from instructor

Storing data as matrices

The following data objects can all be conveniently represented as matrices:

- Linear systems of equations

- Data sets in Euclidean spaces

- Digital images and their collections

- Text corpus (collections of text documents)

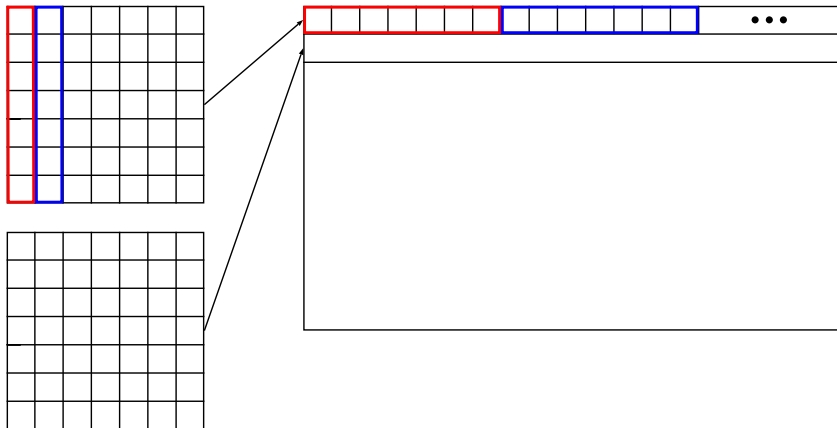- Graph/network data

- Markov chains

Linear systems as matrices

$$\begin{cases} 2x_1 - x_2 + 5x_3 & = 0 \\ x_1 - 2x_2 + 4x_3 & = -1 \\ 3x_1 + 0x_2 + 6x_3 & = 1 \end{cases} \quad \longrightarrow \quad \begin{bmatrix} 2 & -1 & 5 & 0 \\ 1 & -2 & 4 & -1 \\ 3 & 0 & 6 & 1 \end{bmatrix}$$
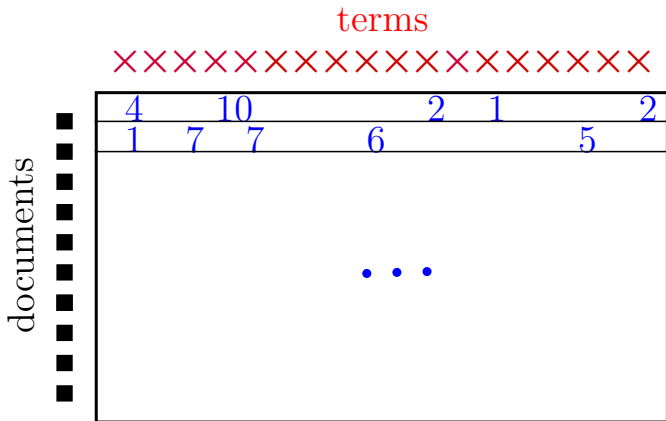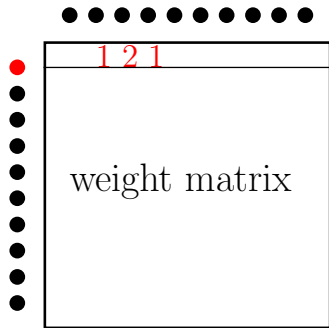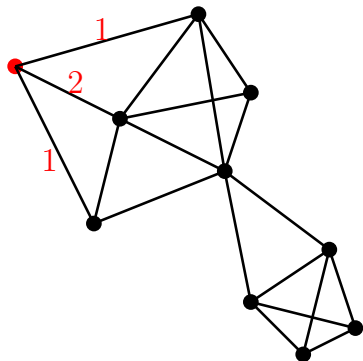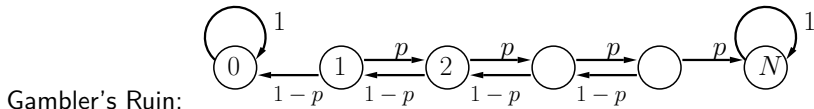
Data sets as matrices
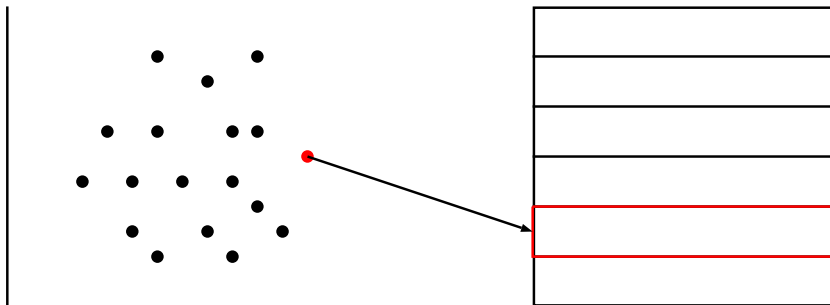
Digital images as matrices

Collections of documents as matrices

Network (graph) data as matrices

Transition probabilities of a Markov chain as matrices

Gambler's Ruin:

$$N = 5: \qquad \mathbf{P} = \begin{pmatrix} 1 & & & & & \\ p & 0 & 1-p & & & \\ & p & 0 & 1-p & & \\ & & p & 0 & 1-p & \\ & & & p & 0 & 1-p \\ & & & & & 1 \end{pmatrix}$$

HW2 assigned (see Canvas)

Due: 2/11, Tuesday, in class.