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Exercise
Scientific programming in mathematics

Series 1

Exercise 1.1. Complete the MATLAB on ramp introductory course under Matlab introduction. Please hand in the certificate together with the solutions of the remaining exercises.

Exercise 1.2. Let $A \in \mathbb{R}^{m_A \times n_A}$ and $B \in \mathbb{R}^{m_B \times n_B}$ be given matrices. Write a MATLAB script which generates a block diagonal matrix C of the following form.

$$C = \begin{pmatrix} A & 0 \\ 0 & B \end{pmatrix}$$

Here, the 0-entries are 0-matrices of appropriate dimension. Avoid loops! Instead, use matrix functions and matrix indexing!

Exercise 1.3. Write a MATLAB function which returns for $n \in \mathbb{N}$ the chessboard-matrix $B \in \mathbb{N}^{n \times n \times n}$ with

$$B_{jk} = \begin{cases} 0 & \text{if } j+k \text{ even} \\ 1 & \text{if } j+k \text{ odd} \end{cases}$$

Avoid loops! Instead, use matrix functions and matrix indexing!

Exercise 1.4. Write a MATLAB function which determines the maximum of a vector $x \in \mathbb{R}^n$ and how often the maximum appears in x. The result has to be displayed. Avoid loops! Instead, use matrix functions and matrix indexing!

Exercise 1.5. Write a MATLAB script which displays for a given vector $x \in \mathbb{C}^N$ and a given bound $C > 0$ the trimmed vector $y \in \mathbb{C}^n$ where all entries x_j with $|x_j| > C$ are cut out of x. For example, for $x = (1, 6, 5, -7, 3, 2) \in \mathbb{C}^6$ and $C = 5$ the trimmed vector is $y = (1, 5, 3, 2) \in \mathbb{C}^4$. Avoid loops! Instead, use matrix functions and matrix indexing!

Exercise 1.6. Write a MATLAB function which calculates and returns for a vector $x \in \mathbb{C}^n$ and some $1 \le p < \infty$ the ℓ_p-norm

$$\|x\|_p := \Big(\sum_{j=1}^{n} |x_j|^p \Big)^{1/p}.$$

Avoid loops and use appropriate vector functions and arithmetics instead.

Exercise 1.7. Write a MATLAB function which calculates and returns for a vector $A \in \mathbb{C}^{m \times n}$ the row-sum norm

$$\|A\| := \max_{j=1,\dots,m} \sum_{k=1}^{n} |A_{jk}|.$$

Avoid loops and use appropriate vector functions and arithmetics instead.

Exercise 1.8. Let $p(x) = \sum_{j=0}^{n} a_j x^j$ be a polynomial with coefficient vector $a \in \mathbb{C}^{n+1}$. Write a MATLAB function which takes a and returns the coefficient vector of the derivative p'. Avoid loops and use appropriate vector functions and arithmetics instead. Your function should work for column and row vectors a and should always return a column vector; see, e.g., `help reshape`. Think about how you can test your code! What are suitable test-examples?