Tárgytematika / Course Description
Numerical linear algebra

GKNM_MSTA036

Tárgyfelelős neve / Teacher's name: dr. Gáspár Csaba
Félév / Semester: 2023/24/1
Beszámolási forma / Assesment: Vizsga
Tárgy heti óraszáma / Teaching hours(week): 2/2/0
Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

The main goal of the course is to outline the solution techniques for linear systems of equations, eigenvalue problems and matrix decompositions with special focus on the linear algebra needed for data science and numerical methods for differential equations.

TANTÁRGY TARTALMA / DESCRIPTION

Week 1: Challenges and solution techniques: image compression, scattered data interpolation, potential problems – an overview.

Week 2: Vector norms, inner product. Matrices, operations with matrices. Finite dimensional linear operators and matrices. Projections.

Week 3: Eigenvalues, eigenvectors. Self-adjoint matrices, positive, negative definite matrices.

Week 4: Matrix norms. Linear systems of equations. Perturbed systems, condition number. Overdetermined systems.

Week 5: Direct methods for solving linear systems of equations. Gaussian elimination. Gauss-Jordan elimination. Singular systems. Matrix inversion by elimination. Fast solution of tridiagonal systems.

Week 6: Matrix decompositions. The LU and Cholesky factorization. The QR-factorization.

Week 7: The Singular Value Decomposition, overview. Partial SVD. Generalized inverse.

Week 8: Iterative methods. Fixed point iteration, Richardson iteration, Jacobi and Seidel iterations.

Week 9: Iterative methods. Variational methods. The gradient and the conjugate gradient method. Krylov subspace methods.

Week 10: The method of least squares. Direct solution, iterative techniques.

Week 11: Calculation of eigenvalues. The power iteration and the inverse iteration. The Cholesky method for calculating the complete eigenvalue system of selfadjoint, positive definite matrices.

Week 12: An excellent tool: the Discrete and Fast Fourier Transform. Application to image compression.

Week 13: An important and difficult problem. Scattered data interpolation. The method of radial basis functions. Applications.

Week 14: Further applications.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

A classroom test is necessary during the semester.

The semester ends with a written exam (evaluated by 5 marks).

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

C. Gáspár: Numerical Linear Algebra. Lecture notes (electronic), Széchenyi István University, 2020.

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL

W. Layton, M. Sussman: Numerical Linear Algebra http://people.sc.fsu.edu/~jburkardt/classes/nla_2015/numerical_linear_algebra.pdf

The SciPy Linear Algebra Toolbox, https://docs.scipy.org/doc/scipy/reference/linalg.html

Volker Mehrmann: Numerical Linear Algebra. http://www.hamilton.ie/ollie/Downloads/NLA10.pdf

Kerstin Hesse: Numerical Linear Algebra. http://www.hesse-kerstin.de/NLA_Lecture_Notes.pdf