

UČNI NAČRT PREDMETA / COURSE SYLLABUS						
Predmet:		Iterativne numerične metode v linearni algebri				
Course title:		Iterative numerical methods in linear algebra				
Študijski program in stopnja Study programme and level		Študijska smer Study field		Letnik Academic year	Semester Semester	
Magistrski študijski program Matematika		ni smeri		1 ali 2	prvi ali drugi	
Master's study programme Mathematics		none		1 or 2	first or second	
Vrsta predmeta / Course type				izbirni		
Univerzitetna koda predmeta / University course code:				M2410		
Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15	30			105	6
Nosilec predmeta / Lecturer:		prof. Bor Plestenjak				
Jeziki / Languages:	Predavanja / Lectures:	slovenski/Slovene, angleški/English				
	Vaje / Tutorial:	slovenski/Slovene, angleški/English				
Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:				Prerequisites:		
Vsebina:				Content (Syllabus outline):		

<p>Kadar imamo opravka z velikimi razpršenimi matrikami, se moramo numeričnega reševanja linearnega sistema in problema lastnih vrednosti lotiti drugače kot z direktnimi metodami (na primer Gaussova eliminacija oziroma QR metoda), saj nam sicer zmanjka spomina ali pa računanje poteka prepočasi.</p> <p>Iterativne metode za linearni sistem. Jacobijeva, Gauss-Seidlova in SOR metoda. Simetrična SOR metoda s pospešitvijo Čebiševa. Podprostor Krilova. Lanczosev in Arnoldijev algoritem, GMRES, MINRES in sorodne metode. Metoda konjugiranih gradientov. Bi-konjugirani gradienti. Predpogojevanje.</p> <p>Nelinearni sistemi. Newton-GMRES, Broydova metoda. GMRES za najmanjše kvadrate.</p> <p>Iterativne metode za problem lastnih vrednosti. Rayleigh-Ritzeva metoda, Metode podprostorov Krilova, Jacobi-Davidsonova metoda. Posplošeni problem lastnih vrednosti, polinomski problem lastnih vrednosti.</p>	<p>In case of large sparse matrices we can not apply direct methods (e.g., Gaussian elimination or QR algorithm) to solve a linear system or compute the eigenvalues, as we run out of time or memory.</p> <p>Iterative methods for linear systems. Jacobi, Gauss-Seidel and SOR method. Symmetric SOR with Chebyshev acceleration. Krylov subspace. Lanczos and Arnoldi algorithm, GMRES, MINRES and similar methods. Conjugate gradients. Bi-conjugate gradients. Preconditioning.</p> <p>Nonlinear systems. Newton-GMRES, Broyden's method, GMRES for least squares.</p> <p>Iterative methods for eigenvalue problems. Rayleigh-Ritz method, methods based on Krylov subspaces, Jacobi-Davidson method. Generalized eigenvalue problem, polynomial eigenvalue problem.</p>
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Temeljni literatura in viri / Readings:

J. W. Demmel: Uporabna numerična linearna algebra, DMFA-založništvo, Ljubljana, 2000.

R. Barrett, M. W. Berry, T. F. Chan, J. Demmel, J. Donato, J. Dongarra, V. Eijkhout, R. Pozo, C. Romine, H. van der Vorst: Templates for the Solution of Linear Systems : Building Blocks for Iterative Methods, SIAM, Philadelphia, 1994.

Z. Bai, J. Demmel, J. Dongarra, A. Ruhe, H. van der Vorst: Templates for the Solution of Algebraic Eigenvalue Problems : A Practical Guide, SIAM, Philadelphia, 2000.

G. H. Golub, C. F. Van Loan: Matrix Computations, 3rd edition, Johns Hopkins Univ. Press, Baltimore, 1996.

C. T. Kelley: Iterative Methods for Linear and Nonlinear Equations, SIAM, Philadelphia, 1995.

H. van der Vorst: Iterative Krylov methods for large linear systems, Cambridge University Press, Cambridge, 2003.

Y. Saad: Iterative methods for sparse linear systems. Second edition, SIAM, Philadelphia, 2011.

Cilji in kompetence:

Slušatelj spozna iterativne numerične metode za reševanje linearnih sistemov in problemov lastnih vrednosti, ki se jih uporablja pri razpršenih matrikah. Dopolni vsebine, ki jih sreča pri Uvodu v numerične metode in Numerični linearni algebri. Pridobljeno znanje praktično utrdi z domačimi nalogami in reševanjem problemov s pomočjo računalnika.

Objectives and competences:

Students learn iterative numerical methods for linear systems and eigenvalue problems where matrices are sparse. New knowledge complements the content of courses Numerical linear algebra and Introduction to numerical methods. The acquired knowledge is consolidated by homework assignments and solving problems using computer programs.

Predvideni študijski rezultati:

Znanje in razumevanje: Razumevanje osnovnih numeričnih algoritmov za razpršene matrike. Obvladanje numeričnega reševanja problemov z velikimi matrikami. Sposobnost izbire najprimernejšega algoritma glede na lastnosti matrike. Znanje programiranja in uporabe Matlaba oziroma drugih sorodnih orodij za reševanje tovrstnih problemov.

Uporaba: Ekonomično in natančno numerično reševanje linearnih sistemov oziroma lastnih problemov z razpršenimi matrikami.

Refleksija: Razumevanje teorije na podlagi uporabe.

Prenosljive spretnosti – niso vezane le na en predmet: Spretnost uporabe računalnika pri reševanju matematičnih problemov. Razumevanje razlik med eksaktnim in numeričnim računanjem. Predmet konstruktivno nadgrajuje zahtevnejša znanja linearne algebre.

Intended learning outcomes:

Knowledge and understanding: Understanding of basic numerical algorithms for sparse matrices. Being able to numerically solve problems with large sparse matrices. The ability to choose an appropriate algorithm based on matrix properties. Knowledge of computer programming package Matlab or other similar software for solving such problems.

Application: Economical and accurate numerical computation of linear systems or eigenvalue problems with sparse matrices.

Reflection: Understanding of the theory from the applications.

Transferable skills: The ability to solve mathematical problems using a computer. Understanding the differences between the exact and the numerical computation. The subject enriches constructively the knowledge of linear algebra.

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Metode poučevanja in učenja:

predavanja, vaje, domače naloge, konzultacije, projekti

Learning and teaching methods:

Lectures, exercises, homeworks, consultations, projects

Delež (v %) /

Weight (in %)

Načini ocenjevanja:**Assessment:**

Način (domače naloge, pisni izpit, ustno izpraševanje, naloge, projekt): domače naloge ali projekt		Type (homeworks, examination, oral, coursework, project): homeworks or project
pisni izpit		written exam
ustni izpit	20%	oral exam
Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	40%	Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)
	40%	

Reference nosilca / Lecturer's references:

Bor Plestenjak:

- HOCHSTENBACH, Michiel E., KOŠIR, Tomaž, PLESTENJAK, Bor. A Jacobi-Davidson type method for the two-parameter eigenvalue problem. SIAM journal on matrix analysis and applications, ISSN 0895-4798, 2005, vol. 26, no. 2, str. 477-497 [COBISS.SI-ID 13613401]
- MUHIČ, Andrej, PLESTENJAK, Bor. On the quadratic two-parameter eigenvalue problem and its linearization. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2010, vol. 432, iss. 10, str. 2529-2542 [COBISS.SI-ID 15469913]
- HOCHSTENBACH, Michiel E., MUHIČ, Andrej, PLESTENJAK, Bor. On linearizations of the quadratic two-parameter eigenvalue problem. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2012, vol. 436, iss. 8, str. 2725-2743 [COBISS.SI-ID 16095065]